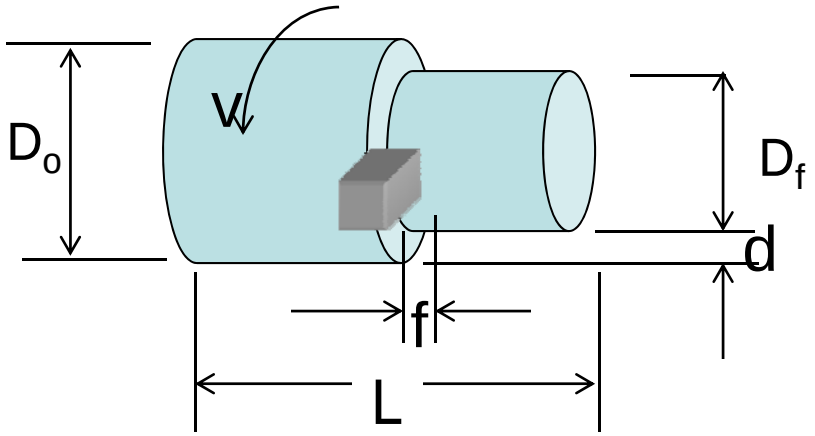
MACHINING OPERATIONS AND MACHINE TOOLS

1. Turning and Related Operations
2. Drilling and Related Operations
3. Milling
4. Machining & Turning Centers
5. Other Machining Operations
6. Shape, Tolerance and Surface Finish
7. Machinability
8. Selection of Cutting Conditions
9. Product Design Consideration

1. Turning & Related Operations

- Turning – a machining process in which a single-point tool remove material from the surface of a rotating work piece. (Lathe)



