

Outline

Metal Cutting

● Chip Formation Processes

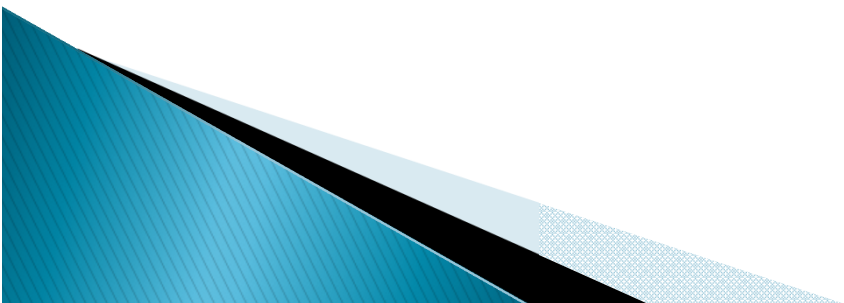
- Conditions
- Back rake angle
- Shear angle

● Chip Formation

- Continuous formation
- Built up edge formation
- Discontinuous formation

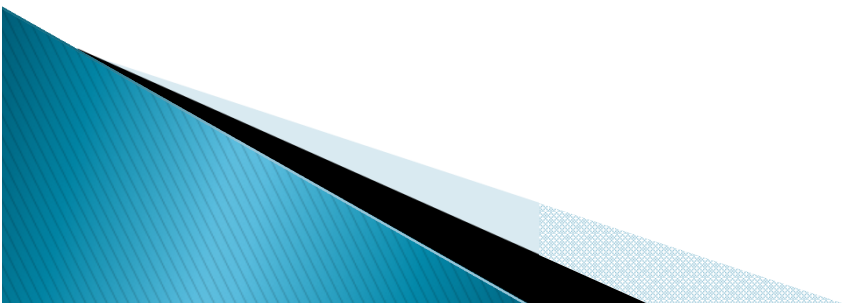
● Effects

- Chip formation
- Shear angle



Chip Formation Processes

- Shaping
- Turning
- Milling
- Drilling
- Sawing
- Broaching
- Grinding



Machining Operations

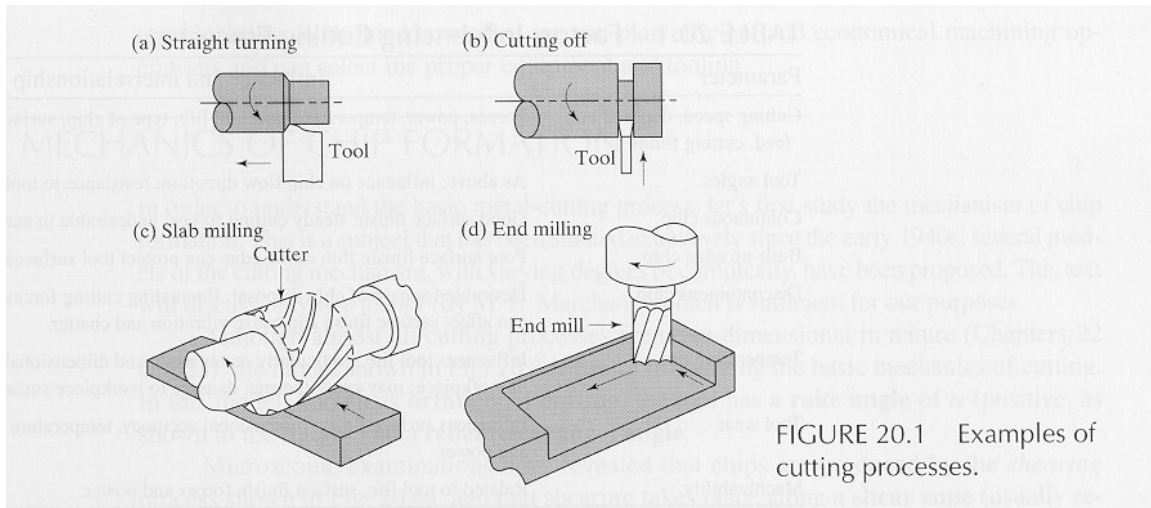


FIGURE 20.1 Examples of cutting processes.

