Basics of Machining Processes

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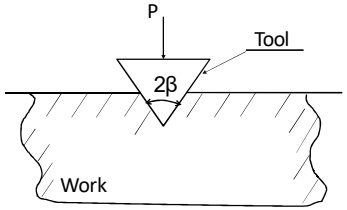
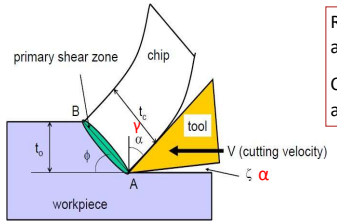
Basic Tool Shape



Wedge angle : 2β

Tool – Work Kinematics



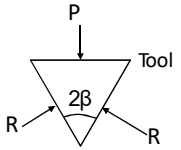
Rake angle γ

Clearance angleα α

Outline

- Basic Tool Shape
- Tool – Work Kinematics
- Mechanisms of Surface Generation
- Basic Machining Processes
- Orthogonal and Oblique machining

Cutting Efficiency



P= 2R sinβ

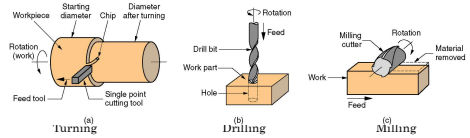
CuttingEfficiency η = $\frac{R}{P}$

$$\eta \propto \frac{1}{\sin\beta}$$

Material Removal Processes

Direct Contact between Tool – work

- Turning, Drilling, Milling, Grinding,, Thread cutting..



Non Contact – Using Non Conventional Energy source

- ECM, EDM, LBM, AJM, ..

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Basic Parameters in machining

Cutting Speed - V
- Primary Cutting motion
- High Speed – based on Tool-Work material

Feed - f
- Secondary Tool-Work motion
- Low - based on part Quality , Surface finish

Depth of Cut - t
- Interference between Tool- Work
- Low – based on Part Quality, Productivity

Process Parameters – V , f, t

Directrix and Generatrix

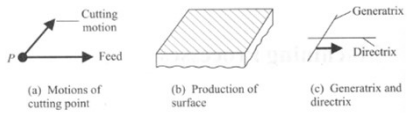
Surface Generated by combination of Cutting motion (V) and Fed motion (f)

- Cutting motion : Generatrix - For material removal
- Feed motion : Directrix - for providing **new** surface

Directrix and Generatrix are often Interchangeable !

Planar surface

Generatix : Cutting direction, Directrix : Feed direction



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Types of Tools and Processes

Single Point Cutting Tools
- Turning , Shaping, Planing, Slotting

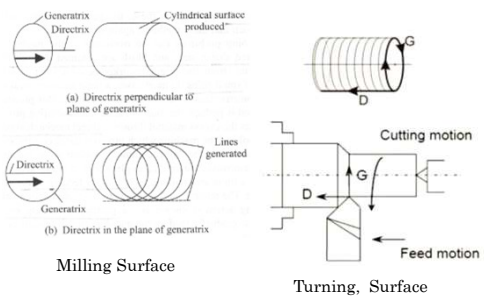
Multi Point Cutting Tools
- Regular Geometry
  - Drilling, Milling, Reaming, Threading
- Random Geometry
  - Grinding, Honing, Lapping, Abrasive

Mechanisms of Surface Generation

Profiling
- Simultaneous Cutting (V) and Feed (f) motions
- Single / Multipoint Tool
- Types of Surfaces
  - Planar, Cylindrical, Conical, Spherical
  - Freeform surfaces – dies / molds

Form Cutting
- Form of Tool conforms to the cavity/ gap
- Broach, Gear milling

Surface Generation in machining



Milling Surface

Turning, Surface

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Tools and Machining process

Types of Tools

Single point	Multi points	Abrasive
Turning	Drilling	Grinding
Boring	Milling	Lapping
Shaping	Tapping	Honing
Planing	Reaming	
	Broaching	
	Sawing	

