Machining is a term used to describe a variety of material removal processes in which a cutting tool removes unwanted material from a workpiece to produce the desired shape.

Machining can be used to create a variety of features including:

- **Holes**,  
- **Slots**,  
- **Flat surfaces, and**  
- **Complex surface contours**.

While machined parts are typically metal, almost all materials can be machined, including:

- **Metals**,  
- **Plastics**,  
- **Composites, and**  
- **Wood**.

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Machining Processes Tools

- Hand Tools
- Mechanical Tools

Hand Tools:
- Files
- Saw
- Chisel

Mechanical Tools:
- Grinding process
- Milling process
- Shaping process
- Drilling process
- Turning process

Machining Processes Tools:
- Drilling process (Drill)
- Turning process (Lathe)
- Shaping process (Scraper)
- Milling process (Mill)
A **chisel** is a tool with a characteristically shaped cutting edge (such that wood chisels have lent part of their name to a particular grind) of blade on its end, for carving or cutting a hard material such as wood, stone, or metal. The handle and blade of some types of chisel are made of metal or wood with a sharp edge in it.
A saw is a tool that uses a hard blade or wire with an abrasive edge to cut through softer materials. The cutting edge of a saw is either a serrated blade or an abrasive. A saw may be worked by hand, or powered by steam, water, electricity or other power.
Cutting processes are those in which a piece of sheet metal is separated by applying enough force (exceed ultimate shear strength) to cause the material to fail.
The shearing process is performed on a shear machine, often called a squaring shear or power shear, that can be operated manually (by hand or foot) or by hydraulic, pneumatic, or electric power.
Blanking is a cutting process in which a piece of sheet metal is removed from a larger piece of stock by applying a great enough shearing force. In this process, the piece removed, called the blank, is not scrap but rather the desired part.
Punching is a cutting process in which material is removed from a piece of sheet metal by applying a great enough shearing force.

Punching is very similar to blanking except that the removed material, called the slug, is scrap and leaves behind the desired internal feature in the sheet, such as a hole or slot.
Hand files are used in the workshop to smooth rough edges. They can be used to smooth a range of materials including metals such as brass and steel to wood based materials such as MDF.

They are made from high carbon steel and they are heat treated so that they are tougher than the steel or other materials that they are to be applied to.
Hand files are normally held in both hands. The file is held flat against the surface it is to cut / smooth. The file is then pushed forward and it cuts on the forward stroke. It is then lifted away from the metal and returned to the starting point for the next push forward. This is called ‘through filing’
Machining Processes

Types of Files

المبرد المثلث
المبرد المربع
المبرد العدل أو المنبسط

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Types of Files

المبرد المستدير (زيل الفار)
المبرد النصف مستدير (نصف دائري)
المبرد السكيني

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طريقة استخدام المبرد
Machining Processes

Types of Filling

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وضع الابتدائي

وضع النهائي
Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material.

The turning process requires a turning machine or lathe, workpiece, fixture, and cutting tool.

Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as:

- Holes,
- Grooves,
- Threads,
- Tapers,
Types of Turning Machine

Turning machines can be found in a variety of sizes and designs.

- Horizontal turning machine (most lathes),
- Vertical turning machine (for large diameter workpiece).

Turning machines can also be classified by the type of control:

- A manual turning machine (operator to control the motion of cutting tool during the turning operation).
- Computerized turning machine (computer numerical control lathe, CNC). CNC lathes rotate the workpiece and move the cutting tool based on commands that are preprogrammed and offer very high precision.
Lathe
Bed
The bed of the turning machine is simply a large base that sits on the ground or a table and supports the other components of the machine.

Headstock assembly
The headstock assembly is the front section of machine that is attached to the bed. This assembly contains the motor and drive system which powers the spindle. The spindle supports and rotates the workpiece, which is secured in a workpiece holder or fixture, such as a chuck or collet.
**Lathe**

**Tailstock assembly**

The tailstock assembly is the rear section of the machine that is attached to the bed. The purpose of this assembly is to support the other end of the workpiece and allow it to rotate, as it's driven by the spindle.

**Carriage**

The carriage is a platform that slides alongside the workpiece, allowing the cutting tool to cut away material as it moves.
**Cross slide**

The cross slide is attached to the top of the carriage and allows the tool to move towards or away from the workpiece, changing the depth of cut.

