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National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Department of Theoretical and Applied Economics

Organisation of production: lectures

Recommended by the Methodological Council of Igor Sikorsky Kyiv Polytechnic Institute, as a manual for foreign students of "Bachelor" educational degree specialty 051 "Economics" "International Economics" specialization

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Electronic online educational textbook

International trade: coursework

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The textbook covers the basics of organizing production activities. The production system and its components are considered in detail. Features of placement of production systems in space are revealed. The process of organizing the production of new products is analysed. Labour productivity and its influence on production activity are considered. The issues of planning and control of production activities are revealed.

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Т.В. Павленко, Є.А. Удовицька,

ОРГАНІЗАЦІЯ ВИРОБНИЦТВА:
КОНСПЕКТ ЛЕКЦІЙ

Рекомендовано Методичною радою КПІ ім. Ігоря Сікорського
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ОРГАНІЗАЦІЯ ВИРОБНИЦТВА:
конспект лекцій

Навчальний посібник: Конспект лекцій з навчальної дисципліни «**Організація виробництва**» [Електронний ресурс] : навч. посіб. для студ. спеціальності 051 «Економіка», спеціалізації «Міжнародна економіка»
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У навчальному посібнику висвітлені основи організації виробничої діяльності. Детально розглядається виробнича система та її складові. Розкриваються особливості розміщення виробничих систем у просторі. Аналізується процес організації виробництва нової продукції. Розглянуто продуктивність праці та її вплив на виробничу діяльність. Розкрито питання планування та контролю виробничої діяльності.

Content

Introduction

Organisation of production is about the transformation of production and operational inputs into outputs, that when distributed, meet the needs of customers.

Chapter 1 THE THEORETICAL BASIS OF PRODUCTION

Unit1 Definitions of Production

Production is the process of making or manufacturing goods and products from raw materials or components.

According to Bates and Parkinson:

"Production is the organised activity of transforming resources into finished products in the form of goods and services; the objective of production is to satisfy the demand for such transformed resources".

In other words, production takes inputs and uses them to create an output which is fit for consumption – a good or product which has value to an end-user or customer.

Since the purpose of any economic activity is the satisfaction of human wants, any activity which helps to satisfy wants is defined as production. In order to survive man must consume; in order to consume he must produce.

The forms of production:

- Extraction and cultivation – obtaining products from nature or using natural resources to grow. Example: chicken, tomatoes, and broccoli
- Processing – changing and improving the form of another product. Example: honey, mango, and soil
- Manufacturing – combining raw materials and processed goods into finished products. Example: cosmetics, china, and shoes

Three Types of Production:

1. Primary Production:

Primary production is carried out by 'extractive' industries like agriculture, forestry, fishing, mining and oil extraction. These industries are engaged in such activities as extracting the gifts of Nature from the earth's surface, from beneath the earth's surface and from the oceans.

2. Secondary Production:

This includes production in manufacturing industry, viz., turning out semi-finished and finished goods from raw materials and intermediate goods—conversion of flour into bread or iron ore into finished steel. They are generally described as manufacturing and construction industries, such as the manufacture of cars, furnishing, clothing and chemicals, as also engineering and building.

3. Tertiary Production:

Industries in the tertiary sector produce all those services which enable the finished goods to be put in the hands of consumers. In fact, these services are supplied to the firms in all types of industry and directly to consumers. Examples cover distributive traders, banking, insurance, transport and communications. Government services, such as law, administration, education, health and defence, are also included.

Unit 2 Factors of production

Factors of production are the inputs available to supply goods and services in an economy

Fig. 1. Factors of production

Land

Land includes all **natural physical resources** – e.g. fertile farm land, the benefits from a temperate climate or the harnessing of wind power and solar power and other forms of **renewable energy**

Some nations are richly endowed with natural resources and then specialise in their extraction and production – for example – the high productivity of the vast expanse of farm land in the United States and the oil sands in Alberta, Canada. Other countries such as Japan are heavily reliant on importing these resources

Labour

Labour is the **human input** into production e.g. the supply of workers available and their productivity

An increase in the size and the quality of the labour force is vital if a country wants to achieve **growth**. In recent years the issue of the **migration of labour** has become important. Can migrant workers help to solve labour shortages? What are the long-term effects on the countries who suffer a drain or loss of workers through migration?

Capital

Capital goods are used to produce other consumer goods and services in the future

Fixed capital includes machinery, equipment, new technology, factories and other buildings

Working capital means **stocks** of finished and semi-finished goods (or components) that will be either consumed in the near future or will be made into consumer goods. New items of capital machinery, buildings or technology are used to boost the **productivity** of labour. For example, improved technology in farming has vastly increased productivity and allowed millions of people to move from working on the land into more valuable jobs in other industries.

Types of capital

Table 1

Fixed capital	Working capital
Investing capital in the long-term assets of an enterprise.	Working capital is the capital invested in the current assets of an enterprise.
Used to acquire non-current assets for the company	Used to acquire current assets for the company
Fixed capital is less liquid	Working capital is highly liquid
Serves strategy - oriented objectives	Serves operational objectives

Entrepreneurship

Regarded by some as a specialised form of labour input An **entrepreneur** is an individual who supplies products to a market to make a profit

Entrepreneurs will usually invest their own **financial capital** in a business and take on the risks. Their main reward is the **profit** made from running the business.

The total materials cycle

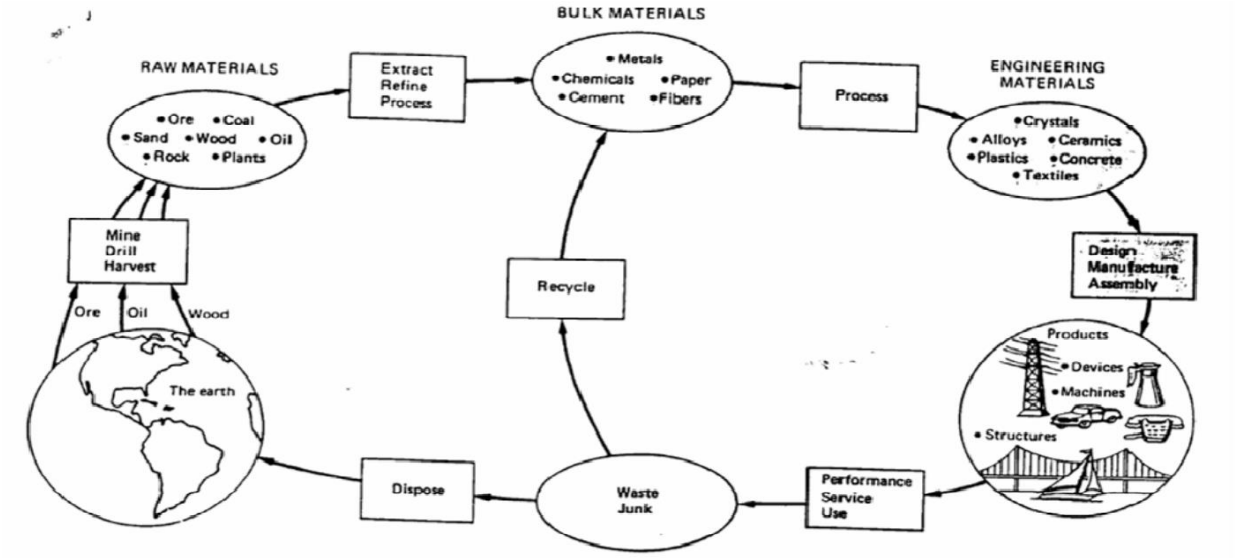

Fig. 2 The total materials cycle

(reproduce from “Materials and man’s needs” National Academy of Science, Washington D.C.)

Unit 3 Production in Economy

Any activity connected with money earning and money-spending is called an economic activity. Production is an important economic activity. It results in the output (creation) of an enormous variety of economic goods and services.

In fact, consumption needs determine production plans, and the actual production satisfies those original consumption needs.

The economic law of growth of needs

The economic law of growth of needs reflects the relationship between production and consumption, needs and existing opportunities to meet them. The continuous

development of needs is the driving force of economic and spiritual progress of mankind, which in turn stimulates the emergence of new and new needs.

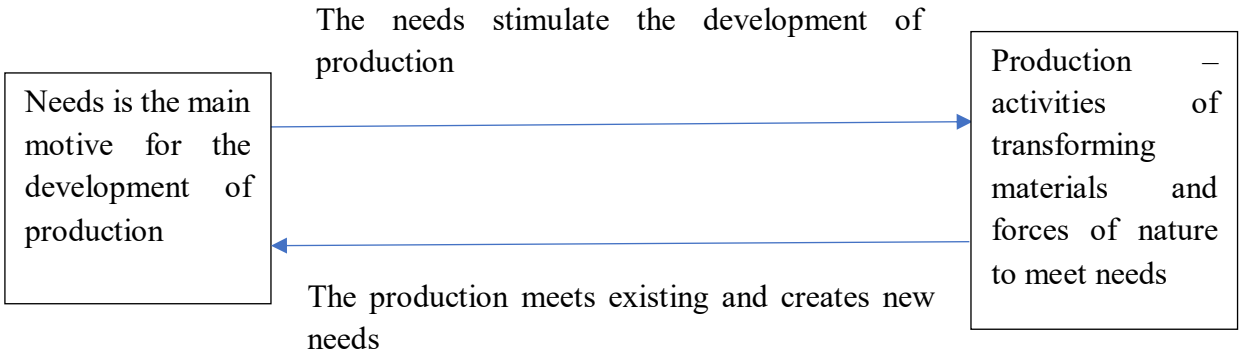

Fig.3 The connection between needs and production

There are three aspects (components) of the production process, viz., inputs (or factors of production), output (saleable goods having utility or want-satisfying capacity) and technology (the art or method of production). Services are also considered as being produced. Inputs are the beginning of the production process and output is the end of the process. Technology lies at the intermediate stage of the whole process.

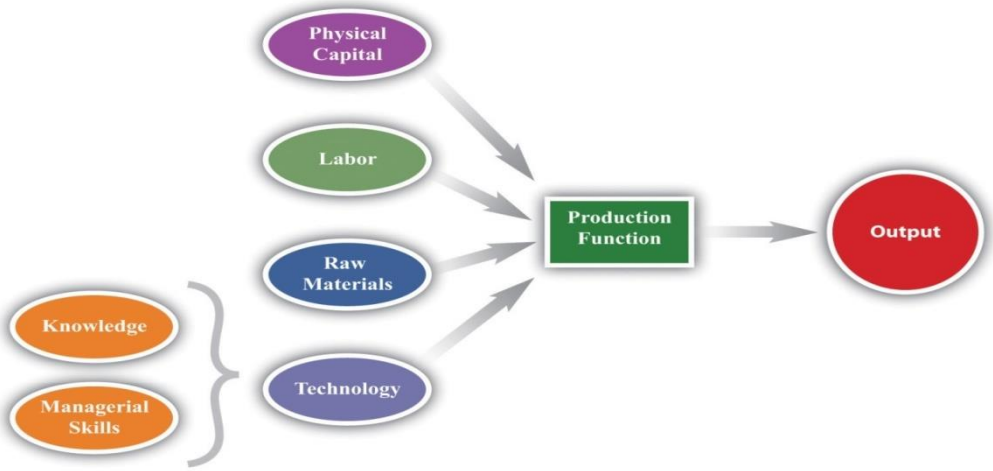

Fig. 4. The production process

The producing unit is either the agricultural farm or the (industrial) factory. Business firms are important components (units) of the economic system. They are artificial entities created by individuals for the purpose of organising and facilitating production. It is a technical unit in which inputs are converted into output.

The essential characteristics of the business firm is that it purchases factors of production such as land, labour, capital, intermediate goods, and raw material from

households and other business firms and transforms those resources into different goods or services which it sells to its customers, other business firms and various units of the government as also to foreign countries.

In short, production, in economics, is taken to include the production of both goods and services. Since people pay for the services (of doctors, teachers, lawyers, accountants, athletes, etc.) the term ‘production’ is to be used in broad sense to include both commodities and services. In the language of G. F. Stanlake, “Production must be understood therefore as comprising all those activities which provide the goods and services which people want and for which they are prepared to pay a price.”

Commodities are not actually created; production is basically concerned with changing the form of things, changing raw materials into finished articles, changing substances by chemical action, assembling many small parts to make (say) a watch or a motor car etc.

Since the economist does not regard the process of production as complete until a commodity has reached the person who wishes to make use of it, production includes the commercial services of distribution — transport, whole-selling, retailing, etc. and the holding of stocks of things (i.e., inventories) in warehouses until they are required.

Chapter 2 PRODUCTION SYSTEM

Unit 4 Production system: The Heart of an Organisation

The production system of an organisation is that part, which produces products of an organisation. It is that activity whereby resources, flowing within a defined system, are combined and transformed in a controlled manner to add value in accordance with the policies communicated by management.

A production organisation is another name for a business commonly referred to as a manufacturer. This type of company engages in business activities related to the production of products and equipment. As opposed to resale organisations, production firms earn revenue and profit from the design and development of high-quality products.

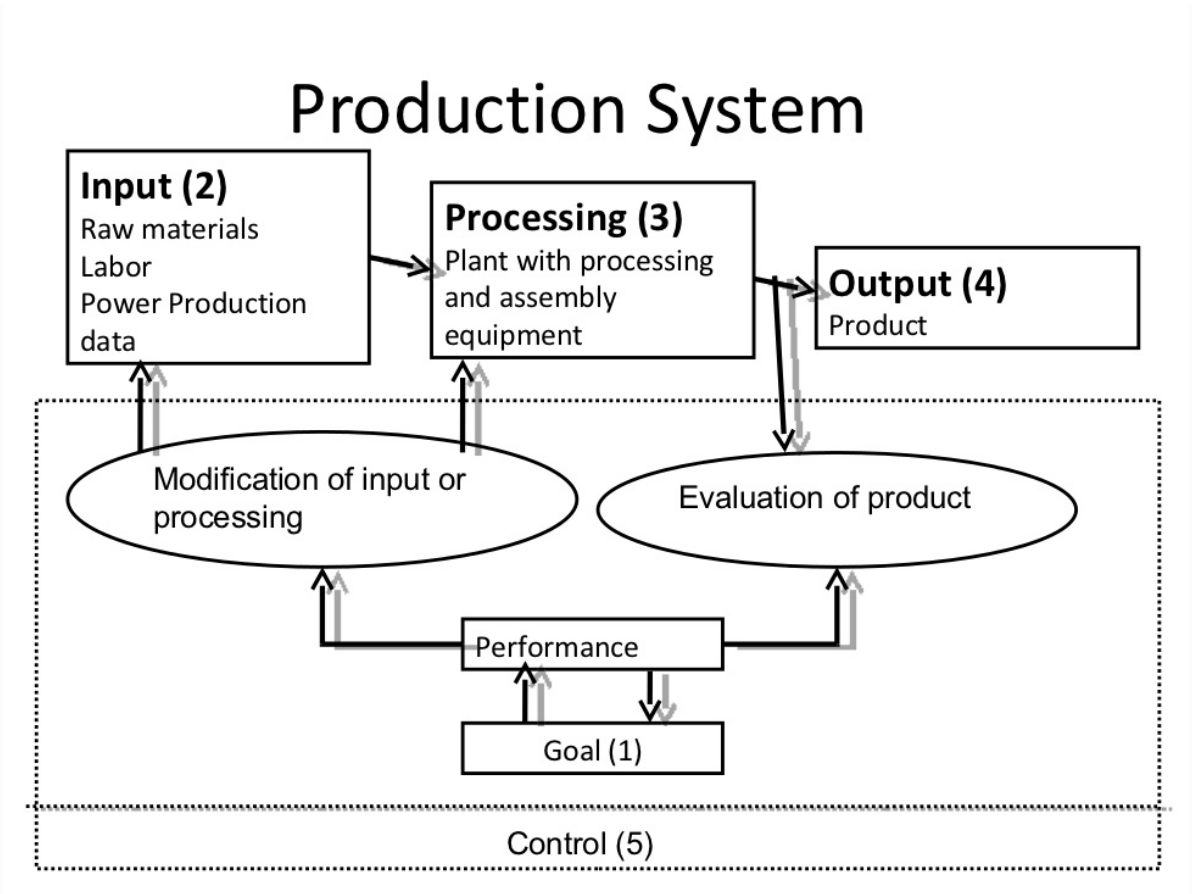

Fig.5 The production system

Production systems are a special class of systems that combine workers, tools and objects of labour and other elements that are necessary for the functioning of the system in the process of which products or services are created.

The elements of the production system are people and material objects - labour, tools, objects and products of labour, as well as technology, organisation of production.

The theory of production lies at the heart of managerial economics. It forms the foundation for the theory of supply, which, is one of the basic concepts in the determination of prices. Furthermore, production decisions are an important part of managerial decision making.

Managers are required to make four different but interrelated production decisions:

(1) Whether or not to actually produce or to shut down;
(2) How much to produce;
(3) What input combination to use and
(4) What type of technology to use.

The production system has the following characteristics:

- Production is an organized activity, so every production system has an objective.
- The system transforms the various inputs to useful outputs.
- It does not operate in isolation from the other organisation system.
- There exists a feedback about the activities, which is essential to control and improve system performance.

The structure of the production system is formed on a **technological** or **functional principle**. It consists of **main and auxiliary elements**. The main elements include technological equipment and facilities that are designed for direct processing or assembly of objects of labour (machines, machine complexes, conveyors, tools, devices, accessories, etc.).

The production system, along with technological (material) contains **social elements** - workers who use the means of labour and manage them in the manufacture of products. The set of groups of people of a certain professional composition, who interact in a coordinated manner in the process of performing predetermined functions on technological equipment to achieve this goal, is the **social structure of the production system**. Thus, social and material elements formally act as an integral part of the production system. The existence of material and social structures is due to the division of labour within the production system. Therefore, the structure of the elements must meet its general objectives and constantly adapt to them, because each element and subsystem as relatively separate parts perform clearly defined tasks.

The structure of the production system is determined by the composition and relationships of its elements and subsystems, as well as relationships with the external environment. There are **spatial** (location of system elements in space) and **temporal** (sequence of changes over time the state of the elements and the system as a whole) structure of production systems. They are closely interconnected and interdependent.

When viewed as a process, a production system may be further characterized by flows (channels of movement) in the process: both the physical flow of materials, work in the intermediate stages of manufacture (work in process), and finished goods; and the flow of information and the inevitable paperwork that carry and accompany the physical flow. The physical flows are subject to the constraints of the capacity of the production system, which also limits the system's ability to meet output expectations. Similarly, the capacity of the information-handling channel of the production system may also be an important measure of a system's output. The management of information flows, or the planning and control of the system to achieve acceptable outputs, is an important task of the production manager.

The production system can be seen as consisting of three elements – inputs, the production process and outputs. In reality, the outputs are the starting point of the operation inasmuch as they must be considered in the light of the market possibilities.

Unit 5 Production processes

Production processes are carried out in the production system. Their basis and defining part are **technological processes**, during which the worker with the help of tools affects the objects of labour and turns them into a product of labour - finished products.

The production process is a way, method, and technique to create or add to the usefulness of a product by optimizing the existing production resources. Production systems according to the process produce extreme output can be divided into two types, namely:

Continuous Production Process

Production Process Disconnected

The main difference between the two processes lies in the length of time the set-up of the production equipment. The continuous process does not require a long set-up time as this process produces continuously for the same type of product.

Classification of production processes

The classification of the production processes depend on the nature of the activities. There are:

1. technological processes,
   - direct impact processes,
   - natural processes,
   - measurement and inspection processes, e.g. quality inspection
2. transport processes,
   - external transport,
   - internal transport,
3. storage processes.

Technological process

During the technological process activities are carried out, the purpose of which is to change the character of the raw material into the finished product. Technological process is divided also into subtypes. The first is the process of direct impact. It consists of all actions carried auto by employees directly on raw material of pre-processed item (e.g. shaping a piece of metal by hammer in the forge).

Functions of production processes

Another type of production processes classification is division depending on the way in which they are associated with the product development. There are:

- primary production processes
- secondary production processes
- support processes
- waste utilization processes

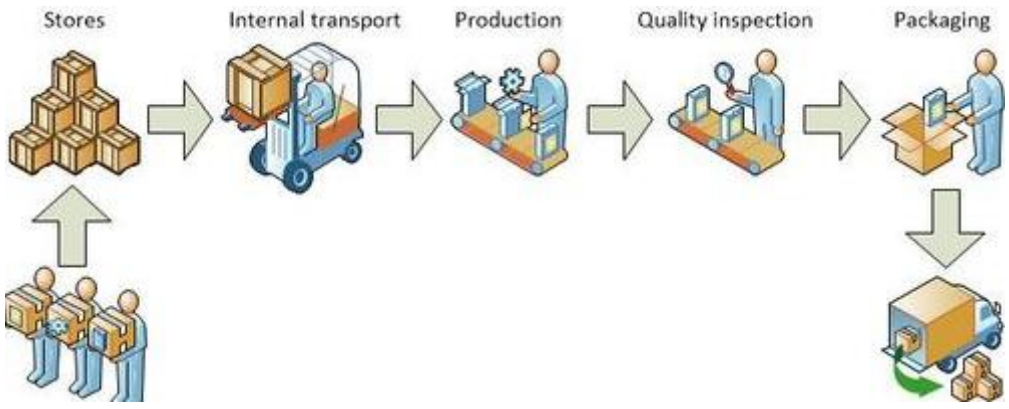

Fig.6. The production processes

The normal functioning of the main elements depends on providing them with energy, tools, repairs, as well as transportation, storage of items, control and test benches and devices. These functions are performed by the corresponding auxiliary elements of the production system, which have both external and internal connections at the input, and only internal at the output. Therefore, only those auxiliary elements, products and services that are not the result of other independent systems (industries, enterprises) may be necessary for the main elements of the production system.

Unit 6. Classifications of production systems

There are many production modes available and often the products or the market will determine which mode is required for a manufacturer.

