Unit No: 05. Introduction to Manufacturing

Objective: To introduce proper manufacturing process applicable to produce components.

Outcome: Discuss several manufacturing processes and identify suitable process.

Manufacturing:

The process of converting raw materials, components or part into finished good that meets customers expectations or specification.

Manufacturing process of workpiece involves transforming a raw material from its original state to a finished state by changing it's shape or the properties of the material.

Classification of manufacturing Process

Process	Examples
Primary shaping Processes	• Casting • powder metallurgy • Processing of plastics.
Deforming Processes	• Forging, • Extrusion • Rolling • Sheet metal working
Machining Processes	• Turning, • Drilling • milling, • shaping • Reaming.
Joining Processes	• Welding, soldering, • Brazing, Screwing, • Riveting, Adhesive Bond.
Surface Finishing Processes	• Honing, Lapping, • plating, coating, • Grinding.
Material properties modification Processes.	• Hot & cold working, • Heat treatment, • Shot Peening.

Casting :

"Casting process is the process of forming object by pouring molten metal in moulds and letting it solidify. This solidified piece of metal is called as casting".

Types of Casting :

i) Sand casting
ii) Die casting
iii) Shell mold casting
iv) Investment Casting
v) Plaster mold casting
vi) Centrifugal casting.

* Sand casting :

The casting process in which the castings are made using sand mould is known as sand casting process.

Steps (stages) in Sand casting process:

i) Making the pattern
ii) Mould making
iii) Core making
iv) Melting and pouring of metal
v) Cooling and solidification of casting
vi) Cleaning and inspection of casting.

i) Pattern making :

Pattern is defined as the model or replica of a casting, used for making a cavity or mould. It is madeup of wood, metals (like cast iron, aluminium) plastic, etc.

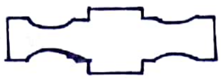


Fig: Pattern.

2) Mould Making: Mould making is the process of making a cavity which conforms to the shape of the desired components, in a suitable refractory material like sand, that can withstand the high temperature of molten metal.

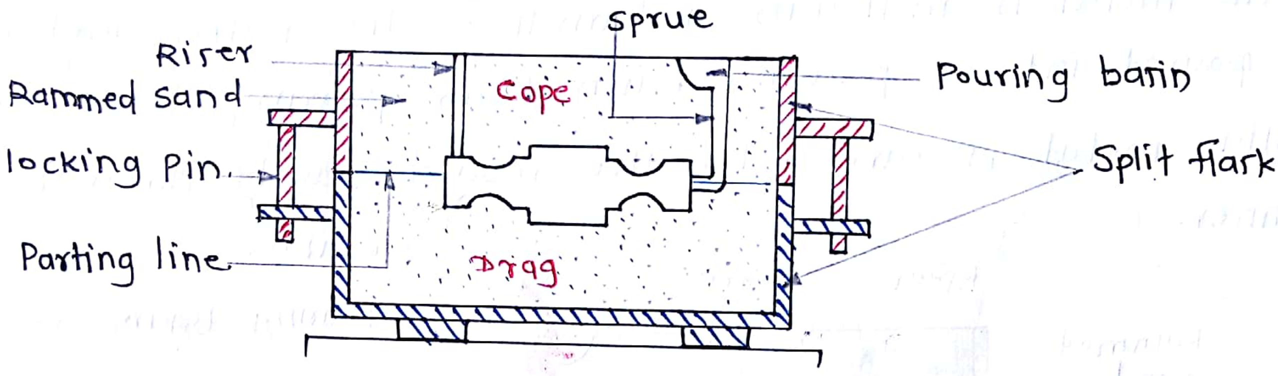


Fig. Mould making.

Steps:

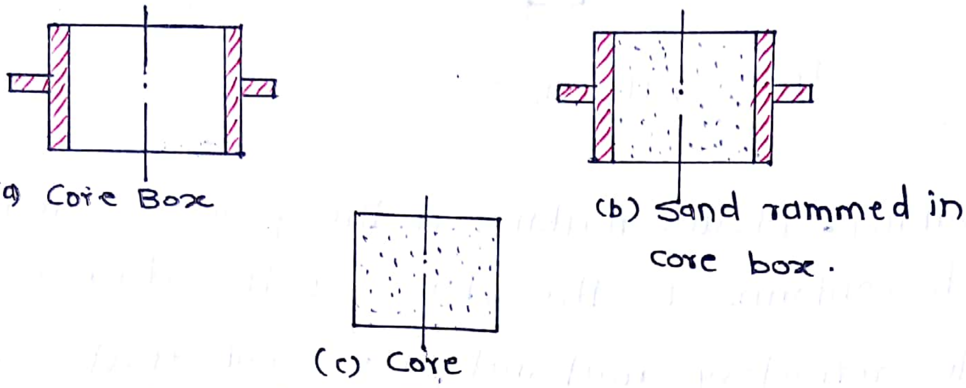
1) The pattern is kept in flask, which is split type and moulding sand is rammed or pressed around the pattern. The upper part of two part casting flask is called as cope while the lower part of two part casting flask is called as drag.

2) The pattern is then taken out of the sand and the shape of the pattern is left in the rammed sand as shown in fig.

3) Core Making:

Many castings require holes or other internal hollow spaces, which are not to be filled by the metal. Such holes or hollow spaces are obtained by using cores in moulds.

Cores are made seperately from mould an placed in the mould before pouring the molten metal.



4.) Melting and Pouring of Metal:

The metal is melted in a furnance. The molten metal is poured into a pouring basin. from pouring basin, the molten metal is carried to the mould cavity through the runner.

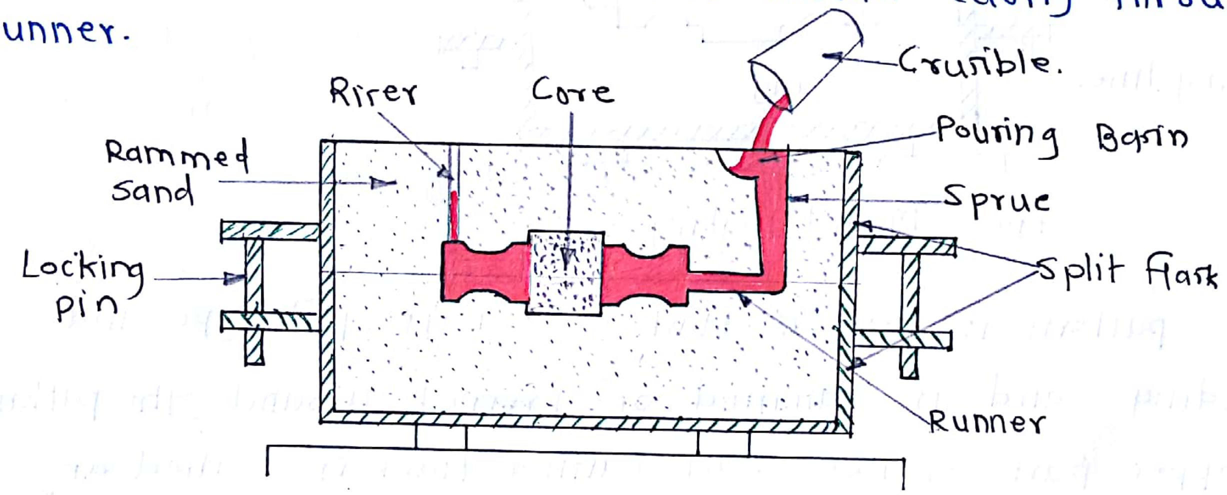


Fig. Pouring of Metal.

A riser is a hole cut in a moulded sand to permit the molten metal to rise above the highest point in the casting. The riser serves following purposes:

i) It facilitates escaping of the air, gas and steam from the mould cavity as the mould is filled with the metal.

ii) It serves as a feeder to feed the molten metal into the mould cavity to compensate for shrinkage during the solidification.

5.) Cooling and Solidification of Casting:

The molten metal is then allowed to cool and solidify in mould.

6.) Cleaning and inspection of casting:

After solidification, the sand mould is broken to taken out the casting from the mould cavity. The casting is then cleaned and inspected. The cleanning involves the trimming of rises and runners from the casting.

Advantages of Sand Casting:

i) The sand casting process is highly economical

ii) It does not require high initial investment

iii) It does not require highly skilled manpower

iv) The process is suitable for small quantity job production as well as mass productions.

v) The cost of the components produced by sand casting process is low.

Disadvantages:

i) Components produced by sand casting process have poor dimensional accuracy as well as poor surface finish.

ii) This process is not suitable for precision casting.

iii) It is not suitable to produce highly intricate shapes.

iv) It can not produce extremely thin sections.

v) This process require large manpower for mould making.

vi) It requires large working space.

Applications of Sand casting process:

The sand casting process can be used for making

i) Gear box housing

ii) Machine tool beds

iii) Machine tool frames

iv) Gears

v) Bearing housing, etc.

Forging:

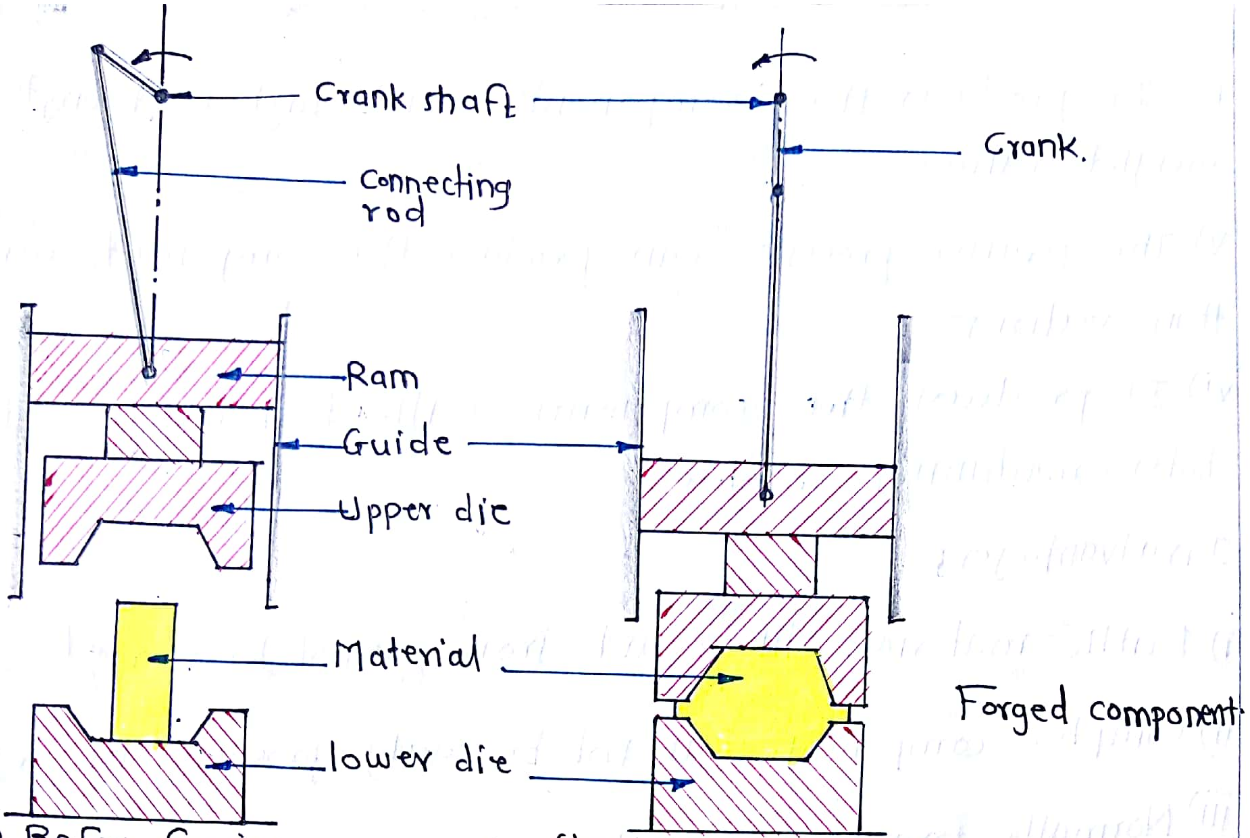
Forging is metal forming process in which the metal is first heated and then plastically deformed to the desired size and shape by the application of compressive force using hand hamer, a power hammer or a press.