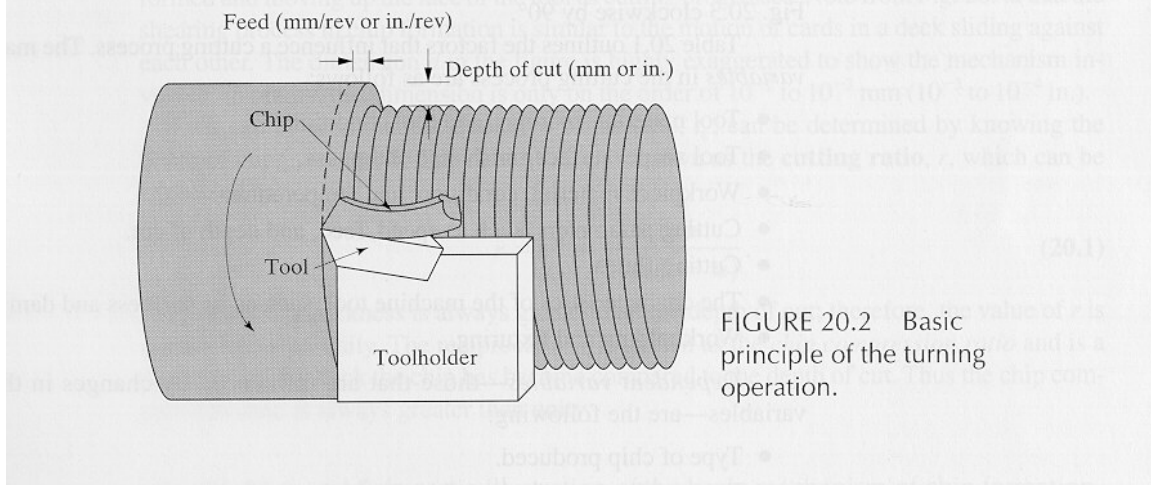
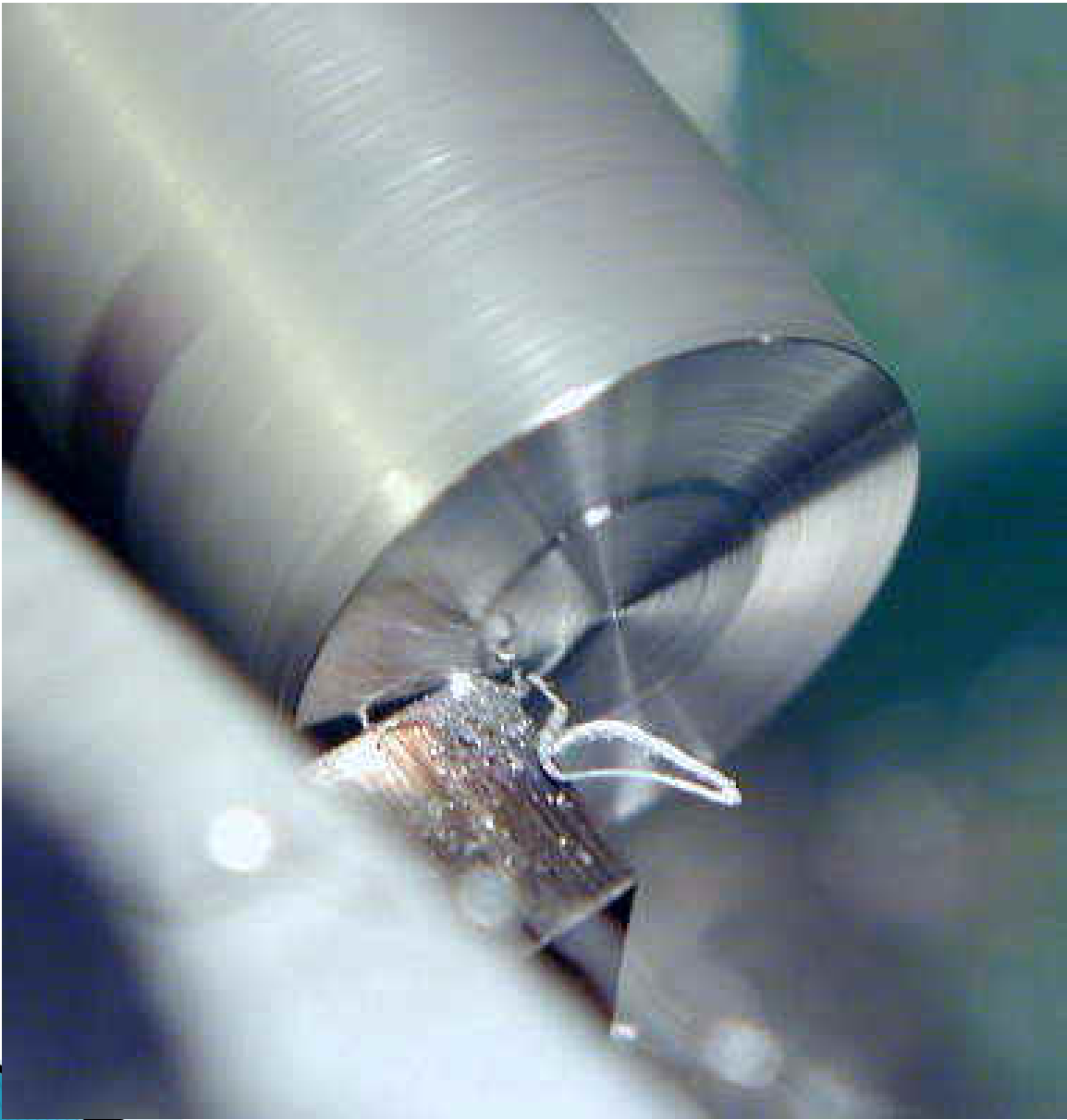
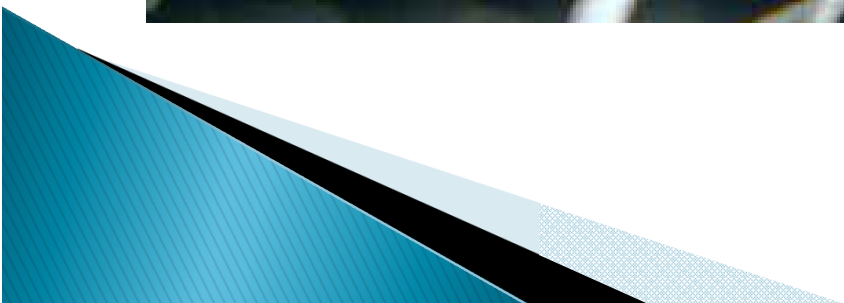
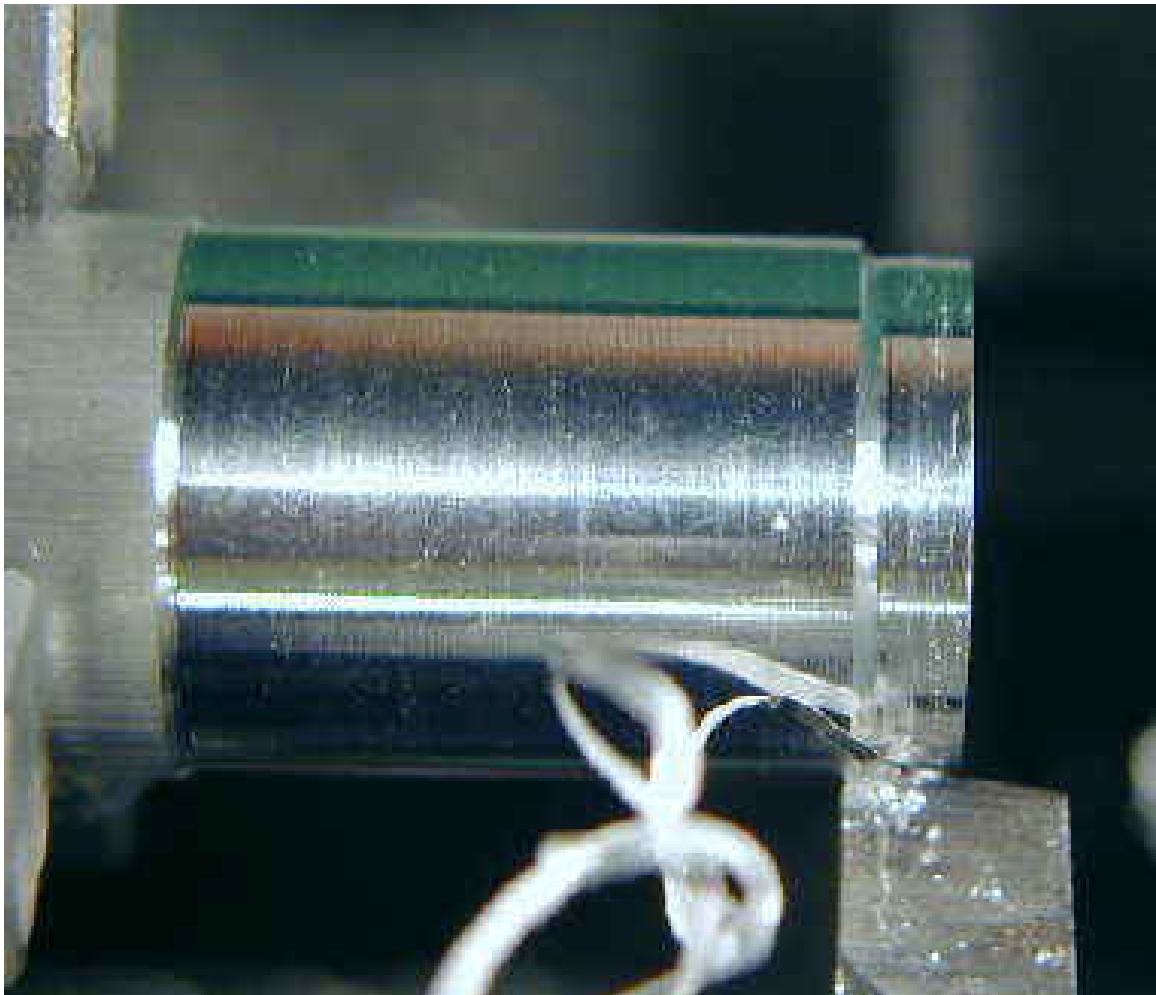


FIGURE 20.2 Basic principle of the turning operation.