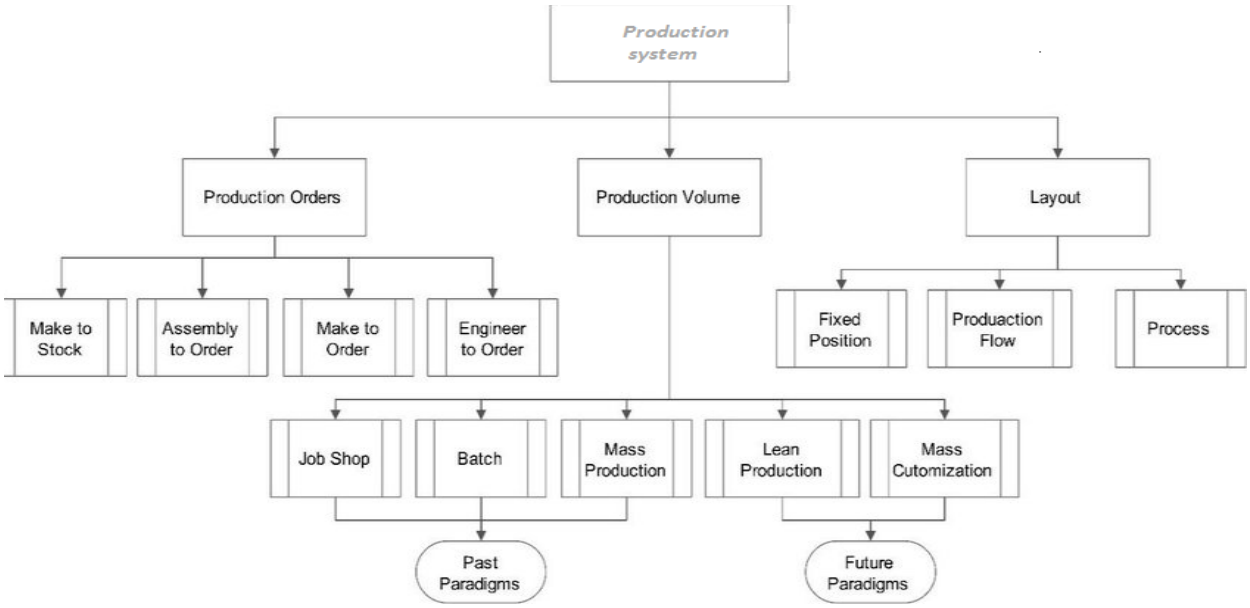

Fig. 7 Classifications of production systems

Production orders

Based on the production orders production system divided into four types namely; Make to Stock, Assembly to Order, Make to Order and Engineer to Order. Make to stock (MTS) is a strategy that is manufacture to the forecasted demands of consumers.

Production process terms

Customer lead time: the time needed to respond to a customer order

Customer order decoupling point: refers to the point in the value chain at which a customer triggers the production activities.

Production systems according to the process produce output

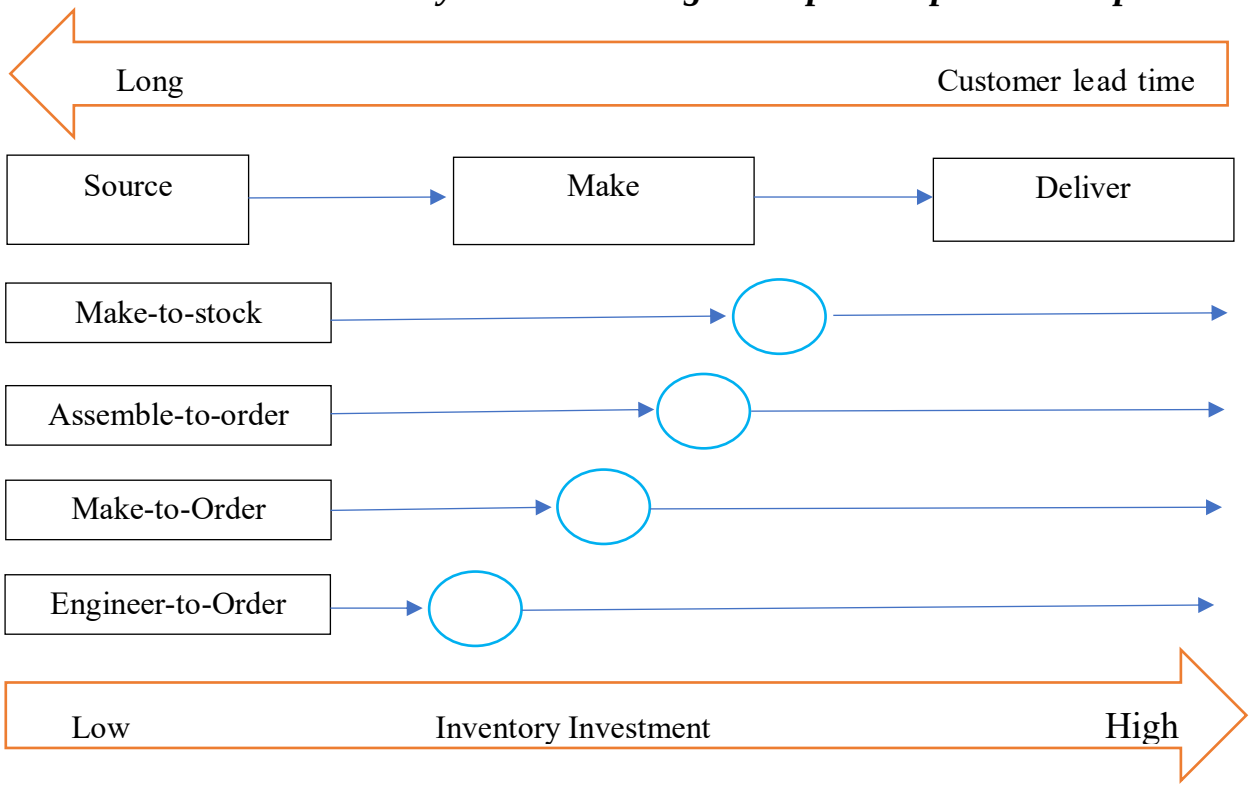

Fig.8 Production systems according to the process produce output

Make to stock (MTS) production system / manufacturing strategy

Production processes are completed and the product is placed in the stock even before the customer order is received. MTS strategy applies to standard items.

The customer engagement point is:

Concept	Design	Procurement	Manufacturing	In stock

Assemble to order (ATO) production system

In ATO approach product is built based on customers specifications from a stock of existing sub-components. Final assembly can be done once the customer order is received.

The customer engagement point is:

Concept	Design	Procurement	Sub-assembly	Assembly	Delivery

Make to order (MTO) production system

Production process starts only after receiving a customer order. MTO is the most appropriate approach used for *highly customized* or *low volume* products. Industries with expensive inventory use this production approach.

The customer engagement point is:

Concept	Design	Procurement	Manufacturing	Delivery

Engineer-to-order (ETO) production system

The steps are:

Customer order - Product design - Approval - Purchase and building the product

The customer engagement point is:

Concept	Design	Procurement	Manufacturing	Delivery

Production systems according to the production orders process

Table 2

MTS	ATO	MTO	ETO
Finished goods are stocked	Subassemblies / subcomponents are stocked	No finished goods or subcomponents are stocked	No finished goods or subcomponents are stocked
Engineering is complete	Engineering is complete but configurations may need specification design	Engineering is complete but configurations may need specification design	Engineering is required
Delivery is possible on the same or next day	Delivery is possible as per capacity	Delivery is possible as per capacity	Delivery is possible as per capacity

Production output volume

Types of production systems are classified on the basis of Product/output variety

The types of production system are depicted in the following image.

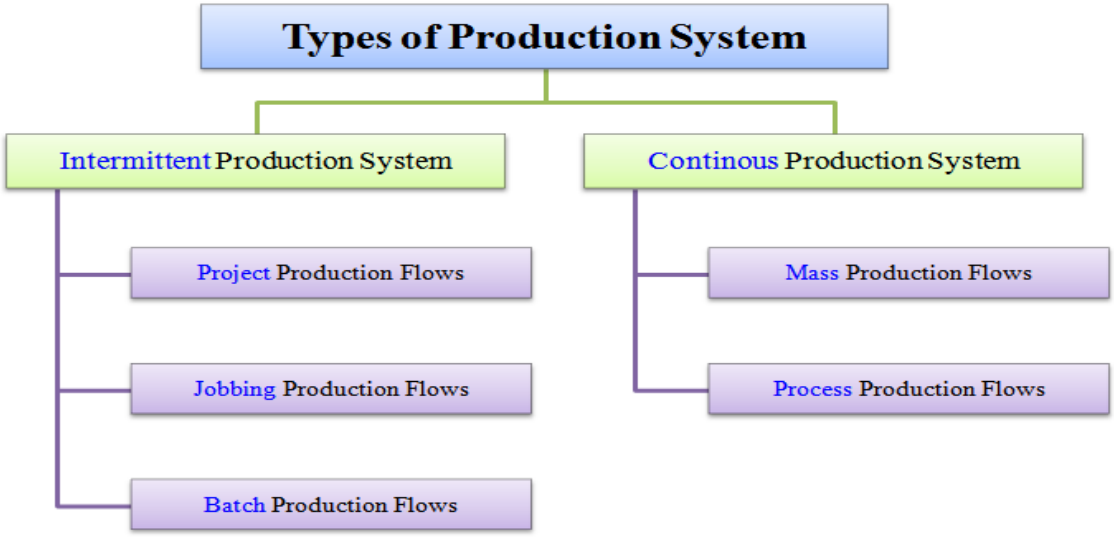

Fig. 9 Types of production process

The types of production system are grouped under two categories viz., Intermittent production system, and Continuous production system.

Intermittent production system

Intermittent means something that starts (initiates) and stops (halts) at irregular (unfixed) intervals (time gaps).

In the intermittent production system, goods are produced based on customer's orders. These goods are produced on a small scale. The flow of production is intermittent (irregular). In other words, the flow of production is not continuous. In this system, large varieties of products are produced. These products are of different sizes. The design of these products goes on changing. It keeps changing according to the design and size of the product. Therefore, this system is very flexible.

Following chart highlights the concept of an intermittent production system.

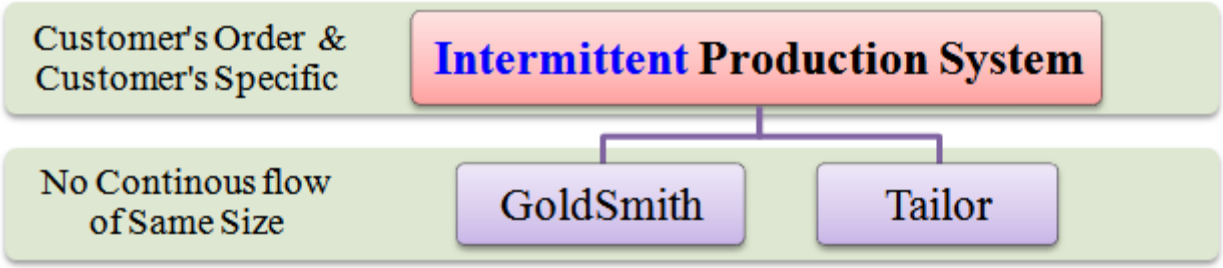

Fig. 10 The concept of an intermittent production system

Following are examples on the intermittent production system. Please refer above chart while reading examples given below.

The work of a goldsmith is purely based on the frequency of his customer's orders. The goldsmith makes goods (ornaments) on a small-scale basis as per his customer's requirements. Here, ornaments are not done on a continuous basis.

Similarly, the work of a tailor is also based on the number of orders he gets from his customers. The clothes are stitched for every customer independently by the tailor as per one's measurement and size. Goods (stitched clothes) are made on a limited scale and is proportional to the number of orders received from customers. Here, stitching is not done on a continuous basis.

The features of an intermittent production system are depicted below.

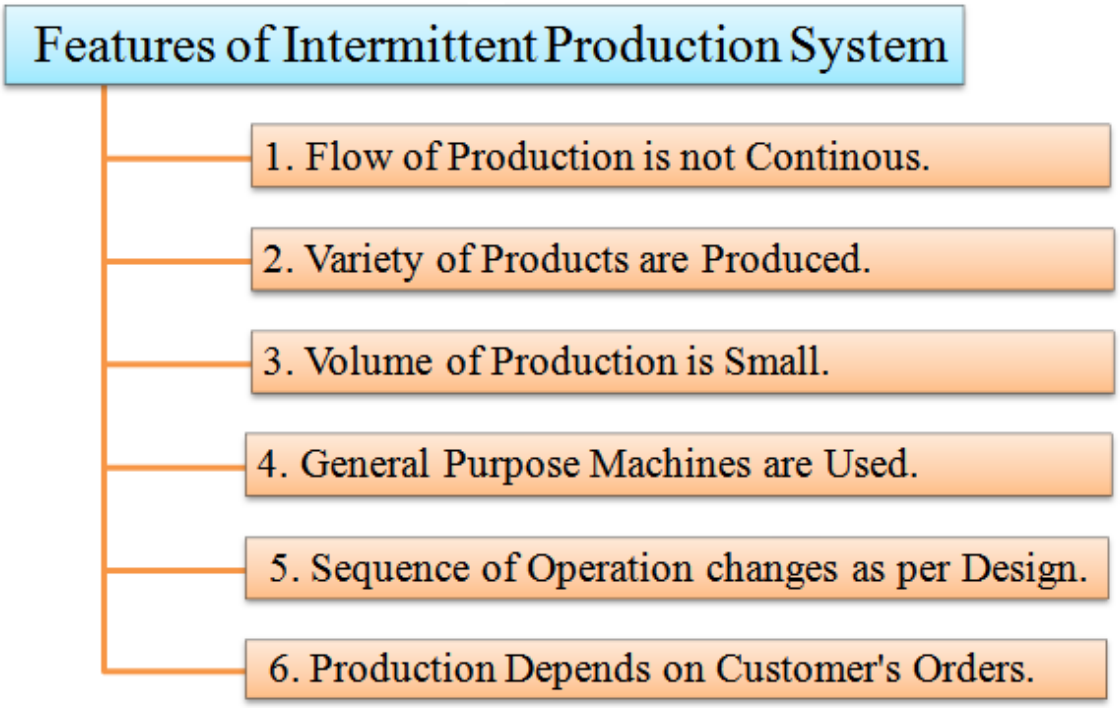

Fig. 11 Features of an intermittent production system

The characteristics of an intermittent production system are listed as follows:

- The flow of production is not continuous. It is intermittent.
- Wide varieties of products are produced.
- The volume of production is small.
- General purpose machines are used. These machines can be used to produce different types of products.

- The sequence of operation goes on changing as per the design of the product.
- The quantity, size, shape, design, etc. of the product depends on the customer's orders.

Advantages of the intermittent manufacturing:

You can adapt to changes in a product's design or if a machine or tool breaks, you can avoid bottlenecks since another workstation will be able to perform the same tasks;

— You can focus on a smaller group of products, which will help you improve quality control and make the process for manufacturing products easier each time;

— You can reduce your manufacturing costs as workers will be able to focus on specific tasks and your machines and tools can be repurposed for different product configurations;

— Repeat orders lead to a smoother and more consistent production flow;
— A workstation will have downtime, saving you on energy costs.

Disadvantages of intermittent manufacturing

— It’s a complex method, yes you can offer customization, but without a standardized approach, products will have a long manufacturing lead time;
— Production planning and scheduling is complicated since manufacturing orders (MOs) come in at different times;
— The raw materials and work-in-progress (WIP) inventories are high because of the irregular flow of work.

The types of intermittent production system include:

- Project production flows,
- Jobbing production flows, and
- Batch production flows.

Continuous production system

Continuous means something that operates constantly without any irregularities or frequent halts.

In the continuous production system, goods are produced constantly as per demand forecast. Goods are produced on a large scale for stocking and selling. They are not produced on customer's orders. Here, the inputs and outputs are standardized along with the production process and sequence.

Following chart highlights the concept of a continuous production system.

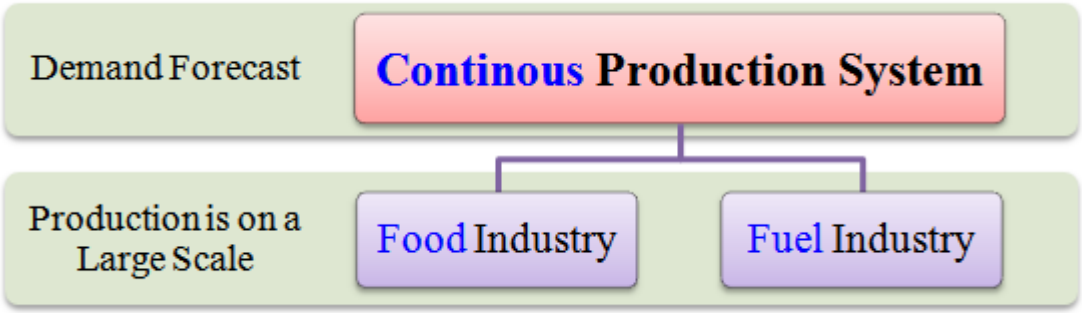

Fig.12. The concept of a continuous production system

Following are examples on the continuous production system. Please refer above chart while reading examples given below.

The production system of a food industry is purely based on the demand forecast. Here, a large-scale production of food takes place. It is also a continuous production.

Similarly, the production and processing system of a fuel industry is also purely based on, demand forecast. Crude oil and other raw sources are processed continuously on a large scale to yield usable form of fuel and compensate global energy demand.

Continuous production system involves a continuous or almost continuous physical flow of materials. It makes use of special purpose machines and produces standardized items in large quantities. The examples are petrochemical, cement, steel, sugar and fertilizer industries, etc. In a Continuous Production System, the items are produced for the stocks and not for specific orders.

Before planning manufacturing to stock, a sales forecast is made to estimate the likely demand of the product and a master schedule is prepared to adjust the sales forecast based on past orders and level of inventory. Here, the inputs are standardized and a standard set of processes and sequence of processes can be adopted. Due to this, routing and scheduling for the whole processes can be standardized.

The advantages of Continuous System

The main advantage of the continuous system is that work-in-progress inventory is minimum.

The quality of output is kept uniform because each stage develops skill through repetition of work.

Any delay at any stage is automatically detected.

Handling of materials is reduced due to the set pattern of the production line. Mostly the materials are handled through conveyor belts, roller conveyors, pipelines, overhead cranes, etc.

Control over materials, cost, and output are simplified.

The work can be done by semi-skilled workers because of their specialization.

The disadvantages of Continuous System

The continuous system, however, is very rigid and if there is a fault in one operation the entire process is disturbed. Due to continuous flow, it becomes necessary to avoid piling up of work or any blockage on the line. Unless the fault is cleared immediately, it will force the preceding as well as the subsequent stages to be stopped. Moreover, it is essential to maintain stand by equipment to meet any breakdowns resulting in production stoppages. Thus, investments in machines are fairly high.

The features of a continuous production system are depicted below.

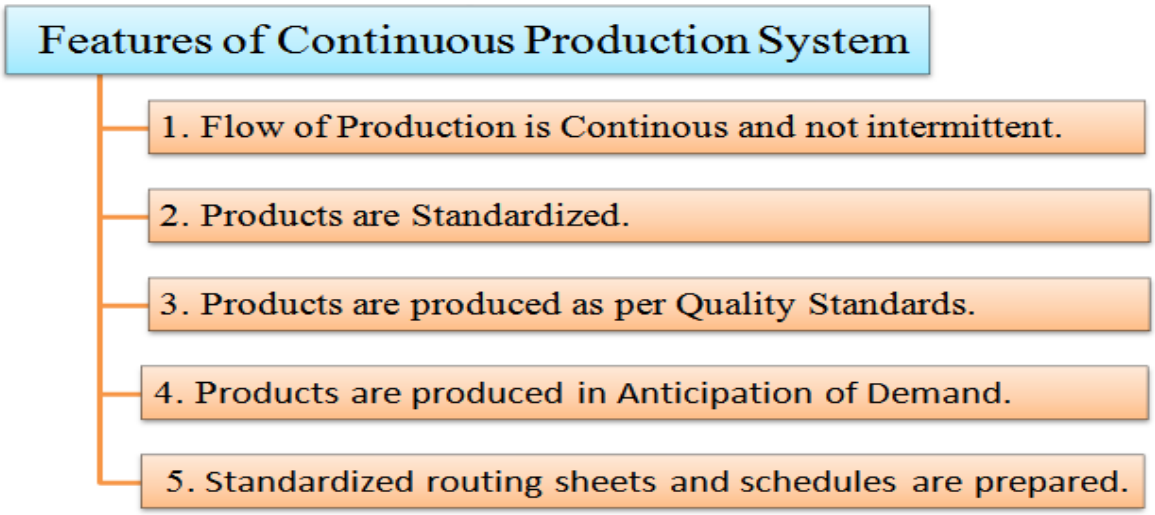

Fig. 13. The features of a continuous production system

The characteristics of a continuous production system are listed as follows:

- The flow of production is continuous. It is not intermittent.
- The products are standardized.
- The products are produced on predetermined quality standards.
- The products are produced in anticipation of demand.
- Standardized routing sheets and schedules are prepared.

The types of continuous production system include:

Mass production flows, and Process production flows.

Production systems can be classified as Job-shop, Batch, Mass and Continuous production systems.

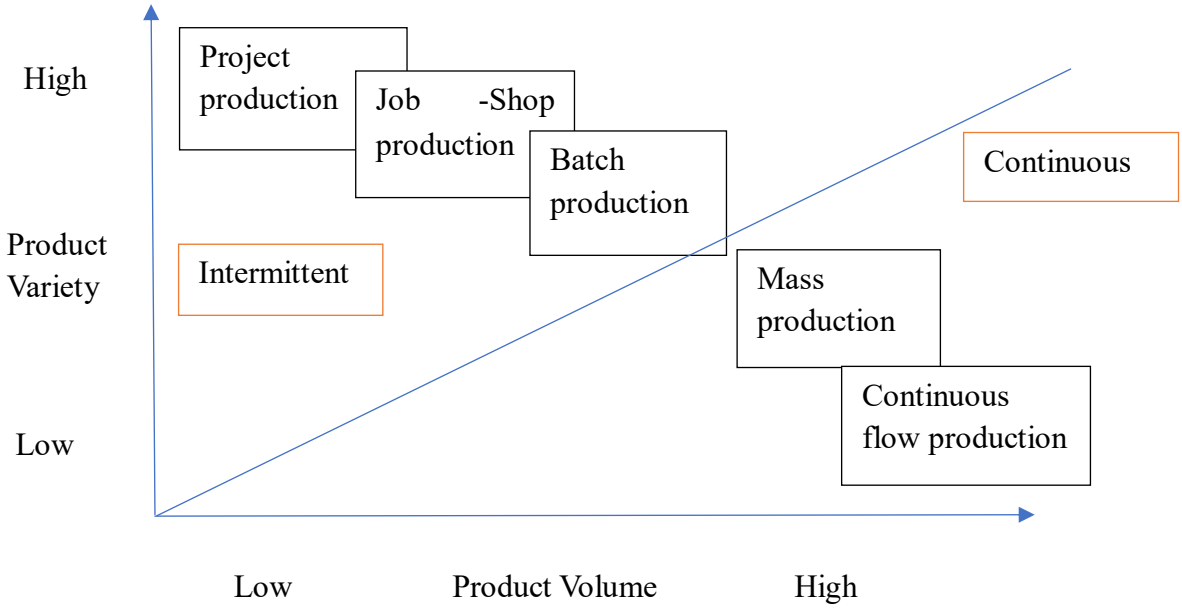

Fig. 14 The types of production systems

Characteristics of production systems

Table 3

Characteristics	Job Shop	Batch	Assembly line	Continuous flow
Flow type	Intermittent	Intermittent	Continuous	Continuous
Output volume	The lowest	Moderate	High	The highest
Output variety	The highest	High	Low – two or three types	The lowest – standardized product
Capital investment	High – general purpose machines	Low	High	The highest
Types of supervision	Specific	Specific	General	General
Types of machines	General purpose	General purpose	Specific purpose	Specific purpose
Skill requirement	High qualification requirements	Semiskilled	Semiskilled	Low skilled

Types of Continuous System

Mass Production:

This production refers to the manufacturing of standardized parts or components on a large scale. Mass production system offers economies of scale as the volume of

output is large. Quality of products tends to be uniform and high due to standardization and mechanization. In a properly designed and equipped process, individual expertise plays a less prominent role.