In forging process, the material is heated to a temp at which it's elastic properties completely disappear. This temp is known as forging temp. and it varies from material to material.

At forging temp., the material becomes soft and obeys the law of plastic flow. When the compressive force is applied on the material it plastically deforms in the direction of least resistance without fracture.

Working of Forging Process:

In forging process, the material (billet) is deformed into the desired shape between two parts called dies. The shape of the dies matches with the desired shape of the forged components.



(a) Befor forging (b) After forging

The forging press shown in fig consist of lower die fixed to the frame while upper die connected to the ram. The hot material is kept on the lower die as shown in fig.

In mechanical press, the ram is driven by an electric motor through the crank shaft and the connecting rod, while in hydraulic press it is driven by hydraulic cylinder. During the downward stroke of the ram the upper die exerts the sudden compressive force on the hot metal. Due to this the hot material is converted in to desired shape. as shown in fig.

Advantages:

i) It gives high dimensional accuracy & good surface finish.

ii) It reduces the material remove during the machining process.

iii) The forging process reduces the grain size, which results in improving the strength and toughness of the component.

iv) It produces the components with higher strength to weight ratio.

v) The forging process can produce the components with thin sections

vi) It produces the components without shrinkage, blow holes, machining scratches,.

Disadvantages:

i) Brittle materials like cast iron cannot be forged

ii) complex components can not be easily produced by forging.

iii) Normally, forged components cost more than cost of of cast components

iv) The cost of forging dies is high.

v) Noisy in operation.

Applications:

i) I.C. engine parts like crankshaft, connecting rods, rocker arms, etc

ii) small tools

iii) gear blanks, levers, and

iv) Automobile and aircraft components.

*** Classification of forging process based on Types of Dies**

- 1. Open Die forging process
- 2. Closed Die forging process

1. Open Die forging Process:

In open die forging process, the material or workpiece is deformed between the two flat dies or dies of very simple shape as shown in fig.

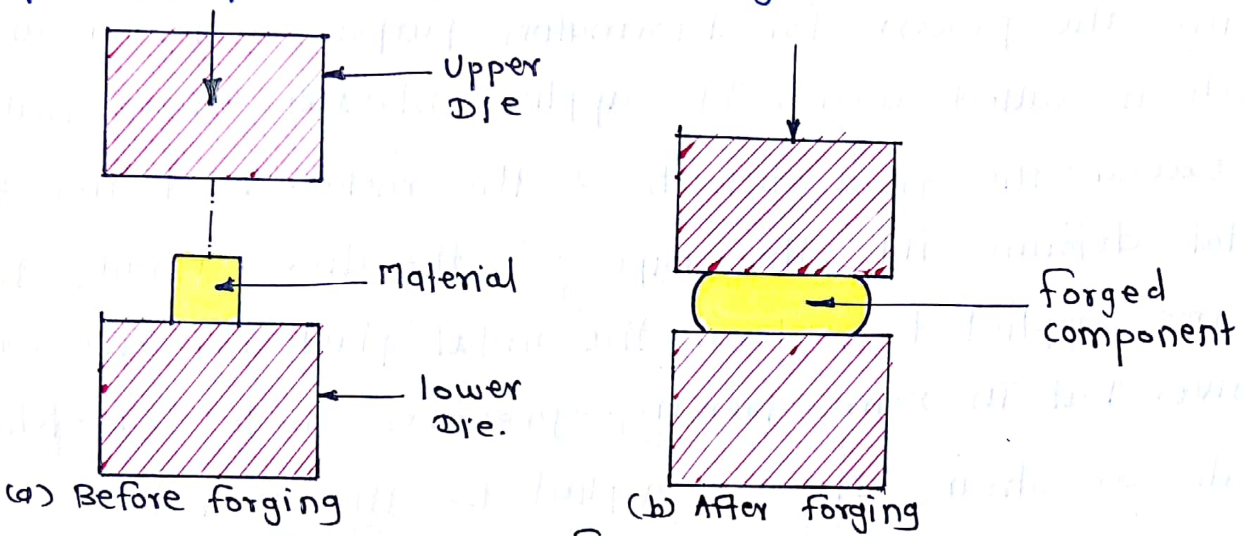


Fig. Open Die forging.

2. Closed Die forging process:

In closed die forging process, the material or workpiece is deformed between the two dies which have the impressions of the desired shape as shown in fig.

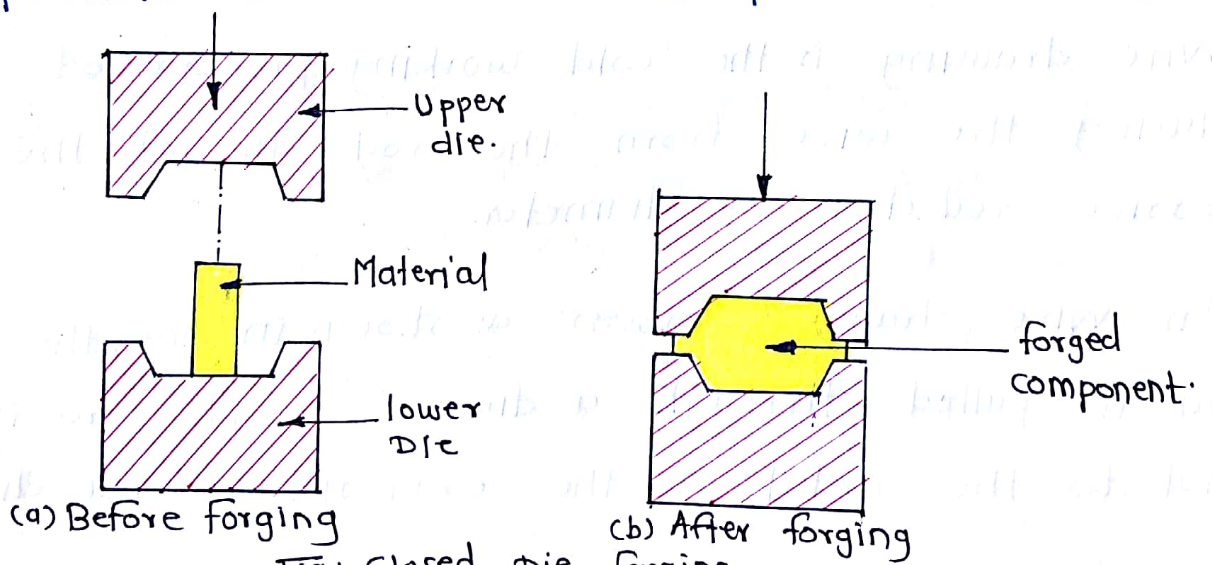


Fig: Closed Die forging.

When the two dies are closed, the cavity formed is of the desired final shape.

* Metal forming :

Metal forming includes a large no. of manufacturing processes in which plastic deformation property is used to change the shape and size of metal workpieces. During the process, for deformation purpose, a tool is used which is called a die. It applies stresses to the material to exceed the yield strength of the metal. Due to this the metal deforms into the shape of the die. Generally, the stresses applied to deform the metal plastically are compressive. But in some forming processes metal stretches, bends or shear stresses applied to the metal.

1. **Drawing :** Drawing is an operation in which the cross-section of a bar, rod or wire is reduced by pulling it through a die opening.

* Wire Drawing :

Wire drawing is the cold working process of producing the wire from the rod through the successive reduction of diameter.

In wire drawing process as shown in fig, the metal is pulled through a die. A tensile force is applied to the metal on the exit side of the die for pulling purpose. There is a gradual reduction of cross-sectional area inside the die. Due to this, as the the tensile force is applied to the metal on the exit side of the die, the dies exerts the radial compressive force on the metal. This causes the plastic flow of the metal

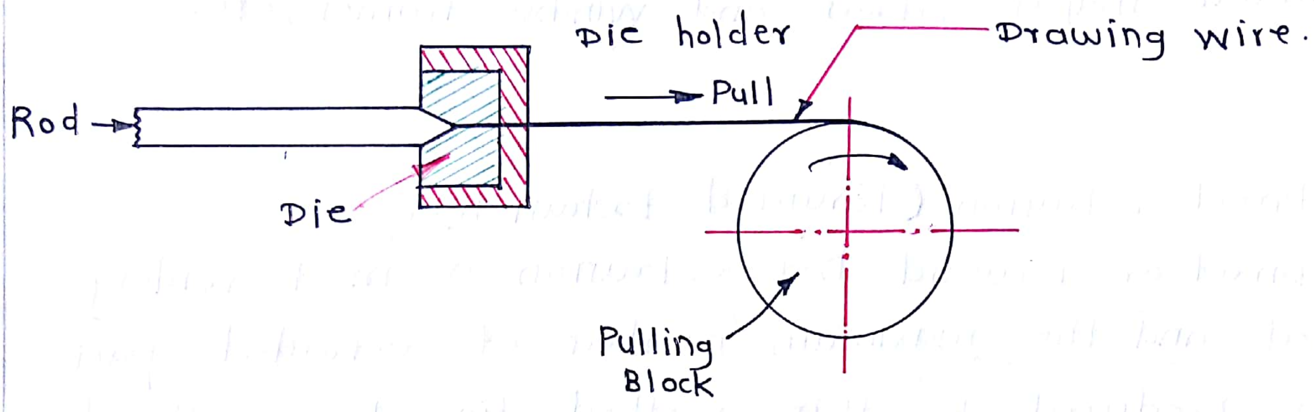


Fig: Wire Drawing Process.

For obtaining the significant changes in size, the multiple passes are required. The wire drawing gives excellent dimensional accuracy and surface finish. For wire drawing, the material must have a good ductility.

