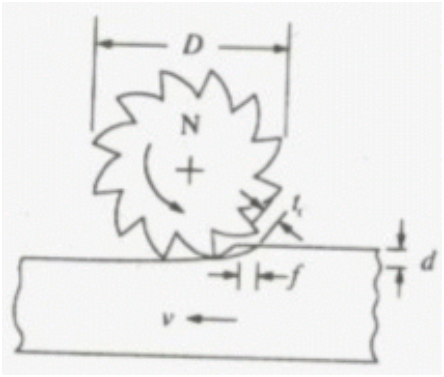
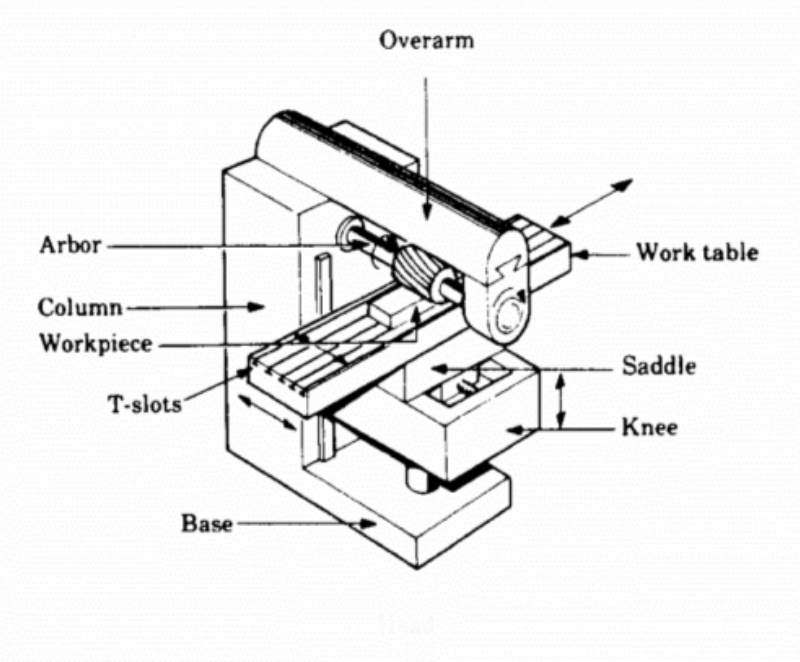
Milling

- One of the Most Widely Used Processes
  - Rotating Tool
  - Moving Tool or Workpiece
- Can Be Used to
  - Flatten Edge
  - Flatten Face
  - Cut Slit
- Milling Machines Often Have Other Features
  - Combined With Drills / Lathes



Horizontal Milling

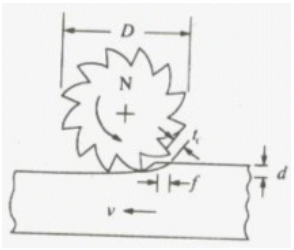
- Slab Milling Shown
  - Rotating Tool
  - Moving Work Piece
- Process
  - Depth of Cut (?)
  - Productivity

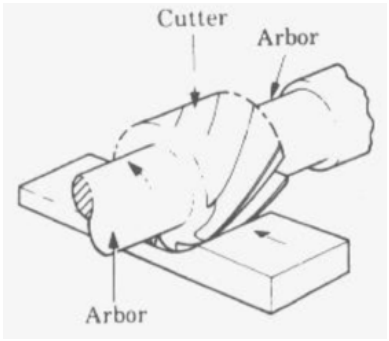
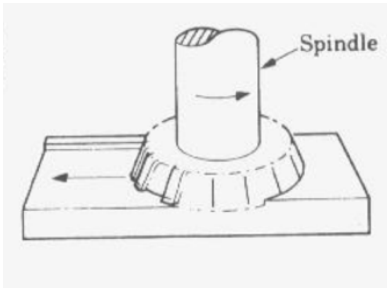
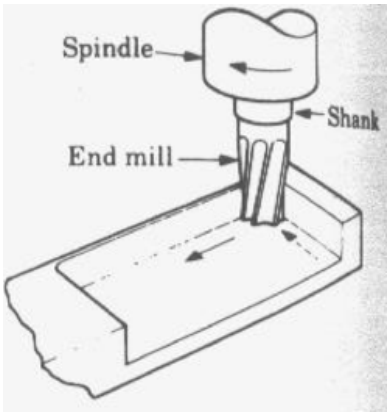