Rotational Speed: $N = \dfrac{v}{\pi D_o}$

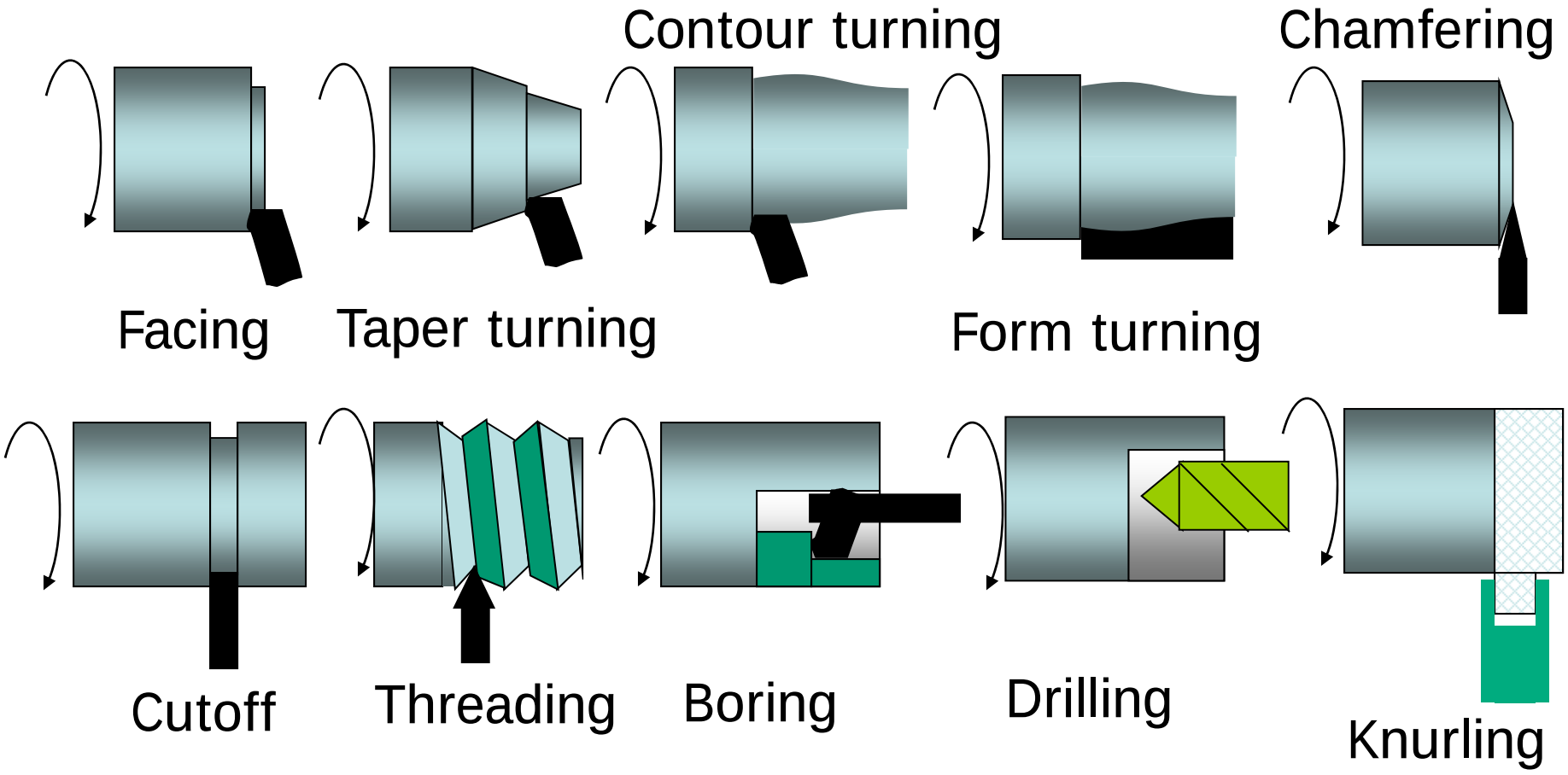
$$D_o - D_f = 2d$$

Feed rate: $f_r = Nf$

Time of machining: $T_m = \dfrac{L}{f_r}$

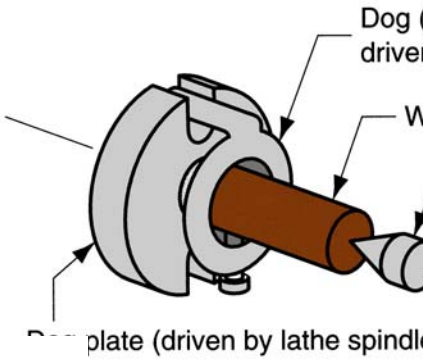
Material Removal Rate: $MRR = vfd$

Operations related to Turning

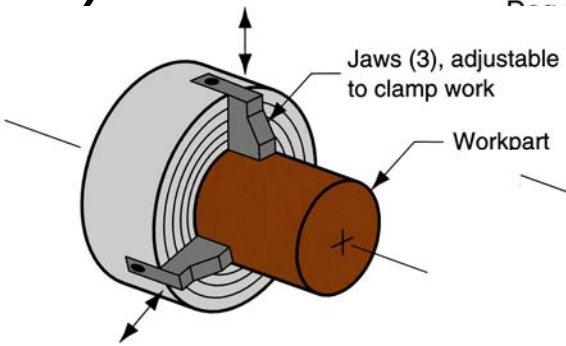


Work Holding

- Mounting between two centers (Dog & Live center)
- Chuck
- Collet
- Face plate



(a)



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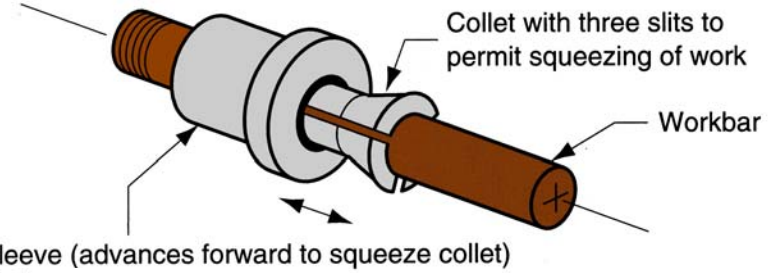