2. Extrusion:

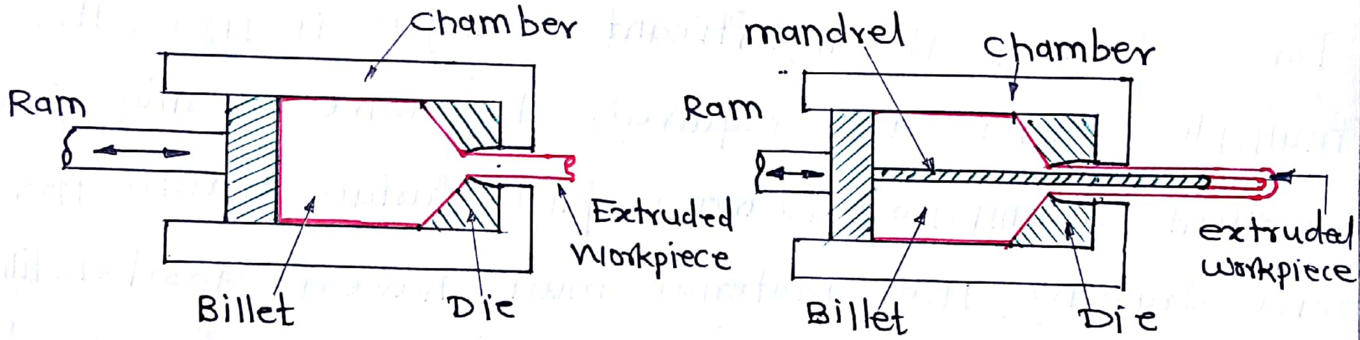
Extrusion is a compression process in which the work metal is forced to flow through a small opening which is called as die to produce a required cross-sectional shape.

Almost any solid or hollow cross-section may be produced by extrusion process. As geometry of the die remains same during the operation, extruded parts have the same cross-section. During the process, a heated cylindrical billet is placed in the container and it is forced out through a steel die with the help of a ram or plunger.

The products made by extrusion process are tubes, rods, railings for sliding doors, structural and architectural shapes, doors and window frames, etc.

* Direct Extrusion (Forward Extrusion):

Direct or forward hot extrusion is most widely used and the maximum number of extruded parts are produced by this method. Fig. shows the direct extrusion process in which raw material is a billet.



(a) Solid Component (b) Hollow components

Fig. Direct extrusion.

A billet is heated to it's forging temperature and fed into the machine chamber. Pressure is applied to the billet with the help of ram or plunger which forces the material through the die. The length of the extruded part will depend on the billet size and c/s of the die. The extruded part is then cut to the required length. Direct extrusion process is also used to produce hollow or semi-hollow sections

To produce hollow sections by direct extrusion process a mandrel is used. When the billet is compressed, the material is forced to flow through the gap between the mandrel and die opening. This results in tubular cross-section.

—x—

*Indirect Extrusion (Backward Extrusion):

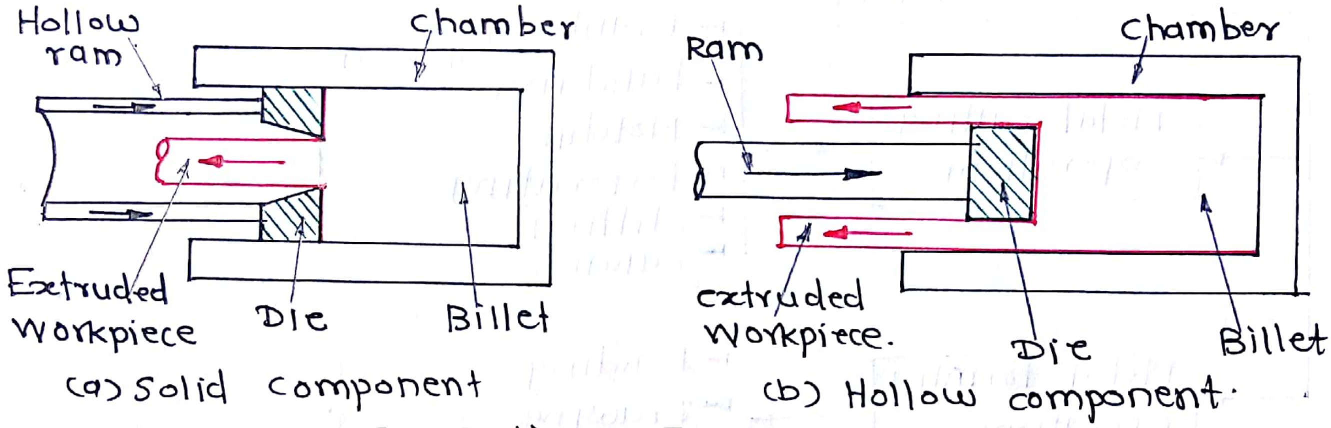


Fig. Indirect Extrusion.

In this type, the ram or plunger used is hollow and it presses the billet against the backwall of the closed chamber, the metal extruded back into the plunger. as shown in fig.

It involves no friction between the metal, billet and the chamber because the billet does not move inside the chamber. Indirect extrusion is also used to solid as well as hollow components. For producing solid parts ram is hollow whereas for producing hollow parts ram is solid as shown in fig.

* Sheet Metal Working:

Sheet metal working is generally associated with press machines and press working. Press working is a cheapest manufacturing process by which various compts are produced from sheet metal

Sheet metal Working

- Metal cutting operations
  - Blanking, Punching } Shearing
  - Notching
  - Perforating
  - Slitting
  - Lancing
- Metal forming operations
  - Bending
  - Drawing
  - Embossing
  - forming
  - coining

---

1) Blanking:

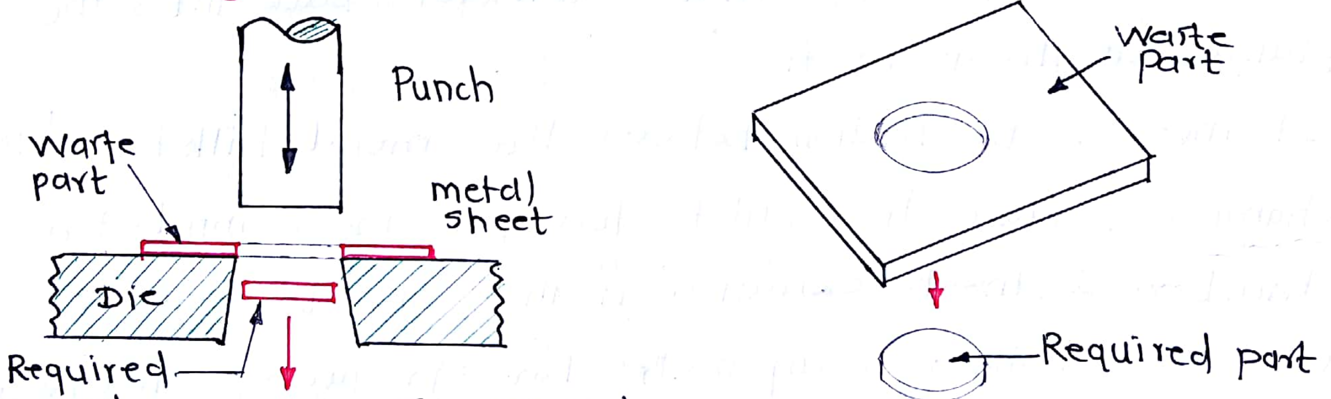


Fig. Blanking.

Blanking is the cutting operation of a flat metal sheet and the article punched out is known as blank. Blank is the required product of the operation and the metal left behind is considered as a waste.

2. Punching: It is the cutting operation with the help of which holes of various shapes are produced in the sheet metal

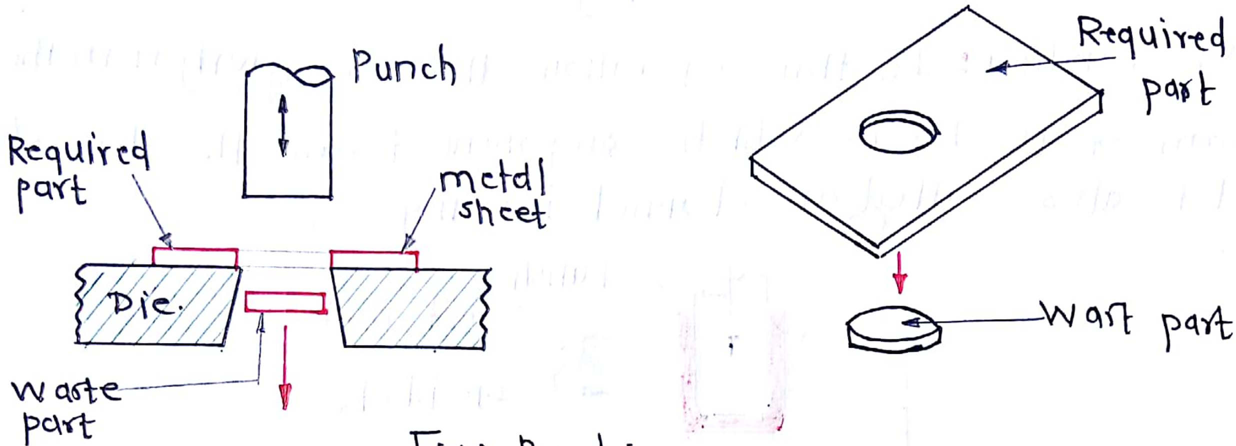


Fig: Punching.

It is similar to blanking only the difference is that, the hole is the required product and the material punched out to form a hole is considered as waste.

3. Shearing:

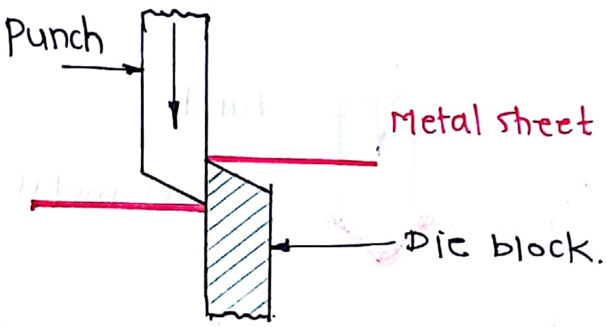


Fig. Shearing.

It is an operation through which a metal is cut along a single line which is generally a straight line.

4. Bending: It is a metal forming operation in which the straight metal sheet is transformed into a curved form. In bending operations the sheet metal is subjected to both tensile and compressive stresses. During the opern, the plastic deformation of material takes place beyond its elastic limit but below it's ultimate strength.

Bending
- U-Bending
- V-Bending
- Angle Bending
- Curling.

a) U-Bending: In this operation, the die cavity is in the form of U due to which component forms the shape of U. It is also called as channel bending.

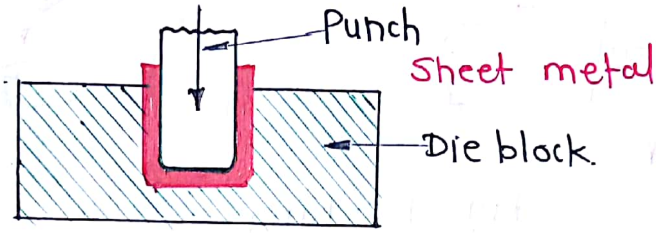


Fig. U-Bending.

b) V-Bending: Figure shows V-Bending, operation in which, wedge shape punch is used. The angle of V may be actute, 90° or.