E.g. of mass production is the production of toothpastes, soaps, pens, etc.

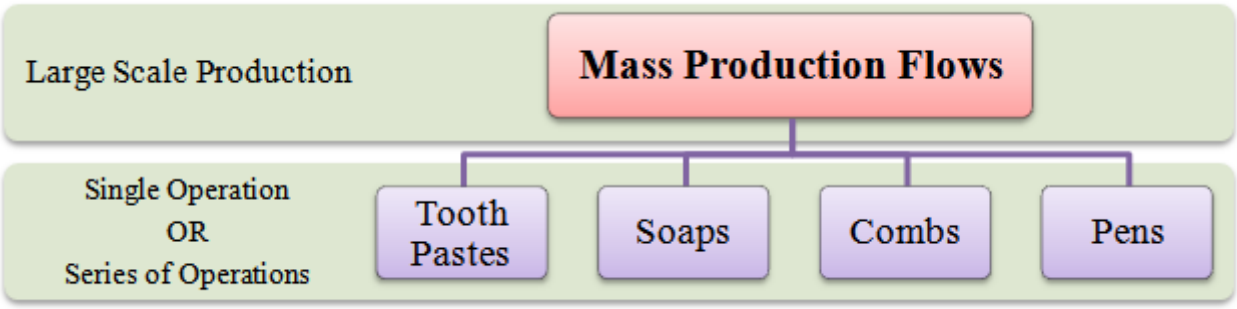

Fig.15 The mass production

The **characteristics** or features of mass production flows are as follows:

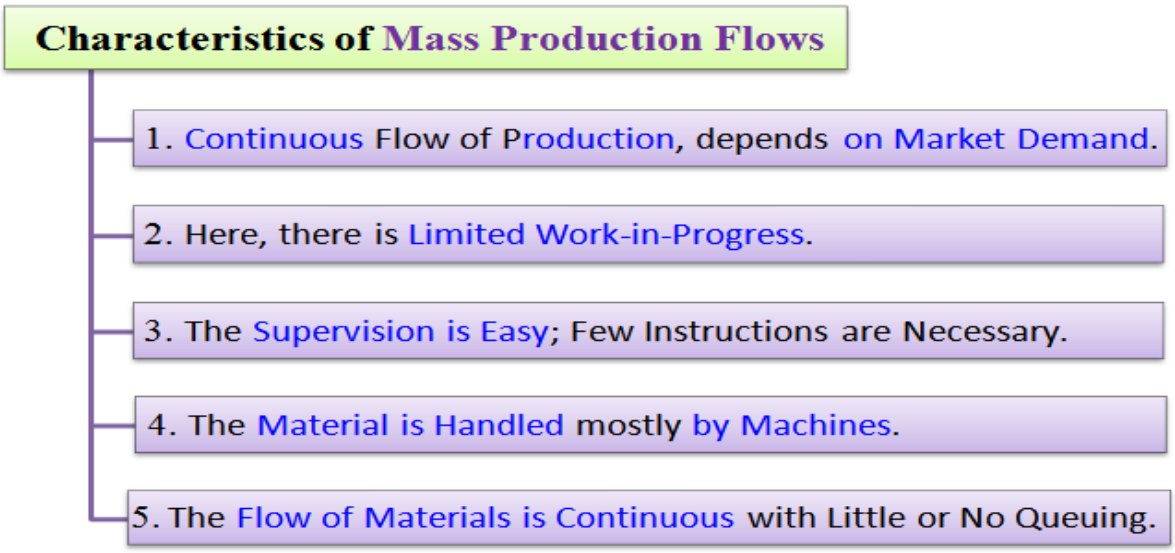

Fig.16. The characteristics of mass production

There is a continuous flow of production. However, this depends on the demand in the market.

Here, there is limited work-in-progress.

Supervision is easy because only few instructions are necessary.

The material handling is done mostly by machines, i.e. conveyors and automatic transfer machines.

The flow of materials is continuous. There is little or no queuing at any stage of production.

Process Production

Production is carried on continuously through a uniform and standardized sequence of operations. Highly sophisticated and automatic machines are used. Process production is employed in the bulk processing of certain materials. The typical processing Industries are fertilizers plants, petrochemical plants, and milk dairies which have highly automated systems and sophisticated controls.

Examples of these plants include, steel, cement, paper, sugar, etc.

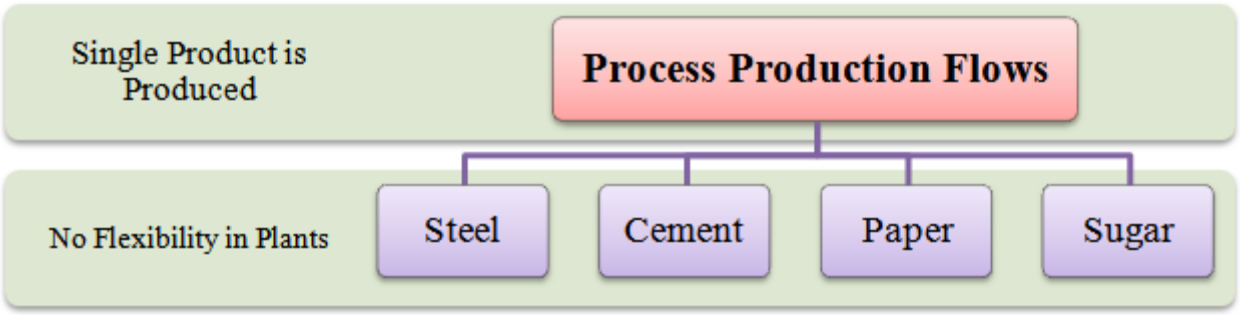

Fig.17 The process production

The characteristics or features of process production flows are as follows:

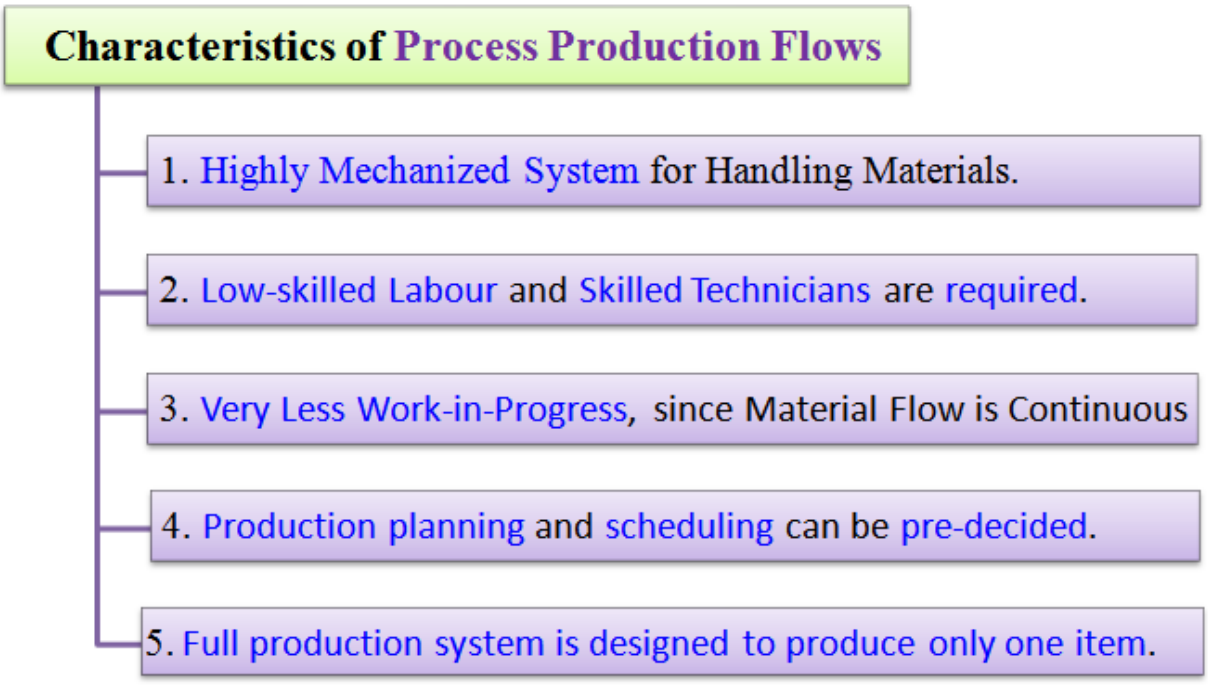

Fig.18. The characteristics of process production

There is a highly mechanized system for handling materials. Conveyors and automatic transfer machines are used to move the materials from one stage to another.

Low-skilled labour and skilled technicians are required.

There is very less work-in-progress because material flow is continuous.

The production planning and scheduling can be decided well in advance.

The full production system is designed to produce only one specific type of item.

They are not labour-intensive and the worker is just an operator to monitor the system and take corrective steps if called for. *On the basis of the nature of the production process, flow production may classify into Analytical and Synthetic Production.*

Analytical Process: In the Analytical Process of production, the raw material is broken into different products e.g. crude oil is analysed into gas, petrol, etc. Similarly, coal is processed to obtain coke, coal gas, coal tar, etc.

Synthetic Process: Synthetic Process of production involves the mixing of two or more materials to manufacture a product, for instance, lauric acid, myristic acid, stearic acid are synthesized to manufacture soap.

Assembly Lines

Assembly line a type of flow production which is developed in the automobile industry. A manufacturing unit prefers to develop and employ an assembly line because it helps to improve the efficiency of production. In an assembly line, each machine must directly receive material from the previous machine and pass it directly to the next machine.

Machine and equipment should be arranged in such a manner that every operator has free and safe access to each machine. Space should be provided for free movement of forklifts, trucks, etc. which deliver materials and collect finished products.

Types of intermittent System

Batch Production

Batch Production as a form of manufacturing in which the job pass through the functional departments in lots or batches and each lot may have a different routing. It is characterized by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Examples of batch production flows include, manufacturing of drugs and pharmaceuticals, medium and heavy machineries, etc.

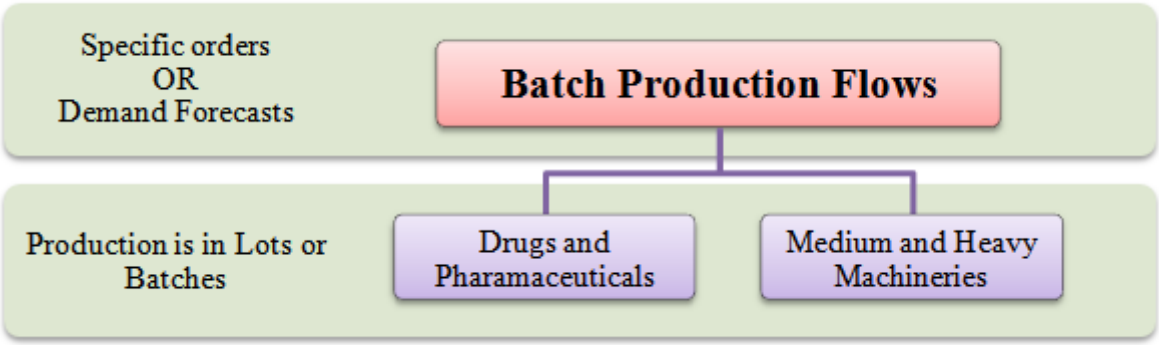

Fig.19 Batch production

The characteristics or features of batch production flows are as follows:

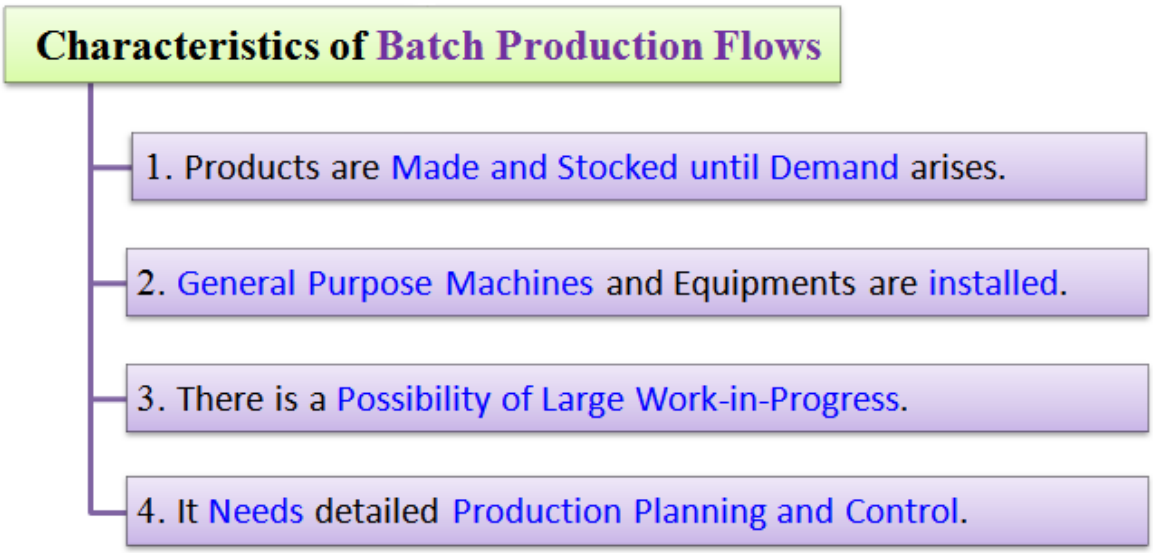

Fig.20 The characteristics of batch production

The products are made and kept in stock until their demand arises in the market.
General purpose machines and handling equipments, which can do many different jobs quickly are installed. This is because large varieties of items are to be produced.
There is a possibility of large work-in-progress due to many reasons.
There is a need for detailed production planning and control.

Batch Production is characterized by
1. Shorter production runs.
2. Plant and machinery are flexible.
3. Plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch.
4. Manufacturing lead-time and cost are lower as compared to job order production

Job Production:

Job or unit production involves the manufacturing of a single complete unit with the use of a group of operators and process as per the customer's order. This is a "special order" type of production. Each job or product is different from the other and no repetition is involved. The product is usually costly and non-standardised.

Customers do not make a demand for exactly the same product on a continuing basis and therefore production becomes intermittent. Each product is a class by itself and constitutes a separate job for the production process. Shipbuilding, electric power plant, dam construction, etc. are common examples of job production.

Examples of such jobbing production flows include, services given by repair shops, tailoring shops, manufacturer of special machine tools, etc.

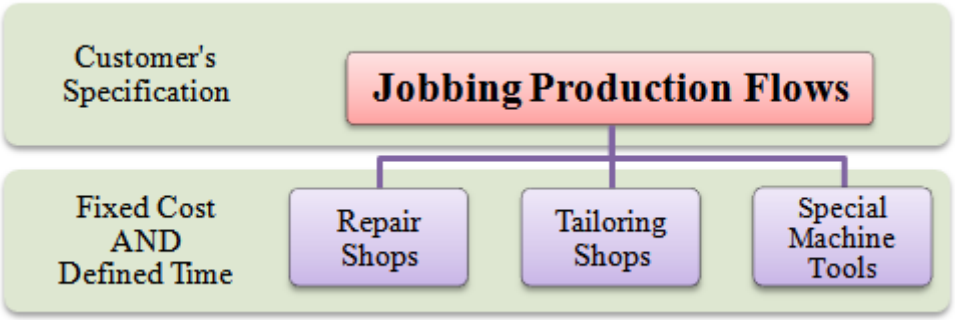

Fig.21 Job production

The characteristics or features of jobbing production flows are as follows:

Fig. 22 The characteristics of jobbing production

The production of items takes place in small lots. Sometimes only one product is produced at one time.

The items are manufactured strictly as per customer's specifications.

Highly skilled labour is required to perform specialized jobs.

There is disproportionate manufacturing cycle time. For e.g. the time needed to design the product may be more than the manufacturing time.

Characteristics of Job Production:

The product manufactured is custom-made or non-standardised.

The volume of output is generally small.

Variable path materials handling equipment are used.

A wide range of general-purpose machines like grinders, drilling, press, shaper, etc. is used.

Advantages of Job Production:

It is flexible and can adapt easily to changes in product design. A fault in one operation does not result in complete stoppage of the process. Besides, it is cost-effective and time-effective since the nature of the operations in a group is similar. There is reduced material handling since machines are close in a cell. The waiting period between operations is also reduced. This also results in a reduced work-in-progress inventory.

The disadvantages of Job Production:

Job shop manufacturing is the most complex system of production e.g. in building a ship thousands of individual parts must be fabricated and assembled. A complex schedule of activities is required to ensure the smooth flow of work without any bottlenecks. Raw materials and work-in-progress inventories are high due to uneven and irregular flow of work. Workloads are unbalanced, speed of work is slow and unit costs are high.

Project production

Here, in Project production flows, company accepts a single, complex order or contract. The order must be completed within a given period of time and at an estimated cost. ¨

Examples of project production flows mainly include, construction of airports, dams, roads, buildings, shipbuilding, etc.

Characteristics project production

The requirement of resources is not same (it varies). Generally, the resource requirement at the beginning is low. Then in mid of production, the requirement increases.

Finally, it slows down when the project is near its completion phase.

Many agencies are involved in the project. Each agency performs specialized jobs. Here, coordination between agencies is important because all jobs are interrelated. ¨ Delays take place in completion of projects due to its complexity and massiveness.

¨ As routing and scheduling changes with fresh orders, proper inspection is required at each stage of production.

Examples of project production flows mainly include, construction of airports, dams, roads, buildings, shipbuilding, etc.

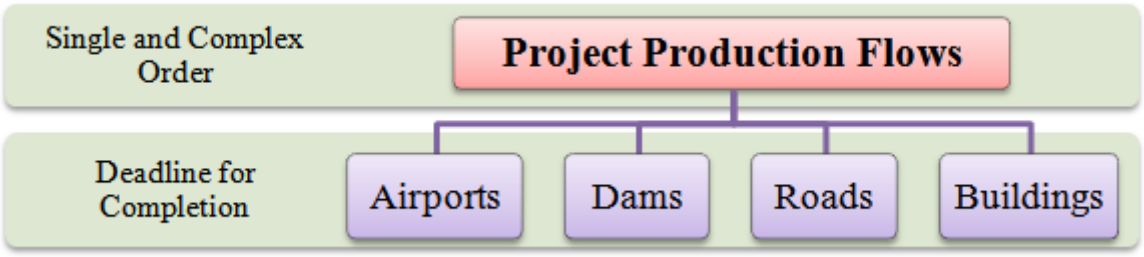

Fig.23 Project production

The characteristics or features of project production flows are as follows:

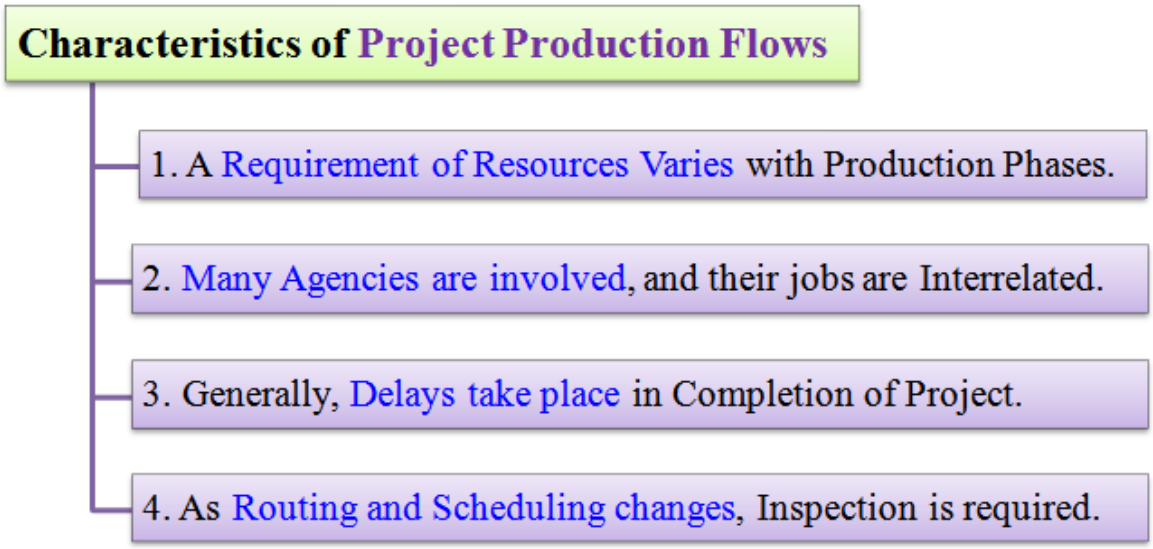

Fig. 24 The characteristics of project production

The requirement of resources is not same (it varies). Generally, the resource requirement at the beginning is low. Then in mid of production, the requirement increases. Finally, it slows down when the project is near its completion phase.

Many agencies are involved in the project. Each agency performs specialized jobs. Here, coordination between agencies is important because all jobs are interrelated.

Delays take place in completion of projects due to its complexity and massiveness.

As routing and scheduling changes with fresh orders, proper inspection is required at each stage of production.

What is a Project?

A project is a temporary endeavour undertaken to produce a unique product or service.

Fig. 25 Main characteristics of projects

Temporary – Definitive beginning and end

Unique – New undertaking, unfamiliar ground

The project is successful when:

- customer requirements satisfied/exceeded;
- completed within allocated time frame;
- completed within allocated budget;
- accepted by the customer.

The project failure when:

- scope creep;
- poor requirements gathering;
- unrealistic planning and scheduling;
- lack of resources.

Project Management is the application of skills, knowledge, tools and techniques to meet the needs and expectations of stakeholders for a project.