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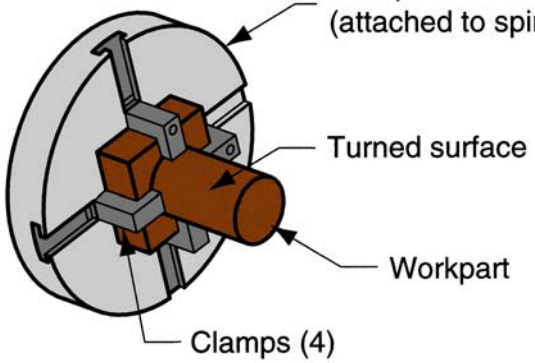
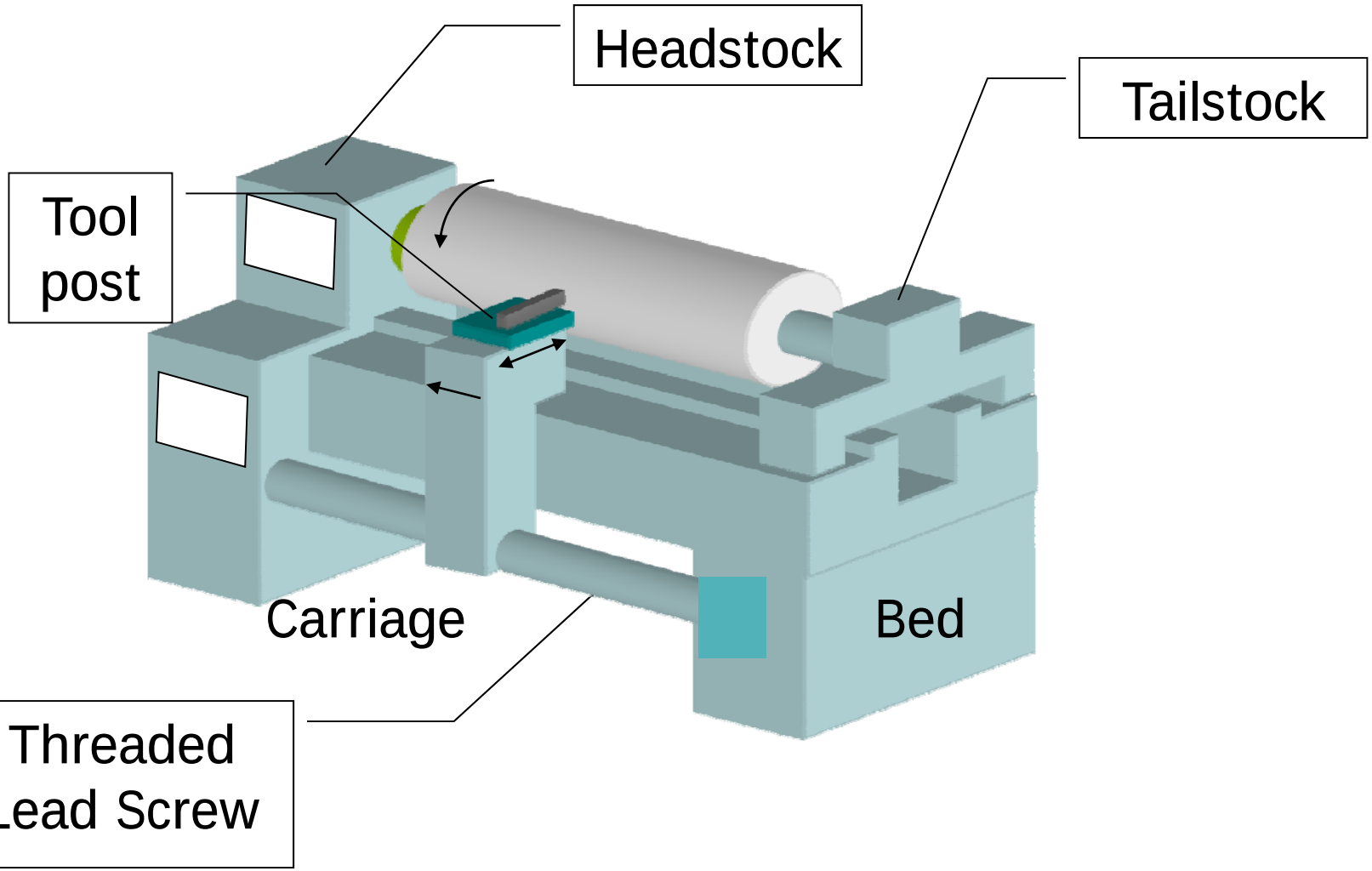