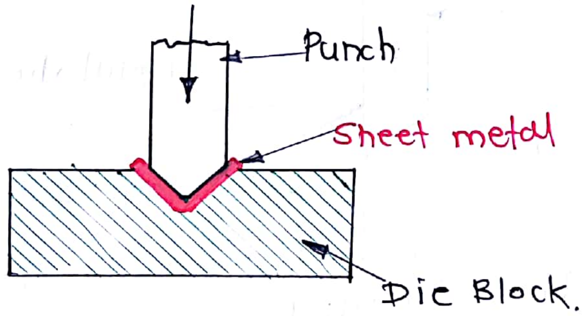
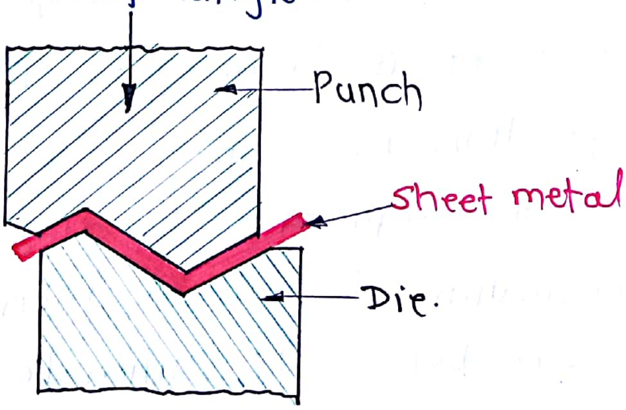


Fig. V-Bending.

c) Angle-Bending: In this operation there is a bending of sheet metal at a sharp angle.



d) Curling :→ In this operation, the edge of a sheet metal is curled around

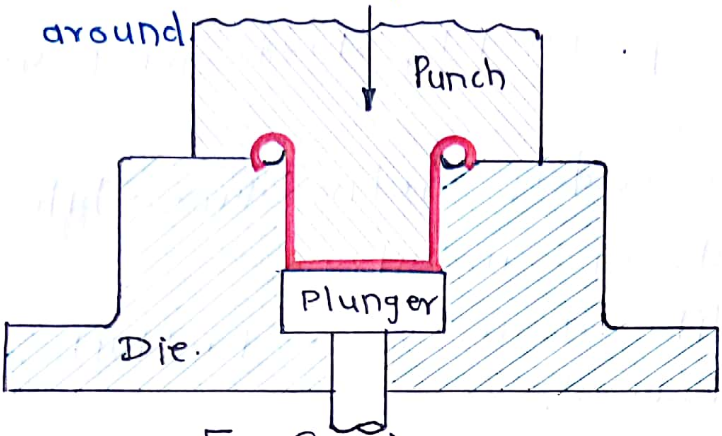


Fig. Curling

After operation, punch moves up and workpiece is ejected out with the help of plunger as shown in fig.

Advantages of Sheet Metal Working :

i) Sheet metal working is associated with press machine, on which number of operations can be performed.

ii) Metal sheets of less thickness can be formed into various shapes.

iii) The components produced by sheet metal working are of low cost

iv) Production rate of press machine is very high.

v) The process does not require skilled labour.

Disadvantages of sheet metal working :

i) Sheet metal working is only used for mass production.

ii) The cost of die is very high

iii) Initial cost of machine is also high.

iv) Metals of thickness more than 10 mm are difficult to form.

v) The operation produces more noise and vibrations.

Applications of sheet Metal Working:

The components produced by sheet metal working are as:

i) Press parts are widely used in automobile (bikes, cars, buses, trucks, etc). industry.

ii) Vehicle parts like doors, roofs, fuel tanks, front guards, etc. can be produced.

iii) Aircraft industry, radio & telephone industry, electrical parts, etc

* Metal Joining Process:

Joining processes are used for joining metal parts and in general fabrication work. The commonly used joining processes are as follows.

1. Welding
2. Soldering
3. Brazing
4. Adhesive Bonding.

* Welding Process:

Welding is the process of joining the two metallic parts together by heating them to a plastic or semi-molten state, with or without application of a pressure and with or without a filter material.

Welding process needs three input elements

1) Heat (essential), 2) Application of pressure (optional)
3) Filler material (optional)

The classification of welding processes is as follows.

Classification of Welding Process

Gas Welding
1. Oxy-acetylene
2. Air-Acetylene
3. Oxy-Hydrogen

Resistance Welding
1. Butt
2. Spot
3. Seam
4. Projection

Arc Welding
1. Carbon Arc
2. Metal Arc
3. Plasma Arc
4. Gas Metal Arc
5. Gas Tungsten Arc

Newer Welding
1. Electron Beam
2. Laser

Solid state Welding
1. Friction
2. Ultrasonic
3. Diffusion
4. Explosive.

Shielded Metal Arc Welding Process (SMAW):

It is also called as flux shielded metal arc welding. It is an arc welding process where coalescence is produced by heating the workpiece with an electric arc setup between the flux coated electrode and the workpiece.

Principle: Required heat for welding is obtained from the arc struck between the coated electrode and the workpiece. By employing higher or lower currents, the arc temperatures and thus arc heat can be increased or decreased.

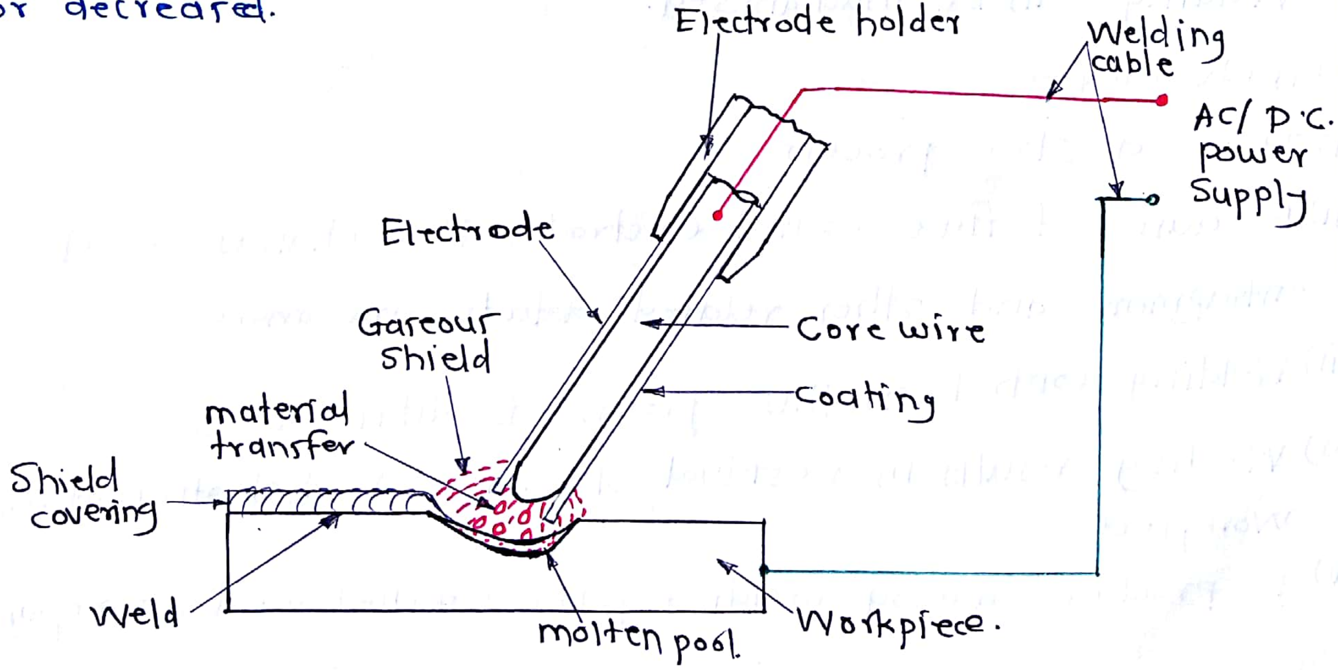


Fig. Shielded metal arc welding

5.19

Generally, the arc temperature is about 2400°c to 2600°c., A high current with a smaller arc length produces very intense heat. The arc melts the electrode and the workpiece. Material droplets are transferred from the electrode to workpiece through the arc and are deposited along the welded joint. The coating of flux melts and produces a gaseous shield and slag to prevent atmospheric contamination of the molten weld metal. Fig shows the working of flux shielded metal arc welding.

Advantages:

i) It is simplest of all arc welding processes

ii) The equipment is portable and less expensive

iii) Various metals and their alloys can be welded.

iv) Welding can be done in any direction (position) with high weld quality

V) Welding can be machanised.

Disadvantages:

i) It is a slow process

ii) Because of flux coated electrodes, the chances of slag entrapment and other related defects are more

iii) Welding control in this process is difficult.

iv) Welding results in residual stresses and distortion of the workpiece

v) To produce a good welding jobs, a skilled welder is required

Applications :

i) It is used in fabrication process and for repair & maintenance of jobs.

ii) It is also used in,

- Air receiver, boiler, pressure vessel fabrication
- Automotive and aircraft industry
- Ship welding and bridge construction.
- Machine parts (frames, beds, tools, dies, etc).
- Air craft construction.

Metal cutting Process :

All metal cutting operations basically involve forcing a cutting tool with one or more cutting edges progressively through the excess material on the workpiece. The workpiece and the tool are securely held in a machine tool and it's accessories while power is supplied to provide relative motion between the tool and the workpiece.

Machin tools are defined as the machines used for carrying out metal cutting processes (removing material from workpiece in the form of chips by using cutting tools) and surface finishing process (imparting good surface finish to the already machined workpiece, with the neglegible removal of material.

The shapes which are commonly produced through the machine tool based for metal cutting processes are flat, cylindrical, spherical, or combination of two or all of them.

Lathe Machine:
(Turning Machine):

The lathe is a machine tool on which metal machining is done by combining the rotation of the job with a perpendicular feed of the tool.

Working Principle:

Lathe is a machine tool which holds the workpiece securely between the two rigid and strong support called as centres or in a chuck or face plate, while workpiece revolves.

The cutting tool is rigidly held and supported in a tool post and is fed against the revolving workpiece. While the workpiece revolves about it's own axis, the tool is made to move in parallel or at an inclination with the axis of a material to be cut.

