1 INTRODUCTION

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1.1 INTRODUCTION

Workshop is a place where products are manufactured. It may involve operations or trades like bench work and fitting, smithy, forging, sheet metal, wood working, pattern making, foundry, welding, mechanical working, machining etc.

The subject of workshop technology has become very important to the engineer, supervisor or worker. Work can be performed skillfully, when the work to be performed in the shop is understood both in its practical and theoretical aspects. So the study of workshop technology has been made compulsory these days for a worker, foreman and engineer so that he can make himself acquainted with basic knowledge of manufacturing processes and materials.

1.2 PRODUCTION

The art of converting raw materials into finished goods with the application of tools and manufacturing processes, is known as production.

Basically there are three types of production systems :

- Job production.
- Batch production.
- Continuous production.

1.2.1 Job Production

In this type of production, an operator or group of operators work upon a job and complete it before proceeding to the next job, which may be different or may be another of same type.

Job production normally concerned with special projects, models, prototypes, special machinery or equipment to perform specialised and specific tasks such as large turbogenerators, large engines, boilers, ship building etc.

Three types of job production can be defined according to the regularity of manufacture :

- A small number of pieces produced only once.
- A small number of pieces produced intermittently when the need arises.
- A small number of pieces produced periodically at known time intervals.

1.2.2 Batch Production

Manufacturing of a number of identical articles to fulfil the specific and continuous needs of the customer is called batch production. When the production of the batch is over, the plant machines are available for the production of other item.

It may be of three types :

- Batch produced once.
- Batch produced repeatedly at irregular intervals.
- Batch produced periodically at regular intervals.

Batch production is a very common feature in industry. Machine tool work, forging and casting processes, glass manufacturing and chemical processes very often operate on a batch basis.

1.2.3 Continuous Production

In this type of production, a large number of identical items are produced. Production time and cost is reduced by using auxiliary aids such as special tools, fixtures, positioners, feeders, material handling systems, special inspection devices, special weighing and packing equipment.

Continuous production may be of two types :

- Mass production.
- Flow production.

1.3 MANUFACTURING PROCESSES

The process of producing the desired object from the raw material is called manufacturing process. Most of the metals used in industry are available in the form of rough casting called ingots. These ingots are further subjected to various processes to convert these into usable products. The processes which are used for changing the ingots into usable products can be classified into the following categories :

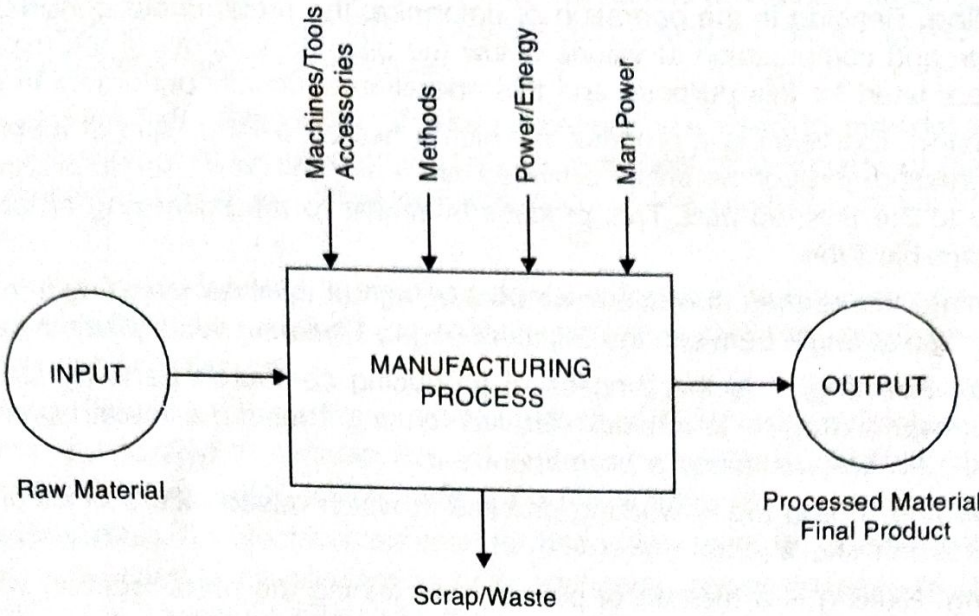

Fig. 1.1. *Manufacturing Process.*

1.3.1 Classification of Manufacturing Processes

❖ ***Primary Shaping Processes.*** The ingots available in the market need remelting in cupola or some other foundry furnace. The molten metal is then poured into the moulds to obtain the casting or sometimes ingots are converted into useable form by forging or other primary shaping process. Primary shaping processes include :