**Compound**

The compound is attached on top of the cross slide and supports the cutting tool. The cutting tool is secured in a tool post which is fixed to the compound. The compound can rotate to alter the angle of cutting tool relative to the workpiece.
Workpiece Fixation

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Jaw Chuck

3-Jaw Chuck

4-Jaw Chuck
All cutting tools that are used in turning can be found in a variety of materials, which will determine the tool's properties and the workpiece materials for which it is best suited. These properties include the tool's **hardness**, **toughness**, and **wear resistance**. The most common tool materials that are used include the following:

- High-speed steel (HSS)
- Carbide
- Carbon steel
- Cobalt high speed steel
Methods of mounting inserts on tool holders:
(a) Clamping, and
(b) Wing lock pins.
(c) Examples of inserts mounted using threadless lock pins, which are secured with side screws.
Cutting Tools
Turning - the cutting tool moves axially, along the side of the workpiece, removing material to form different features, including steps, tapers, and contours.
Facing – the cutting tool moves radially, along the end of the workpiece, removing a thin layer of material to provide a smooth flat surface.
**Grooving** – the cutting tool moves radially, into the side of workpiece, cutting a groove equal in width to the cutting tool.

**Cut-off** – the cutting tool moves radially, into the side of the workpiece, and continues until the center or inner diameter of the workpiece is reached.

**Thread cutting** – the cutting tool, typically with a 60 degree pointed nose, moves axially, along the side of the workpiece, cutting threads into the outer surface.
**Internal Operations**

**Drilling** - A drill enters workpiece axially through the end and cuts a hole with a diameter equal to that of the tool.

**Boring** - A cutting tool enters the workpiece axially and cuts along an internal surface to form different features, such as steps, tapers, chamfers, and contours.
Reaming - A reamer enters the workpiece axially through the end and enlarges an existing hole to the diameter of the tool. Reaming removes a minimal amount of material and is often performed after drilling to obtain both a more accurate diameter and a smoother internal finish.

Tapping - A tap enters the workpiece axially through the end and cuts internal threads into an existing hole. The existing hole is typically drilled by required tap drill size.
Types of Turning machine (lathe)

المخرطة المتوازية (العامة)
Types of Turning machine (lathe)
Types of Turning machine (lathe)

CNC Machine

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A milling machine is a power driven machine that cuts by means of a multi-tooth rotating cutter. The mill is constructed in such a manner that the fixed workpiece is fed into the rotating cutter. Varieties of cutters and holding devices allow a wide range of cutting possibilities.
The Main Parts of Milling Machine

**Base and column** - The base of a milling is simply the platform that sits on the ground and supports the machine. A large column is attached to the base and connects to the other components.

**Table** - The workpiece is mounted onto a table along its surface. The workpiece may be secured in a fixture (a vise), which is secured into the T-slots, or can be clamped directly into these slots. The table provides the horizontal motion of the workpiece in the **X-direction**.

**Saddle** - The saddle is the platform that supports the table and allows its longitudinal motion. The saddle is able to move and provides the horizontal motion of workpiece in **Y-direction**.

**Knee** - The knee is the platform that supports the saddle and the table. In most milling machines, the knee provides the vertical motion (**Z direction**) of the workpiece.

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(a) The difference between conventional milling and climb milling.
(b) Slab-milling operation, showing depth of cut, $d$; feed per tooth, $f$; chip depth of cut, $t_c$ and workpiece speed, $v$.
(c) Cutter travel distance, $l_c$, to reach full depth of cut.
Basic Types of Milling Cutters

Cutters for
(a) Straddle milling;
(b) Form milling;
(c) Slotting; and
(d) Slitting operations.

T-slot cutting with a milling cutter.

A shell mill
Basic Types of Milling Cutters

(a) Peripheral milling
(b) Face milling
(c) End milling

(d)
(e)
Milling Machines

Horizontal spindle column and knee type milling machine.

Vertical spindle column and knee type milling machine.
**End milling** - An end mill makes either peripheral or slot cuts, across the workpiece in order to machine a specified feature, such as a profile, slot, or even a complex surface contour.