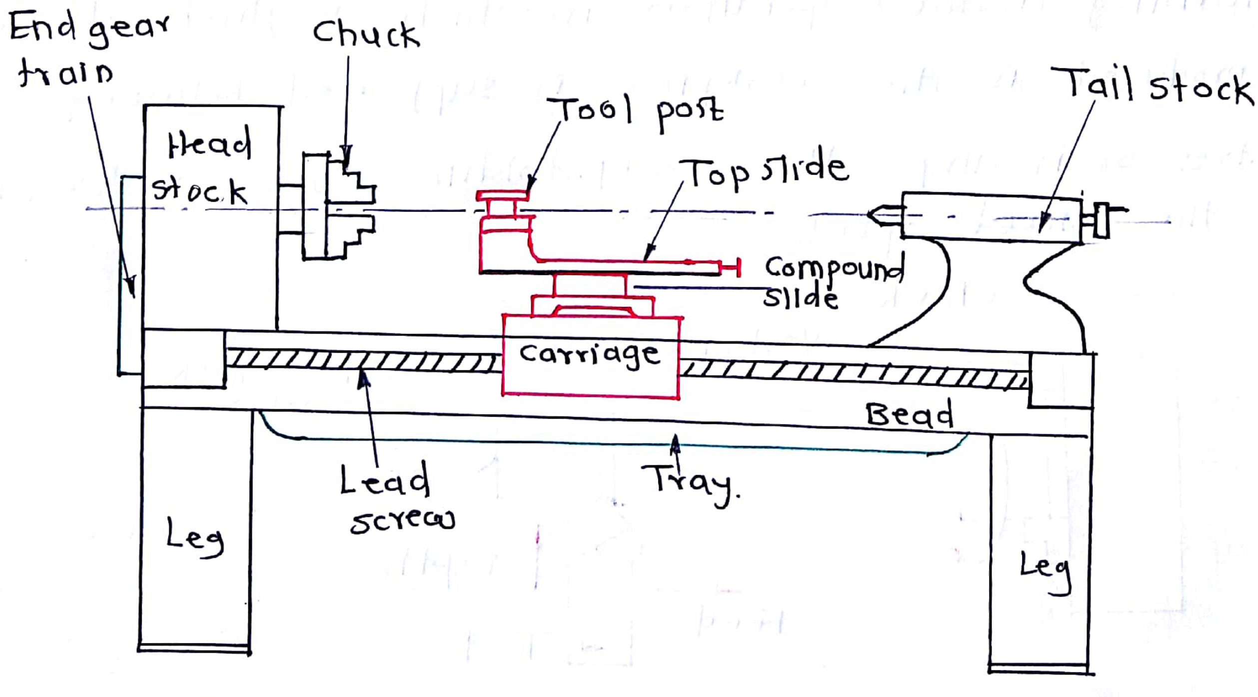


Fig. Block diagram of Lathe machine

Hence, the main function of a lathe is to remove metal from a workpiece to give it desired shape & size. The meterial from the workpiece is romoved in the form of chips. The tool material should be harder than the workpiece material.

Operations Performed on the Lathe:

Operations on a lathe are quite diversified. With suitable attachments and modifications a lathe can be made to perform most machining operation done on a number of general purpose machines.

Operations commonly performed on a lathe include, turning, facing, parting, grooving, drilling, boring, knurling, chamfering, taper turning and thread cutting.

Turning:

Turning is the operation in which a cylindrical surface is produced ~~des~~ the workpiece is supported between centres or in any other workpieceholding device, and rotated at the desired speed.

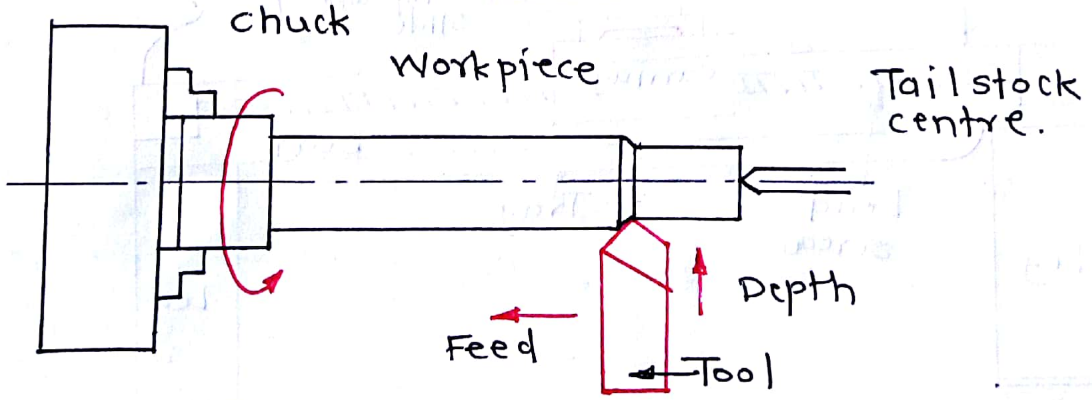


Fig. Turning between centres.

The tool is first given a depth of cut by using the cross slide motion of the carriage and then given an axial feed by hand or power.

The simultaneous motion of the workpiece and the tool result in a helical cut on the periphery of the job which can be made to overlap to produce a cylindrical surface on the workpiece by adjusting the feed and having a large nose radius.

Repeated cuts may be necessary to obtain a desired reduction of size.

A final finishing cut may be given to the workpiece with low depth of cut and feed but high speed to attain the desired degree of surface finish.

a) Straight Turning:

This operation is performed for producing a cylindrical surface by removing the excess material from the workpiece.

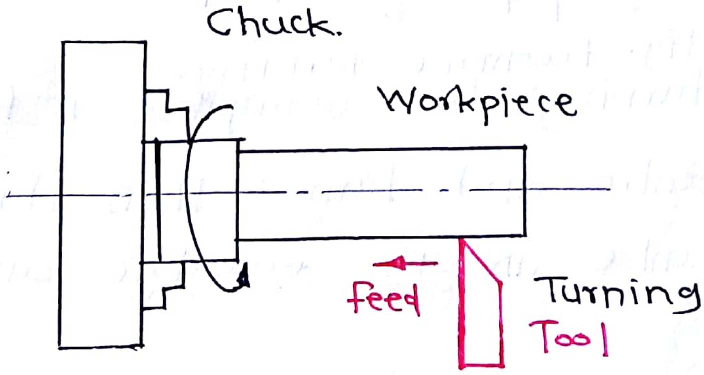


Fig. Straight turning.

The cutting tool is held in the tool post and fed into the rotating work parallel to the lathe axis. The tool used in this operation is called as turning tool.

b) Step turning: Step turning is also called as shoulder turning. When workpiece of different diameters are turned, the surface formed from one diameter to the other is called as shoulder.

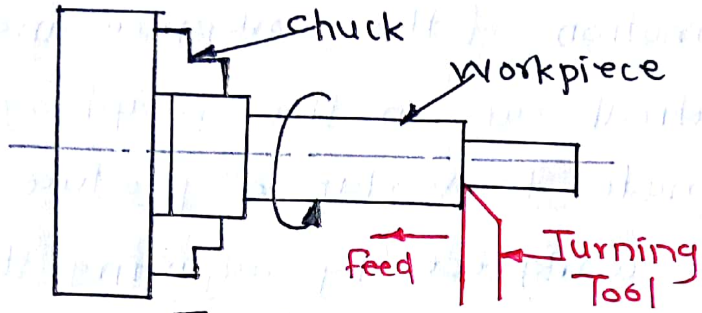


Fig. Step turning.

The machining of this part of the workpiece is know as shoulder turning.

c) Eccentric turning: If a cylindrical workpiece has two seperate axis of rotation one being out of centre to the other, then workpiece is called as eccentric.

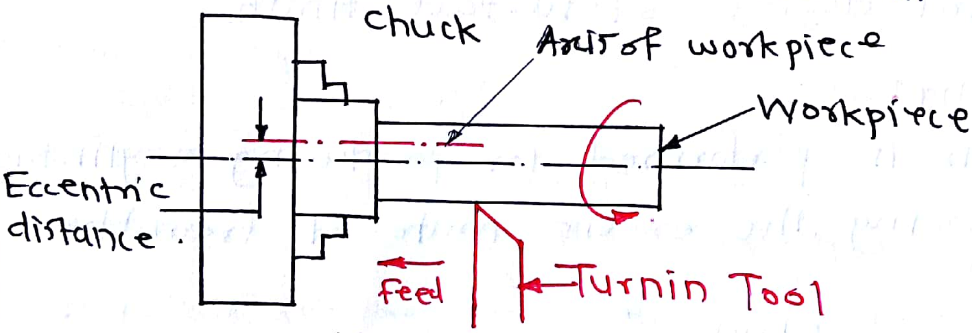


Fig. Eccentric turning.

For eccentric turning, the workpiece is first mounted on it's true centre and turned, then it is remounded on the offset centre and the eccentric surface are machined.

d) Taper turning: In taper turning, workpiece is rotated on the lathe axis and tool is fed at an angle to the axis of rotation of the workpiece.

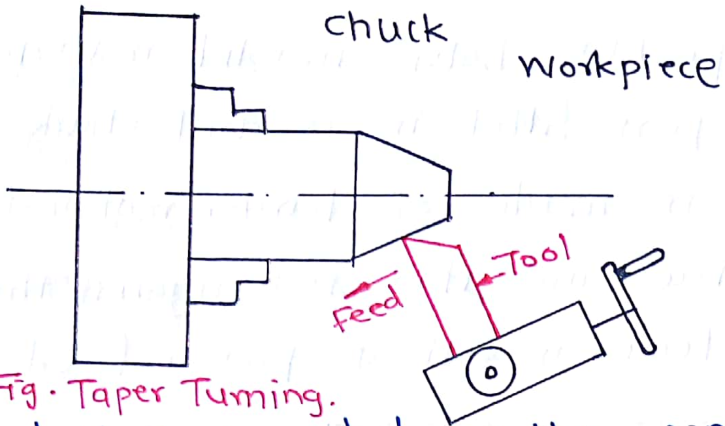


Fig. Taper Turning.

The tool is mounted on the compound rest which is attached to circular base. A circular base is arranged in degrees which can be swivelled and clamped at any required angle.

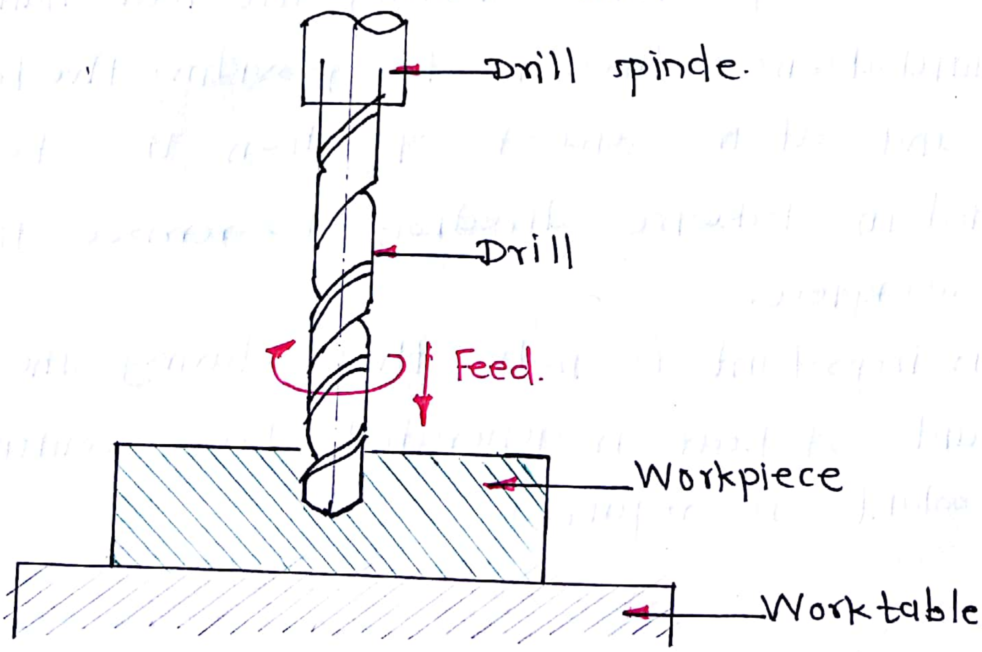
★ Drilling :-

Drilling is an operation through which holes are produced in a solid material by using a revolving tool which is called as drill.