(*a*) **Casting.** Casting is a process of production of objects of desired shapes and sizes by introduction of molten metal into a predesigned mould cavity created in a mould material with the help of a pattern or in a metallic mould (die-casting) and allowing it to solidify.

Some general purpose casting processes are as follows:

1. Permanent mould casting
2. Centrifugal casting
3. Die casting
4. Shell mould casting
5. Precision or investment casting
6. Continuous casting
7. Plaster mould casting

(*b*) **Forging.** The plastic deformation of metals, generally at elevated temperatures, into desired shapes by the application of steady blows or steady pressure is known as forging.

(*c*) **Smithy.** The conversion of small objects from raw material; heated in a apex furnace, operated by manual labour is known as smithing.

(*d*) **Drawing.** Drawing is defined as a process of making cup shaped parts from sheet metal blank by forcing it into die with the help of punch without any constraint other than against buckling.

(*e*) **Rolling.** Rolling is the process of reducing the thickness of the work parts by passing it between the rotating rollers having spacing approximately equal to reduced thickness.

(*f*) **Bending.** Bending is the operation of deforming the metal under consideration in both tension and compression at values below the ultimate strength of the material. Formed dies are used for this purpose and this operation is usually performed in many stages.

(*g*) **Extrusion.** Extrusion is a process in which a heated billet or slug of metal is forced by high pressure through an orifice provided into a die. Orifice is used to provide the desired shape to the finished part. This process is similar to the squeezing of toothpaste from a collapsible tube.

(*h*) **Shearing.** In shearing operation, material being cut involves stressing it in shear above its ultimate strength between the adjacent edges. Shearing takes place in the form of cut.

(*i*) **Stretch Forming.** It is the process of producing contoured parts by stretching metal sheets over a shaped form-block. Stretch forming strains the metal beyond the elastic limit to give the workpiece a permanent set.

(*j*) **Embossing.** It is a press working process in which raised letters or other designs are impressed in sheet metal.

(*k*) **Staking.** Staking is a method of permanently joining the parts together when one part protrudes through a hole in the other.

(*l*) **Ironing.** It is the process of thinning the walls of a drawn cylinder by passing it between a punch and die whose clearance is less than the original wall thickness of a drawn cylinder.

(*m*) **Sizing.** It means squeezing all or a selected area of forgings or castings to acquire or to achieve a desired thickness or precision.

❖ ***Machining Processes.*** Machining operations are performed on various machine tools (*e.g.* lathe, shaper, milling machines, drilling machines, grinder etc.) Machining processes are needed because sometimes we need complex shapes, profiles, contours etc. These factors need following machining operations :

(*a*) **Shaping.** Shaping is a process to produce flat surfaces in horizontal, vertical or angular planes by using shaper.

(*b*) **Turning.** Turning is the process of reducing the diameter of the cylindrical workpieces by using lathe machine tool.

(*c*) **Milling.** Milling is the machining operation in which excess (undesired) metal is removed by means of multipoint cutting tool using milling machine tool.

(*d*) **Drilling.** Drilling is the machining operation performed to produce holes in workparts. The cutting tool is a multipoint cutting tool, known as drill.

(*e*) **Grinding.** Grinding is the machining operation in which undesired material is removed from the workpiece by a powered abrasive wheel, stone, belt, paste, slurry etc.

(*f*) **Boring.** Boring is the machining operation performed to enlarge a hole that already has been drilled or cored. It is internal turning, in which usually a single point cutting tool forms the internal shape.

