Chapter One: Introduction

1.1. General Introduction

The word manufacturing is derived from the Latin "**manu factus**", meaning made by hand. Manufacturing is the process of converting raw materials into products covering the design and manufacturing of goods using various production methods and techniques.

- **Manufacturing includes three main stages:**
    1. Design of the product.
    2. Selection of raw materials.
    3. Sequence of processes needed.
- **Basic Needs or Basic Requirements:**
    1. Minimize design and manufacture changes.
    2. Minimize time and cost in taking the product from conceptual design to production and introduction of the product to market.
- **Keys of Success:**
    1. Full support of an organization's top management.
    2. Multifunctional and interacting work team, including support groups.
    3. Utilization of all available state of the art technologies
- **Sustainable Manufacturing:**
    1. Reducing waste of materials.
    2. Reducing the use of hazardous materials in products and processes.
    3. Ensuring proper handling and disposal of all waste.
    4. Making improvements in waste treatment and recycling and reuse of materials.

1.2. Objective of Manufacturing Processes:

To understand the various basics of M.P. and machine tools . How to select M.P. for a given component .

1.3. Production Processes

It is the process followed in a plant for converting semi- finished products or raw materials into finished products or raw materials into finished products. The art of converting raw material into finished goods with application of different types of tools, equipments, machine tools, manufacturing set ups and manufacturing processes, is known as production. Generally there are three basic types of production system that are given as under.

1. Job production

2. Batch production

3. Mass production

Job production comprises of an operator or group of operators to work upon a single job and complete it before proceeding to the next similar or different job. The production requirement in the job production system is extremely low. It requires **fixed type** of layout for developing same products.

Manufacturing of products (less in number say 200 to 800) with variety of similar parts with very little variation in size and shape is called batch production. Whenever the production of batch is over, the same manufacturing facility is used for production of other batch product or items. The batch may be for once or of periodical

type or of repeated kinds after some irregular interval. Manufacturing of products in this case requires **process or functional layout.**

Where as mass production involves production of large number of identical products (say more than 50000) that needs line **layout type of plant layout** which is highly rigid type and involves automation and huge amount of investment in special purpose machines to increase the production.

1.4. Materials Selection

Materials used in today's manufacturing:

1. Ferrous metals: carbon steels, alloy steels, stainless steels, and tool and die steels.
2. Nonferrous metals and alloys: Al, Mg, Cu, Ni, superalloys, Ti, refractory metals (Mb, Nb, W, beryllium, Zr, low melting alloys (lead, zinc and tin), and precious metals.
3. Plastics: Thermosets, thermoplastics, and elastomers.
4. Ceramics: Glass ceramics, glasses, graphite, and diamond.
5. Composites: Reinforced plastics, metal-matrix and ceramics-matrix composites, structures.
6. Nanomaterials, shape-memory alloys, metal foams, , super conductors and semiconductors.

Material Substitution:

1. Material properties: mechanical, physical, chemical, manufacturing.
2. Cost and availability.
3. Service life and recycling.

1.5. Process Planning

Process planning consists of selection of means of production (machine-tools, cutting tools, presses, jigs, fixtures, measuring tools etc.), establishing the efficient sequence of operation, determination of changes in form, dimension or finish of the machine tools in addition to the specification of the actions of the operator. It includes the calculation of the machining time, as well as the required skill of the operator. It also establishes an efficient sequence of manufacturing steps for minimizing material handling which ensures that the work will be done at the minimum cost and at maximum productivity. The basic concepts of process planning are generally concerned with the machining only. Although these concepts may also be extended to other processes such as casting, forging, sheet metal forming, assembling and heat treatment as well.

1.6. Manufacturing Process

Manufacturing process is that part of the production process which is directly concerned with the change of form or dimensions of the part being produced. It does not include the transportation, handling or storage of parts, as they are not directly concerned with the changes into the form or dimensions of the part produced.

1.7. Classification of Manufacturing Processes

All processes used in manufacturing concern for changing the ingots into usable products may be classified into six major groups as primary shaping processes, secondary machining processes, metal forming processes, joining processes, surface finishing processes and processes effecting change in properties. These are discussed as under.