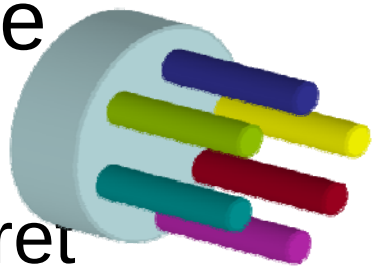
(d)

Engine Lathe



Other Lathes & Turning Machine

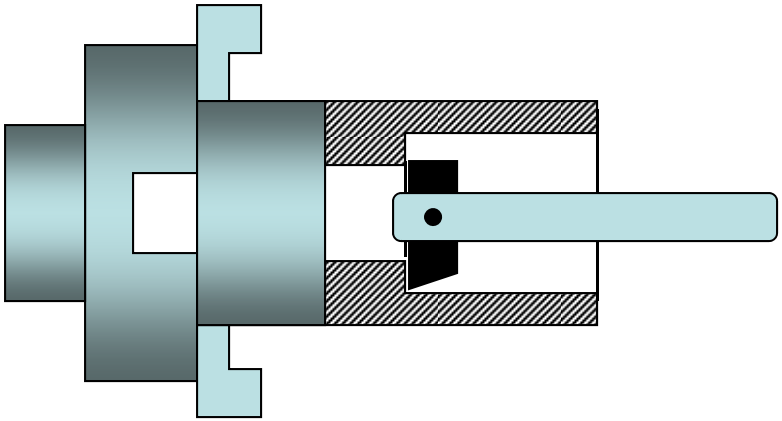
- Toolroom Lathe and Speed Lathe
- Turret Lathe
  - The tailstock is replaced with a turret



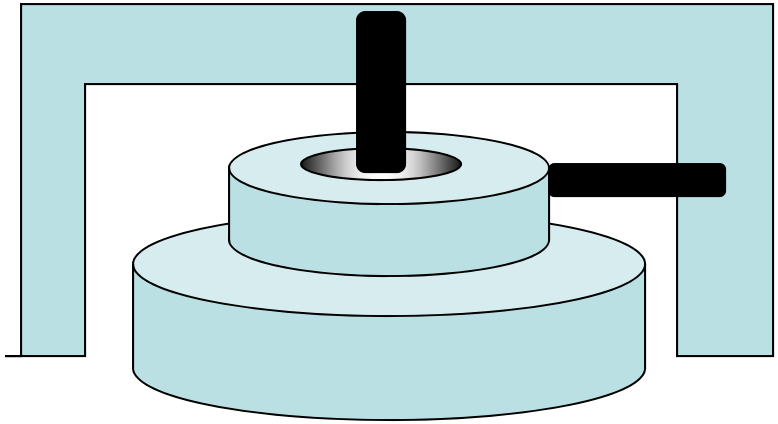
- Chucking Machines – No tailstock
- Automatic Bar Machine – Similar to chuck machine but with a collet
  - A single- and multiple-spindle bar machines
- NC Lathe

Boring Machining

- Boring – Cutting is done inside diameter of the work material



Horizontal Boring Machining



Vertical Boring Machining

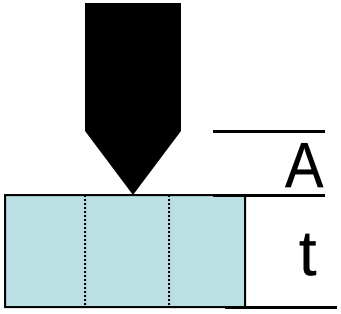
2. Drilling & Related Operations

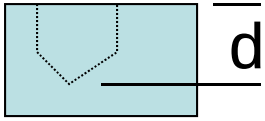
- Geometry of Twist drill
  - Shank, Neck and Drill body
  - Helix angle, Point angle, Flute, cutting edge, Chisel edge, Margin
- Cutting conditions