The purpose of project management is **prediction** and **prevention**, NOT recognition and reaction

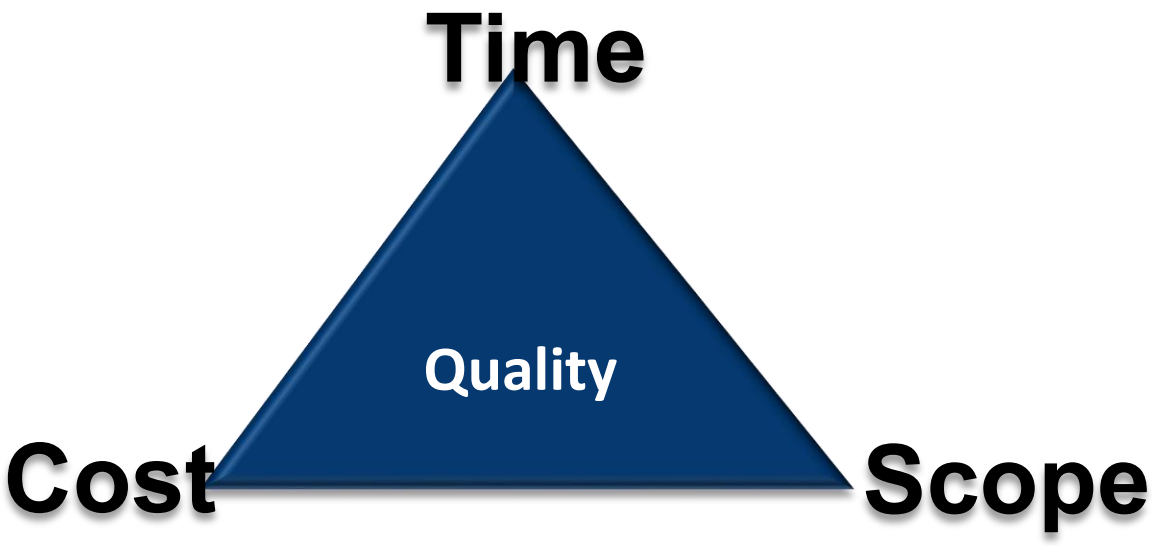

Fig. 26 Triple Constraint

Increased **Scope** = increased time + increased cost

Tight **Time** = increased costs + reduced scope

Tight **Budget** = increased time + reduced score

Key Areas of Project Management

Scope Management. Primarily it is the definition and control of what ***IS*** and ***IS NOT*** included in the project.

Issue Management. Issues are restraints to accomplishing the deliverables of the project. Typically identified throughout the project and logged and tracked through resolution. Issue already impacting the cost, time or quality.

Cost Management. This process is required to ensure the project is completed within the approved budget and includes: resources, people, equipment, materials.

Quantities.

Budget.

Quality Management is the process that ensure the project will meet the needs

“conformance to requirements” - Crosby

“fitness for use” - Juran

“the totality of characteristics of an entity that bear on its ability to satisfy stated and implied need’ - ISO 8402:1994

Communications Management. This process is necessary to ensure timely and appropriate generation, collection, dissemination, and storage of project information.

Communications planning: Determining the needs (who needs what information, when they need it, and how it will be delivered) Information Distribution: Defining who and how information will flow to the project stakeholders and the frequency Performance Reporting: Providing project performance updates via status reporting.

Communications planning

Information Distribution

Performance Reporting

Define the schedule for the Project Meetings (Team, OSC, ESC), Status Meetings and Issues Meetings to be implemented

Risk Management. Risk is potential negative impact to project.

Risk identification and mitigation strategy

Risk update and tracking

Change Control Management. Define how changes to the project scope will be executed Define how changes to the project scope will be executed

Formal change control is required for all of the following

Scope Change

Schedule changes

Technical Specification Changes

Training Changes

All changes require collabouration and buy in via the project sponsor’s signature prior to implementation of the changes.

Chapter 3 PRODUCTION AND MANUFACTURING OPERATIONS AND SERVICE OPERATIONS

Unit 7 Manufacturing operations

Manufacturing operations is the process of transforming materials or components into finished products that can be sold in the marketplace. Every physical product that you buy in a store or online is manufactured somewhere.

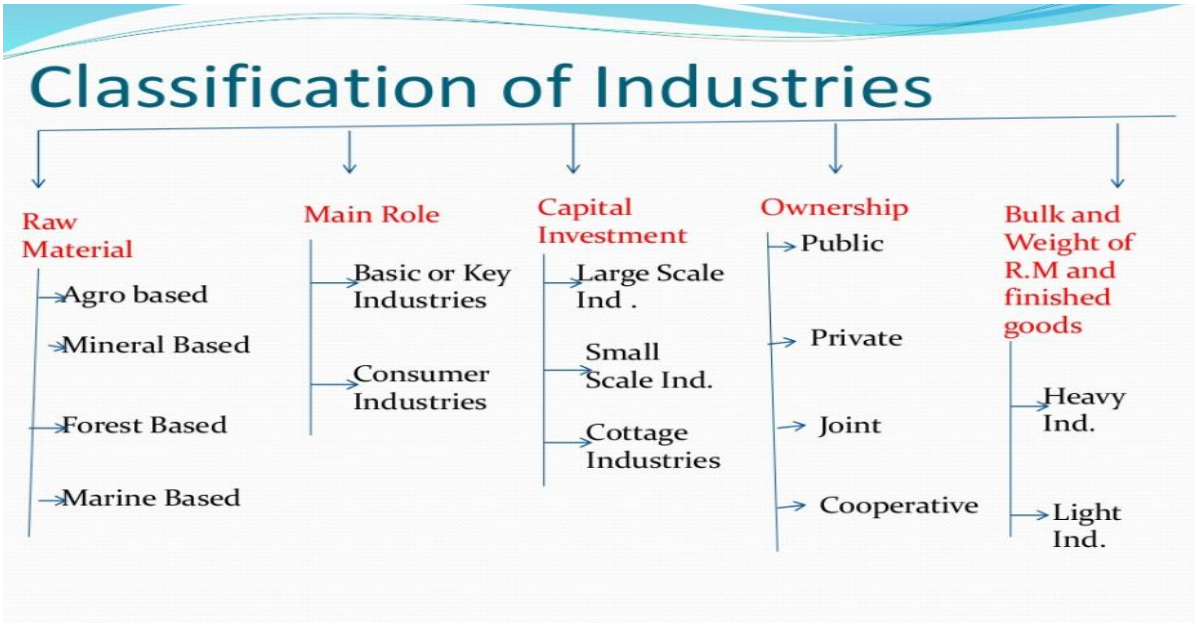

Fig.27 Classification of industies

Types of Manufacturing Processes

- Machining
- Joining
- Forming
- Casting

Machining

Tools used for machining are immobile power-driven units used to form or shape solid materials, specifically metals. The forming is done by removing extra materials from a work-piece. Machine tools make up the foundation of advanced industry and are utilized either indirectly or directly in the manufacturing of tool parts.

They are categorized under three main categories:

Traditional Chip-making tools.

Presses.

Modern machine tools.

Joining

Every joining approach has particular design needs, while certain joint needs may propose a particular joining approach. Design for assembly, and fastener selection apply their own specifications.

Bolting is a standard fastening method, for instance, but welding may cut down the weight of assemblies. Naturally, joints intended for the two approaches would differ tremendously.

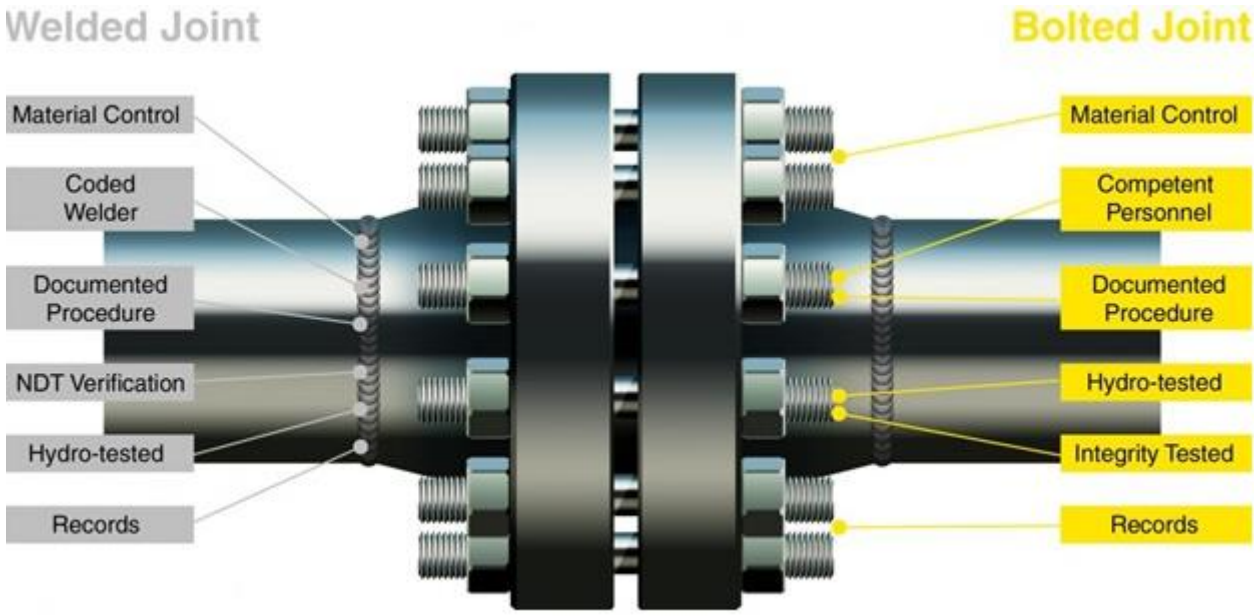

Fig. 28. Joining

However, all joint patterns must consider features such as load factors, assembly effectiveness, operating surroundings, overhaul and upkeep, and the materials chosen.

Welding is generally a cost-effective approach to fabricate. It doesn't require overlapping materials, and so it removes excess weight brought on by other fastening methods. Fasteners don't have to be purchased and stored in stock. Welding also can minimize costs related to extra parts, for example angles mounted between parts.

Forming

Metal forming is the approach of creating the metallic components by deforming the metal but not by removing, cutting, shredding or breaking any part. Bending, spinning, drawing, and stretching are a few important metal forming process in

manufacturing. The metal press such as die and punching tools are implemented for this manufacturing process.

Casting

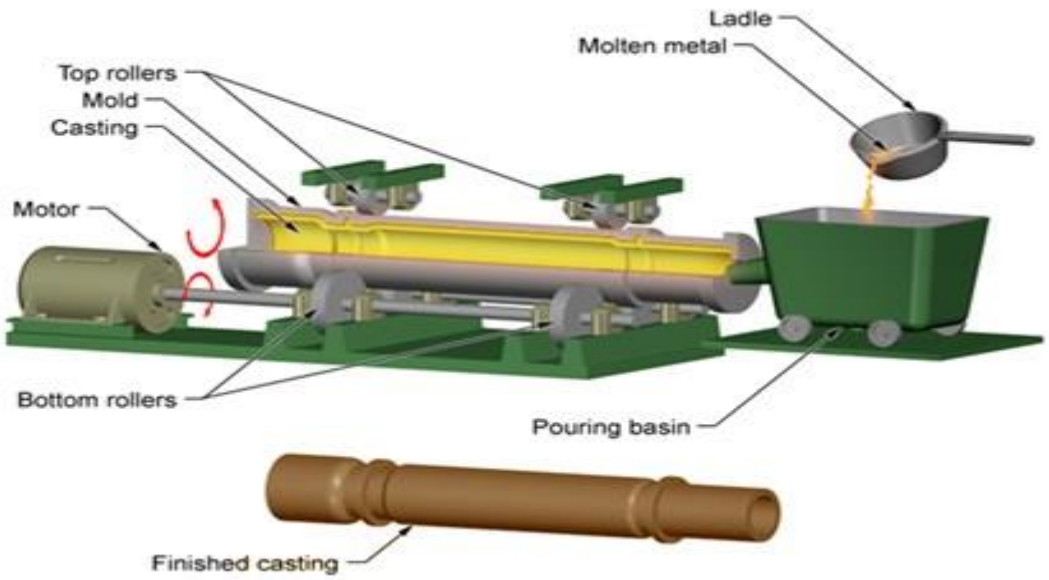

Fig. 29. Casting

Casting is a manufacturing process in which a solid is dissolved into a liquid, heated to appropriate temperature (sometimes processed to change its chemical formula), and is then added into a mould or cavity. Thus, in just one step, complex or simple shapes can be crafted from any kind of metal that has the capability to be melted. The end product can have practically any arrangement the designer wants.

Unit 8 Service operations

A service is a time-perishable, intangible experience performed for a customer acting in the role of a co- producer. (James Fitzsimmons). Services are economic activities offered by one party to another, most commonly employing time-based performances to bring about desired results in recipients themselves or in objects or other assets for which purchasers have responsibility. In exchange for their money, time, and effort, service customers expect to obtain value from access to goods, labour, professional skills, facilities, networks, and systems; but they do not normally take ownership of any of the physical elements involved. (Christopher Lovelock and Lauren Wright)

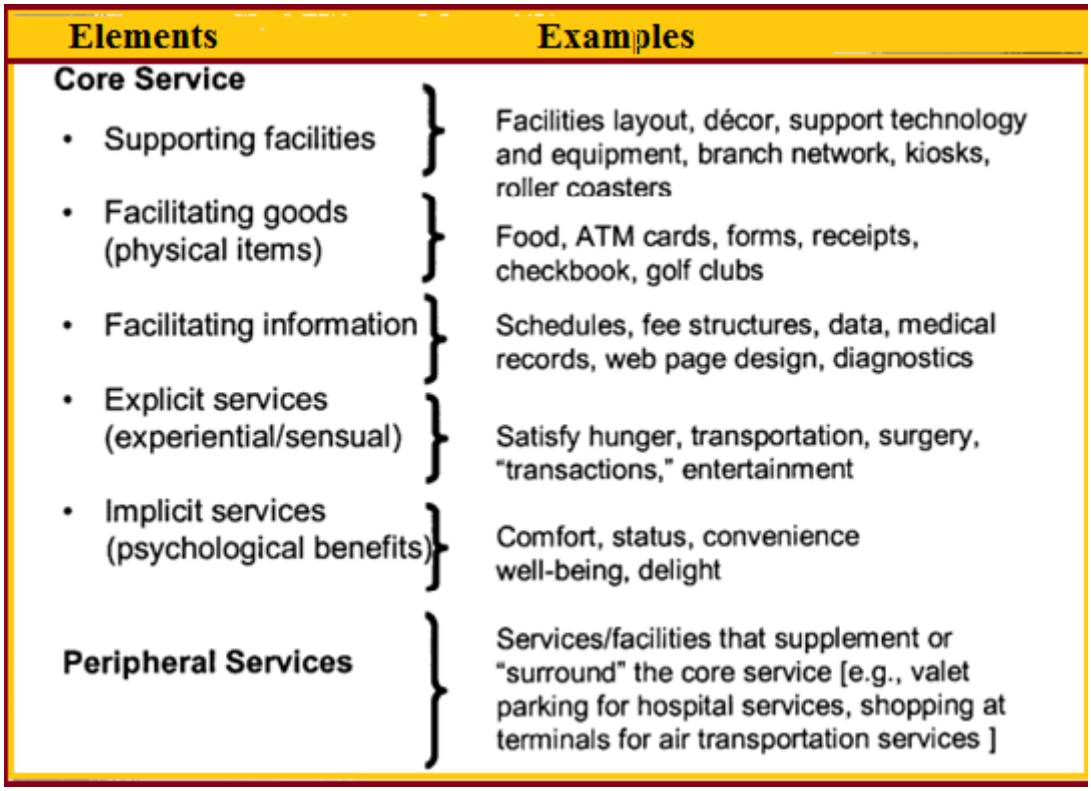

Fig.30 Elements of service operations

Key objectives of service operation are to synchronize and perform the activities and processes required to deliver and manage services at agreed levels to business users and customers. Service operation is also responsible for on-going management of the technology that is used to deliver and support services. Management scholars sated that highly designed and well implemented processes will be worthless if day to day operation of those processes is not suitably conducted, controlled and managed, nor will service improvements be possible if day to day activities to monitor performance assess metrics and gathering data are not systematically conducted during service operation.

Other objectives of service are:

- approachable stable services
- robust end to end operational practices
- business as usual - day to day
- implementation of processes and services
- responsive and operational validation
- realising value
- accomplishing service excellence.

There are numerous factors in implementing service operation.

Service operations are mainly associated with efficiency, effectiveness, Quality and Cost. Dimensions of service quality are Reliability, Responsiveness, Assurance, Empathy and Tangibles.

Service operation processes

Request fulfilment: Request fulfilment is the process to deal with service requests via the Service Desk, using a process similar but separate to that of incident management. Request fulfilment records/tables are linked, where necessary, to the incident or problem records that initiated the need for the request. Major aims of the request fulfilment process to provide a channel for users to request and receive standard services for which a predefined approval qualification process exists, to give information to users and customers about the availability of services and the procedure for obtaining them, to source and deliver the components of requested standard services and help with general information, complaints or comments. It effectively decreases the bureaucracy involved in requesting and receiving access to existing or new services, thereby reducing the cost of providing these services.

Incident management: Incident management is highly noticeable to companies and it is easier to demonstrate its value than in most areas of service operation. Incident management is often one of the first processes to be implemented in service management projects. The major benefit of doing this is that incident management can be used to high spot other areas that need attention, thus providing a reason for implementing processes. The purpose of incident management is to reinstate normal service operation as quickly as possible and diminish the adverse impact of the Incident on business operations, thus ensuring that the best possible levels of service quality and availability are maintained.

Problem management: This is vital for companies. Problem management comprises of the activities required to identify the root cause of incidents and to determine the resolution to the problems. It is also responsible for ensuring that the resolution is implemented through the appropriate control procedures. Effective problem management stops the recurrence of incidents and has benefits to the individual and the organisation as it improves availability and user productivity. Major aim of this service process is to lessen the adverse impact of incidents and problems on the business that are caused by errors within the information technology infrastructure, and to prevent recurrence of incidents related to these errors.

Access management: Access management is the procedure to grant authorized users the right to use a service, while preventing access to non-authorised users. It

is; therefore, the execution of policies and actions are defined in information security and availability management. The objectives of access management are Protecting Confidentiality, Integrity and Availability (CIA), sometimes knowing as Rights Management or Identity, Management, Security incidents and problems related to access management is discreetly recorded. Access management ensures that users are given the right to use a service, but it does not ensure that this access is available at all agreed times. This is provided by availability management.

Event management: In this process, effective service operation is dependent on knowing the status of the infrastructure and detecting any deviation from normal or expected operation. The objectives of event management to provide the entry point for the execution of many service operation processes and activities. Additionally, it provides a way of comparing actual performance and behaviour against design standards and Service Level Agreements.

Other aims include the ability to detect, interpret and initiate appropriate action for events, basis for operational monitoring and control and the entry point for many service operation activities, offer operational information as well as warnings and exceptions to aid automation and supports continual service improvement activities of service assurance and reporting.

Event management can be applied to any aspect of service management that needs to be controlled and which can be automated such as configuration Items, environmental conditions, software licence monitoring for usage to ensure optimum/legal licence utilisation and allocation, security and normal activity.

Major advantages within service operation are as under:

Scalability: Service organisation can be adapted for any size of organisation.

Reduction in costs: Service organisation has established its value in reducing the overall cost of managing services.

Improved quality: Service organisation helps improve the quality of IT services through sound management practices.

Alignment to standards: Service organisation may well align to the ISO/IEC 20000 Standard for Service Management.

Return on Investment (ROI): Service organisation helps IT organisations demonstrate their return on investment and measurable value to the business. This helps establish a business case for new or continuing investment in IT.

Seamless sourcing partnerships: Outsourcing, often with multiple service providers, is increasingly common today and service organisation offers a common practice base for improved service chain management.

There are numerous issues in service operation management:

- New service development
- Managing service experiences
- Front-office/Back-office
- Analysing processes
- Service quality
- Yield management
- Inventory management
- Waiting time management

To summarize, business companies are continually involved to enhance their performances in order to compete actively in the market. Service industries manage and market their operations and services differently from manufacturing products. It is established that providing excellent and quality customer service is a crucial factor in an intrinsic capable market environment between the product and service industries. Service operations can be grouped into many industries, such as banking, hospitality. Most services industries which provide clients what they need and are satisfied. This helps the company to enhance its market share, and generate more profit. Service operations provide certain intangible services that may not be easily recognisable.

Chapter 4 PRODUCTION LOCATION AND PLANT LAYOUT.

Unit 9 Production location

Facilities location may be defined as selection of suitable location or site or place where the factory or plant or facilities to be installed, where plant will start functioning. The development of a location strategy depends upon the type of firm being considered. Industrial location analysis decisions focus on minimising costs; retail and professional service organisations typically have a focus of maximising revenue. Warehouse location, on the other hand, may be determined by a combination of cost and speed of delivery. The objective of location strategy is to maximise the benefit of location to the firm. Facility planning has developed, in the past decade, into a major thriving business sector and discipline. One of the major reasons for new facilities is the global economic boom that has been accompanied by an enhancement of capacity worldwide. In addition to the global economic boom, there are several other reasons for changing or adding locations:

1. The cost or availability of labour, raw materials, and supporting resources often change. These changes in resources may spur the decision.

2. As product markets change, the geographical region of demand may shift. For example, many international companies find it desirable to change facility location to provide better service to customers.

3. Companies may split, merge, or be acquired by new owners, making facilities redundant.

4. New products may be introduced, changing the requirement and availability of resources.

5. Political, economic and legal requirements may make it more attractive to change location. Many companies are moving facilities to regions where environment or labour laws are more favourable. Well-planned facilities enable an organisation to function at its most efficient and effective level, offering real added value improvements to the organisation’s core business.

One of the most important long-term cost and revenue decisions company makes is where to locate its operation. Location is a critical element in determining fixed and variable costs for both industrial and service firms. Depending on the product and type of production or service taking place, transportation costs alone can total as much as 25% of the selling price. That is one fourth of the total revenue of a firm may be needed just to over freight expenses of the raw materials coming in and the finished product going out. Other costs that may be influenced by location include taxes, wages and raw material costs. The choice of locations can alter total

production and distribution costs by as much 10%. Lowering costs by 10% of total production costs through optimum location selection may be the easiest 10% savings management ever makes.

Once an operations manager has committed an organisation to a specific location, many costs are firmly in place and difficult to reduce. For instance, if a new factory location is in a region with high energy costs, even good management with an outstanding energy strategy is starting at a disadvantage. The same is true of a good human resource strategy if labour in the selected location is expensive, ill-trained, or has a poor work ethic. Consequently, hard work to determine an optimal facility location is a good investment.

Manufactured products differ from many service products as production may take place at a location, and then the goods are distributed to the customer. [p 234]

The typical factors that require consideration are:

1. ***Location of markets:*** Locating plants and facilities near the market for a particular product or service may be of primary importance for many products in the sense that location may impact the economics of the manufacturing process. This may be because of:

(a) Increased bulk or weight of the product

(b) Product may be fragile.

(c) It susceptible to spoilage.

(d) Add to transportation costs.

(e) Increase transit time.

(f) Decrease deliveries.

(g) Affect the promptness of service.

(h) Affect the selling price of the product – the transportation cost often makes the product expensive. Assembly-type industries, in which raw materials are gathered together from various diverse locations and are assembled into a single unit, often tend to be located near the intended market. This becomes especially important in the case of a custom-made product, where close customer contact is essential.