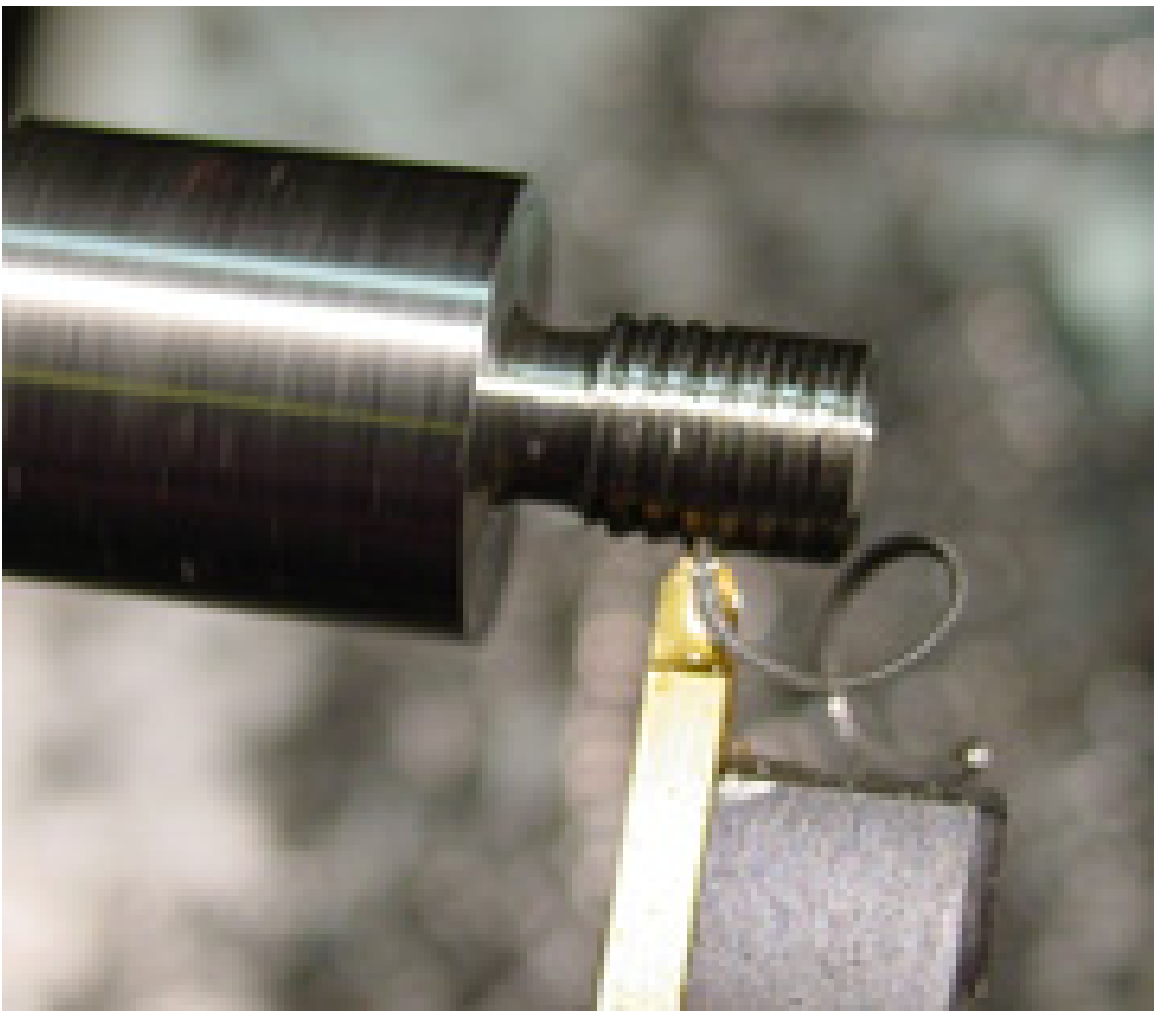
Basic Cutting – Face Cutting



Basic Cutting – Turning Diameters



Basic Cutting – Thread Cutting



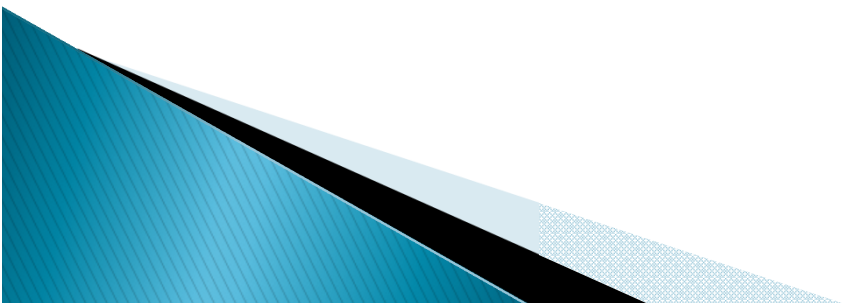
Chip Formation Processes

● Control

- Feed
- Speed
- Depth of Cut

● Conditions

- Machining Process
- Machine Limitations
- Material
- Tool Type
- Tool material
- Surface Finish
- Tolerances