Spindle: $N = \frac{v}{\pi D}$ Feed rate: $f_r = Nf$ f(in/rev)

Metal Removal Rate: $MRR = \frac{\pi D^2 f_r}{4}$

Machining time: $T_m = \frac{t + A}{f_r}$ For a through hole





$T_m = \frac{d}{f_r}$ For a blind hole

Twist Drill and Drilling Operations

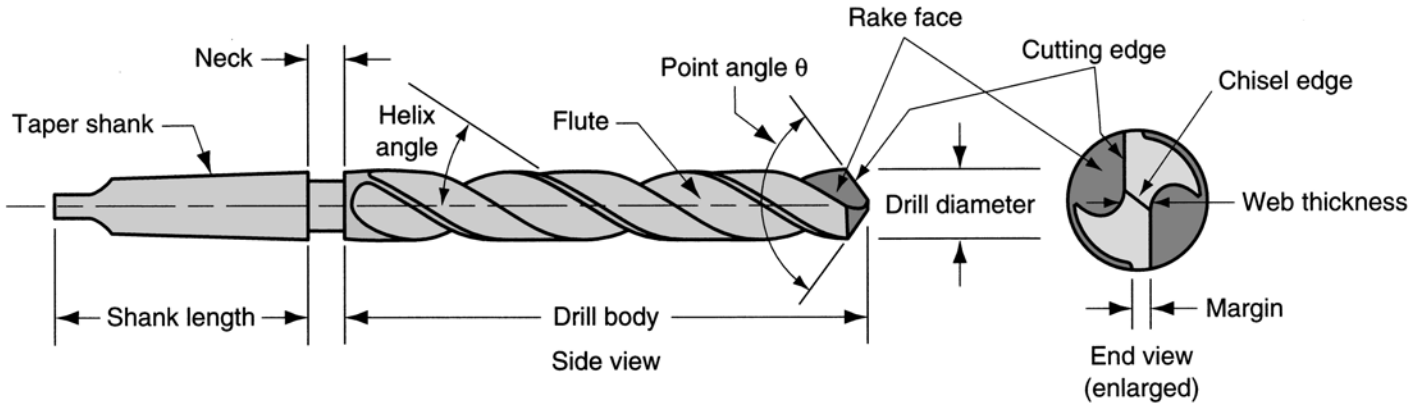
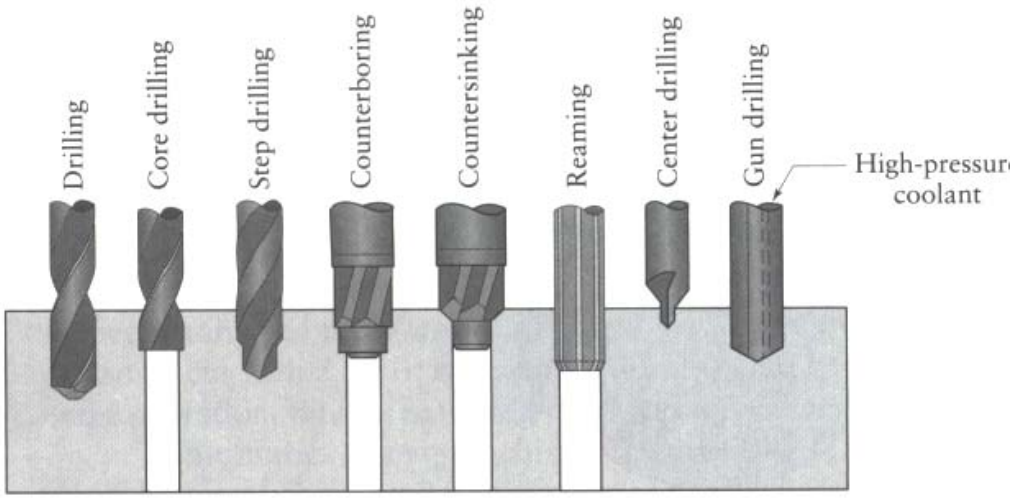


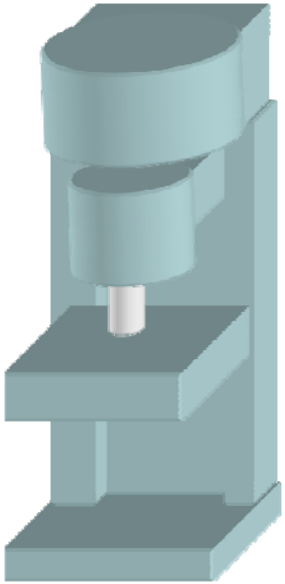
FIGURE 8.49 Various types of drills and drilling operations.