2. ***Location of materials:*** Access to suppliers of raw materials, parts, supplies, tools, equipment, etc., are very often considered to be of paramount importance. The main issue here is the promptness and regularity of supply from suppliers and the level of freight costs incurred. In general, the location of materials is likely to be important if:

(a) Transportation of materials and parts represent the major portion of unit costs.
(b) Material is available only in a particular region.

(c) Material is bulky in the raw state.

(d) Material bulk can be reduced in various products and by products during processing.

(e) Material is perishable and processing increases the shelf life. Keeping in mind those materials may come from a variety of locations; the plant would then be located such as to minimize the total transportation costs. Transportation costs are not simply a function of distance – they can vary depending on the specific routes as well as the specific product classifications.

3. ***Transportation facilities:*** Adequate transportation facilities are essential for the economic operation of a production system. These can include – road, rail waterways airports. The bulk of all freight shipments are made by rail since it offers low costs, flexibility and speed. For companies that produce or buy heavy and bulky low-value-per-ton commodities as are generally involved in import and export activities, shipping and location of ports may be a factor of prime importance in the plant location decision. Truck transport for intercity transport is increasing as is airfreight and executive travel. Traveling expenses of management and sales personnel should also be considered in the equation.

4. ***Labour supply:*** Manpower is the costliest input in most production systems. An ample supply of labour is essential to any enterprise. The following rule of thumb is generally applied:

(a) The area should contain four times as many permanent job applicants than the organisation will require.

(b) There should be a diversification between industry and commerce-roughly 50/50. Organisations often take advantage of a location with an abundant supply of workers. Labour costs and/or skills are often a very important consideration for locating a facility.

Though, this is often very appealing, you need to bear in mind that conditions can change in time. For example, while labour costs may be low in a certain geographic location now, this will change if the demand for labour grows significantly. In considering the labour supply, the following points should be considered.

(a) Skills available – size of the labour force – productivity levels.

(b) Unionization – prevailing labour – management attitudes.

(c) History of local labour relations – turnover rates – absenteeism, etc. Some organisations have relocated from a high skill/high cost area to a low skill/low cost area without any decrease in productivity. Sometimes it has been due to skill availability and labour-management relations but often it has been the result of higher investment in mechanization.

5. ***Location of other plants and warehouses:***

Organisations need to look at their plant locations for the complete system point of view.

(a) Distribution and supply requirements require the support of sister-plants and warehouses that complement the system.

(b) The system should be designed to minimize total system costs.

(c) The locations of competitor's plant and warehouses must also be considered (what do they know, that you don't) the object being to obtain an advantage in both freight costs and the level of customer service.

6. ***Climate:*** The recent typhoons in the Gulf of Mexico have indicated the need to look at climatic conditions as a parameter for making location decisions.

7. ***Governmental controls and regulations:*** Table below shows the composite ranking of the business environment in 20 countries, based upon factors including government controls, regulations and incentives and labour conditions. Labour conditions include skills, availability, unionization and history of labour relations.

[Production and operations management Edited By Neha Tikko p.230 (Dmgt206… pdf)]

Unit 10 Meaning of plant layout.

Facility layout and design is an important component of a business's overall operations, both in terms of maximizing the effectiveness of the production process and meeting the needs of employees. The basic objective of layout is to ensure a smooth flow of work, material and information through a system. The basic meaning of facility is the space in which a business's activities take place. The layout and design of that space impact greatly how the work is done. The key to good facility layout and design is the integration of the needs of people (personnel and customers), materials (raw, finishes and in process), and machinery in such a way that they create a single, well-functioning system.

A plant layout designer has the important responsibility of planning/organizing a facility or factory to optimize production process efficiencies with respect to:

- Cost
- Time
- Safety.

Consequently, an effective plant layout ensures the smooth flow of work by planning and positioning the following in the most effective manner:

- Staff
- Materials
- Machinery
- Information
- Support Systems.

The plant layout designer pays attention to such issues:

- materials flow – eliminate backtracking or bottlenecks to save time/money;
- materials management – ease-of-access for systematic and simple handling;
- production flexibility – ability to easily change set-ups for different products;
- space utilization – e.g. proper width of traffic lanes, full use of vertical space;
- communication – systematic location of departments to facilitate interactions;
- shipping and receiving – inclusion of satisfactory space to operate efficiently;
- employee well-being – plant must adhere to occupational health/safety standards;
- long-range planning - relative to future expansion or changing business needs.

Plant layout means the disposition of the various facilities (equipment, materials, manpower, etc.) within the area of the site selected. Plant layout begins with the design of the factory building and goes up to the location and movement of work. All the facilities like equipment, raw materials, machinery, tools, fixtures, workers, etc. are given a proper place.

Plant layout is the plan for arranging the physical facilities and manpower requires to manufacture a product to utilize them effectively. It 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.

They also known as facilities design. Plant layout constitutes planning of the amount of space required for all kind of activities in an industry, i.e., equipment, machinery, furniture and fittings, offices, restrooms, warehouses, etc. It is a **"Technique of locating different machines and plant services within the factory so that the greatest possible output of high quality at the lowest possible total cost can be available"**. The primary objective of plant layout is to minimize the movement of men and materials in the plant.

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

"It identically involves the allocation of space and the arrangement of equipment in such a manner that overall costs are minimized." (James Lundy)

"A good layout results in comforts, convenience, appearance, safety, and profits. A poor layout results in congestion, waste, frustration, and inefficiency." (Mo Naughton Waynel)

It is very complex as it involves concepts relating to such fields as engineering, architecture, economics and business administration. Since a plant layout, when properly designed, encompasses all production' and service facilities and provides

for the most effective utilization of men, with materials and machines constituting the process, is a master blueprint for coordinating all operations.

The objective of a Good Plant Layout:

The principal objective of a proper plant layout is to maximize the production at the minimum of the costs. This objective should keep in mind while designing a layout for a new plant as well as while making the necessary changes in the existing layout in response to changes in management policies and processes and techniques of production. Besides, it must satisfy the needs of all people associated with the production system, i.e. workers, supervisors, and managers.

If a layout wants to fulfill this goal, it should be planed with the following clear objectives in mind:

There is the proper utilization of cubic space (length, width, and height). Maximum use of volume available should make. For example, conveyors can be run above head height and used as moving work in progress or tools and equipment can suspend from the ceiling. The principle is particularly true in stores where goods can store at considerable heights without inconvenience.

Waiting time of the semi-finish products minimize.

Working conditions are safer, better (well-ventilated rooms, etc.) and improve.

Material handling and transportation minimize and efficiently control. For this, one has to consider the movement distances between different work areas – as well as the number of times such movements occur per unit period.

The movements made by the workers are minimizing.

Suitable spaces are allocating to production centers.

Plant maintenance is simpler.

There increases flexibility for changes in product design and future expansion. It must be capable of incorporating, without major changes, new equipment to meet technological requirements or to eliminate waste.

A good layout permits materials to move through the plant at the desired speed with the lowest cost.

There are increasing productivity and better product quality with reduced capital cost.

Boosting up employee well-being by providing employee comforts and satisfaction.

The workers should so arrange that there is no difficulty in supervision, coordination, and control. There should be no “hiding-places” into which goods can mislay. Goods – raw materials and ready stocks – must be readily observable at all times. They will reduce the pilferage of material and labour.

It should note here that the above-stated objectives of plant layout are worthy in themselves. It is often difficult to reconcile all of them in a practical situation. This requires a close connection between professional entrepreneurs and experienced engineers.

Unit11 Principles of plant layout

While designing the plant layout – the following principles must keep in view:

Movement: Materials and labour should move over minimum distances – saving cost and time of transportation and material handling.

Space Utilization: All available cubic space should effectively utilize – both horizontally and vertically.

Flexibility: Layout should be flexible enough to be adaptable to changes required by expansion or technological development.

Interdependence: Interdependent operations and processes should locate near each other; to minimize product travel.

Overall Integration: All the plant facilities and services should fully integrate into a single operating unit – to minimize the cost of production.

Safety: There should be an in-built provision in the design of the layout – to provide for comfort and safety of workers.

Smooth Flow: The layout should so design to reduce work bottlenecks and facilitate the uninterrupted flow of work throughout the plant.

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

Supervision: A good layout should facilitate effective supervision over workers.

Satisfaction: A good layout should boost up employee well-being – by providing them with maximum work satisfaction.

Let's look at the principle of safety in more detail.

Safety

Plant layout is often a compromise between a number of factors such as:

- The need to keep distances for transfer of materials between plant/storage units to a minimum to reduce costs and risks;
- The geographical limitations of the site;
- Interaction with existing or planned facilities on site such as existing roadways, drainage and utilities routings;
- Interaction with other plants on site;
- The need for plant operability and maintainability;
- The need to locate hazardous materials facilities as far as possible from site boundaries and people living in the local neighbourhood;

- The need to prevent restriction of movement where release of flammable substances may occur;
- The need to provide access for emergency services;
- The need to provide emergency escape routes for on-site personnel;
- The need to provide acceptable working conditions for operators.

The most important factors of plant layout as far as safety aspects are concerned are those to:

- Prevent, limit and/or mitigate escalation of adjacent events (domino);
- Ensure safety within on-site occupied buildings;
- Control access of unauthorized personnel;
- Facilitate access for emergency services.

In determining plant layout designers should consider the factors in outlined in the following sections.

Inherent safety

The major principle in Inherent Safety is to remove the hazard altogether. The best method to achieve this is to reduce the inventory of hazardous substances such that a major hazard is no longer presented. However, this is not often readily achievable and by definition no COMAH facility will have done so. Other possible methods to achieve an Inherently Safer design are:

Intensification to reduce inventories;

Substitution of hazardous substances by less hazardous alternatives;

Attenuation to reduce hazardous process conditions i.e. temperature, pressure;

Simpler systems/processes to reduce potential loss of containment or possibility of errors causing a hazardous event;

Fail-safe design e.g. valve position on failure.

Plant layout considerations to achieve Inherent Safety are mainly those concerned with domino effects.

Domino effects

Hazard assessment of site layout is critical to ensure consequences of loss of containment and chances of escalation are minimised. Domino may be by fire, explosion (pressure wave and missiles) or toxic gas cloud causing loss of control of operations in another location.

Fire

A fire can spread in four ways:

Direct burning (including running liquid fires);

Convection;

Radiation;

Conduction.

The spread of fire from its origin to other parts of the premises can be prevented by vertical and horizontal compartmentation using fire-resisting walls and floors. Consideration should also be given to the spread of flammable material via drains, ducts and ventilation systems. Delayed ignition following a release may result in spread of flames through such systems via dispersed flammable gases and vapours.

Protection against domino effects by convection, conduction and radiation can be achieved by inherent safety principles i.e. ensuring that the distances between plant items are sufficient to prevent overheating of adjacent plants compromising safety of those plants also. Where this is not possible due to other restrictions, other methods such as fire walls, active or passive fire protection may be considered.

Explosion

Explosion propagation may be directly by pressure waves or indirectly by missiles. As for fires, inherently safe methods that should be considered are:

arranging separation distances such that damage to adjacent plants will not occur even in the worst case;

provision of barriers e.g. blast walls, location in strong buildings;

protecting plant against damage e.g. provision of thicker walls on vessels;

directing explosion relief vents away from vulnerable areas e.g. other plants or buildings, roadways near site boundaries.

However, the latter may not provide practical solutions, particularly against missiles, and risk analysis may be required to prove adequate safety.

Toxic gas releases

Toxic gas releases may cause domino effects by rendering adjacent plants inoperable and injuring operators. Prevention/mitigation of such effects may be affected by provision of automatic control systems using inherently safer principles and a suitable control room.

Reduction of consequences of event on and off plant site

In addition to the measures described in the sections above, Plant Layout design techniques applicable to the reduction of the risks from release of flammable or toxic materials include:

Locating all high-volume storage of flammable / toxic material well outside process areas;

Locating hazardous plant away from main roadways through the site;

Fitting remote-actuated isolation valves where high inventories of hazardous materials may be released into vulnerable areas;

Provision of ditches, dykes, embankments, sloping terrain to contain and control releases and limit the safety and environmental effects;

Siting of plants within buildings as secondary containment;

Siting of plants in the open air to ensure rapid dispersion of minor releases of flammable gases and vapours and thus prevent concentrations building up which may lead to flash fires and explosions;

Hazardous area classification for flammable gases, vapours and dusts to designate areas where ignition sources should be eliminated.

Risk management techniques should be used to identify control measures that can be adopted to reduce the consequences of on or off site events. See references cited in further reading material.

Positioning of occupied buildings

The distance between occupied buildings and plant buildings will be governed by the need to reduce the dangers of explosion, fire and toxicity. In particular, evacuation routes should not be blocked by poor plant layout, and personnel with more general site responsibilities should usually be housed in buildings sited in a non-hazard area near the main entrance. Consideration should be given to siting of occupied buildings outside the main fence. In all cases occupied buildings should not be sited downwind of hazardous plant areas. Further guidance is available in standard references.

Aggregation / trapping of flammable vapours

To avoid aggregation and trapping of flammable / toxic vapours which could lead to a hazardous event, buildings should be designed so that all parts of the building are well ventilated by natural or forced ventilation. Flammable storages should be sited in the open air so that minor leaks or thermal outbreathing can be dissipated by natural ventilation. Maintenance procedures should include the displacement of vapours from hazardous areas before work begins.

Unit 12 Types of plant layouts

Process layout

It is also known as functional layout and is characterized by keeping similar machines or similar operations at one location (place). In other words, all lathes will be at one place, all milling machines at another and so on, that is machines have been arranged according to their functions. This type of layout is generally employed for industries engaged in job order production and non-repetitive kind of maintenance or manufacturing activities.

Suitability of process layout

Process layout is suitable in the following cases, where:

1. Non-standardised 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 frequently 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.

Advantages of process layout

(1) Wide flexibility exists as regards allotment of work to equipment and workers.

(2) Better utilization of the available equipment.

(3) Comparatively less number of machines are needed, thus involving reduced capital investment.

(4) Better product quality, because the supervisors and workers attend to one type of machines and operations.

(5) Varieties of jobs coming as different job orders make the work more interesting for the workers.

(6) Workers in one section are not affected by the nature of the operations carried out in another section. For example, a lathe operator is not affected by the rays of the welding as the two sections are quite separate.

Disadvantages of Process Layout (When Compared with Product Layout):

(1) For the same amount of production, process layout needs more space.

(2) Automatic material handling is extremely difficult.

(3) More material-in-process remains in queue for further operations.

(4) Completion of same product takes more time.

(5) Work-in-process inventory is large.

(6) Production control becomes difficult.

(7) Raw material has to travel larger distances for being processed to finished goods. This increases material handling and the associated costs.

(8) It needs more inspections and efficient co-ordination.

Product layout

It is also known as line (type) layout. It implies that various operations on raw material are performed in a sequence and the machines are placed along the product flow line, i.e., machines are arranged in the sequence in which the raw material will be operated upon. This type of layout is preferred for continuous production, i.e., involving a continuous flow of in-process material towards the finished product stage.

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 arranged

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.

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 is required.

Advantages of product layout

(1) Less space requirements for the same volume of production.

(2) Automatic material handling, lesser material handling movements, times and costs.

(3) Less in-process inventory.

(4) Product completes in lesser time.

(5) Better co-ordination and simple production planning and control.

(6) Smooth and continuous work flow.

(7) Less skilled workers may serve the purpose.

Disadvantages as Compared with Process Layout

(1) Since the specified product determines the layout, a change in product involves major changes in layout and thus the layout flexibility is considerably reduced.

(2) The pace or rate of working depends upon the output rate of the slowest machine. This involves excessive idle time for other machines if the production line is not adequately balanced.

(3) Machines being scattered along the line, more machines of each type have to be purchased for keeping a few as stand by, because if one machine in the line fails, it may lead to shut down of the complete production line. This is how product layout involves higher capital investments.

(4) Though it involves less supervision as compared to process layout, sometimes it (inspection) becomes difficult when one inspector has to look after many (say all welding) machines in two or more production lines.

(5) It is difficult to increase production beyond the capacities of the production lines.

Difference between process and product layout

Process layout	Product layout
Customized goods	Standardized goods
Varied path	Direct path
Low/fluctuating demand	High/stable demand
Fixed costs= low, variable cost= high	Fixed costs = high Variable costs = low
General-purpose equipment	Special purpose equipment
Functional grouping of activities	Sequential grouping of activities

Fig. 31 Difference between process and product layout

Combination layout

A combination of process and product layouts combines the advantages of the both types of layouts. Moreover, these days pure product or process layouts are rare. Most of the manufacturing sections are arranged in process layout with manufacturing lines occurring here and there (scattered) wherever the conditions permit. A combination layout is possible where an item is being made in different types and sizes.

In such cases machinery is arranged in a process layout but the process grouping (a group of number of similar machines) is then arranged in a sequence to manufacture various types and sizes of products. The point to note is that, no matter the product varies in size and type, the sequence of operations remains same or similar.

A combination layout is also useful when a number of items are produced in same sequence but none of the items are to be produced in bulk and thus no item justifies for an individual and independent production line. For example, files, hacksaws,

circular metal saws, wood saws, etc. can be manufactured on a combination type of layout.

Cell layout

Cellular manufacturing is a type of layout where machines are grouped according to the process requirements for a set of similar items (part families) that require similar processing. These groups are called cells. Therefore, a cellular layout is an equipment layout configured to support cellular manufacturing.

Processes are grouped into cells using a technique known as group technology (GT). Group technology involves identifying parts with similar design characteristics (size, shape, and function) and similar process characteristics (type of processing required, available machinery that performs this type of process, and processing sequence).

Workers in cellular layouts are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output. Sometimes the cells feed into an assembly line that produces the final product. In some cases, a cell is formed by dedicating certain equipment to the production of a family of parts without actually moving the equipment into a physical cell (these are called virtual or nominal cells). In this way, the firm avoids the burden of rearranging its current layout. However, physical cells are more common.

An automated version of cellular manufacturing is the flexible manufacturing system (FMS). With an FMS, a computer controls the transfer of parts to the various processes, enabling manufacturers to achieve some of the benefits of product layouts while maintaining the flexibility of small batch production.

Advantages of cellular manufacturing layout

Cost. Cellular manufacturing provides for faster processing time, less material handling, less work-in-process inventory, and reduced setup time, all of which reduce costs.

Flexibility. Cellular manufacturing allows for the production of small batches, which provides some degree of increased flexibility. This aspect is greatly enhanced with FMSs.

Motivation. Since workers are cross-trained to run every machine in the cell, boredom is less of a factor. Also, since workers are responsible for their cells' output, more autonomy and job ownership are present.

Fixed position layout

Layout by fixed position of the product is inherent in ship building, aircraft manufacture and big pressure vessels fabrication. In other types of layouts discussed

earlier, the product moves past stationary production equipment, whereas in this case the reverse applies; men and equipment are moved to the material, which remains at one place and the product is completed at that place where the material lies.

It is also called stationary layout. In this type of layout men, materials and machines are brought to a product that remains in one place owing to its size. Ship-building, air-craft manufacturing, wagon building, heavy construction of dams, bridges, buildings etc. are typical examples of such layout.

Advantages of fixed position layout

(1) It is possible to assign one or more skilled workers to a project from start to finish in order to ensure continuity of work.

(2) It involves least movement of materials.

(3) There is maximum flexibility for all sorts of changes in product and process.

(4) A number of quite different projects can be taken with the same layout.

Disadvantages:

(1) It usually involves a low content of work-in-progress.

(2) There appears to be low utilization of labour and equipment.

(3) It involves high equipment handling costs.

Application:

Layout by fixed position of product is limited to large items made singly or in very small lots.

Chapter 5 PRODUCTION AND PROCESS DESIGN

Unit 13 Organisational characteristics of process design

Production processes are designed to produce the required quantity of goods of the desired quality, at the right time, and at minimal costs.

Process design helps develop a detailed plan for manufacturing products or services, and provides the foundation and structure for production operations. Decisions regarding the selection of a process design for producing a product or a service are influenced by many factors such as the nature of demand for the product, the degree of vertical integration, product and volume flexibility, the degree of automation, the quality level required, and the degree of customer contact involved.

Process designs are basically of three types: product-focused, process-focused, and group technology.

- In product-focused production systems, the material flow is linear without any backtracking or side tracking. They are organized by the type of product or service being produced. They are primarily designed for high-volume and standardized products.
- Process-focused systems are designed for low-volume, small batch and customized products and are used mostly by processing industries.
- In a group technology layout, dissimilar machines are grouped into work centres to work on products similar in shape and processing requirements. It also identifies families of parts with common characteristics that are produced in larger batches and gives them a common code.

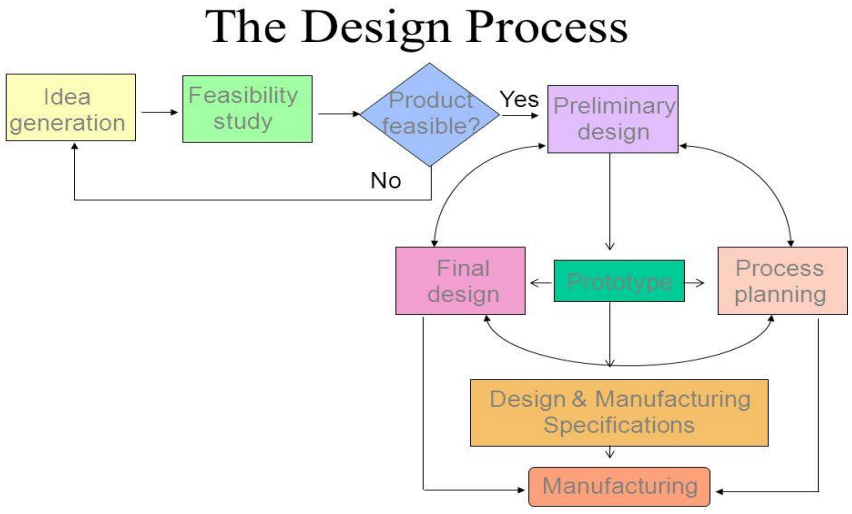

Fig. 32 The design process

An effective design process:

- Matches product or service characteristics with customer requirements.
- Ensures that customer requirements are met in the simplest and least costly manner.
- Reduces the time required to design a new product or service.
- Minimizes the revisions necessary to make a design workable.

Production design:

- Refers to how the product will be made. Designs that are difficult to make always result into poor quality products. Recommended approaches to production design include simplification, standardisation and modularity.
- Simplification reduces the number of parts, assemblies, or options in a product, whereas with standardisation, commonly available and interchangeable parts can be used.
- Modular designing combines standardized building blocks, or modules, to create unique finished products.