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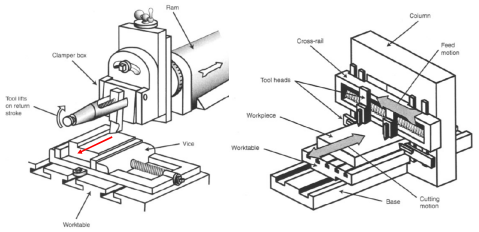
Shaping/Planning



Single Point Tools

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Broaching Process

Broaching tool

Internal teeth formation in gears

Threading Tap and Die

External threads

Internal threads

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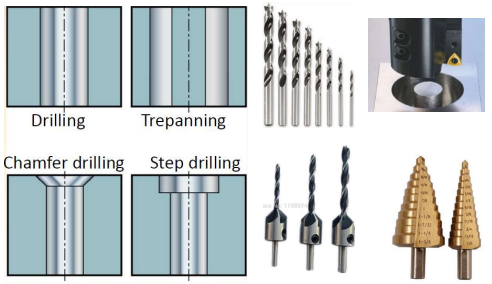
Drilling process



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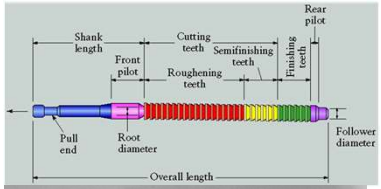
Broaching process



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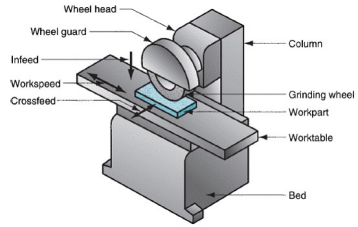
Grinding Process



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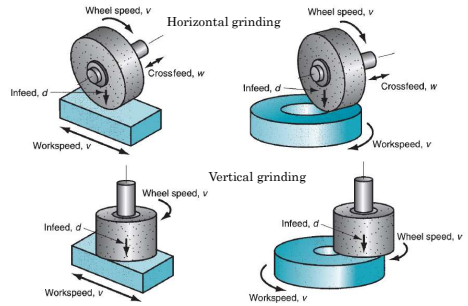
Grinding types



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Types of Machining

- Orthogonal machining
- Oblique machining

Classification based on

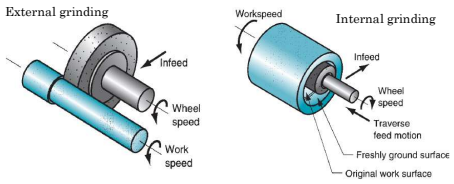
- Tool Geometry – Tool angles
- Orientation of Tool during machining

Orthogonal machining

Characteristics

- Tool Cutting edge is Perpendicular to the cutting Velocity Vector (V)
- Plain Strain (2D) deformation phenomenon
- No Spread of material along the Tool width

External and Internal Grinding



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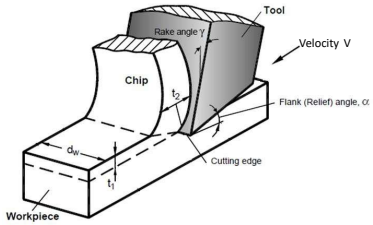
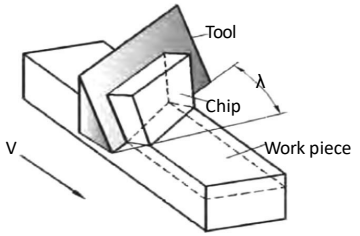
Orthogonal machining



Oblique machining



Inclination Angle λ

Oblique machining

Characteristics

- Tool Cutting edge is at an angle (λ) to the Normal to the velocity vector (V) in the cutting plane
- Inclination angle λ
  - modifies Tool angles
  - governs the Direction of chip flow

Stabler's Law for Chip flow

$n_c = k. \lambda$ nc = chip flow angle

K = 0.8 – 1.0

Chip Flow

Free Restricted

Free and Restricted Chip flow