(*g*) **Slotting.** Machining, normally milling, that creates slots, grooves and similar recesses in workpieces, including T-slots and dovetails.

(*h*) **Broaching.** It is a process of machining a surface with a special multipoint tool called a broach, whose teeth remove the whole machining allowance in a single stroke.

(*i*) **Sawing.** It is a machining operation in which convenient length or size for machining is cutting off from the bar stock or raw material.

(*j*) **Knurling.** It is a machining operation which produces a regularly shaped, rough surface on a workpiece. The knurling tool (multipoint cutting tool) is pressed against the workpiece, which produces the rough surface.

❖ ***Surface Finishing Processes.*** These processes are used to provide a good surface finish to the metal surface of the product. In this, either a negligible amount of metal is removed or a small amount of material is added to the surface of the product. Various surface finishing processes are :

(*a*) **Polishing.** It is done with a very fine abrasive in loose form smeared on the polishing wheel with the work rubbing against the flexible wheel. A very small amount of material is removed in polishing.

(*b*) **Buffing:** In this process the abrasive grains in a suitable carrying medium such as grease are applied at suitable interval to the buffing wheel. This buffing wheel is used to generate a very high lustre surface on the workpiece.

(*c*) **Electroplating.** An electrical process for depositing metal on a conductive surface that uses a cathode in an electrolytic bath containing dissolved salts of the metal being deposited is known as electroplasting.

(*d*) **Honing.** It is a low velocity abrading process in which material removal is accomplished at lower cutting speeds. The cutting action is obtained using abrasive sticks (aluminium oxide and silicon carbide) mounted on a metal mandrel.

(*e*) **Lapping.** It is a finishing operation in which a loose, fine grained abrasive in a liquid medium abrades the workpiece material. It is an extremely accurate process that corrects minor shape imperfections, refines surface finishes and produce a close fit between mating surfaces.

(*f*) **Burnishing.** Burnishing is an operation by which a bright, polished finish is produced on the surface of a metal by a rubbing action which smooths out small scratch marks.

(*g*) **Super Finishing.** It is an abrading process, efficient in surface refining of cylindrical, flat, spherical and cone shaped parts. Super finishing produces a high wear resistant surface on any object which is symmetrical.

(*h*) **Painting.** It is an operation to give lustre to the surface by using paints. Paint fill the space between crest and roots of the metallic surface and appears smooth.

❖ ***Joining Processes.*** These processes are used for joining two or more pieces of metal parts. Joining processes are used to join two or more workparts either temporary or permanent. Permanent joining processes are as follows:

(*a*) **Welding.** Welding is a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filler metal.

Welding may be further classified as :

1. Arc welding
2. Gas welding
3. Resistance welding
4. Solid state welding
5. Radiant energy welding

(*b*) **Soldering.** Soldering is a process of joining two pieces of metals in which a fusible alloy or metal having melting point below 450°C is introduced in a liquid state between the workpieces to be joined with the help of capillary action.

(*c*) **Brazing.** Brazing is a process of joining two pieces of metals in which a non-ferrous alloy having melting point above 450°C (but lower than the melting temperature of the parent metal) is introduced (in a liquid state) and filled by capillary action between the workpieces to be joined.

(*d*) **Braze Welding.** Braze welding is the process of joining the metals like brazing using a filler metal whose melting temperature is above 450°C but below the melting temperature of the parent metal and no capillary action is used to fill the filler metal.

(*e*) **Riveting.** In riveting, holes are created between the two parts to be joined and rivets are placed in the holes. Shank of the rivets are converted into heads by hammering and rivet joint take place.

Temporary joining processes are as follows:

(*a*) **Nut and Bolts Joints.** In this method of fastening, two or more parts are joined temporarily by nut and bolts. Bolts shanks are having threads. Nuts are having holes and internal threading. Nut will be tightened by passing over the bolt.

(*b*) **Screwing.** Screwing is a joining method in which workparts to be joined are having hole. Screws are passed through that hole and tightened.

(*c*) **Keys and Cotter Joints.** Keys and cotters are used to join the two parts temporarily.