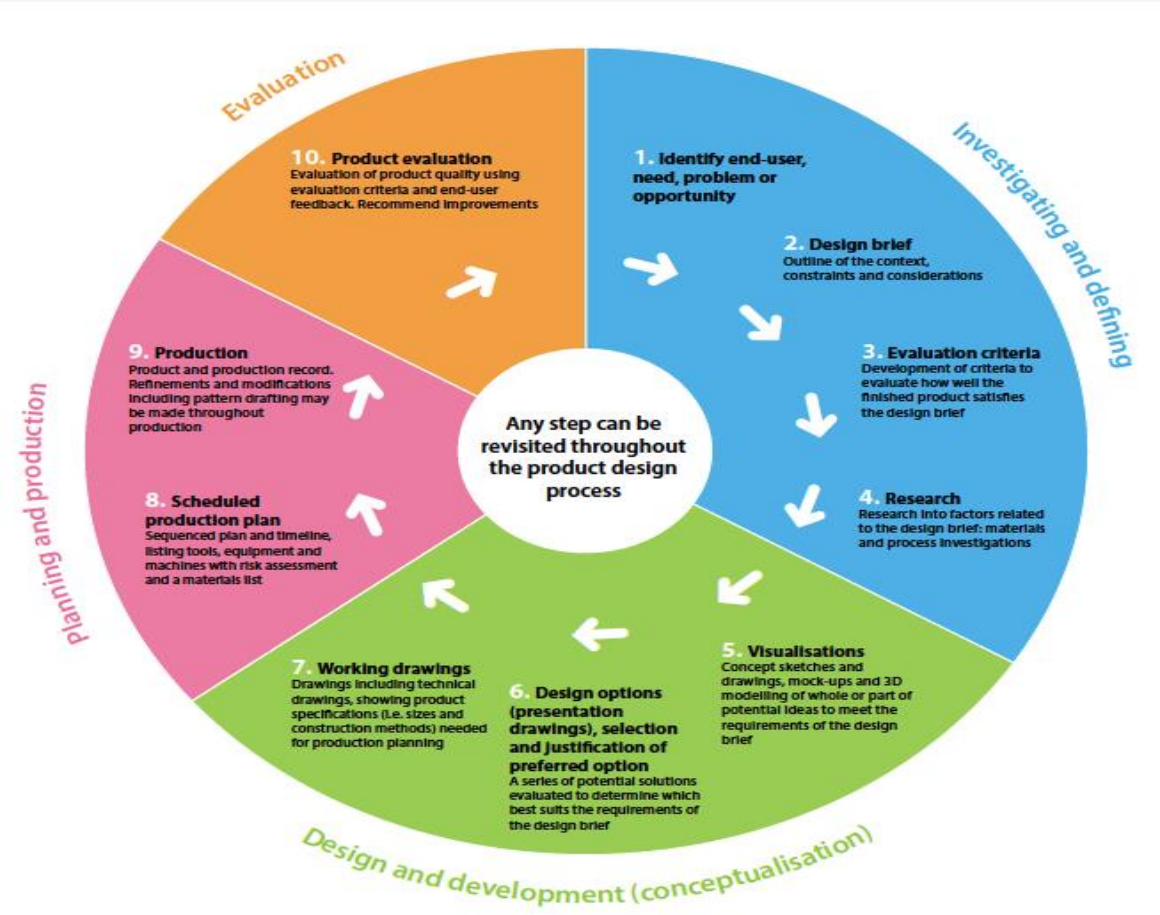

Fig.33 The design process

Functional Design (How the Product Performs)

Reliability. Probability product performs intended function for specified length of time

Maintainability. Ease and/or cost or maintaining/repairing product

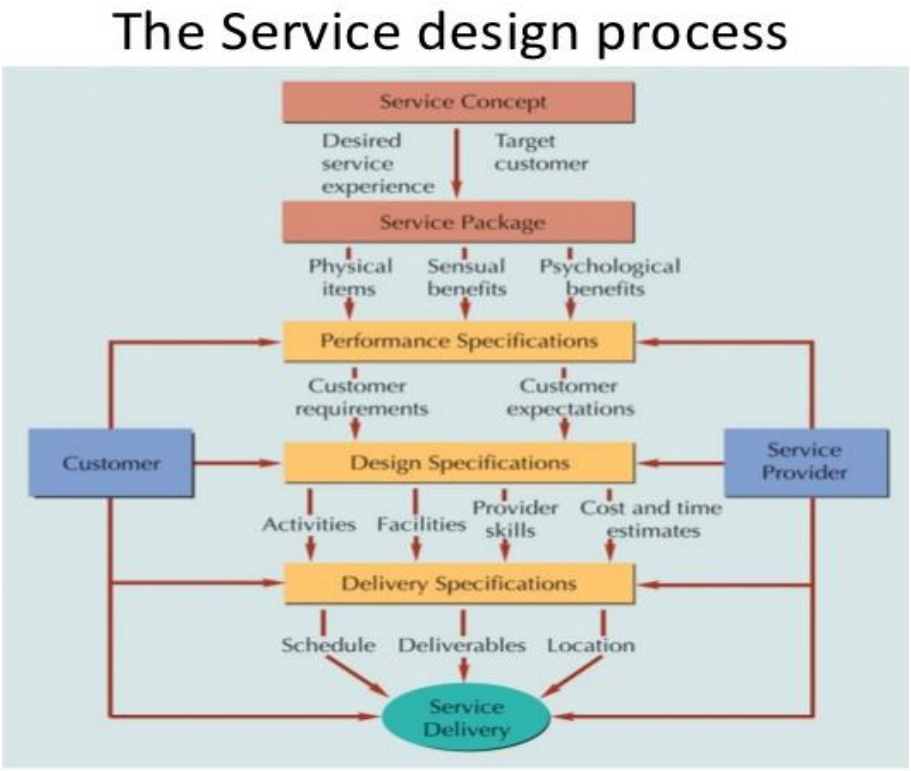

Fig. 34 The service design process

Final design and process plans:

- produce detailed drawings & specifications;
- create workable instructions for manufacture;
- select tooling & equipment;
- prepare job descriptions;
- determine operation & assembly order;
- program automated machines.

This design consists of detailed drawings and specifications for the new product or service. It also includes process plans, which are instructions for manufacture, including necessary equipment and tooling, component sourcing recommendations, job descriptions and procedures for workers and computer programmes for automated machines.

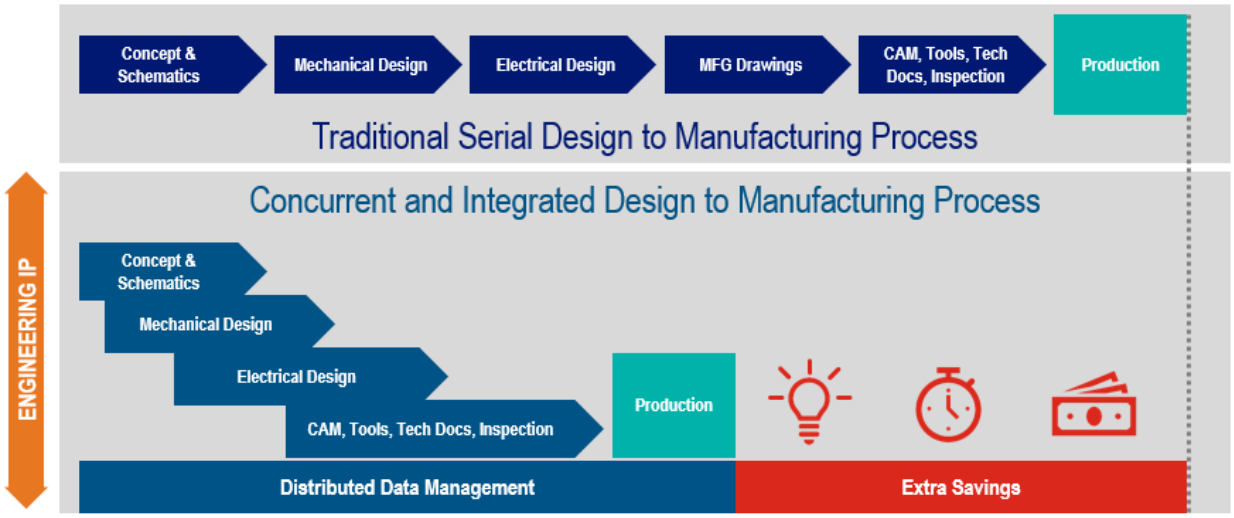

Fig.35 From design to manufacturing

Unit 14 Organisation of the new product production

When you want to start a new business, organise production or start another project, you have to formulate a goal.

SMART Goals

Fig. 36 SMART Goals

Goals should meet the following criteria:

Specific. well defined; clear to anyone that has a basic knowledge of the project;

Measurable and know if the goal is obtainable and how far away completion is.

Find out when you have achieved your goal.

Agreed Upon /Achievable. Agreement with all the stakeholders what the goals should be. Attainable and not impossible to achieve

Realistic/ Relevant. Within the availability of resources, knowledge and time

Time-Based. Enough time to achieve the goal. Not too much time, which can affect project performance.

Organisation of the new product production

A production organisation is another name for a business commonly referred to as a manufacturer. This type of company engages in business activities related to the production of products and equipment. As opposed to resale organisations, production firms earn revenue and profit from the design and development of high-quality products.

Organisation of production involves coordinated implementation of various processes i.e.: planning of operations, operative scheduling and quantity control. In particular, the manufacturing process consists of:

- research and development processes, including: the preparation of the production, supply and training of staff,
- manufacturing processes, which are divided into:
- manufacturing process including the implementation of the basic operations: technology, control, transport, storage, assembly, and manufacturing services,
- secondary manufacturing process associated with the management of technological equipment, maintenance, operation management tool, energy, storage of raw materials and finished products as well as external transport,
- service process involve administrative actions, security, safety and cleaning,
- distribution processes and customer service, responsible for sales and efficient service.

Three levels of product – core value, actual product, augmented product.

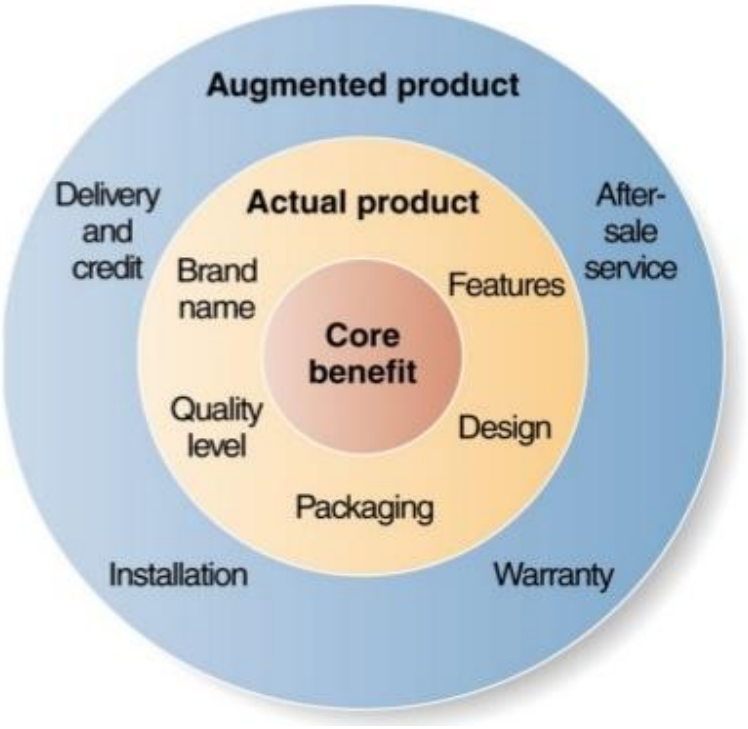

Fig. 37 Three levels of product

Research and development definition includes characterization of two interrelated processes in the company or whole industry, which result in the application of technological innovations, new products or improvements of the products. According to the official nomenclature research & development (R&D) is systematic creative work undertaken to increase the knowledge of man, culture and society, and the search for new solutions based on this knowledge.

Areas of research and development activity

To define research and development, three areas of activity should be distinguished:

- basic research,
- applied research,
- development work (prototypes making, testing).

Basic research performed at the level of theory and experiments have the goal to increase knowledge concerning the causes of phenomena and events, and their results can be applied in practice or not. Basic research does not apply to the economic primacy of their usefulness.

Applied research, in contrast to the previous category, uses knowledge to enable the achievement of practical goals or seeking applications for the results of basic research,

Development work consist in the use of the existing body of knowledge for the development of new or significantly improve existing products, processes or services. This is also the production of prototypes and pilot plants.

Research and development is related to the development of new products (product innovation) and processes (process innovation), performed by company's development team or acquired from other units should be seen as a kind of innovative activity. Research and development are the first stage of product life cycle.

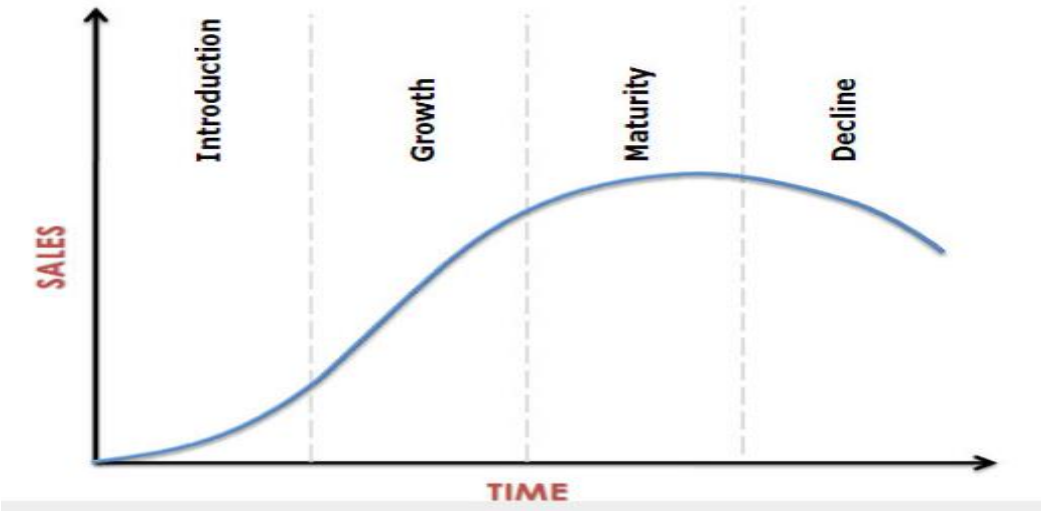

Fig. 38. Product life cycle

Product life cycle begins with product introduction, growing, maturating and ending with declining. The reason of that is continuous evolution of science and technology. Old and out-of-fashion things are in time replaced with new and fresh ones, which is absolutely natural event.

Introduction: A period of slow sales growth as the product is introduced in the market. Profits are non-existent in this stage because of the heavy expenses incurred with product introduction.

Growth: A period of rapid market acceptance and substantial profit improvement.

Maturity: A period of a slowdown in sales growth because the product has achieved acceptance by most potential buyers. Profits stabilize or decline because of increased competition.

Decline: The period when sales and profits decline.

According to the OECD innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation.

Meaning of innovation

Turning an idea into a solution that adds value from a customer's perspective (Nick Skillicorn)

The application of ideas that are novel and useful. Creativity, the ability to generate novel and useful ideas, is the seed of innovation but unless it's applied and scaled it's still just an idea. (David Burkus)

Very simply put, innovation is about staying relevant. We are in a time of unprecedented change. As a result, what may have helped an organisation be successful in the past could potentially be the cause of their failure in the future. Companies need to adapt and evolve to meet the ever-changing needs of their constituents. (Stephen Shapiro)

The introduction of new products and services that add value to the organisation. (Kevin McFarthing)

The fundamental way the company brings constant value to their customers business or life and consequently their shareholders and stakeholders (Paul Hobcraft).

Chapter 6 INTELLECTUAL PROPERTY IN INNOVATIVE ENTERPRISE

Unit 15 Intellectual Property for Business.

In an increasingly knowledge-driven economy, you invariably need creative or inventive ideas or concepts to improve an existing feature, add a useful new feature to your product or develop a totally new product. If your business develops such an idea or concept that solves a technical problem in an unexpectedly new or better way than it should take adequate and timely steps to protect its creative idea, concept or knowledge by converting it into a proprietary technical advantage by patenting it.

Sources of inventions

1. From in-house R&D facilities

If your business has some in-house research and development (R & D) capability, then it would be creating new or improved technology or adapting existing technology to meet your emerging needs.

2. From the marketing and sales side

Even if your business has no formal R & D facilities, yet some of your employees on the shop floor may be inventing, often without realizing it, while copying competing products or when required making adaptations to your existing products for a variety of reasons. Inventive ideas may come from any part of the company. A particularly good place to find inventions is on the marketing and sales side, who is in touch with the market trends and emerging needs of customers, and may come up with technical solutions to such needs.

3. From outside of the company

However, even when you have in-house R & D capability, there are many situations in which you may have to look for inventions or technology from outside your company.

Free source

Sometimes, you may get it free, for example, from the numerous, free, and easily available online patent databases, which include a lot of technologies that were either not protected at all in your market or by now their patent protection has lapsed or expired. As the information contained in a patent is free for anyone to use, both directly and indirectly, depending on the patent's legal status, therefore, you must always try this route, before developing it in-house and before looking around to buy it from outside. Most patent savvy businesses skillfully use patent databases, for example, to identify opportunities for adapting or acquiring patented inventions, or technologies. Also, mining a patent database may provide you with a solid basis for developing new ideas and concepts. However, the availability of useful information in patent databases depends on the nature of your business or industry, as some areas of technology have much more patent activity than others.

b. Licensing

But really useful new or improved technology is generally not available free of charge. In order to get useful inventions, you may have to buy or license it from others that are willing to do so on mutually acceptable terms and conditions.

Reasons for patenting an invention

(1) Competitive edge, market power and earning more money

When you are able to use a patented invention embodied in a technology in your business, it is likely to improve your market power, provide your business with a competitive edge, and help you to make more money. A patent provides protection when you disclose your invention publicly. For example, it would enable you to go to a fair, exhibition, or an industry trade show and display it without fear. It also enables you to go to a wholesaler or distributor and say with confidence that no one else in that market is allowed to make, sell, use or distribute your new or improved product without your express approval. This may either diminish, or eliminate competition. If that happens there would be typically increased sales, and if marketed properly, you may be able to charge a higher price because your competition is barred from offering an equal product. So, whenever you are able to use a patented invention embodied in a technology in your business, it is likely to improve your market power, provides your business with a competitive edge over competitors, and help you to make more money.

(2) Add New Revenue Stream. You may be able to add a new revenue stream by licensing a patent, or better still, a portfolio of your patents.

Fig. 39. Opportunities to generate income from the use of intellectual property

(3) Raise funds and attract potential investors

a. Patents may be bought, sold or licensed.

b. Patents may also serve as collateral for bank loans. Patents may attract potential investors to your company, as they are happy to see some type of barrier to entry for competitors, which may not only protect your investments in R & D and, thereby, improve the return on your investments, but also may provide income through licensing of your patents to others.

Most venture capitalist, investment bankers, financial analysts, and other investors favourably recognize the value of a patent.

(4) Bargaining Chip for Securing “Freedom to Operate”

A patent application, a patent or a portfolio of patents, is not only an asset for earning licensing revenue, but it is also often a valuable trading or cross-licensing asset if your patent is faced with a dominating senior patent and/or complementary patents. It can also be used as a bargaining chip during licensing negotiations with a competitor or when you are accused by another of patent infringement. Generally, when such negotiations result in a stalemate, the two sides agree to cross-license their patent portfolios to each other, with little or no need for exchanging money. So, a company, such as yours, may wish to obtain patents simply to defend itself against your competitor's patent portfolio, even though you may not want to take, or be capable of taking, any offensive action by relying on your patent portfolio. In other words, it improves your freedom to operate in the marketplace. The principal goal of a defensive IP strategy should be to obtain the freedom to market planned products. This process requires the identification and neutralization of any patent infringement risks.

(5) Selling the invention

Having a patent means you have a tradable asset which can therefore be sold. Generally, a large company will not agree to even talk to you unless one or more patents protect your technology or at least you have filed a patent application to protect your invention. It could be that your talks with a potential buyer end in failure. If that happens, you may need a way to stop such a party from stealing your idea, especially if a confidentiality agreement had not been signed or, even if such an agreement had been signed, if the other party acts in breach of it. Having a patent and thus the right to exclude the others enables you to take preventive action

(6) Strategic Partnerships, Mergers and Acquisitions, IPO, and Higher Sale Price

A patent or a patent portfolio may provide substantial value for entering new markets through strategic partnerships, or in mergers and acquisitions, and for getting a start-up company listed on the stock exchange through a good initial public offering (IPO) or for getting a higher sale price of an established company. In fact, one of the most valuable assets that a technology company could have is a portfolio of patents consisting of patents that may be owned, co-owned or licensed from others.

(7) Convoyed sales

When a customer goes to a shop to buy one item, he often ends up buying other related items. Similarly, when a customer is attracted by a patented improvement of a product, increased sales of non-patented articles may follow. This happens when

the patented product is a component of a more complex product or the patented product is sold in association with other products. These types of linked sales are known as add-on, collateral, derivative, follow-on or convoyed sales.

(8) Basis for Recognition and Rewarding Employees

A patent allows you to recognize or reward the tangible achievement to your inventor-employees.

(9) Part of Branding and Marketing Strategy

Not only employees, but also your product or even your whole business could use a patent or a portfolio of patents to signal higher technological capabilities, greater innovative abilities and superior performance, in your advertising, marketing and branding strategies.

In other words, a patent provides its owner a 'right to exclude' others but not a 'right or freedom to use" the patented invention. So, a patent gives its owner only an exclusive right to prevent or stop others, from making, using, offering for sale, selling or importing a product or process.

Definition. A patent is an exclusive right granted by a government for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem.

Criteria for granting a patent

In order to be patentable, an invention must meet the following three criteria:

a. It must be new;

b. It must involve an inventive step (that is, non-obvious to a person skilled in the relevant field of technology);

c. It must be capable of industrial application [10].

IP assets are a sub-set of intangible assets and distinguished from other intangible assets by the fact that these are created by law. As such, IP assets are legally protected and can be legally enforced. These can be independently identified, are transferable and have an economic life (in contrast to their legal life, which is generally longer than their economic life). IP assets include patents, industrial designs, trademarks, copyright and trade secrets.

Legal perspective: An IP asset can be defined in terms of particular qualitative characteristics or standards (such as that of novelty, originality).

Economic perspective: An IP asset can be defined in terms of the economic benefit linked to the IP asset.

An asset is a resource that is controlled by an entity (such as a company or a business) as a result of past events (for example, purchase or self-creation) and from which future economic benefits (inflows of cash or other assets; or reduction in costs) are expected [10].

Basically, the wealth of a business comprises of the following types of assets:

Wealth = Working Capital + Fixed Asset + Intangible Assets

An understanding of intellectual property (IP) can help your business become more competitive and manage IP related risks.

The IP system has an important role to play in helping you:

protect innovative products and services;

increase the visibility, attractiveness and value of your products on the market;

distinguish your business and its products from the competition;

access technical and business information and knowledge;

avoid the risk of unknowingly using third party proprietary content or inadvertently losing your own valuable information, innovations or creative output.