Ref. W. Riffe Slides

Basic Milling Operations

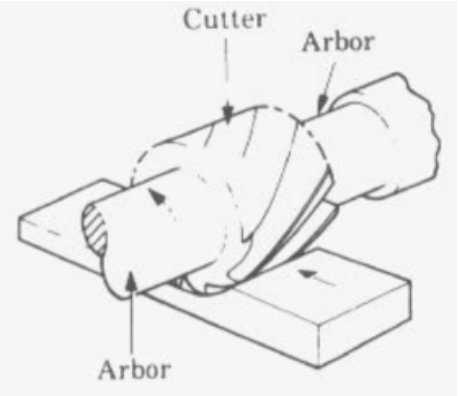
- Three Forms
  - Same Basic Principle



Slab Milling	Face Milling	End Milling
		

Milling Productivity

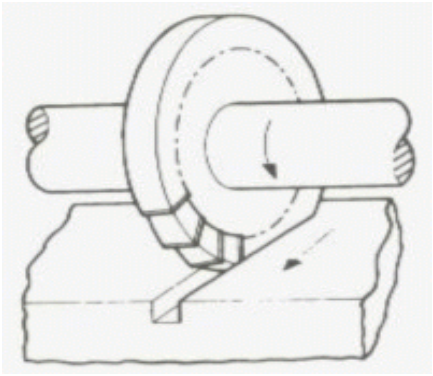
- Same Basic Parameters as Lathes
  - Cutting Speed (V)
  - Material Removal Rate (Q)
  - Power (P)
  - rpm (N)
  - Depth of Cut (d)
- Other Parameters
  - width of piece (w)
  - work piece velocity (v)



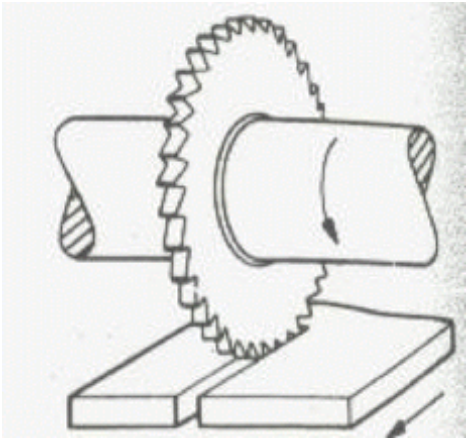
Cutting Speed	Material RR	Power
$V = \pi DN$	$Q = wdv$	$P = UQ$

Specialized Milling Processes

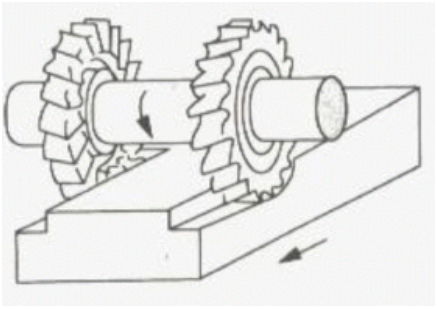
Slotting



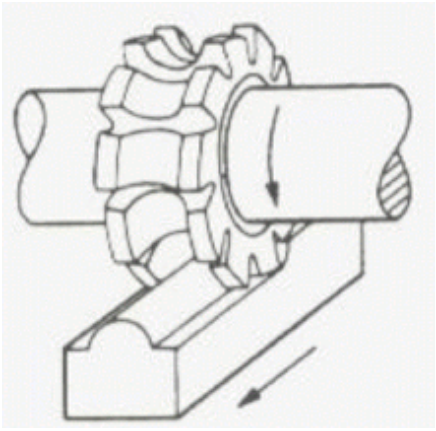
Slitting



Straddle Milling

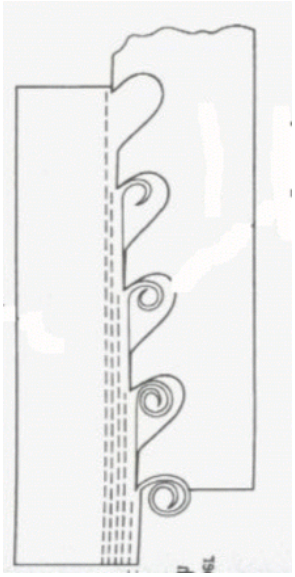


Form Milling



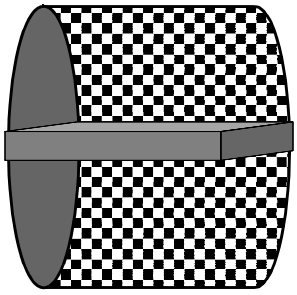
Team Problem
When Would You Use Each Milling Process in Manufacturing?

Broaching



- Milling and Lathes Are Not Always Practical
  - Internal Holes
  - Irregular Holes
  - Irregular Surfaces
- Broaching Tool
  - Successively Larger Teeth
  - Horizontal or Vertical

Grinding



- Abrasive Wheel Against Workpiece
  - High Tolerances
  - Surface Finish
- Abrasive
  - Grit Size
  - Hard Soft
- Safety
  - Hands / Eyes
  - Broken Wheels
- Same Productivity Terms

Advanced Machining Techniques

- Waterjet
  - High Pressure Water
  - Abrasive Water Jet
- Laser Beam
  - Very Precise
  - Expensive
  - Melt Material
- Electrochemical
  - Utilize a Chemical Reaction

Summary

- Machining Techniques
  - Sawing
  - Drilling
  - Lathes
  - Milling
  - Broaching
  - Grinding
  - Advanced
- Production / Cost Considerations
  - Material Removal Rate
  - Tool Life
  - Energy Costs