The machine tool used for producing the hole in a solid material is called as drilling machine.

Working Principle:

In a drilling machine, the workpiece is clamped firmly on the worktable by using nuts and bolts



The tool used to produce holes in solid material called as drill is press fitted in a drill chuck.

The rotating drill is made of harder material than that of the workpiece and it is fed against the workpiece by hand feed as well as power feed.

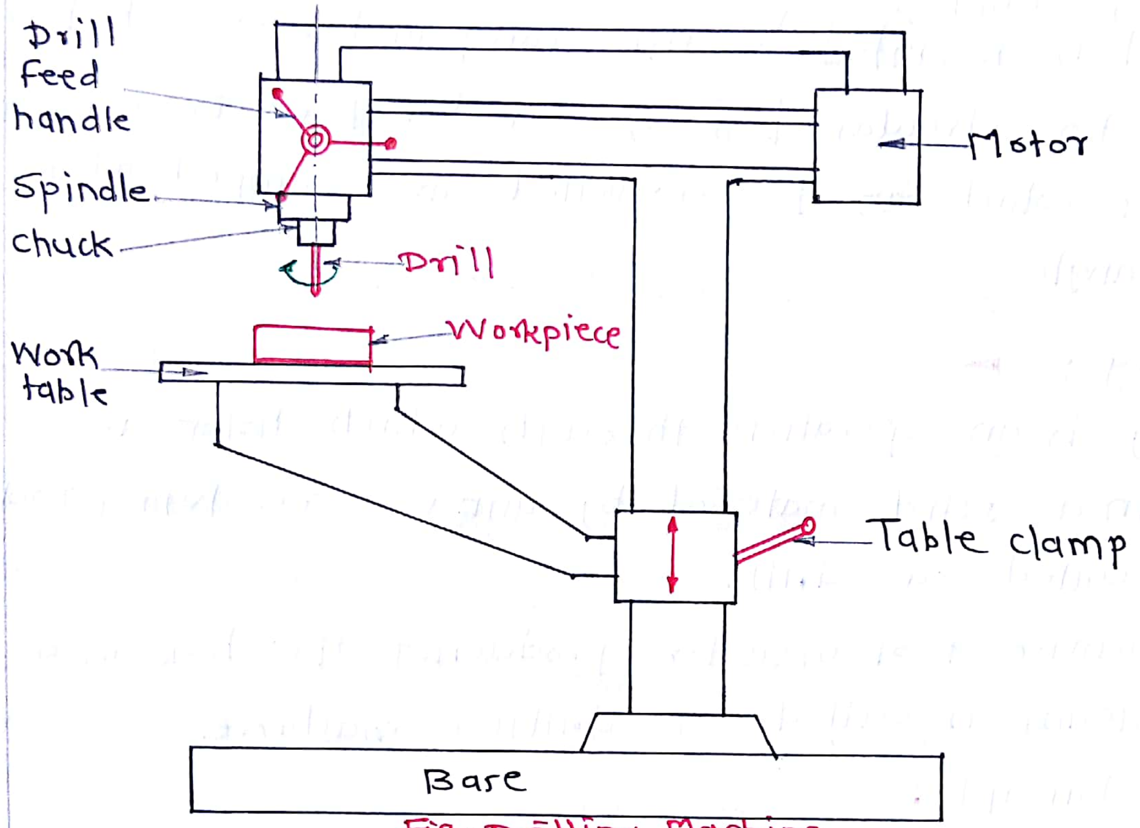


Fig. Drilling Machine.

During the operation, the material is removed in the form of chips. While drilling, the feed handle is rotated in anticlockwise direction for providing the feed to the drill and at the end of operation the feed handle is rotated in clockwise direction to remove the drill from the workpiece.

It is important to note that during the process high amount of heat is generated, hence continuous supply of coolant is required.

* Milling :

Milling is the machining process in which the metal removal takes place due to the cutting action of a revolving cutter when workpiece is fed past it.

Working Principle:

The revolving cutter is held on a spindle or arbor and the workpiece is clamped on the machine table.

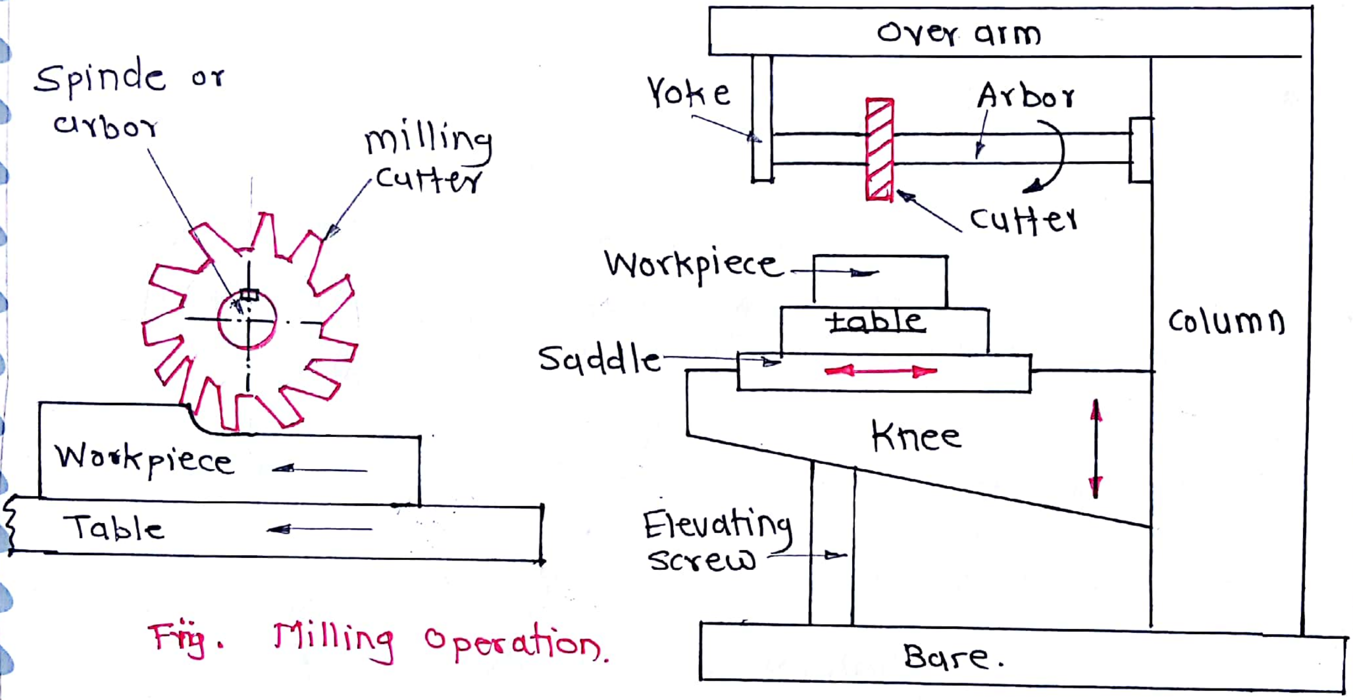


Fig. Milling Operation.

During the process, to produce the desired shape, the cutter removes the metal in the form of chips from the workpiece surface. The machine tool on which the milling operation is performed is called as milling m/c.

Also, the workpiece can be fed in a vertical, longitudinal or cross direction. Fig. shows the working of milling machine.

The table acts as a support on which workpiece is supported. then feed is given to table to move the workpiece across the cutter to remove material from workpiece

Micro-Machining :-

As many of the components used in modern products are becoming smaller and smaller miniaturization is the central theme in modern fabrication technology.

Miniaturization is now no longer remaining to micro-level accuracy, but deals with nano level accuracy also.

The removing of small amount of material by action other than that of a sharp-edged tool, micro-machining is done with an electron beam.

In micromachining removal of material in the form of chips or debris having the size in the range of microns. Creating micro feactures or surface characteristics especially surface finish in the micro level.

Need:

Now a days there is a growing need for Industrial product with multi dimensional, increased and versatile functions and of reduced dimensions.

Micro machining is the most basic technology for such miniture parts production & components

Micromachining is an ability to produce feactures with the dimensions as small as from 1 um to 999 um with the material to produce Integrated circuitry components & microstructures.

Also now a days in manufacturing industries demand for micro products & micro components are increased.

The form of each layer is determined by a geometric pattern representing circuit design information that is transferred to the water surface by a procedure known a lithography.

Following are the lithographic technologies.

① Photolithography ② Electron lithography

③ X-ray lithography ④ Ion lithography.

Advantages:

i) High flexibility regarding design of tiny structures

ii) High machining speed

iii) High precision.

iv) constant machining speed. & machining quality

v) Systems are highly flexible & can be configured to cut, drill, etc.

vi) Contactless machining with no tool wear

vii) Cost effective for both small & large volume

Disadvantages:

i) The equipment required for micro machining is very costly

ii) Need highly skilled person to operate

iii) Material limitation (including crystaline & reflective materials

iv) Reflected laser light can present a safety hazard

Applications:

i) Micro hole drilling, ii) cutting, iii) 3D machining, iv) micro miling, v) Surface treatment, vi) countouring. etc.

* Additive Manufacturing :

Additive manufacturing (AM) is an appropriate name to describe the technologies that build 3D object by adding layer-upon-layer of material whether the material is plastic, metal, concrete or one day human tissue.

Once a CAD sketch is produced, the AM equipment reads in data from the CAD file and lays down or adds successive layers of liquid, powder, sheet material, or other, in a layer-upon-layer to fabricate a 3D object.

AM process generally involve the following eight steps:

i) CAD model
ii) Conversion to STL format
iii) File transfer to AM machine
iv) Machine setup
v) Build
vi) Removal
vii) Post-processing
viii) Application or Use.

I) All kind of AM parts start from a 3D CAD model which describe its geometry for this purpose any CAD software can be used.

ii) Every AM machine accepts only STL (Standard Triangulation Language) file format, so it becomes a de facto standard and every CAD software can output this file format. It act as a basis for calculation of the Slicer as it describes external surface of original CAD model.

iii) File transfer to AM machine: Converted file to STL format is transferred to the AM machine where general manipulation of the file like correct size, position, etc are carried out.