Understanding the benefits of IP

Defending your competitive space

Your innovative product/process or improved product/process can be protected by a patent right that can give your business a competitive advantage. The right to exclude others provided through patent protection allows you to fend off competition, assume a lead and secure market position.

Understanding how to protect trade secrets is also key to defending your competitive space. Specific product details, technological know-how and strategic business information are often key to the success of a business, allowing it to maintain its edge over the competition. Theft or accidental disclosure of trade secrets can deprive a business of these important advantages.

Visibility in crowded markets

Trademarks allow customers to distinguish your products/services from those of your competitors and serve as a guarantee of consistent quality. Great care should be taken in choosing and designing your trademark, protecting it, using it in advertising and policing its misleading/improper use by others.

The aesthetic aspect of your product, protected by an industrial design right, is another means by which you can distinguish yourself from the competition and gain market share. A visually attractive design alone can attract a demanding and diversified clientele and could constitute your product's single most important distinguishing factor [10].

Unit 16. IP valuation

Value of an asset

The value of an asset is the value of the future economic benefits it brings. The value of an asset, whether tangible or intangible, can be estimated. Some assets are

easier to value than others, and some valuations are more precise than others. Monetary or financial valuation is the process of determining or measuring reliably the value or worth of an asset in certain circumstances, the cost or price of an asset may be a good indicator of its value.

Value of an IP asset?

(1) The value of an IP asset derives, in essence, from its ability to exclude competitors from a particular market. Whilst the legal right grants exclusivity or the right to exclude, the economic right is based on exclusivity of use, that is, the ability to control the use of the IP asset. For an IP asset to have a quantifiable value, it should:

- generate measurable amount of economic benefit to its owner/user.
- enhance the value of other assets with which it is associated.

(2) How to derive value from an IP asset

a. Direct exploitation of the IP

b. Through sale or licensing of the IP

c. Even by not exploiting an IP asset (i.e., by merely owning it), it may be possible to add value, for example, by:

- minimizing the negotiating power of customers,
- raising barriers to entry by competitors,

reducing the threat of substitutes.

Definition of IP valuation

IP valuation is a process to determine the monetary value of IP object.

(1) Prerequisites for Undertaking IP Valuation

To be able to do the valuation of an IP asset, it must be separately identifiable.

a. The IP asset must be subject to specific identification and a recognizable description.

b. There should be some tangible evidence or manifestation of the existence of the IP asset (e.g., a contract, a license, a registration document, a CD, a set of procedural documentation, a listing of customers, recorded on a set of financial statements, etc.)

c. It should have been created or have come into existence at an identifiable time (or time period) or as the result of an identifiable event.

d. It should be capable of being legally enforced and legally transferred.

e. It should be capable of having its income stream separately identifiable and isolated from the contribution of other assets employed in the business.

f. It should be capable of being sold, without selling the other business assets of the enterprise to the same buyer.

g. It should be subject to being destroyed or to a termination of existence at an identifiable time (or time period) or as the result of an identifiable event

IP valuation triggers.

There are numerous individual reasons or motivations for conducting an IP valuation. The **valuation triggers** refer to the reason or purpose of the valuation are shown in the table 4.

The IP valuation triggers

Table 4

Classification	Valuation trigger
Transaction	Licensing of IP assets; franchising; Sale or purchase of IP assets M&A; divestures, spin-offs Joint venture or strategic alliance Donation of IP assets
Enforcement of IP rights	Calculation of damages when IP right is infringed
Internal use	Investment in R&D Internal management of IP assets Strategic financing and/or raising equity/capital Investor relations
Other purposes	Financial reporting Bankruptcy/liquidation Optimizing taxation Insurance of IP assets

Transaction

1) Licensing of IP assets; franchising

Before conducting negotiations for licensing-in or licensing-out of IP, a thorough understanding of the value of the IP assets ensures more informed negotiation and decision-making concerning the terms and conditions of the proposed license, especially in determining fair and robust royalty rates for optimal exploitation of the IP asset. In franchising too, both the franchisor and the franchisee require a thorough understanding of the value of the IP assets, notably trademark(s) and trade secrets or know how.

2) Sale or purchase of IP assets

Before selling or buying IP assets, proprietary technology or a company, one needs to know the value of the relevant IP assets to decide whether to proceed with the sale or purchase and, if so, at what price.

3) Merger & Acquisition (M & A); divestitures, spin-offs

Often, the primary reason for considering an M & A transaction is the value of the IP assets of the target company. In such a case, one should consider whether the stand-alone purchase or licensing-in of the relevant IP assets would suffice. If not, then only one should proceed to consider an M & A transaction. In both cases, IP valuation is crucial to making an informed decision. Valuation of the IP assets of the target company often identifies additional value that significantly enhances the final sale or purchase price. Doing so also ensures that deals are priced and structured by keeping IP risks and value realization opportunities in mind. Further, IP valuation enables the parties to take an informed decision on the acceptable cost of capital or deciding on financial leverage strategy to be followed. Understanding fully the strategic fit and value extraction opportunities of the target's core and non-core IP assets facilitates post-deal IP integration and maximization of the returns from the acquisition. It also influences positively the resulting company's value and share price.

4) Joint Venture or Strategic Alliance

Before contemplating entering into a joint venture or other types of strategic alliances one should make a comparative analysis of the value of IP assets involved in the various options under consideration. In structuring a joint venture deal, the parties involved should understand as to how much value IP assets contribute to it. The same is true of a strategic alliance, as both parties would be well placed to take advantage of the deal if they are not only aware of the technological contribution of the IP assets but also of their monetary value.

5) Donation of IP Assets

When an enterprise owning IP assets is not using the IP assets in its core business or is not usefully licensing-out, whether the IP assets are core or non-core to its business, it should consider donating such IP assets, as donation of IP assets may attract significant tax benefits in some countries. For calculating the tax benefit, it is important to value such IP assets. Tax authorities would not be interested in understanding how the value of any donated IP asset was calculated but may also prescribe rules as to how the value of an IP asset should be calculated.

Enforcement of IP rights

Calculation of Damages

Knowledge of the value of an IP asset influences the decision about the strategy to be used when it is infringed. IP valuation enables an entity to decide whether to

pursue the infringement through a court action (by filing a suit for infringement), take recourse to alternative dispute resolution mechanisms, such as mediation or arbitration, or consider licensing of the IP asset to the infringer. In the event of a successful infringement prosecution IP valuation plays an important role in calculating damages, whether those damages are based on an assessment of the infringer's profits or a reasonable royalty.

Internal Use

1) Investment in Research and Development (R&D)

While considering whether to invest in R & D, the value of potential IP assets may be a key factor in taking a decision.

2) Internal Management of IP Assets

IP valuation helps in budgeting and resource allocation decisions. For example, if a company is spending a significant amount of money on internal R&D but is losing ground to competitors due to slow or late product introductions, it may need to rethink its R&D strategy and processes. In today's knowledge economy, more companies are turning to an open innovation model of actively buying and licensing innovations from other entities to supplement or even replace internal R&D. During an IP audit, the review of an IP portfolio provides an opportunity to identify IP assets whose value, for example, has become insignificant or markedly decreased. If such IP assets are used only in a non-core business activity or their strategic importance has become insignificant, it may be decided as to whether to continue maintaining such IP assets, license them, sell them or let these IP assets lapse. Thus, an informed decision to discontinue payment of maintenance fees may lead to substantial cost savings. IP valuation also provides strategic guidance for new product development, brand-extensions, line-extensions, managing foreign filing and prosecution costs, etc.

3) Strategic Financing and/or Raising Equity/Capital

Despite challenges in perfecting a security interest in IP assets, some banks are relying on IP assets to secure debt financing. In the past, for monetizing an IP asset, meant taking steps to create a product or secure a royalty stream. With an emerging secondary market for IP assets, new ways to monetize IP assets are being devised. For example, in the recent past, revenue streams linked to a portfolio of copyright or patent assets have provided the basis for creating IP asset backed securities. For such IP asset-backed securitization, the valuation of an entity's IP assets is crucial. As a result, in recent years, IP financing deals have been completed through a number of financial vehicles – securitization, bank debt, hedge funds and private equity. Venture capitalists are beginning to look at patent strategies and patent portfolios. Usually, they do not engage in quantitative valuation of IP assets or of portfolios of

IP assets. Rather venture capitalists prefer to value the company as a whole and consider the role of IP in that process. Asset-backed securitisation is the process of pooling homogeneous financial assets and issuing securities backed by the financial assets into the capital markets. It relies on the structured financing and characteristics of collateral to achieve creditworthiness. Pools of assets are transferred into a special purpose vehicle (SPV). Securities are rated on the strength of the legal structure and level of credit enhancement, based on historical performance.

4) Investor Relation

In the case of a listed company, an IP valuation helps to communicate the value of its IP assets to capital markets, supports its share prices, and helps to obtain funding from investors. Valuation of IP assets is also required for initial public offering (IPO) documents.

Other Purposes

1) Financial Reporting

The recognition of the increasing share of IP assets in the total market value of enterprises has contributed to the change in the way the accounting community has begun to treat IP assets in financial reporting. Historically, accounting practice did not recognize the separability of IP assets from other forms of intangible assets and, hence, IP assets were not included in the balance sheets of a company. However, the international accounting standards board (IASB) now recognizes acquired and identifiable intangible assets (i.e., IP assets) and requires all acquired IP assets to be recognised as assets, separately from goodwill, on the balance sheet of the business acquiring the IP assets. The value of internally generated IP assets continues to be left out of the balance sheets of companies. The reason for excluding internally generated IP assets is that any value reported on the balance sheet has to be objective, reliable, and verifiable/auditable. Any asset whose value is calculated on the basis of predictions of future cash flows and on the basis of estimation of an “appropriate” discount rate is considered to be too subjective for financial reporting purposes. In many countries, acquired intangible (including IP) assets are amortizable provided their useful life to business, or income generation, is of a limited duration, and provided the useful life can be accurately estimated. IP assets, such as trademarks, with an indefinite useful life must undergo an annual impairment test. When a brand is acquired, IP valuation is done for the initial valuation as well as the periodical impairment tests for the derived values to be included in the balance sheet.

2) Bankruptcy/Liquidation

In a bankruptcy, the IP assets of the bankrupt company have to be valued, as also its physical assets, in determining how those are assets are to be distributed.

3) Optimizing Taxation

In devising ways to optimize the tax to be paid by a company, its assets, including its IP assets, require to be valued. IP assets create numerous opportunities for tax planning in both third-party transactions as well as internal strategies such as cross-border transfer pricing and centralizing the ownership of IP assets in IP holding companies. The internal revenue service or other tax authorities would like to know as much as possible about the basis for any value determination used when allocating portions of the purchase price associated with the acquisition of a company. In the past, many companies had allowed their affiliates to use their trademarks for little or no charge, but as the realization has grown of the profit generating powers of trademarks, companies have increasingly taken to charging royalties for their use. This has alerted tax authorities around the world, with many now asking companies to charge their subsidiary operations for the use of their trademarks. Valuation of IP assets helps in assessing fair transfer prices for the use of IP assets, including brands, to subsidiary companies.

4) Insurance of IP assets

A new market is opening up for the insurance of IP assets with a number of major insurers in the developed countries creating products tied to the capital value of IP assets, especially trademarks/brands.

Methods of valuation

Cost method

The **cost method** establishes the value of an IP asset by calculating the cost of a similar (or exact) IP asset. The cost method is particularly useful when the IP asset can be easily reproduced and when the economic benefits of the asset cannot be accurately quantified. This method does not account for wasted costs, nor does it consider any unique or novel characteristics of the asset.

Advantages of cost method

Cost method is a useful method when:

- Subject IP assets can be easily reproduced, for example, software
- the income stream or other economic benefits associated with the asset being valued cannot be reasonably and/or accurately quantified
- there is no economic activity to review, such as early-stage technology that is not yet producing revenue
- there is no direct cash flow being generated from use of the subject IP assets
- the IP forms part of a larger group of assets when other valuation methods are not appropriate;
- calculating a floor or minimum value/price for an IP asset however, the floor so calculated may be inaccurate when the cost includes elements that do not add value to the IP asset

- establishing a maximum price for buying an IP asset when many candidates for substitution are available.

Disadvantages of cost method

- Cost method does not account for wasted costs

- often vast amounts sums spent on pharmaceutical research projects result in no benefit.

- It does not consider the unique and novel characteristics of IP. Therefore, it usually does not incorporate the expected economic benefits or the income generating potential of the IP asset.

- It does not take into account the factors of risk and uncertainty associated with realizing the economic benefits associated with the IP asset.

- It does not directly incorporate the trend in benefits associated with the IP. An IP asset that provides economic benefits with an increasing growth rate can be far more valuable that which displays a downward trend.

- The duration over which the economic benefits will be enjoyed is yet another element not considered in this method, as the Remaining Economic or Useful Life (RUL) of the IP is a vital component in valuation.

- It may not provide an indication of the "highest price obtainable" in the open market, in the context of the "fair market value" standard.

- This is because potential purchasers, may be willing to pay a premium over the cost they would incur in attempting to replicate the property, to become the proprietor of a novel product on a timely basis.

Market method

The **market method** is based on a comparison with the actual price paid for the transfer of rights to a similar IP asset under comparable circumstances. This method has the advantage of being simple and based on market information, so it is often used to establish approximate values for use in determining royalty rates, tax, and inputs for the income method.

Advantages of market method

Simplicity - Use of market-based information - Can be very useful if exact comparable are available (e.g., license agreements related to the same technology) - Often used to establish "ballpark" values, especially for royalty rates - Favored by tax authorities for deals with affiliates - Best for deriving inputs for the Income method

Disadvantages of market method

By definition, an IP asset is unique. It is not possible to find an exactly alike or even a similar or comparable IP asset. Even if that were possible, it is generally not possible to have readily available information, which could be used for valuing the

subject IP asset. - Market method ends up comparing the general information available in the market; it is unable to consider specific factors leading to a specific transaction. - The time factor may affect the usefulness of historical databases. - It is a difficult method to use for comparing deals with multiple forms of compensations (e.g., equity, milestone payments, running royalties) - Many "hidden" deal factors (e.g., strategic buyer "premiums") cannot be considered. - Outside influences that affect royalty rates of IP assets, (e.g., fame, when celebrities use their images/names as trademarks), cannot be considered.

Due to the depth of the required information to ensure comparability, often the only good transactional data is from a transaction where there is complete access to the legal agreement. Generally, however, such IP transactional data is highly confidential.

Income method

The **income method** is the most commonly used method for IP valuation. It values the IP asset on the basis of the amount of economic income that it is expected to generate, adjusted to its present-day value. This method is easiest to use for IP assets with positive cash flows, for those whose cash flows can be estimated with some degree of reliability for future periods, and where a proxy for risk can be used to obtain discount rates.

Advantages and Disadvantages of income method, especially DCF

Since DCF method is the most frequently used, let's look over the advantages and disadvantages of DCF method as follows:

Advantages

The DCF method is easiest to use for IP assets whose - cash flows are currently positive, and - can be estimated with some reliability for future periods, and - where a proxy for risk that can be used to obtain discount rates is available. It best captures the value of IP assets that generate relatively stable or predictable cash flows. It forces you to think about the underlying characteristics of the firm, and understand its business. If nothing else, it brings you face to face with the assumptions you are making when you pay a given price for an asset.

Disadvantages

The DCF method does not explicitly account for the total riskiness of these cash flows but only for the systematic component of that risk in the form of market determined discount rate. It assumes that the investment in the IP asset is irreversible, irrespective of the circumstances in the future. In brief, the DCF method does not accommodate the option like nature of certain corporate investments and ignores managerial flexibility. It does not capture the unique independent risks associated with an IP asset such as patent. All risks are lumped together and are

assumed to be appropriately adjusted for in the discount rate and the probability of success, rather than being broken out and dealt with individually (i.e., such as legal risk, technological risk, infringement, etc.) It fails to consider dependencies on patents owned by others [10].

Chapter 7 LABOUR AND PRODUCTIVITY

Unit 17 Meaning of Labour.

In simple meaning by 'Labour' we mean the work done by hard manual labour mostly work done by unskilled worker. But in Economics, the term labour means manual labour. It includes mental work also. In other-words we can say that Labour includes both physical and mental work undertaken for some monetary reward. In this way, workers working in factories, services of doctors, advocates, officers and teachers are all included in labour. Any physical or mental work which is not undertaken for getting income, but simply to attain pleasure or happiness, is not labour.

Productive and Unproductive Labour:

Productive Labour is that labour which adds net value to the product. While unproductive labour is that which does not add net value. In other-words we can say that "Labour producing material goods are productive and Labour producing perishable goods including services of servants, teachers, doctors, lawyers etc. are unproductive."

But according to Prof. Marshall all labour is productive. He saw-"no distinction in the work of the baker who provides bread for a family and that of the cook who prepares rice or boiled potatoes". Modern economists following Marshall regard all Labour whether material or non-material or services as productive.

Only that Labour is considered unproductive which is performed by anti-social persons such as pickpockets, thieves, dacoits etc. But Labour used in constructing building, a dam etc. is productive because the workers worked on them and receives wages.

In this connection Prof. Robbins has written "Whether Labour is productive or unproductive does not depend upon its physical or mental nature of work. Rather it depends upon its relative scarcity in relation to its demand. All kinds of Labour which has a demand and receives a wage is regarded as productive."

Labour is the fundamental and active factor of production Labour has important contribution to the production of commodities. Labour is the exertion of mind and body undertaken with a view to some goods other than the pleasure directly derived from the work. Like a commodity, Labour cannot be stored and withdrawn from the market for a favourable time if the wage offered in low.

Further, Labour is inseparable from labourer and has to be be delivered personally, working conditions or environment are of great importance. If the place of work is congenial and the management is kind hearted, even a lower wage can be acceptable. Labour has a weak bargaining power; therefore, the employer has an upper hand in Labour transactions and the wage given is lower than it is due.

The supply of Labour cannot quickly adjust to the change in demand. The wages sometimes rule higher and at other times lower than need be. As the Labour has no calculable cost of production, it has to be satisfied with the wage it can receive or it receives.

Therefore, Karl Marx has said—" Capital is the collective shape of Labour performed in the past. Land which has been made for productive purposes is the important effort of Labour". Hence, we cannot ignore the importance of Labour in Economics.

Unit 18. Labour Productivity

Labour productivity, also known as workforce productivity, is defined as real economic output per labour hour. Growth in labour productivity is measured by the change in economic output per labour hour over a defined period. Labour productivity should not be confused with employee productivity, which is a measure of an individual worker's output.

How to Calculate Labour Productivity

To calculate a country's labour productivity, you would divide the total output by the total number of labour hours.

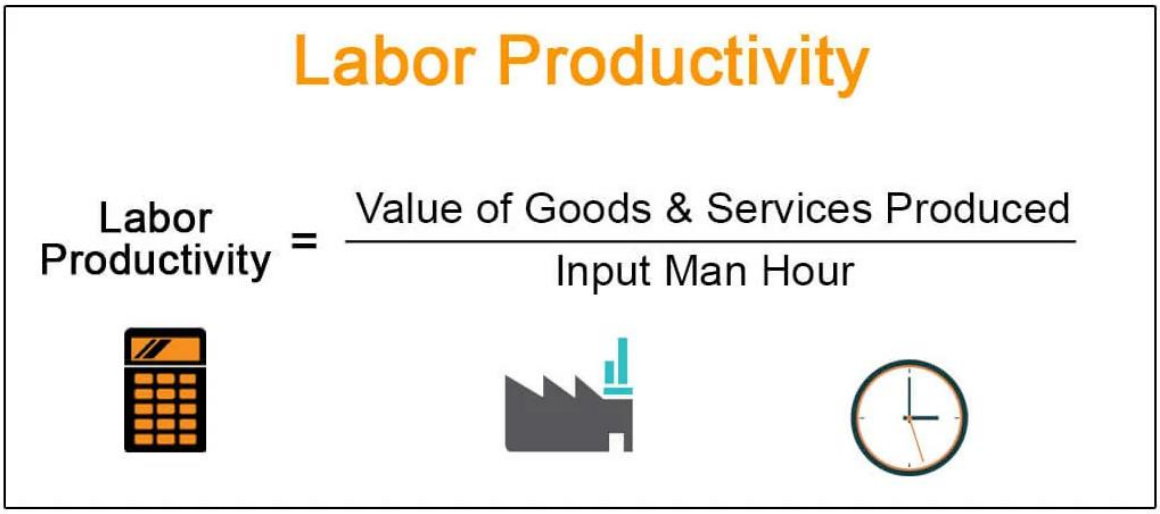

Fig. 40 Labour productivity

Labour productivity is directly linked to improved standards of living in the form of higher consumption. As an economy's labour productivity grows, it produces more goods and services for the same amount of relative work. This increase in output makes it possible to consume more of the goods and services for an increasingly reasonable price.

Growth in labour productivity is directly attributable to fluctuations in physical capital, new technology, and human capital. If labour productivity is growing, it can usually be traced back to growth in one of these three areas. Physical capital is the

tools, equipment, and facilities that workers have available to use to produce goods. New technologies are new methods to combine inputs to produce more output, such as assembly lines or automation. Human capital represents the increase in education and specialization of the workforce. Measuring labour productivity gives an estimate of the combined effects of these underlying trends.

Labour productivity can also indicate short-term and cyclical changes in an economy, possibly even turnaround. If the output is increasing while labour hours remain static, it signals that the labour force has become more productive. In addition to the three traditional factors outlined above, this is also seen during economic recessions, as workers increase their labour effort when unemployment rises and the threat of lay-offs looms to avoid losing their jobs.

Productivity in manufacturing

When measuring labour productivity, the number of output units over a set period of time is important. However, their quality, or the amount of waste they generate is not. Thus, a workforce that rushes out twice as many products in the same amount of time is considered more productive – even if those products are so poorly made, they lead to more returns and customer complaints.

Efficiency in manufacturing

Efficiency is the ability to produce something without wasting materials, time or energy. It is often expressed as a percentage, with 100% being the ideal target of maximum efficiency. In the scenario above the workforce is considered less efficient because they wasted materials, time and energy producing low-quality products.

Similarly, it's possible to run a much more efficient factory – say, where time was taken to pick up every dropped screw or component and return it to the production line – but at the expense of productivity.

Balancing productivity and efficiency

It's important to strike a balance between productivity and efficiency. Imagine if a business focused solely on increasing the number of units, they produce in an hour but neglected costs and quality. They might have achieved their aim but at the cost of wasted materials and lower quality items.

On the flip side, if a business focuses solely on increasing efficiency, they might end up with the most cost-effective products that are of high quality but won't have enough stock on hand to meet customer demands, which can end up hurting the bottom line.

Finding the right combination of productivity and efficiency allows you to optimise your output while minimising losses.

The importance of productivity

Productivity is a key source of economic growth and competitiveness. Economists use productivity growth to model the productive capacity of economies. This helps build better forecasts for business cycles and predict future levels of GDP growth, and assess demand and inflationary pressures.