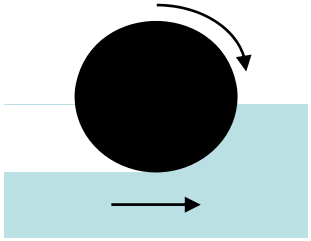
From Kalpakjian and Schmid (2003)

Machine Tool for drilling

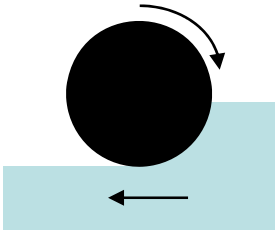
- Drill press
  - Upright drill
  - Bench drill
  - Radial drill
  - Gang drill - 2-6 drills together
  - NC drill
- Vice, Jig and fixture



3. Milling

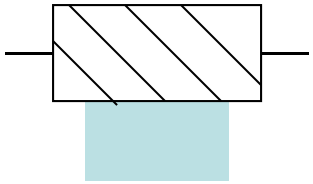


Up Milling

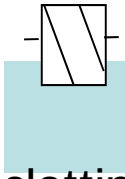


Down Milling

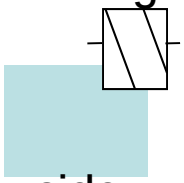
- Milling
  - A machine operation in which a work part is fed past a rotating cylindrical tool with multiple edges. (milling machine)
- Types
  - Peripheral milling
    - Slab, slotting, side and straddle milling
    - Up Milling (Conventional) & down milling (Climb)
  - Facing milling
    - Conventional face, Partial face, End, Profile, Pocket & contour millings



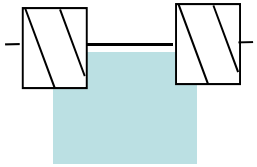
Slab



slotting

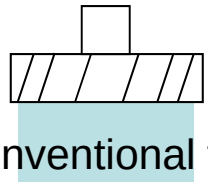


side

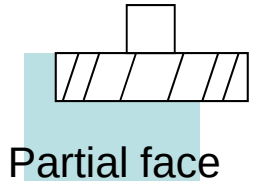


straddle

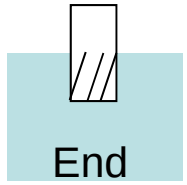
Peripheral Milling



Conventional face



Partial face



End

Profile

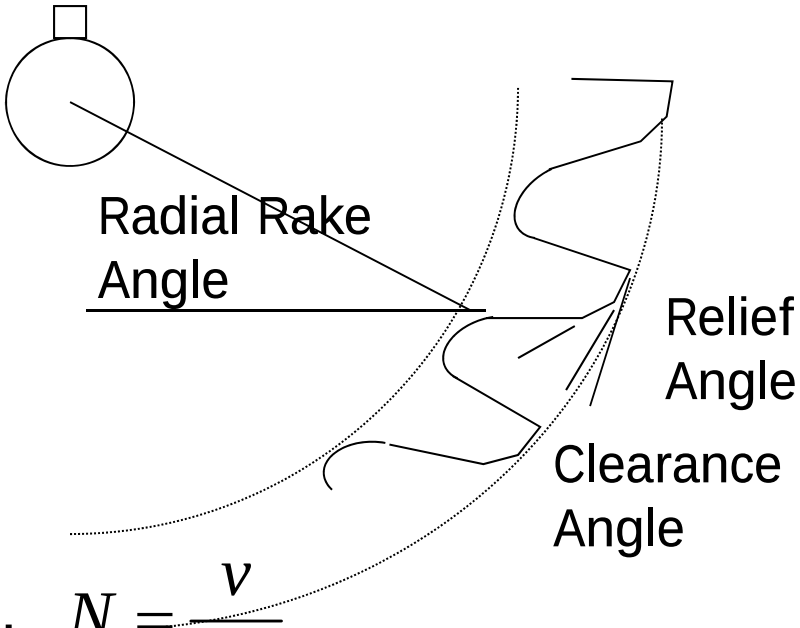
Contour

Pocket

Face Milling

Cutting conditions

- Milling cutters
  - Plain milling cutters
  - Form milling cutters
  - Face milling cutters
  - End milling cutters
- Cutting conditions