**Chamfer milling** - A chamfer end mill makes a peripheral cut along an edge of the workpiece or a feature to create an angled surface, known as a chamfer.
**Face milling** - A face mill machines a flat surface of the workpiece in order to provide a smooth finish.

The depth of the face, typically very small, may be machined in a single pass or may be reached by machining at a smaller axial depth of cut and making multiple passes.
Milling Machine Vises

Plain vise
  Jaws parallel or 90° to axis of spindle

Swivel base vise
  – Can swivel through 360° in horizontal plane

Universal vise
  – Can swivel through 360° in horizontal plane and tilted from 0° to 90 in vertical plane
Operations
Operations
A shaping machine is used to machine surfaces. It can cut curves, angles and many other shapes. It is a popular machine in a workshop because its movement is very simple although it can produce a variety of work.
The main parts

The tool feed handle can be turned to slowly feed the cutting tool into the material as the 'ram' moves forwards and backwards. The strong machine vice holds the material securely.

The vice rests on a steel table which can be adjusted so that it can be moved up and down and then locked in position. Pulling back on the clutch handle starts the 'ram' moving forwards and backwards.
The tool post and the tool slide can be angled as seen below. This allows the shaper to be used for different types of work.

- The tool post has been turned at an angle so that side of the material can be machined.
- The tool post is not angled so that the tool can be used to level a surface.
- The top slide is slowly feed into the material so that a ‘rack’ can be machined for a rack and pinion gear system.
Shapping for metal

عمليات الكشط

THE SHAPING MACHINE
Shapping for metal

عمليات الكشط

Cutting Tool
Tool Feed
Stroke

Stroke (large arc distance)
Return Stroke (small arc distance)
Types of Shapes

Shapers are classified in number of ways depending upon the general features of design or the purpose for which they are intended.

1. According to the type of mechanism used for giving motion to the ram:
   - Crank type,
   - Geared type,
   - Hydraulic type.

2. According to the position and travel of ram:
   - Horizontal type,
   - Vertical type,
   - Traveling head type.

3. According to the type of design of the table:
   - Standard shaper,
   - Universal shaper.

4. According to the type of cutting stroke:
   - Push type,
   - Draw type.
Shaper

Crank shaper
Shaper

Geared shaper

Hydraulic shaper
A grinding machine, often shortened to grinder, is a machine tool used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the workpiece via shear deformation.
**Belt grinder**, which is usually used as a machining method to process metals and other materials, with the aid of coated abrasives. Belt grinding is a versatile process suitable for all kind of applications like finishing.

**Bench grinder**, which usually has two wheels of different grain sizes for roughing and finishing operations and is secured to a workbench or floor stand. Bench grinders are manually operated.
Grinding Machine

Grinding types

**Cylindrical grinder.** A cylindrical grinder may have multiple grinding wheels. The workpiece is rotated and fed past the wheel(s) to form a cylinder.

**Surface grinder.** A surface grinder has a "head" which is lowered, and the workpiece is moved back and forth past the grinding wheel on a table that has a permanent magnet for use with magnetic stock.
Grinding Machine

Grinding types

**Tool and cutter grinder.** These usually can perform the minor function of the drill bit grinder, or other specialist tool room grinding operations.

**Angle grinder,** also known as a **side** or **disc grinder,** is a handheld power tool used for cutting, grinding and polishing.
(a) Chisel-point drill. The function of the pair of margins is to provide a bearing surface for the drill against walls of the hole as it penetrates into the workpiece. Drills with four margins are available for improved drill accuracy.
(b) Crankshaft drills. These drills have good centering ability, and because chips tend to break up easily, they are suitable for producing deep holes.
Drilling
Various types of drills.
(a) Spade drill;
(b) Straight-flute drill;
(c) Drill with indexable carbide inserts;
(d) Drill with brazed-carbide tip
FIGURE 3.16 Terminology of a standard point twist drill.

Helix drills of different helix angles: (a) Standard, (b) slow, (c) quick.
(a) The components of a vertical drill press.
(b) A radial drilling machine.
A three-axis computer numerical-control drilling machine. The turret holds as many as eight different tools, such as drills, taps, and reamers.
Multiple-spindle Drilling Machine