What is productive efficiency?

Productive efficiency, or production efficiency, describes a level in which an economy or business can no longer produce more of one product without lowering the production level of another product. It refers to the level of maximum capacity where the business or economy makes full use of all their resources to generate the most cost-efficient product. Productive efficiency typically happens when production occurs along a **production possibility frontier**.

To measure productive efficiency, divide output over a standard output rate and multiply by 100 to get a percentage. This is used to analyse the efficiency of a single employee, groups of employees, or sections of an economy.

Productive efficiency = (Output rate / Standard output rate) x 100

The standard output rate is a rate of maximum performance or maximum volume of work produced per unit of time using a standard method. Reaching 100% productive efficiency means you have achieved maximum production efficiency.

Maximum production efficiency can be difficult to achieve. Many businesses try to find a balance between using their resources, the rate of production and the quality of goods produced — without reaching full production capacity.

Unit 19 Productivity and the price of labour

Orthodox economic theories

The complex character of labour as a commodity is nowhere more evident than in the relationship between pay and productivity. According to conventional economic theory, productivity should be the straightforward determinant of the employer's demand for labour. An employer who wishes to maximize profits will continue to recruit only up to the point at which the extra output gained from another worker equals the wage that worker is to be paid. This theory of marginal productivity lies at the heart of the orthodox economic theory of labour.

The value of the theory, however, has come under question. Empirically minded economists note the profound difficulty of applying the theory when the productivity of individual labour in most organisations is unmeasurable and wage structures are internally connected. Aware of its weak analytic power, contemporary theorists in the orthodox tradition have suggested minor elaborations. Noting a number of apparently discordant empirical and institutional features of the labour market, they have tried to bring them into the scope of formal economic analysis.

Thus, taking the finding that local labour markets support a wide range of wage rates for a given grade of labour, search theory has tried to explain the phenomenon as a product of imperfections in information about available jobs and the consequent cost of searching. The same phenomenon is addressed by efficiency wage theories, which propose that the higher-paid occupants of a job grade are also achieving above-average productivity. Implicit contract theories, noting the considerable duration of most labour contracts, account for it as a necessary cost in the effort to overcome the difficulty of monitoring an employee's performance. That wages do not fall to levels that might, according to orthodox theory, eliminate unemployment is explained by insider–outsider theorists as a reflection of collusion between self-interested parties—in particular, those possessing jobs.

Such theorizing is promising, but it has shown relatively little explanatory power. It remains limited by a highly constraining view of the worker as an individual of purely rational motives and by an inability to grasp the significance of collective norms and behaviour in labour matters. It fails to explore the consequences of a world of imperfect product and labour markets, and its blindness to the open-ended character of the employment relationship prevents it from analysing the significance of the varied institutional devices with which managers try to elicit productivity.

Empirical, multidisciplinary analysis

Something can be learned from the way in which employers manage productivity in practice. Employers pay great attention to internal pay structures, using job evaluation and other techniques to assure a stable and controlled structure of status within the work force. They give less detailed attention to what other employers are paying, so long as they keep the general level of pay increases broadly in line. They generally use specific incentive schemes more to generate an atmosphere of cooperation and flexibility than to make people work harder. Improvement in labour productivity comes overwhelmingly from technological change, requiring employees not to work harder but to work differently. The stress of such change to the employee is essentially temporary. It involves working with different workmates, facing the daunting challenge of learning a new skill, mourning for the lost opportunity to perform a skill of which one was once proud, and so on. Managers typically respond to the stress of meeting technological change with a temporary payment, although it may not seem temporary at the time. They may, for instance, introduce a new skill grade to match the new technique but remove it in a grade restructuring after a few years when memories of the upheaval have dimmed.

Employers are primarily concerned with unit costs, which involve both absolute wage levels and labour productivity. This concern arises from the pressures of the

product market, which tend to override opportunities to pay what the labour market will bear. Employees, by contrast, think primarily of relative wages, especially very local relativities, and have only a fitful, vague, and temporary concern with their own productivity. They also place a relatively low priority on the opportunities offered by alternative wage levels in the labour market. It is in meeting this asymmetry of aspirations that the successful management of productivity lies, requiring constant tactical skill and personal attention on the part of employers.

Such management implies the antithesis of marginal-productivity theory for two reasons. The first is that in a complex organisation the productivity of the individual means nothing, and the productivity of the overall organisation means everything. The second is that, in a world of imperfect markets, expecting prices to approach equilibrium in just one—the labour market—misses the important fact that competition is a total process, pursued on many fronts, such as design, marketing, and labour productivity—of which a competitive price for labour is only one.

Labour is by any standards an exceptional commodity. The quality of it is molded by its social context, and it is able to influence the shape of its own markets. Only a multidisciplinary analytic approach can unravel this complexity. The competitive forces of the economists' marketplace do indeed have a substantial impact upon the price of labour, although through more than just the specific market for labour itself. The level at which these forces are most evident is at that of broad aggregates and long-time spans.

Movement of the general level of pay

A wage is a price, and the rise of the general level of wages or rates of pay in the course of time has, to some extent, been part of the long-term rise in the general level of all prices—that is, of the cumulative depreciation of the purchasing power of money, largely attributable to increases in its quantity. In another way, however, the movements of rates of pay have been an independent cause of the rising trend of prices. At times those rates rose in common with prices under the pull of monetary demand (in times of inflation, during war, or in the rising phase of the trade cycle), but when the demand fell off they were resistant to cuts; and though they were cut somewhat, they commonly remained at a higher level than when the preceding rise began. A graph of product prices shows big falls as well as big rises, and sometimes a falling trend persisting for many years together; but a graph of money wage rates is more like a flight of steps. This characteristic of wage movements puts a floor under prices and provides a higher starting point for the next upward movement, so that the fluctuations of monetary demand impose a rising trend on prices. In addition, the analysis of cost inflation under full employment,

noted above, has shown that when employers generally expect demand to be sustained, rises in pay may occur in the absence of excess demand, thereby initiating rises in prices; and it is possible that the same process may have played some part in the rising phase of the trade cycles of earlier years.

The rise of real earnings may be traced by comparing the movements of earnings in money with those of an index number of the prices of the articles on which pay is typically expended. Such comparisons indicate that between 1860 and 1960 the real earnings of manual workers rose fourfold in France, Germany, and the United Kingdom; more than fivefold in the United States; and more than sevenfold in Sweden. In considering the standard of living attendant on these movements, it is necessary also to take account of the prevailing reduction in the size of the family, the complex effects of urbanization on the amenities of life, the effects of changed techniques and deployment between occupations on the strains and satisfactions experienced in work, and the reduction of hours of work. The last element has been extensive: it appears that down to World War II the wage earners of the five countries mentioned, save the United States, gave up from a third to a half of the potential increase in annual purchasing power in favour of a shorter working week and longer vacations.

To the extent that real earnings are measured simply by the quantity of consumables that money earnings will buy, their rise has depended on three factors: productivity, or the output per worker in terms of his own product; the share of this product that accrues to the worker; and the rate of exchange between the worker's own product and the goods and services he buys. In the industrialized countries, the last factor has presented itself largely in the form of the terms of trade between manufactured products and primary products, especially foodstuffs: real earnings have risen faster or slower according as a representative consignment of manufacturers may be exchanged, at the prices of the day, for a greater or smaller quantity of foodstuffs and raw materials. There have also been variations from time to time in the second factor: the share of the product accruing to the worker. The effect of the last two factors, however, has been small in comparison with that of the first, the rise of productivity. The salient finding from the statistical record of the last hundred years is that real earnings per worker have risen very nearly in the same proportion as output per worker.

Chapter 8 PRODUCTION PLANNING AND CONTROL

Unit 20 Production planning and control

Meaning:

Production planning involves management decisions on the resources that the firm will require for its manufacturing operations and the selection of these resources to produce the desired goods at the appropriate time and at the least possible cost.

Definition:

"The planning of industrial operations involves four considerations, namely, what work shall be done, how the work shall be done and lastly, when the work shall be done.

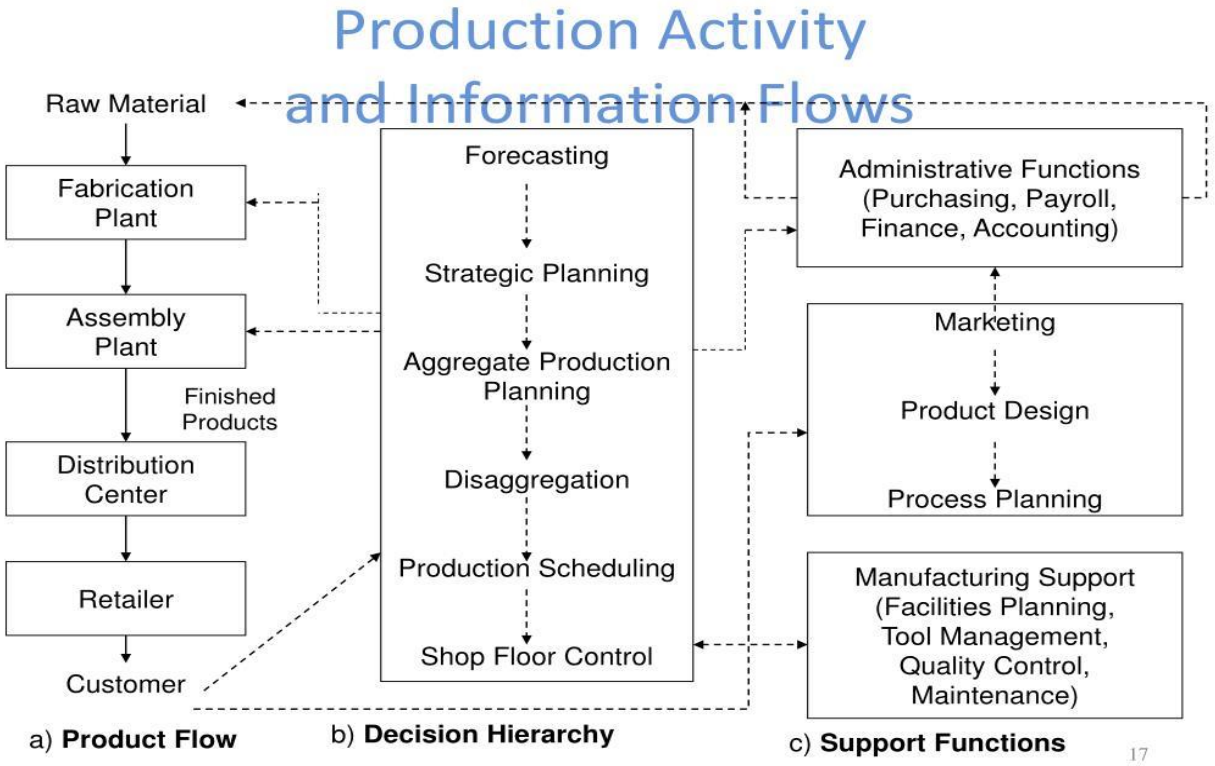

Fig.41 Production activity and information flows

Fig. 42. Objectives of production planning

Objectives of production planning are:

1.To determine the requirements of men, material and equipment.

2.Arranging production schedules according to the needs of marketing demand.

3.Arranging various inputs at a right time and in right quantity.

4.Making most economical use of various inputs.

5.To achieve coordination among various departments relating to production.

6.To make all arrangements to remove possible obstacles in the way of smooth production.

7.To achieve economy in production cost and time.

8.To operate plant at planned level of efficiency.

9.Making efforts to achieve production targets in time.

10.Providing for adequate stocks for meeting contingencies.

Production control

Meaning:

Production control guides and directs flow of production so that products are manufactured in a best way and conform to a planned schedule and are of the right

quality. Control facilitates the task of manufacturing and see that every theme goes as per the plan.

Definition:

"Production control refers to ensuring that all which occurs is in accordance with the rules established and instructions issued". Henry Fayol.

Objectives of production control

1.To implement production plans by issuing orders to those who are supposed to implement them.

2.To ensure that various inputs like men, machine, materials etc. are available in the required quantity and quality.

3.Making efforts to adhere to the production schedules.

4.To ensure that goods are produced according to the prescribed standards and quality norms.

5.To undertake the best and most economic production policies.

6.To introduce a proper system of quality control.

7.To ensure rapid turnover of production and minimizing of inventories of raw materials and finished products.

Production planning and control

Meaning:

Production planning and control is concerned with directing production along the lines set by the planning department.

Definition:

"Production planning and control is the co-ordination of series of functions according to a plan which will economically utilize the plant facilities and regulate the orderly movement of goods through the entire manufacturing cycle from the procurement of all materials to the shipping of finished goods at a predetermined rate." Charles A. Koepke.

Characteristics of production planning and control

1. It is the planning and control of manufacturing process in an enterprise.

2.Questions like-what is to be manufactured? When it is to be manufactured? etc.

3.All types of inputs like materials, men, machines are efficiently used for maintaining efficiency of manufacturing process.

4.Various factors of production are integrated to use them efficiently and economically.

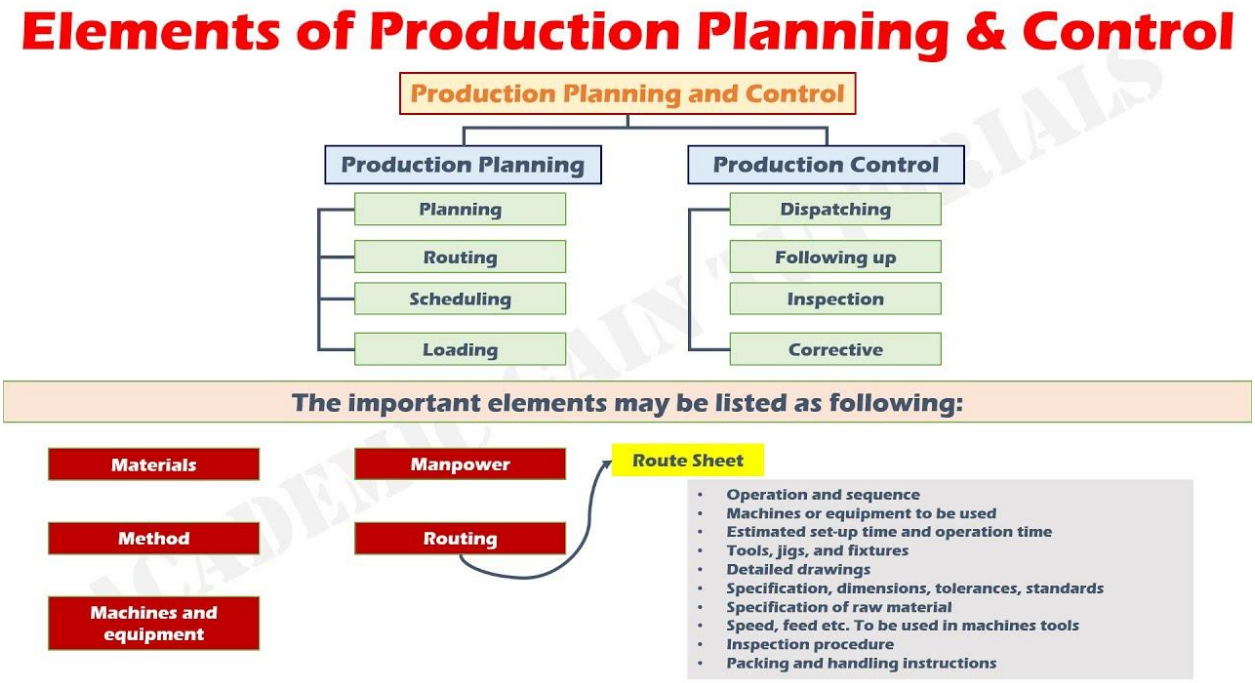

Fig. 43 Elements of production planning and control.

Need and importance of Production Planning and Control

For increasing production. The main purpose of production planning, function is to arrange various inputs like men, materials and machines and integrating them for making their best use. When various factors of production are economically used then production will certainly go up. Efforts are made to avoid production stoppages for want of various inputs. A production control Programme will minimize the idleness of men and machines.

For Co-coordinating Plant Activity. Production planning helps in controlling plant activities. Production targets are set on the basis of sales forecasts. The raw materials, men and equipment are arranged by keeping in view production plans. Different production activities are adjusted as per the plans. If production is carried out in a number of processes, then their activities are synchronized for smooth working.

For Cost Control. It helps in controlling various costs. In the absence of a proper production plan, the idleness of men, material and equipment may not be noticed. Whenever performance is below standards then corrective measures are taken to rectify it. A properly planned system of production will help in controlling costs by not only making full utilization of various inputs but also by increasing output and lowering overhead expenses per unit.

For Rationalisation of Production Activities. An important objective of production planning and control is also to regulate the flow of various inputs into

the production system for running it smoothly. The system is planned in such a way that everything is done automatically. The supply of materials and men follows the demand for goods. The quality standards are followed in routine and sub-standard products are discarded in the processes. The process of entering of raw materials and converting them into finished

For Consumers. The consumer is ensured good quality goods. The process will help in raising quality standards of products. The supply of goods is also prompt and consumer has not to wait for them. Production schedules are prepared by keeping in mind the requirements of consumers. The supplies are regulated for meeting the demand for goods. The increase in production also helps the consumer in getting sufficient supply of goods.

Limitations of production planning and control

1. Based on Assumptions. Production planning and control is based on certain assumptions. In case the assumptions prove correct then the planning and control will go smoothly, otherwise it may not. The assumptions generally are about plant capacity, orders, availability of raw materials and power etc. if these assumptions go wrong then the process of planning and control will go weak.

2. Rigidity. Under production planning and control the things are pre-decided and fixed. There is rigidity in the behaviour of employees and it may not help in smoothening the flow of work.

3. Difficult for Small Firms. This process is time consuming and small firms may not be able to make use of production planning and control.

4. Costly. It is a costly device as its implementation requires separate persons to perform the functions of planning, dispatching, expediting etc. Small firms cannot use the services of specialists due to cost factor.

5. Dependence on External Factors. The external factors sometimes reduce the effectiveness of production planning and control. The factors like natural calamities, change in technology, change in fashion, breakdown of power, government controls etc. limit the use of production planning and control.

Techniques or Elements of Production Planning and Control

The following are the techniques of production planning and control:

A. Planning
B. Routing
C. Scheduling
D. Dispatching
E. Follow-up and Expediting
F. Inspection

Planning. It is the first element of production planning and control. Planning is given an important role in every business. A separate department is set up for this

work. Planning is deciding in advance what is to done in future. Control devices are also decided in advance so that all activities are carried on properly. An organisational set up is created to prepare plans and policies. Various charts, manuals and production budgets are also prepared. If production planning is defective then control will also be defective. Planning provides a sound base for control.

Routing. It is determining the exact path or routing which will be followed in production. The stages from which goods are to pass are decided after a proper thought. Routing may be compared to a train journey for reaching a particular place. If a passenger is to reach Delhi from Ambala Cantt, then he has the option of going via Panipat and via Saharanpur. Both the routes will take him to Delhi. The question is – which route will be economical in time and money? The passenger will decide the route only after taking into consideration various factors affecting his journey. Similar is the case with production routing. It is the selection of the path from where each unit has to pass before reaching the final stage. The path must have the best and cheapest sequence of operations.

Deciding what part to be made or purchased. The product is thoroughly analysed to find out which parts are required for it. The second decision is taken regarding the production or purchase of various components. Some components may be manufactured by the firm and others may be procured from the market. During slack periods most of the components may be manufactured by the firm but when industrial activity is at its peak then supplies from outside may be contracted.

Determining Materials Required. The analysis of the product will enable us to know the type of materials required for producing various components. The right type of quality, quantity, and time when needed should also be decided in advance.

Determining Manufacturing Operations and Sequences. The manufacturing operations and their sequences can be determined from technical experience and layout of machines. A sound and economical operation is selected for manufacturing various components.

Determining of Lot Sizes. A decision has to be taken about the number of units to be produced in one lot. If production is carried on the basis of orders, then size of the lot depends upon the quantity ordered plus some units for possible rejections during the process.

Determining of Scrap Factors. There may be some scrap during the course of manufacture. The finished products are generally less than the units introduced at the beginning. The scrap during manufacturing should be anticipated so that routing is facilitated. If products pass through three processes and a normal scrap is 5% of input at every stage then it will be easy to anticipate the units entering various processes and arrange equipment, and manpower.

Analysis of Cost of the Product. The determination of cost of products may be the duty of department but still production department makes records of direct materials, labour, direct and indirect expenses. These estimates are greatly useful to costing department also.

Preparation of Production Control Forms. The carrying out of routing will be facilitated if forms are prepared to collect information for control purpose. The requirements are: job cards, inspection cards, move tickets, labour cards, tool tickets, etc Scheduling is the determining of time and date when each operation is to be commenced and completed. it includes the scheduling of materials, machines and all other requisites of production.

Scheduling means" fitting specific jobs into a general time table so that order may be manufactured in accordance with contracted liability or in mass production, so that each component may arrive at and enter into assembly in the order and as is required."- Alford and Beaty

Types of schedules

Master scheduling. Scheduling starts with the master schedule. this schedule is prepared by keeping in view the order or likely sales order in near future. Master scheduling is the break-up of production requirements. This may be prepared for a week, a fortnight, a month etc. No definite pattern may be suggested for master schedules because these may differ from industry to industry.

Operation scheduling. Manufacturing or operation scheduling is used where production process is continuous. when same product is produced repeatedly or comparatively small number of products are required then operation schedules are useful. the name and number of the product and the quantity to be produced in a given time are required to prepare a manufacturing schedule.

Detail operation scheduling. It indicated the time required to perform each and every detailed operations of a given machine or process. The term dispatching refers to the process of actually ordering the work to be done. It involves putting the plan into effect by issuing orders. it is concerned with starting the process and operation on the basis of route sheets and schedule charts.

Dispatches put production in effect by releasing and guiding manufacturing order in the sequence previously determined by route sheets and schedule.

The term dispatching refers to the process of actually ordering the work to be done. It involves putting the plan into effect by issuing orders. it is concerned with starting the process and operation on the basis of route sheets and schedule charts.

Procedure:

1.moving of materials from process to process.

2.assigning of work to machines.
3.issuing of tools to production departments.
4.issuing of job orders.
5.recording of time taken.
6.ensuring necessary changes.
7.having proper liaison with routing

Important documents

1.material requisitions
2.work order
3.control sheet
4.internal delivery note
5.tool and gauge ticket

Follow up and expediting. Follow up or expediting is that branch of production control procedure which regulates the progress of materials and part through the production process.

Procedure:

1.progress should be checked
2.causes of differences should be ascertained
3.helping in removing the deviations
4.report with departments supplying materials.

Inspection. Inspection is also an important function of control. the purpose of inspection is to see whether the products manufactured are of requisite quality or not. it is carried on at various levels of production process so that pre-determined standards of quality are achieved. inspection is undertaken both of products and inputs.

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