Chip Formation Processes

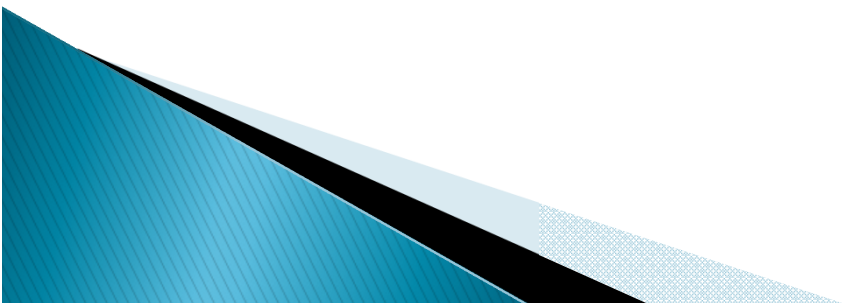
- Back rake angle, α

The angle that the tool makes with respect to a vertical from the work piece

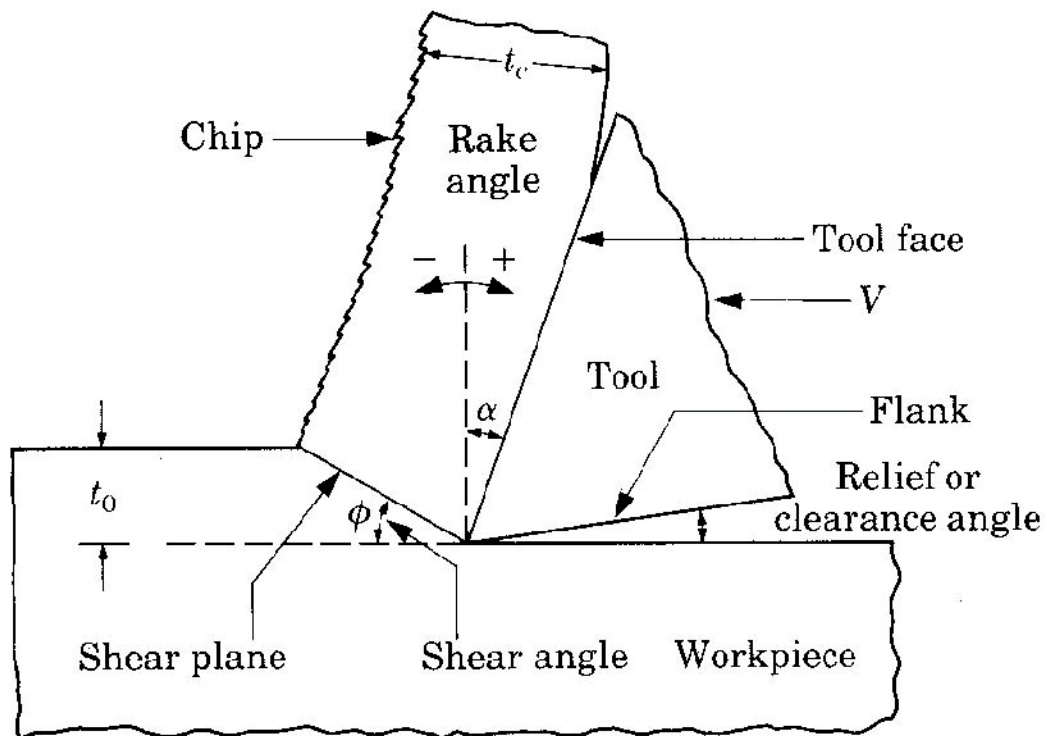
- The chip is formed by shearing along the shear plane

The shear plane or shear angle ϕ is measured with respect to the horizontal

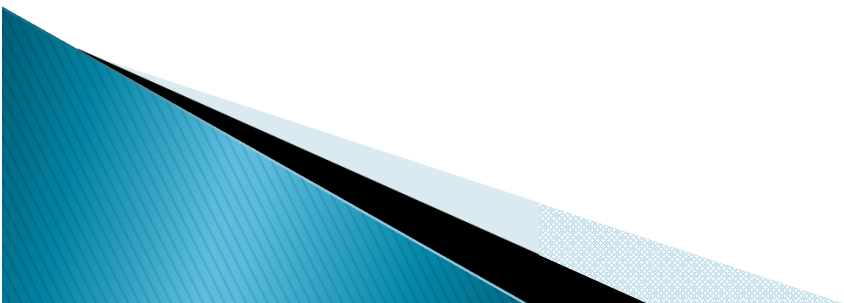
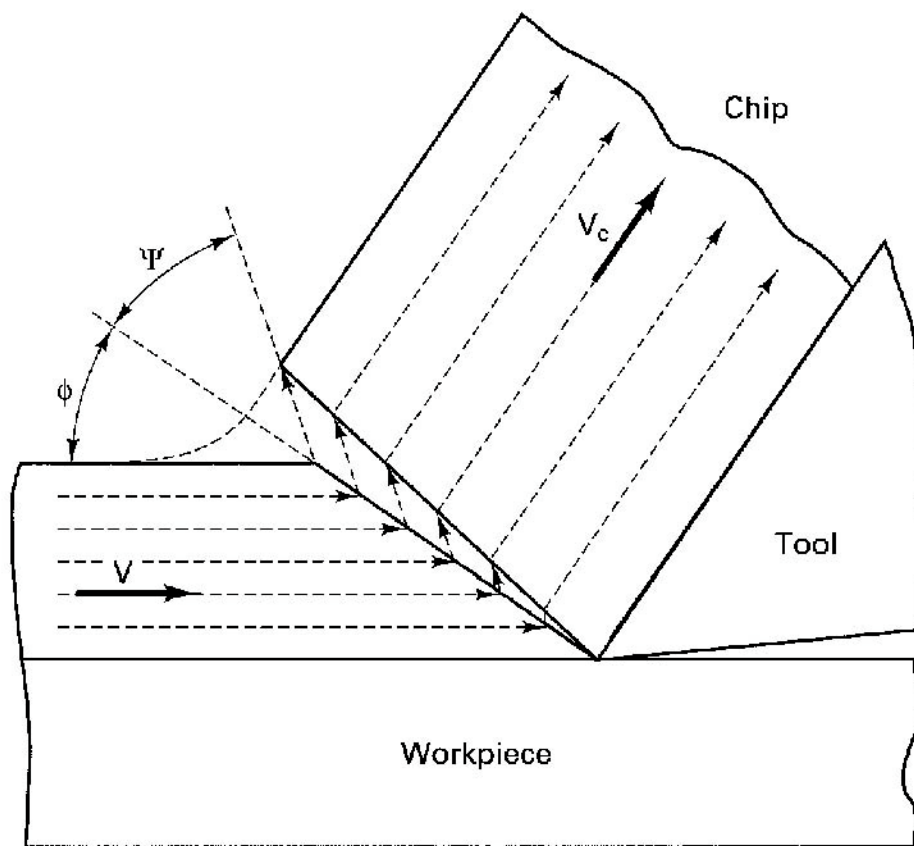
Flank of the tool is the bottom of the tool not in contact with the material



