**Turning** is widely used for machining *external* cylindrical and *conical* surfaces.

The workpiece rotates and a longitudinally fed *single point cutting tool* does the cutting.

Machine tools used for this process are called *lathes*. 
Turning and Related Operations
Besides turning, lathes are capable of performing a variety of processes.

Turning and Related Operations
FIGURE 23-26 Schematic of common single-point lathe tools for showing how they can be used.
1. **Turning**

*(Cylindrical (straight), taper, form and contour turning)*

Machining of an external surface by rotating the workpiece and feeding the tool *along the workpiece.*
2. Boring

*(Cylindrical, taper, form and contour boring)*

Enlargement of an existing hole, which may have been made by drilling or be the result of a core in a casting.
3. **Facing**

Producing a flat surface as the result of the tool being fed across the end of the rotating workpiece.

4. **Cut off or Parting**

Operation by which one section of a workpiece is separated from the remainder by feeding the tool across the rotating workpiece.
5. Drilling, Reaming

Feed
7. Thread cutting

There are two basic requirements cutting a thread on a lathe.

The first is an accurately shaped and mounted tool, because the thread cutting is a form-cutting operation; the resulting thread profile is determined by the shape of the tool and its position relative to the workpiece.

The second requirement is that the tool must move longitudinally in a specific relationship to the rotation of the workpiece, because this determines the lead of the thread.

Both external and internal threads can be cut by using a lathe.
Cutting speeds specified for turning are the speeds at the surface which is being machined.

These surface speeds are used to calculate the rotational speed of the workpiece.

\[ N = \frac{1000 \cdot CS}{\pi D} \]

- \( N \)  Rotational speed (rpm)
- \( CS \)  Cutting speed (m/min)
- \( D \)  Workpiece diameter (mm)
**Speeds and Feeds in Turning**

*Feed* is the axial advance of the tool along the workpiece during each revolution of the workpiece. It is expressed in mm/rev.

**Cutting time**

\[
T = \frac{L + A}{f \cdot N}
\]

- **T** Cutting time (min)
- **N** Rotational speed (rpm)
- **f** Feed (mm/rev)
- **L** Workpiece length (mm)
- **A** Allowance for tool overrun (mm)
The essential components of a lathe are:

- **Bed**
- **Headstock assembly**
- **Tailstock assembly**
- **Carriage assembly**
- **Quick-change gear box**
- **Lead screw**
- **Feed rod**
Cross Slide

Tool Post

Cross Slide

Carriage

Compound Rest

Threading Dial

Cross Slide

Handwheels
**Lathe Construction**

**Apron**, which is attached to the **front of the carriage**, contains mechanisms and controls for providing manual and powered motion for the carriage and powered motion for the cross slide.

For powered motions, apron takes the motion from the **quick-change gearbox** via either the feed rod or the lead screw.
Apron
Through the quick-change gear box, the associated gearing, and the lead screw and feed rod, the carriage is connected to the spindle, and the cutting tool can be made to move a specific distance for each revolution of the spindle.
**Lathe Construction**

**Feed rod** provides powered motion of the cross slide and the carriage for operations other than thread cutting.

**Lead screw** is used to transmit the motion to the carriage for thread cutting.
Size Designation of Lathes

The size of a lathe is designated by two dimensions.

- The first one is the **maximum diameter of work** that can be rotated on a lathe, which is known as swing.
- The second one is the **maximum distance between centers**.
2. **Engine Lathes**

The most frequently used one in manufacturing.

They are heavy-duty machine tools with all the components described previously and have power drives for all tool movements except on the compound rest.

Most have chip pans and a built-in coolant circulating system.

Smaller engine lathes are also available in **bench type**, designed for the bed to be mounted on a bench or cabinet.
Bench Type Lathe
Types of Lathes

5. Turret Lathes

Although engine lathes are versatile and very useful, they are not suitable for quantity production, since,

- Large amount of time is required for changing and setting tools, and for making measurements,
- Skilled operator is required.