Screwing, nut and bolt joints and keys and cotter joints are used to join the workparts temporarily whereas Welding, Soldering, Brazing, Riveting, Adhesive joining, Sintering or Pressing are used to join permanently.

❖ ***Processes Affecting Change in Properties.*** These processes are used to impart certain specific properties to the metal part for specific conditions of use. The following processes are used for this purpose :

(*a*) **Annealing.** It is the process of heating the steel to about 50 to 60°C above the upper critical temperature, holding it at this temperature for a sufficient time and then slowly cooling it in the furnance.

(*b*) **Normalising.** This process consists of heating of steel to a point 40 to 50°C above its upper critical temperature. Hold at that temperature for a short duration and subsequently cooling it in still air at room temperature.

(*c*) **Hardening.** In this process, steel is heated to temperature above the critical point, held at this temperature for a considerable time and then quenched (rapidly cooled) in water, oil or molten salts bath.

(*d*) **Tempering.** Tempering of steel is carried out in liquid baths such as oil, salt or lead. The bath is heated upto an adequate predetermined temperature and metal is immersed in this bath for the determined length of time. After that metal is removed and allowed to cool at room temperature.

(*e*) **Carburising.** The process of inducing carbon to low carbon steels in order to give it a hard surface is known as carburising.

(*f*) **Cyaniding.** In this process, sodium cyanide or potassium cyanide may be used as the hardening medium. The cyanide is heated until it becomes liquid. When the steel is placed in the cyanide bath, both carbon and nitrogen are added to the outer surface.

(*g*) **Nitriding.** Nitriding is a case hardening process in which nitrogen instead of carbon is added to the skin of the steel.

(*h*) **Induction Hardening.** Induction hardening is done by placing the part in a high frequency alternating magnetic field.

(*i*) **Shot Peening.** This process is carried out by blasting a rain of small metallic balls against the surface to be peened. As the shot (balls) strike the surface, small indentations are produced. The tensile stress which is in the interior of the material can be relieved by this action. Surface is also slightly hardened by this process.

❖ ***Powder Metallurgy.*** Powder metallurgy is defined as the art of making objects by the heat treatment of compressed metallic powders.

Powder metallurgy includes the blending of powders, compacting of powder into a desired shape, sintering the compact shape and then final finishing of the product.

❖ ***Modern (Non-Conventional) Manufacturing Methods.*** With the development of workpiece materials of greater hardness, strength and high temperature resistance, it has now become difficult to process them by conventional machining methods. Extensive research and development in the use of magnetic energy, thermal energy, electrical energy and chemical energy lead to the development of non-conventional manufacturing methods which are as follows:

(*a*) **Electrical Discharge Machining (EDM).** It is a process that vaporizes conductive materials by controlled application of pulsed electrical current which flows between the workpiece and the electrode (tool) immersed in a dielectric fluid.

(*b*) **Electro Chemical Machining (ECM).** It is a process in which electrical current flows between a workpiece and conductive tool through an electrolyte. It initiates a chemical reaction that dissolves the metal from the workpiece at a controlled rate.

(*c*) **Ultrasonic Machining (USM).** It is a process in which material is removed due to the action of abrasive grains and ultrasonic energy.

(*d*) **Electron Beam Machining (EBM).** It is a process of machining materials with the use of a high velocity beam of electrons.

(*e*) **Laser Beam Machining (LBM).** It is a process that removes the material by focussing a concentrated laser beam on to the workpiece.

(*f*) **Plasma Arc Machining (PAM).** It is a process in which machining is done by an electric arc between a torch and a workpiece heats and ionizes a gas such as nitrogen, argon etc., which is forced through the torch in a swirling action on to the workpiece. Plasma temperatures is high as 27800°C which melt and vaporize workpiece material.

(*g*) **Abrasive Jet Machining (AJM).** This process consists of directing a stream of fine abrasive grains, mixed with compressed air or some other gas at high pressure through a nozzle on to the surface of the workpiece to be machined.

(*h*) **Chemical Machining.** It is a process in which removal of base material is there by a carefully controlled dissolution. Material not to be removed is usually protected by a strippable mask.