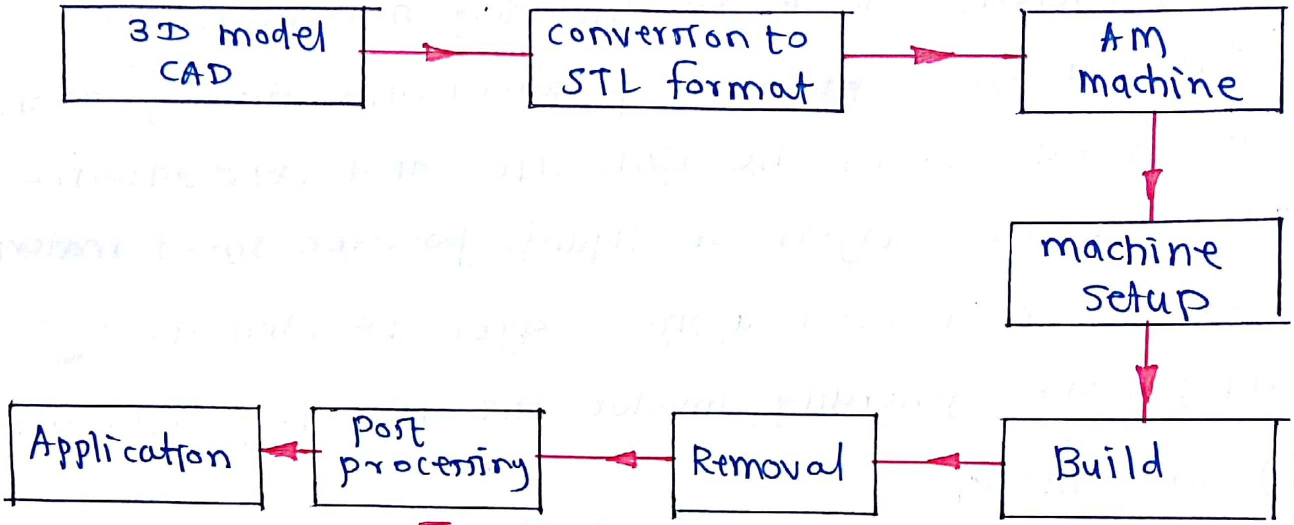


Fig. AM process.

iv) Machine setup: Prior to build process AM machine must be properly set. This setting are related to thickness of layers, timings, etc.

v) Build: In building stage, the layer by layer material is added to form required product.

vi) Removal: Once the building is completed, the components must be removed which require some interaction with the machine

vii) Post-processing: After removing the part from the AM machine, it may require addition cleaning before use

viii) Application or use: Now part is ready to use.

x

Scanned by CamScanner

Rapid Prototyping:

Rapid prototyping is a family of fabrication method to make engineering prototypes in minimum time by using computer Aided Design (CAD) model of part.

Rapid prototyping means developing a prototype a a solid representation of the part from wood, wax, clay models without all of the mechanical properties required for the actual product been used in the manufacturing industry.

Rapid Prototyping techniques:

i) Stereolithography (SLA)
ii) selective Laser sintering (SLS)
iii) 3D printing (3DP)
iv) Fused Deposition modeling (FDM)
v) Laser Engineering Net Shaping (LENS)

* 3D Printing :-

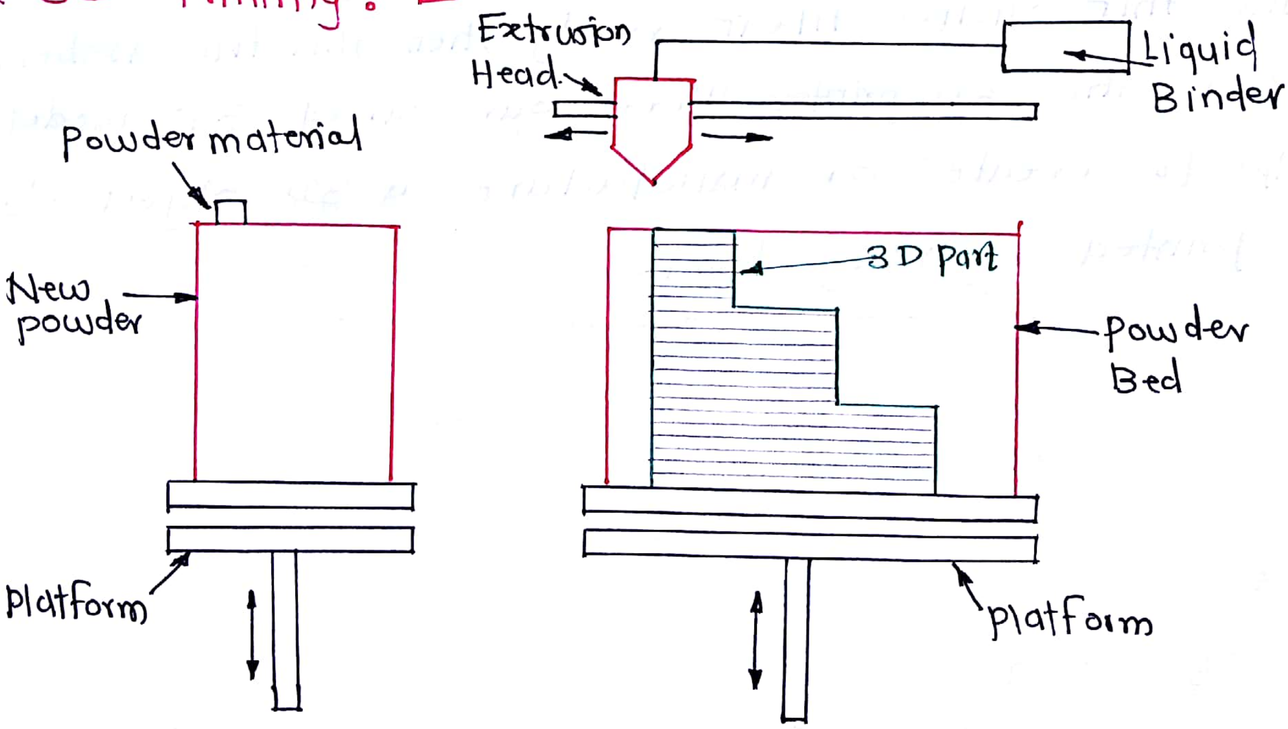


Fig. 3D Printing.

3D printing is an additive, manufacturing process which used to manufacture a three dimension at solid object.

In this process an object is being manufactured by laying down a successive layers of a material in the predefined path, at the predefined location till the whole object is being created. This layer can be observed once it's section in horizontal cross section is taken. The 3D model can be prepared by using 3D modelling software. once 3D model is prepared by using 3D modelling software then to prepare a file for 3D printer. This is called as slicing.

Slicing is nothing but dividing a 3D model into thousands of horizontal layers which is done by slicing software.

Once this slicing file is ready then this file is being fed to the 3D printer. Here our sliced 3D model helps to create or manufacture a 3D object which is printed layer by layer.

Reconfigurable Manufacturing System (RMS)

RMS is designed at the outset for rapid change in 1st structure, hardware and software components also to adjust the production capacity.

It also adjust functionality within a part family with respect to sudden market changes.

The Ideal RMS provides exactly the functionality and production capacity needed and it can be economically adjusted exactly when needed.

An ideal RMS possesses the following six core characteristics:

i) Modularity ii) Integrability iii) Scalability

iv) Convertability v) Diagnosability vi) Customized flexibility

With these characteristics, RMS increases the speed of responsiveness of manufacturing systems to unpredicted events like sudden change in market or sudden failure of machine.

Main components of RMS as follows:

- CNC machine
- Reconfigurable machine tool
- Reconfigurable inspection machines
- Reconfigurable m/c transport system, etc.

RMS Principle:

i) RMS capacity is rapidly scalable in small or optimal increments. Also it is functionality is rapidly adaptable to the production of new products

ii) To enhance the speed of responsiveness of a manufacturing system, RMS characteristics should be embeded in complete system and it's components

iii) It is designed around a part family with just enough customized flexibility required to produce all parts in the family.

iv) RMS contains an economic equipment mix of flexible and reconfigurable machines with customized flexibility.

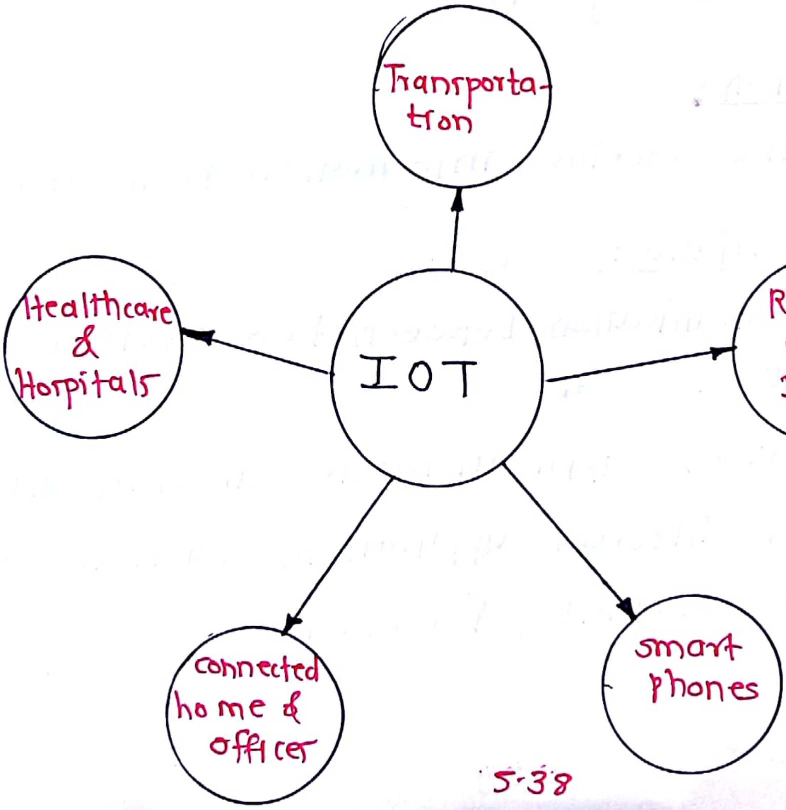
v) RMS possesses hardware and software capabilities to cost effectively respond to unpredictable events

IOT (Internet of things):

The IOT is the network of physical objects i.e. devices vehicles, buildings and other items embeded, with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data.

A phenomenon which connects a variety of things. Everything that has the ability to communicate. The IOT referes to the capability of everyday devices to connect to other devices and people though the existing internet infrastructure. Devices connect & communicate in many ways.