Turret lathes, screw machines, and other types of semiautomatic and automatic lathes have been developed to get rid of these difficulties.
A turret lathe has,

- Two **turrets**, one on the tailstock, and the other on the cross slide,

- **Automatic indexing** at the end of the motion of the tailstock turret which is moved by turning a capstan wheel, thus bringing the next tool into cutting position,
A giant horizontal lathe (Bilim Makina A. Ş.-BURSA)
Brown and Sharpe type is essentially a small automatic turret lathe designed for bar stock with the main turret mounted in a vertical plane on a ram.

All motions of the machine are controlled by disk cams.

These machines usually are equipped with an automatic rod-feeding magazine that feeds bar stock.
Brown and Sharpe Type Screw Machine
Single Spindle Screw Machines

On the **Swiss type** screw machine the cutting tools are held and moved in radial slides.

Disk cams move the tools into cutting position and provide feed into the work in a radial direction only; they provide any required longitudinal feed by reciprocating the headstock.

These machines are particularly well suited for machining very small parts and are used primarily for such work.
2. **Multiple-Spindle Screw Machines**

Have multiple (usually six) spindles used to hold and rotate workpieces.

Since different operations are performed on a number of workpieces simultaneously, they are more productive when compared to single spindle machines.

*Tools are on a tool head.*
1. **Holding between Centers**

Workpieces that are relatively long with respect to their diameters usually are machined between centers.

There are two types of lathe centers:

- **Plain (solid) center**
- **Live center**
Plain (Solid) Center

- **Headstock**
- **Drive plate**
- **Dog**
- **Center**
- **Tailstock**
- **Workpiece**

- **Dog plate**, rotates
- **Dog**, clamped to workpiece
- **Center**
Live centers are often used in tailstock quill. They are free to rotate, thus no lubrication is necessary. They may not be as accurate as the plain type, so they often are not used for precision work.
Workpieces that must be machined on both ends and those that are disk like in shape are mounted on mandrels for turning between centers.
2. Holding in a Chuck

Lathe chucks are used to support a wider variety of workpiece shapes and to permit more operations to be performed than can be accomplished when the work is held between centers.

The jaws on most chucks can be reversed to facilitate gripping either the inside or the outside of workpieces.

- Three-jaw, self centering chucks
- Four-jaw independent chucks
- Combination four-jaw chucks
- Two-jaw chucks
- Special chucks
Three-jaw, Self Centering Chucks

Three-jaw, self centering chucks are used for work that has round or hexagonal cross-section.

The three jaws are moved inward or outward simultaneously by rotation of a spiral cam, which is operated by means of a special wrench through a bevel gear.

Due to this simultaneous motion, these chucks provide automatic centering.
Each jaw in a **four-jaw independent chuck** can be moved inward and outward independent of the others by means of a chuck wrench.

Thus they can be used to support a wide variety of work shapes.

**Combination four-jaw chucks** are available in which each jaw can be moved independently or all can be moved simultaneously by means of a spiral cam.
Two-jaw Chucks, Special Chucks

- **Two-jaw chucks** are also available.
- For mass-production work, often **special chucks** are used in which the jaws are actuated by air or hydraulic pressure, permitting very rapid clamping of the work.
- Chucks can also be used with **soft jaws** (typically made from an aluminum alloy) that can be machined to conform to a particular workpiece. They are self centering.
3. **Holding in a Collet**

Smooth bar stock or workpieces that have been machined to a given diameter can be held more accurately by collets.

At the split end the smooth internal surface is shaped to fit the piece of stock that is to be held and the external surface is a taper which fits within an internal taper of collet sleeve placed in the spindle hole.

Collets are made to fit a variety of symmetrical shapes.
Collets

Spring collet

Collet sleeve

Headstock spindle sleeve

Round collet

Square collet

Hexagon collet

Cutaway view of collet
4. Mounting on a Face Plate

**Face plates** are used to support irregularly shaped work that cannot be gripped easily in chucks or collets.

The work can be bolted or clamped directly on the face plate.

For machining in large quantities, workpieces can be held in **fixtures**.
5. Mounting on the Carriage

When no other means is available, boring occasionally is done on a lathe by mounting the work on the carriage, with the boring bar mounted between centers and driven by means of a dog.

![Diagram of mounting work on lathe carriage](image)
Mounting on the Carriage
***MACHINING/turning and lathes (SME/Wiley’s video)***