1.7.1.Primary Shaping Processes

Primary shaping processes are manufacturing of a product from an amorphous material. Some processes produces finish products or articles into its usual form whereas others do not, and require further working to finish component to the desired shape and size. Castings need re-melting of scrap and defective ingots in cupola or in some other melting furnace and then pouring of the molten metal into sand or metallic moulds to obtain the castings. Thus the intricate shapes can be manufactured. Typical examples of the products that are produced by casting process are machine beds, automobile engines, carburetors, flywheels etc. The parts produced through these processes may or may not require to undergo further operations. Some of the important primary shaping processes is:

1. **Casting**
2. **Powder Metallurgy**
3. **Plastic Technology**
4. **Gas Cutting**
5. **Bending**
6. **Forging.**

1.7.2. Secondary or Machining Processes

As large number of components require further processing after the primary processes. These components are subjected to one or more number of machining operations in machine shops, to obtain the desired shape and dimensional accuracy on flat and cylindrical jobs. Thus, the jobs undergoing these operations are the roughly finished products received through primary shaping processes. The process of removing the undesired or unwanted material from the workpiece or job or

component to produce a required shape using a cutting tool is known as machining. This can be done by a manual process or by using a machine called machine tool (traditional machines namely lathe, milling machine, drilling, shaper, planner, slotter). In many cases these operations are performed on rods, bars and flat surfaces in machine shops.

These secondary processes are mainly required for achieving dimensional accuracy and a very high degree of surface finish. The secondary processes require the use of one or more machine tools, various single or multi-point cutting tools (cutters), job holding devices, marking and measuring instruments, testing devices and gauges etc. for getting desired dimensional control and required degree of surface finish on the workpieces. The example of parts produced by machining processes includes hand tools machine tools instruments, automobile parts, nuts, bolts and gears etc. Lot of material is wasted as scrap in the secondary or machining process. Some of the common secondary or machining processes are:

1. **Turning**
2. **Threading**
3. **Knurling**
4. **Milling**
5. **Drilling**
6. **Boring**
7. **Planning**
8. **Shaping**
9. **Slotting**
10. **Sawing**
11. **Broaching**

12. **Grinding**
13. **Gear cutting**
14. **Thread cutting**
15. **Unconventional machining processes namely machining with Numerical Control (NC) machines tools or Computer Numerical Control (CNC) machines.**

1.7.3 Metal Forming Processes

Forming processes encompasses a wide variety of techniques, which make use of suitable force, pressure or stresses, like compression, tension and shear or their combination to cause a permanent deformation of the raw material to impart required shape. These processes are also known as mechanical working processes and are mainly classified into two major categories i.e., hot working processes and cold working processes. In these processes, no material is removed; however it is deformed and displaced using suitable stresses like compression, tension, and shear or combined stresses to cause plastic deformation of the materials to produce required shapes. Such processes lead to production of directly usable articles which include kitchen utensils, rods, wires, rails, cold drink bottle caps, collapsible tubes etc. Some of the important metal forming processes are:

- **Hot Working Processes:**
    1. Forging
    2. Rolling
    3. Hot spinning
    4. Extrusion
    5. Hot drawing

- **Cold Working Processes:**
    1. Cold forging
    2. Cold rolling
    3. Cold heading
    4. Cold drawing
    5. Wire drawing
    6. Stretch forming
    7. Sheet metal working processes such as piercing, punching, lancing, notching, coining, squeezing, deep drawing, bending etc.

1.7.4 Joining Processes

Many products observed in day-to-day life, are commonly made by putting many parts together may be in subassembly. For example, the ball pen consists of a body, refill, barrel, cap, and refill operating mechanism. All these parts are put together to form the product as a pen. More than 800 parts are put together to make various subassemblies and final assembly of car or aero-plane. A complete machine tool may also require to assemble more than 100 parts in various sub assemble or final assembly. The process of putting the parts together to form the product, which performs the desired function, is called assembly. An assemblage of parts may require some parts to be joined together using various joining processes. But assembly should not be confused with the joining process. Most of the products cannot be manufactured as single unit they are manufactured as different components using one or more of the above manufacturing processes, and these components are assembled to get the desired product. Joining processes are widely used in fabrication and assembly work. In these process two or more pieces of metal parts are joined together

to produce desired shape and size of the product. The joining processes are carried out by fusing, pressing, rubbing, riveting, screwing or any other means of assembling. These processes are used for assembling metal parts and in general fabrication work. Such requirements usually occur when several pieces are to be joined together to fabricate a desired structure of products. These processes are used developing steam or water-tight joints. Temporary, semi-permanent or permanent type of fastening to make a good joint is generally created by these processes. Temporary joining of components can be achieved by use of nuts, screws and bolts. Adhesives are also used to make temporary joints. Some of the important and common joining processes are:

1. Welding (plastic or fusion)
2. Brazing
3. Soldering
4. Riveting
5. Screwing
6. Press fitting
7. Sintering
8. Adhesive bonding
9. Shrink fitting
10. Explosive welding
11. Diffusion welding
12. Keys and cotters joints
13. Coupling
14. Nut and bolt joints