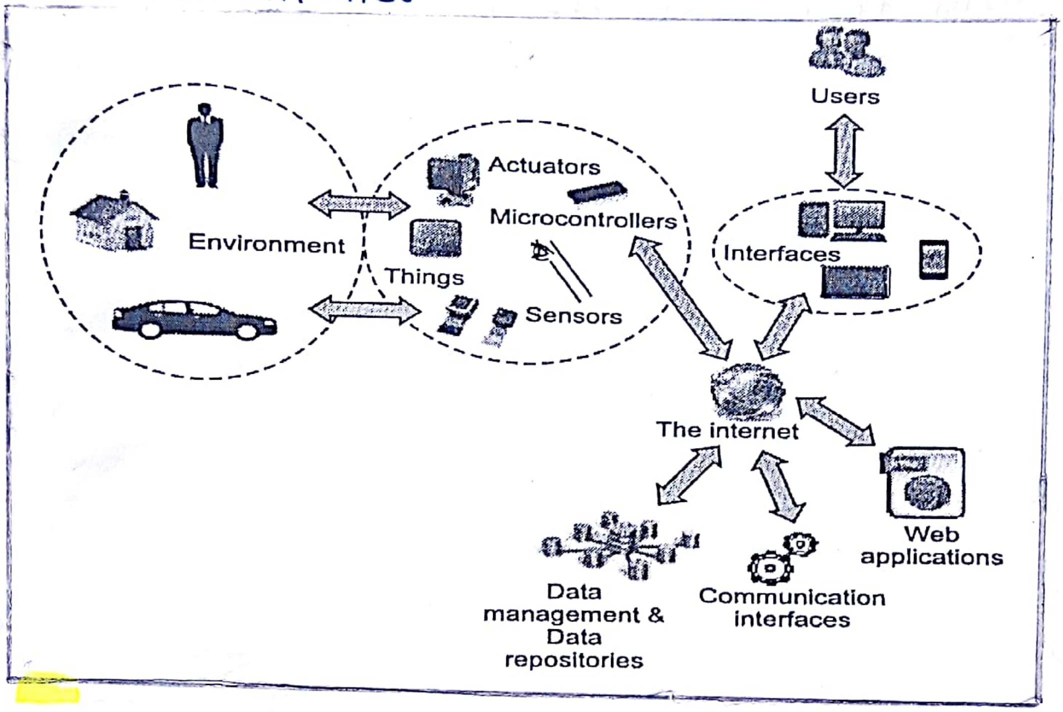
Ex. smart phones that interact with other smart phones, vehicle to vehicle communication, connected video cameras, and connected medical devices. They are able to communicate with consumers, collect & transmit data & compile large amounts of data of third parties.



Working of IoT:

1. Collect and transmit data :

The device can sense the environment and collect information related to it and transmit it to a different device or to the internet.



2. Actuate device based on triggers:

It can be programmed to actuate other devices based on conditions set by user.

3. Receive Information:

Device can also receive information from the network.

4. Communication assistance:

It provides communication between two devices of same network or different network.

Sensors for various applications are used in different IoT devices as per different applications such as temp, power, humidity, proximity, force, etc.

Advantages:

i) Improved customer engagement and communication.

ii) Support for technology optimization

iii) Support wide range of data collection

iv) Reduced waste.

Disadvantages:

i) Loss of privacy & security

ii) Complexity - It is a diverse & complex network.

iii) Currently, there is no international standard of compatibility of the tagging & monitoring equipment.

Applications:

i) Home

ii) offices

iii) Factories

iv) Vehicles

v) cities

vi) Worksites.

---x---

* CNC Machine:

A CNC or computer numerical control machine is a high precision tool thats computer controlled makes repeated accurate movements. It does so by taking computer-generated code and converting it with software to electrical signals.

Computerized Numerical Control (CNC) is a NC system which uses micro-computer as the machine control unit.

Elements of the CNC Machine:

i) Input device
ii) Machine control unit
iii) CNC Machine tool
iv) Driving System
v) Feedback device
vi) Display Unit

I) Input Device: The part programmer can be entered in to the controller via keyboard by using input device like Keyboard, CD, DVD, etc. The G-codes & M-codes can be used as reference while programming

ii) Machine Control Unit: The entered program is read by the micro computer which is the machine control Unit of CNC system. It controls all the movements of machine tool, actuation of all driver, coolant supply, etc of the machine tool.

iii) CNC Machine tool: It is the manufacturing arm of CNC machine tool system. It performs various operations-on raw material which are needed. for performing there operations it receive the information from the MCU In CNC system, all the operations like spindle start and stop, tool positioning, tool changing, speed control, etc are fully automatic.

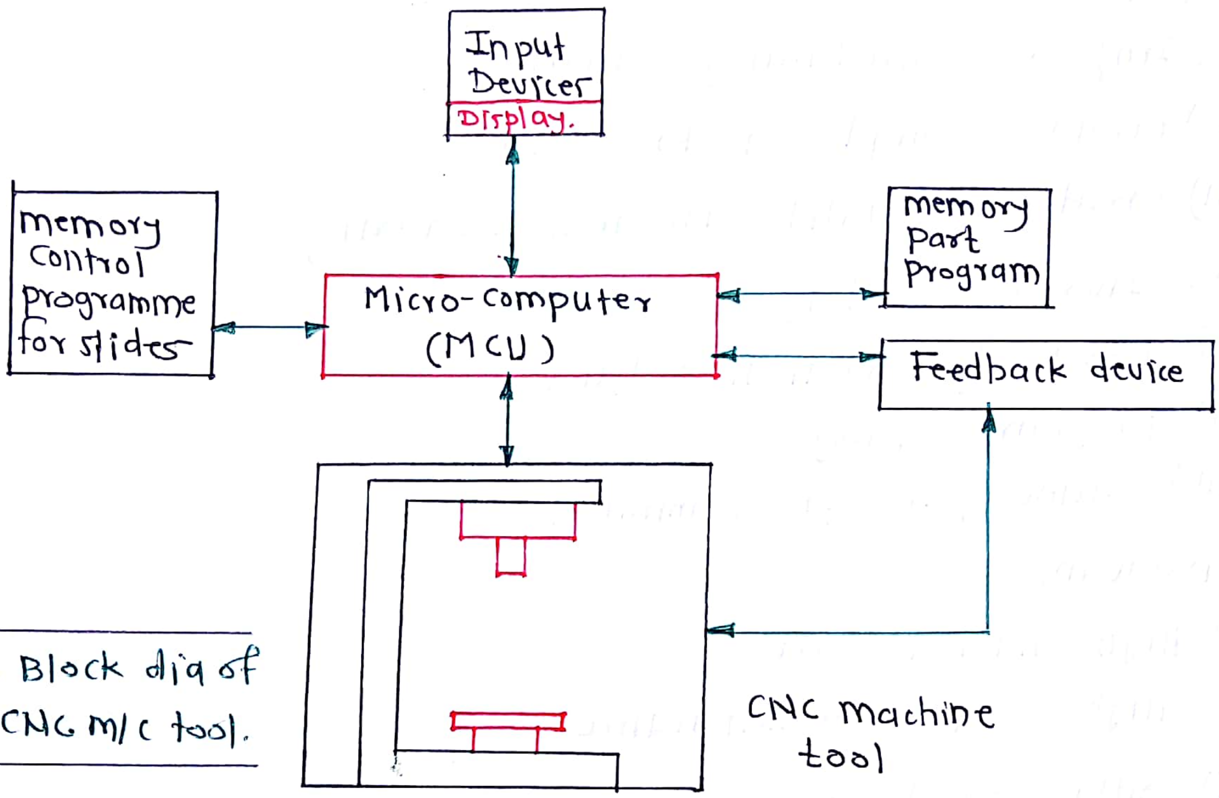


Fig. Block dia of CNC m/c tool.

iv) Driving System: Driving system is an important component of the CNC m/c. This system usually uses electric motors although hydraulic motors for large m/c tools. The motor is coupled either directly or through a gear box to the machine lead screw to move the m/c tool slide or the spindle.

v) Feedback device: In order to have a CNC m/c operating accurately, the positional values & speed of the axes need to be constantly updated. Two types of feedback devices are normally used positional feedback device and velocity feedback device.

vi) Display Unit : The display unit serves as an interactive device between the machine and the operator.

Advantages :

i) Improves machining accuracy
ii) Enables complex tasks, details
iii) Creates flexibility in manufacturing
iv) Increases safety
v) Boosts production volume
vi) Program storage
vii) online part programming.

Disadvantages :

i) High Initial cost
ii) High cost of maintenance
iii) Costly control system.
iv) Skilled operator requires
v) Unemployment.
vi) Costly software.

Applications : used to produce following type of products
i) Parts with complicated contours
ii) Parts requiring close tolerance & good quality
iii) In cases where human errors could be extremely costly
iv) Parts that are needed in a hurry.
v) Parts that may have several engineering changes.

* G codes:

Code	Description	Code	Description
G00	Rapid Move	G59	Fixture Offset 6
G01	Linear Feed Move	G60	Unidirectional Approach
G02	Clockwise Arc Feed Move	G64	Cutting Mode (Constant Velocity)
G03	Counter Clockwise Arc Feed Move	G65	Macro Call
G04	Dwell	G66	Macro Modal Call
G09	Exact stop	G67	Macro Modal Call Cancel
G10	Fixture and Tool Offset Setting	G68	Coordinate System Rotation
G12	Clockwise Circle	G69	Coordinate System Rotation Cancel
G13	Counter Clockwise Circle	G73	High Speed Peck Drilling
G15	Polar Coordinate Cancel	G74	LH Tapping*
G16	Polar Coordinate	G76	Fine Boring*
G17	XY Plane Select	G80	Canned Cycle Cancel
G18	ZX Plane Select	G81	Hole Drilling
G19	YZ Plane Select	G82	Spot Face
G20	Inch	G83	Deep Hole Peck Drilling
G21	Millimeter	G84	RH Tapping*
G28	Zero Return	G84.2	RH Rigid Tapping*
G30	2^{nd}, 3^{rd}, 4^{th} Zero Return	G84.3	LH Rigid Tapping*
G31	Probe function	G85	Boring, Retract at Feed, Spindle On
G32	Threading*	G86	Boring, Retract at Rapid, Spindle Off
G40	Cutter Compensation Cancel	G87	Back Boring*
G41	Cutter Compensation Left	G88	Boring, Manual Retract
G42	Cutter Compensation Right	G89	Boring, Dwell, Retract at Feed, Spindle On
G43	Tool Length Offset + Enable	G90	Absolute Position Mode
G44	Tool Length Offset - Enable	G90.1	Arc Center Absolute Mode
G49	Tool Length Offset Cancel	G91	Incremental Position Mode
G50	Cancel Scaling	G91.1	Arc Center Incremental Mode
G51	Scale Axes	G92	Local Coordinate System Setting
G52	Local Coordinate System Shift	G92.1	Local Coordinate System Cancel
G53	Machine Coordinate System	G93	Inverse Time Feed
G54	Fixture Offset 1	G94	Feed per Minute
G54.1	Additional Fixture Offsets	G95	Feed per Revolution*
G55	Fixture Offset 2	G96	Constant Surface Speed*
G56	Fixture Offset 3	G97	Constant Speed
G57	Fixture Offset 4	G98	Initial Point Return
G58	Fixture Offset 5	G99	R Point Return

* M codes:

Code	Description
M00	Mandatory Program Stop
M01	Optional Program Stop
M02	Program End
M03	Spindle Forward/Clockwise
M04	Spindle Reverse/Counterclockwise
M05	Spindle Stop
M06	Tool Change
M07	Mist Coolant On
M08	Flood Coolant On
M09	All Coolant Off
M19	Spindle Orient
M30	Program End and Rewind
M40-M45	Gear Change
M47	Repeat Program from First Line
M48	Enable Feed/Speed Overrides
M49	Disable Feed/Speed Overrides
M98	Subprogram Call
M99	Return From Subprogram / Rewind
M228	Go To Position