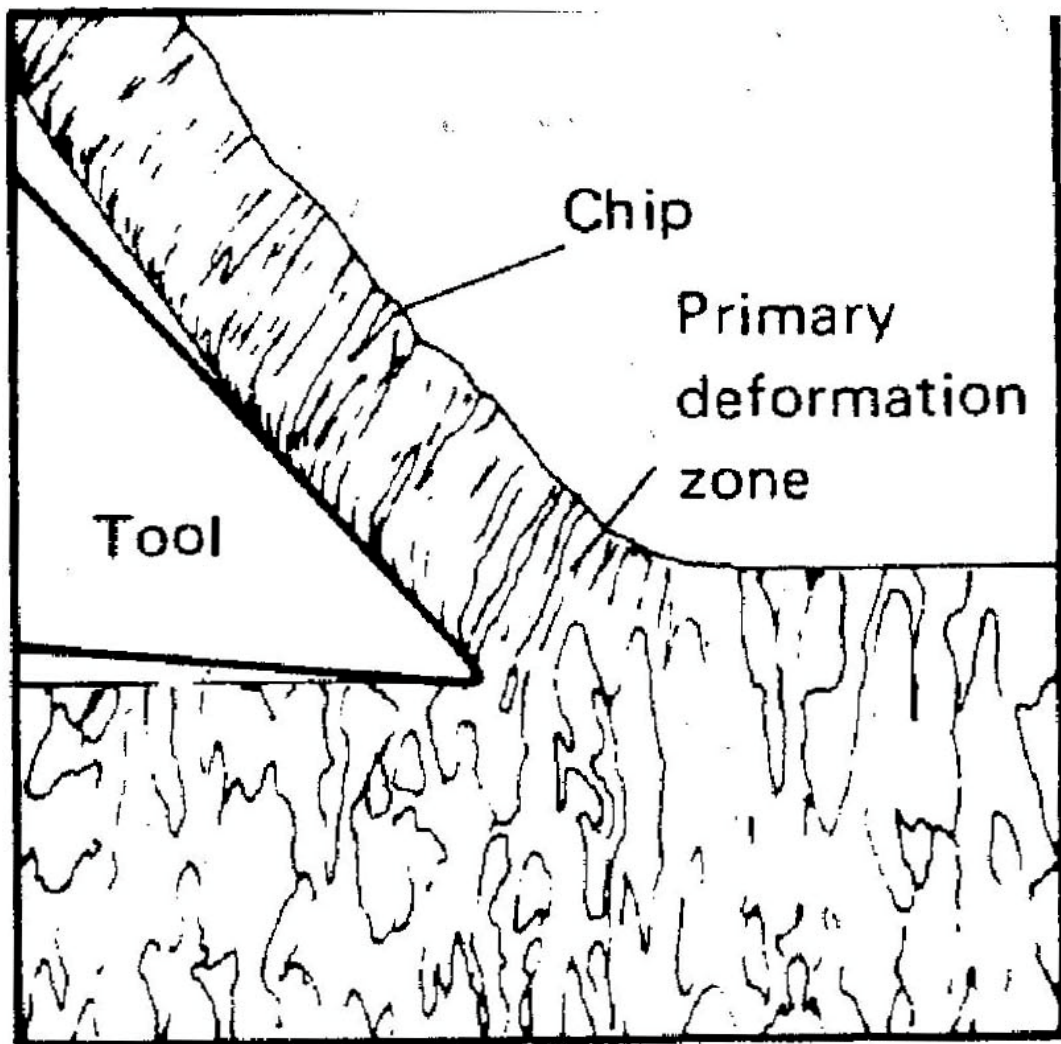
Cutting Definitions



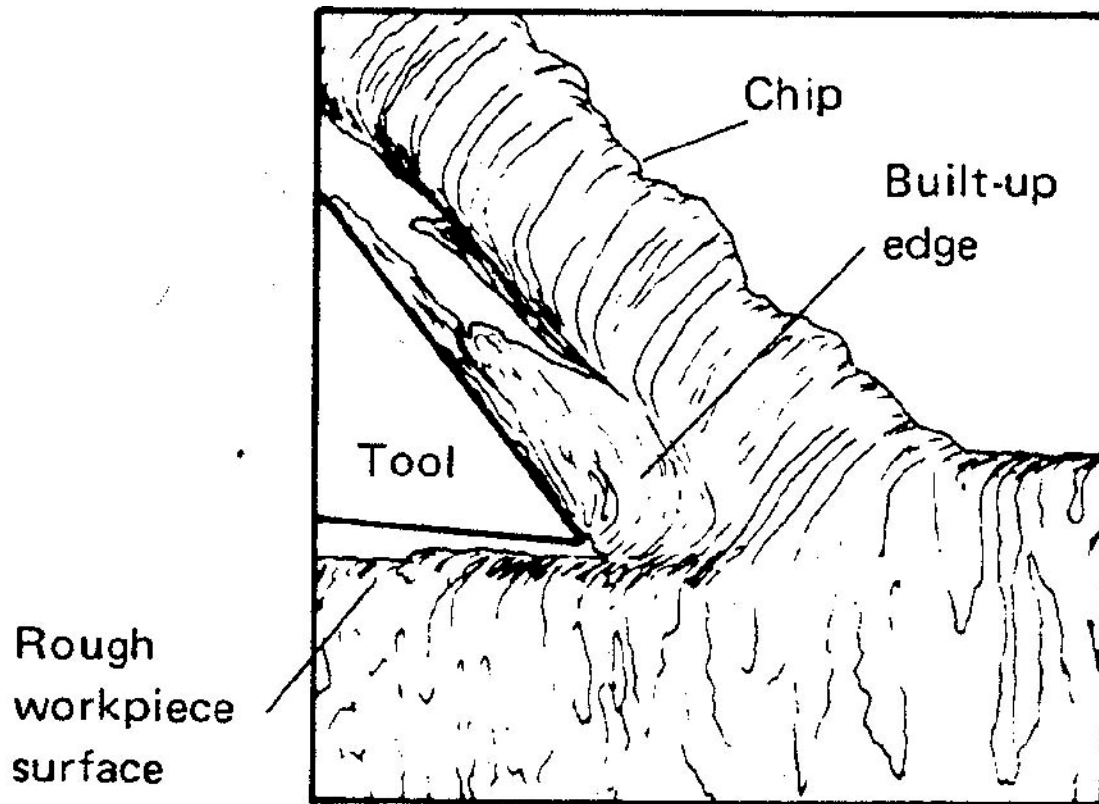
Chip Formation



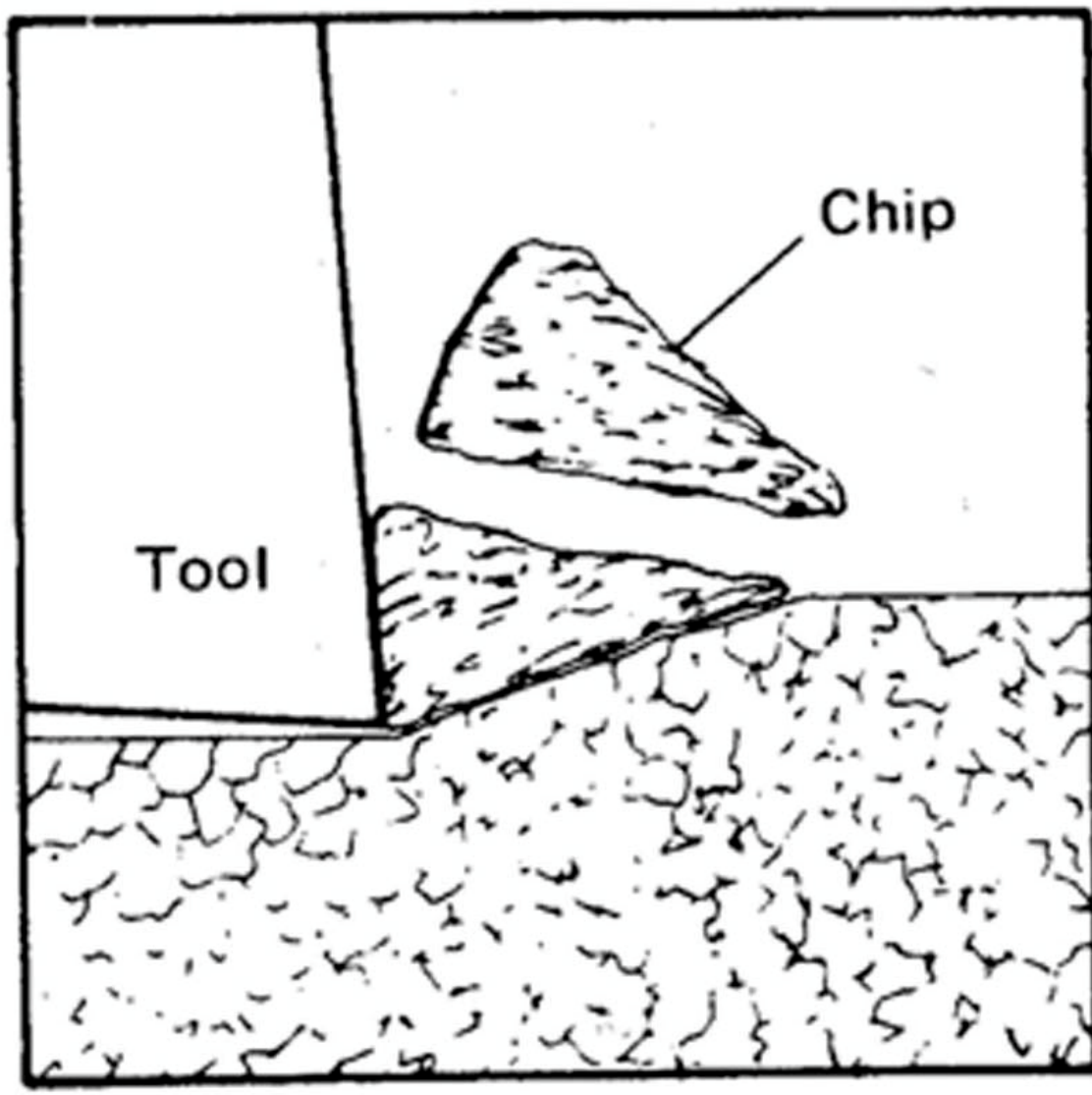
Continuous Chip Formation



Built Up Edge (BUE) Formation



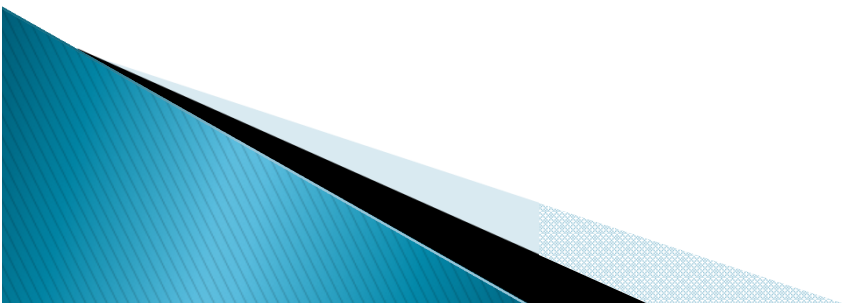
Discontinuous Chip Formation



Chip Formation

Three Characteristic types of chips

1. Discontinuous
2. Continuous