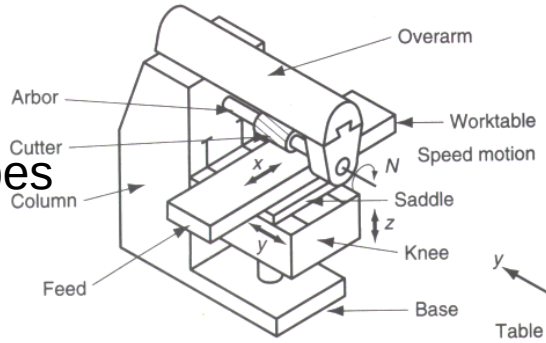
Spindle rotation speed: $N = \frac{v}{\pi D}$

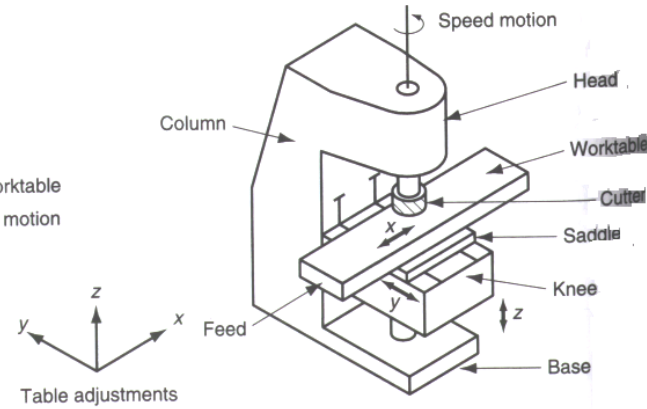
Feed rate: $f_r = N n_t f$

Material Removal Rate: $MRR = w d f_r$

Milling Machines

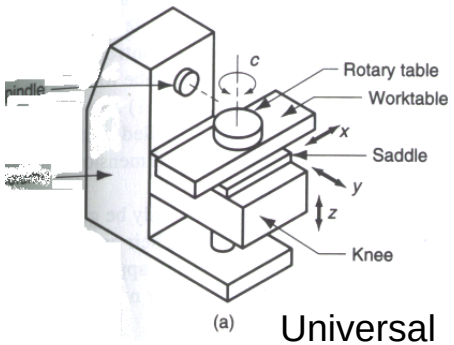
- Knee-and-column Milling Machine
  - Horizontal and Vertical types
  - Universal and Ram types
- Bed-type Mill
- Planer-type Mills – the largest category
- Tracer (profile) Mill – reproduce an irregular part geometry
- CNC Milling machine