1.7.5 Surface Finishing Processes

Surface finishing processes are utilized for imparting intended surface finish on the surface of a job. By imparting a surface finishing process, dimension of part is not changed functionally; either a very negligible amount of material is removed from the certain material is added to the surface of the job. These processes should not be misunderstood as metal removing processes in any case as they are primarily intended to provide a good surface finish or a decorative or protective coating on to the metal surface. Surface cleaning process also called as a surface finishing process. Some of the commonly used surface finishing processes are:

1. Honing
2. Lapping
3. Super finishing
4. Belt grinding
5. Polishing
6. Tumbling
7. Organic finishes
8. Sanding
9. Deburring
10. Electroplating
11. Buffing
12. Metal spraying
13. Painting
14. Inorganic coating
15. Anodizing
16. Sheradising

17. Parkerizing
18. Galvanizing
19. Plastic coating
20. Metallic coating
21. Anodizing
22. Sand blasting

1.7.6 Processes Effecting Change in Properties

Processes effecting change in properties are generally employed to provide certain specific properties to the metal work pieces for making them suitable for particular operations or use. Some important material properties like hardening, softening and grain refinement are needed to jobs and hence are imparted by heat treatment. Heat treatments affect the physical properties and also make a marked change in the internal structure of the metal. Similarly the metal forming processes effect on the physical properties of work pieces Similarly shot peening process, imparts fatigue resistance to work pieces. A few such commonly used processes are given as under:

1. Annealing
2. Normalising
3. Hardening
4. Case hardening
5. Flame hardening
6. Tempering
7. Shot peeing
8. Grain refining

9. Age hardening.

In addition, some allied manufacturing activities are also required to produce the finished product such as measurement and assembly.

1.8. Product Simplification And Standardization

The technique of simplification and standardization of product is closely inter-related that leads to higher efficiency in production, better quality and reduced production cost. Simplification is a process of determining limited number of grades, types and sizes of a components or products or parts in order to achieve better quality control, minimize waste, simplify production and, thus, reduce cost of production. By eliminating unnecessary varieties, sizes and designs, simplification leads to manufacture identical components or products for interchangeability and maintenance purposes of assembly of parts. Standardization is the important step towards interchangeable manufacture, increased output and higher economy. The technique of standardization comprises of determining optimal manufacturing processes, identifying the best possible engineering material, and allied techniques for the manufacture of a product and adhering to them very strictly so long as the better standards for all these are not identified. Thus definite standards are set up for a specified product with respect to its quality, required equipment, machinery, labor, material, process of manufacture and the cost of production. The identified standard with time for a specified product should never be taken as final for ever because improvement is always possible. It must accommodate the outcome of all the new researches in the manufacturing areas in order to keep pace with increasing global competition. Improvements over the existing standards in all respects should always be welcomed. The different standards prevailing in different industries may be of the

types of managerial, design, manufacturing and technical needs. Managerial standards are applicable to administrative functions within industry. These include the company policy, accounting procedures, personnel policies, performance evaluation, control of expenditures, safety aspects, security procedures and regulations, etc. where as design, manufacturing and technical standards are needed for manufacturing concepts of the industry. These include design and manufacturing techniques, practices, materials and parts, supplies, methods of testing, drafting method, abbreviations and symbols, specifications and nomenclature, etc.

1.9. Inspection And Quality Control

A product is manufactured to perform desired functions. It must have a specified dimension such as length, width, height, diameter and surface smoothness to perform or accomplish its intended function. It means that each product requires a defined size, shape and other characteristics as per the design specifications. For manufacturing the product to the specified size, the dimensions should be measured and checked during and after the manufacturing process. It involves measuring the size, smoothness and other features, in addition to their checking. These activities are called measurement and inspection respectively. In the era of globalization, every industry must pay sufficient attention towards maintaining quality because it is another important requirement or function of a production unit. If a manufacturing concern wants to survive for longer time and to maintain its reputation among the users, it should under all condition apply enough efforts not only to keep up the standard of quality of its products once established but to improve upon the same from time to time. For this, every manufacturing concern must maintain a full-fledged inspection and quality control department which inspects the product at different

stages of its production. Vigilant inspection of raw materials and products depends upon the entire process of standardization. The production unit of manufacturing concern must produce identical products. However a minor variation may be allowed to a predetermined amount in their finished dimensions of the products. The two extremities of dimensions of the product are called limits. All the parts of which the finished dimensions lie within these limits are acceptable parts. This facilitates easy and quicker production, easy inspection, requires less skill on the part of worker and accommodates a slight inaccuracy in the machine as well, resulting in an overall reduction in the production cost of the part.