3. Continuous with built-up edge



Three Types of Chips

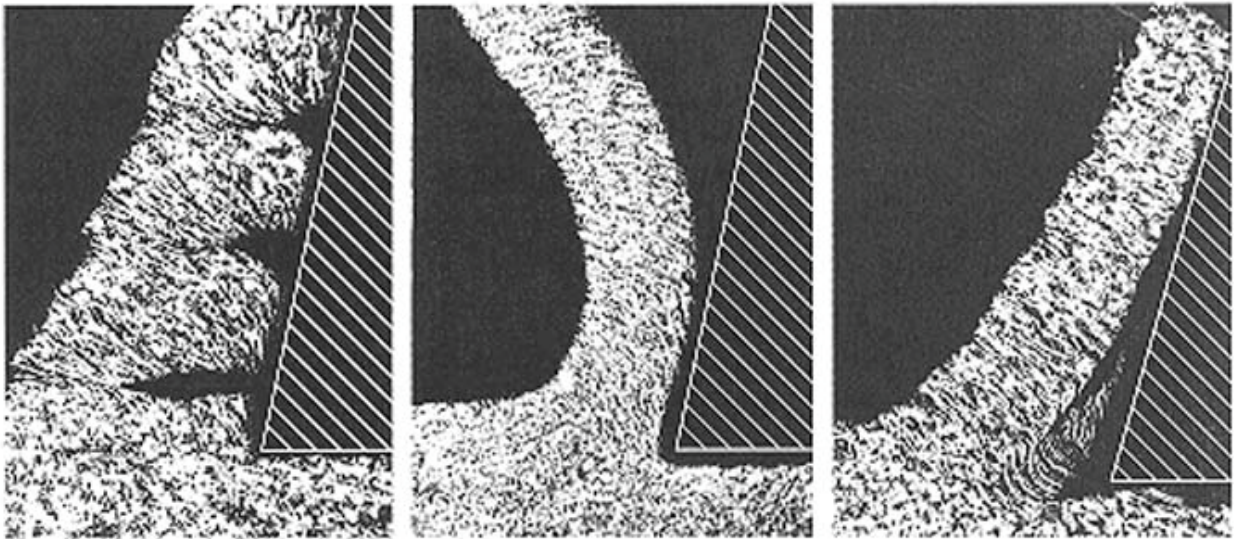
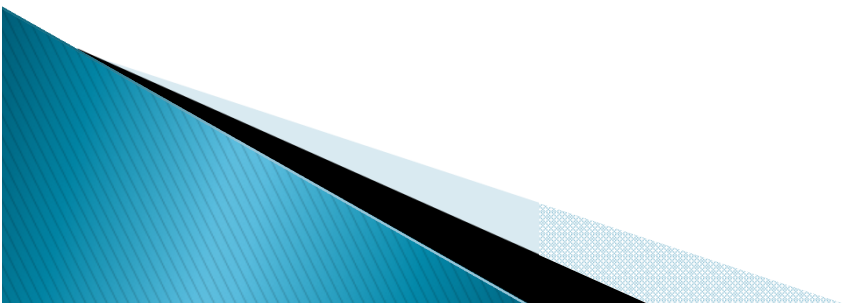
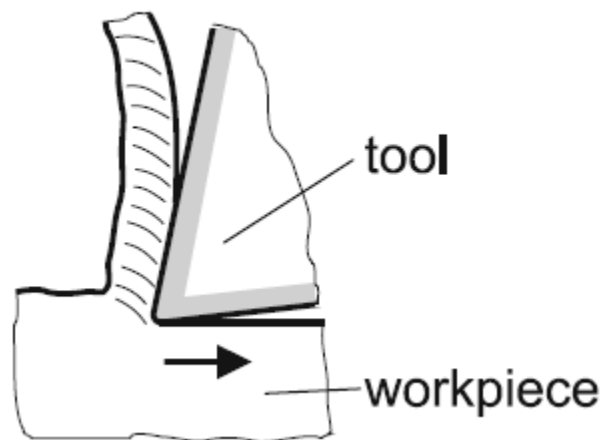


FIGURE 21-15 Three characteristic types of chips. (Left to right) discontinuous, continuous, and continuous with built-up edge. Chip samples produced by quick-stop techniques. (Courtesy of Cincinnati Milacron, Inc.)

Continuous Chip formation

In *continuous chip formation* the chip slides off along the rake face at a constant speed in a stationary flow. Continuous chip formation is promoted by a uniform, fine-grained structure and high ductility of the workpiece material, by high cutting speeds and low friction on the rake face, by positive rake angles and a low undeformed chip thickness

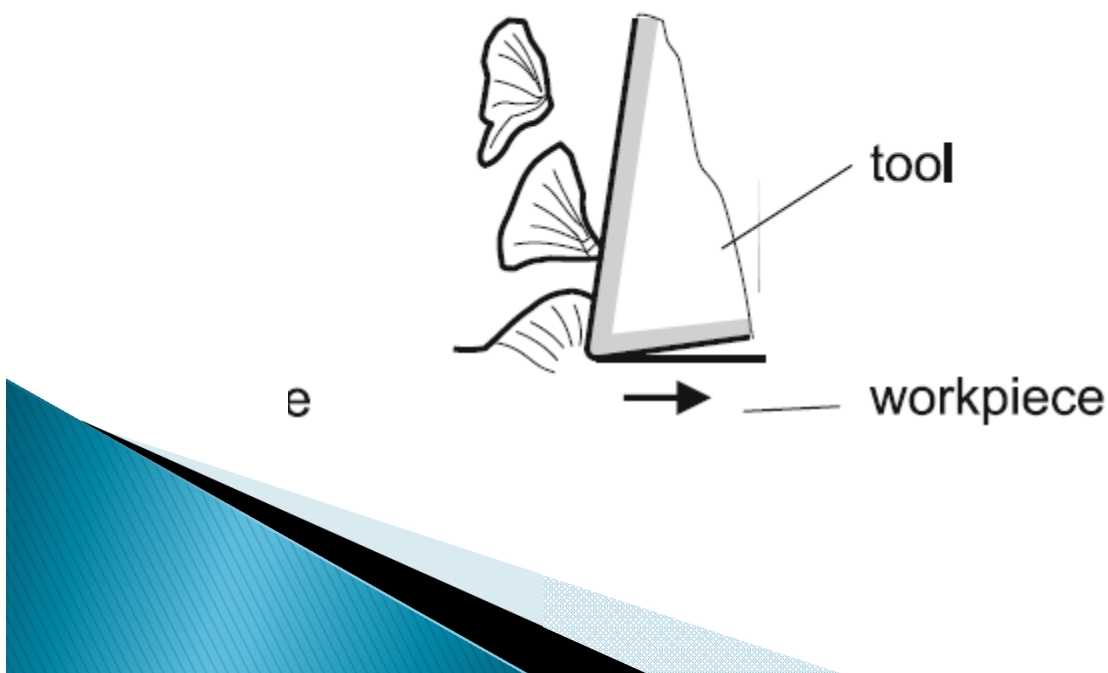
continuous chip formation



Discontinuous Chip formation

Discontinuous chip formation occurs if the plastic ductility of the workpiece material is very low or if predefined slide paths are formed due to high inhomogeneities (e. g. if cast iron with lamellar graphite is machined). Parts of the workpiece material are ripped out of the compound material without significant deformation.

discontinuous chip formation

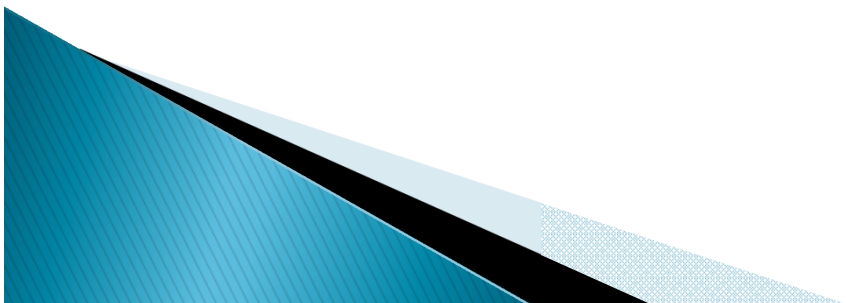
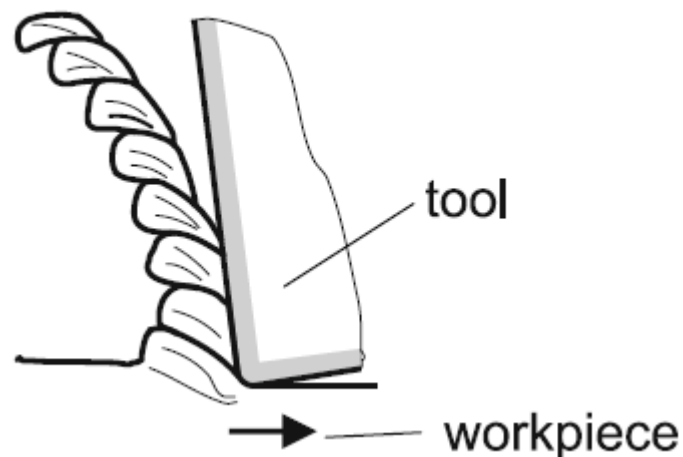


Segmented with built up edge

With continuous chip formation, *built-up edges* can occur

They are formed by particles of the workpiece material, which adhere to the rake face and to the cutting edge. These particles have been subject to high deformation and have been strain-hardened. They are much harder than the base workpiece material.

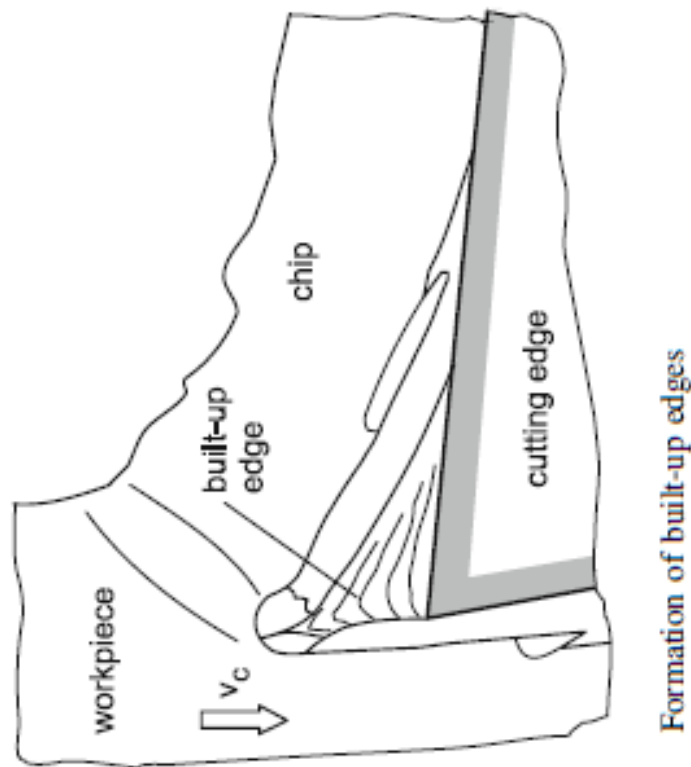
segmented chip formation



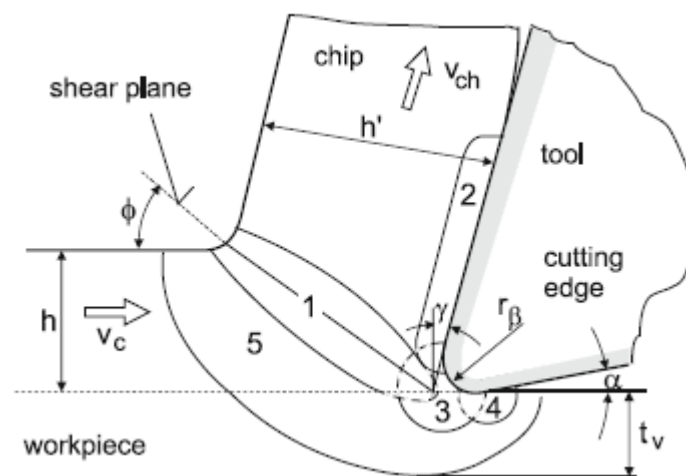
Formation of built up edge

Built-up edges only occur if

- the workpiece material promotes strain-hardening,
- the chip formation is stable and largely stationary,
- there is a stagnant zone in the material flow in front of the cutting edge,
- the temperatures in the chip formation zone are sufficiently low and do not allow for recrystallization.

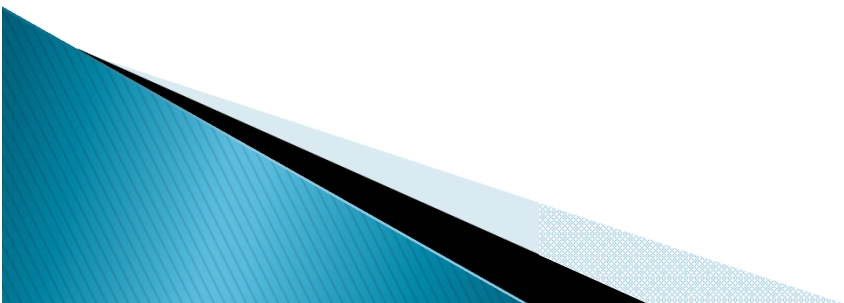


Deformation zone

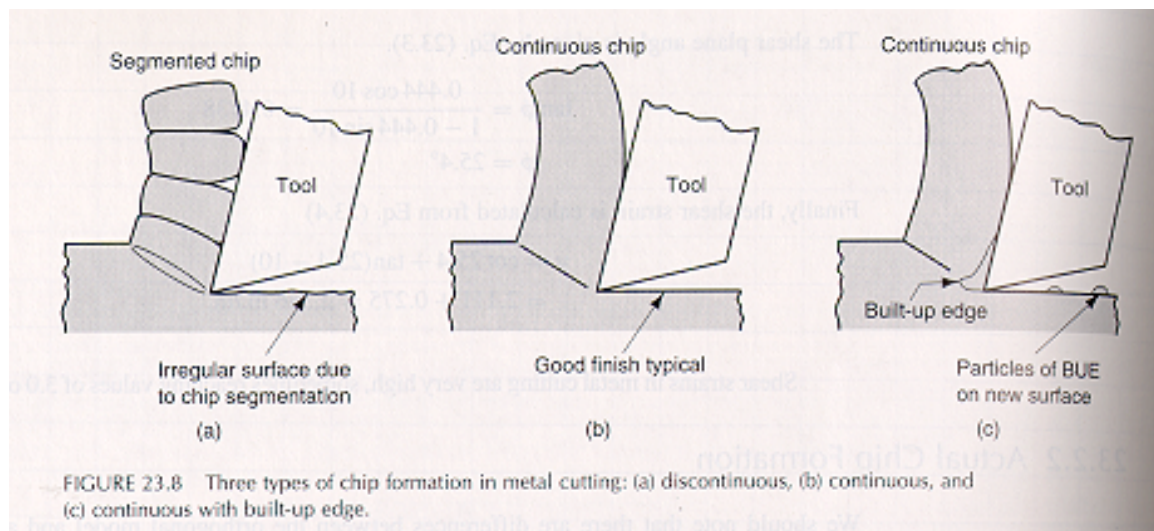


- 1 : primary shear zone
- 2 : secondary shear zone at the rake face
- 3 : secondary shear zone at the stagnation zone/separative zone
- 4 : secondary shear zone at the flank face

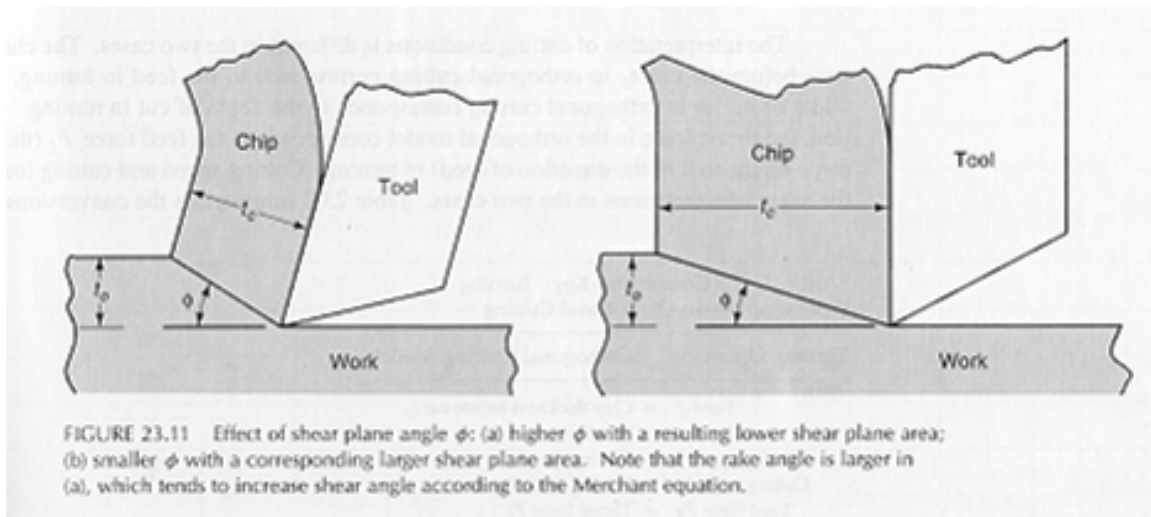
- γ : rake angle
- α : clearance angle
- ϕ : shear angle
- t_v : deformation depth



Resulting Finishes of Chip Formation



Effect of Shear Angle

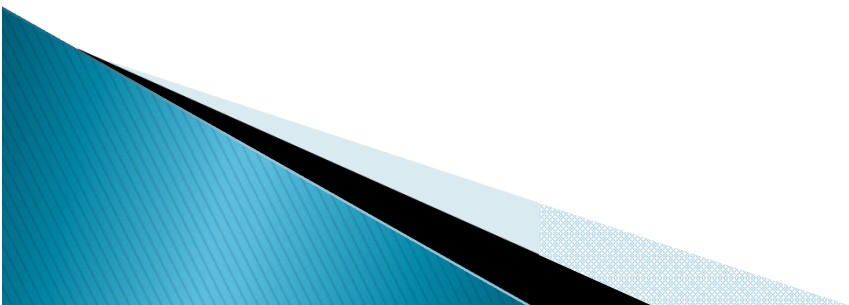


Summary

Chip formation processes are designed to shear off layers of metal

Control and conditions determine the type of chip formation

The type of formation affects the resulting finish of the workpiece





Thank You