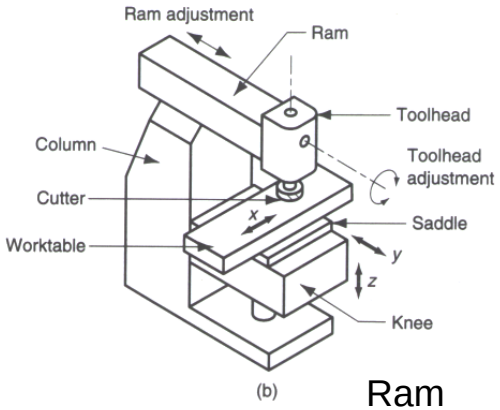


Horizontal

Vertical

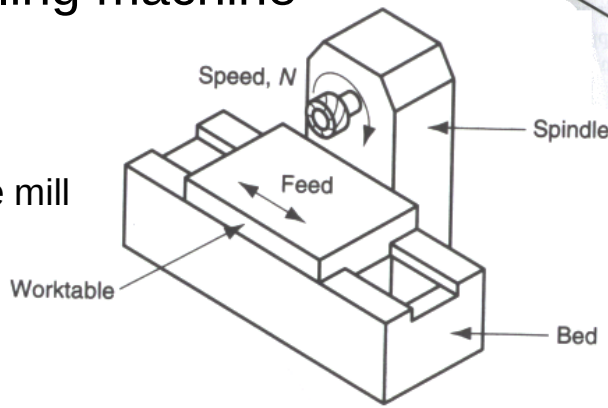


Universal



Ram

Bed-type mill

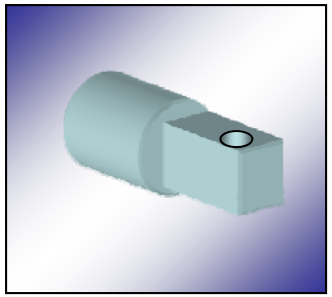


Machining Centers

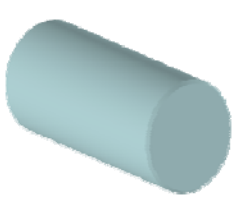
- Machining center – highly automated machine tool capable of performing multiple machining operations under CNC control.
  - Automatic tool changer
  - Pallet shuttles
  - Automatic workpart positioning
- CNC turning center

A CNC mill-turn center

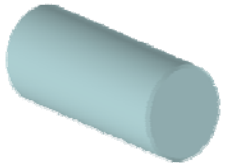
A series of operations without human interactions



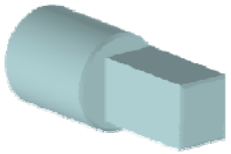
A part



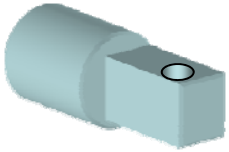
Stock



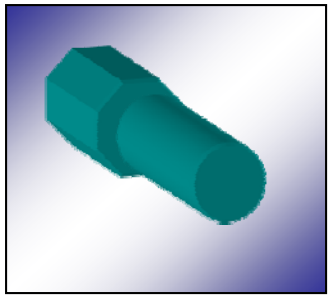
Turning

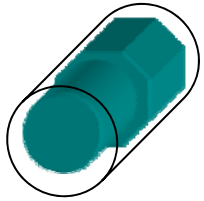


Milling

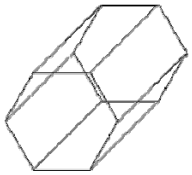


Drilling

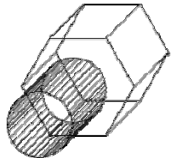




From a round stock



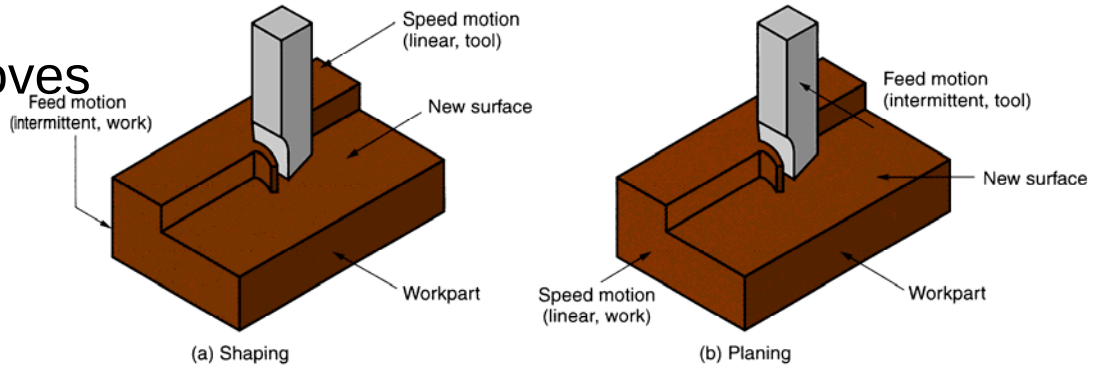
From a casting



From another casting

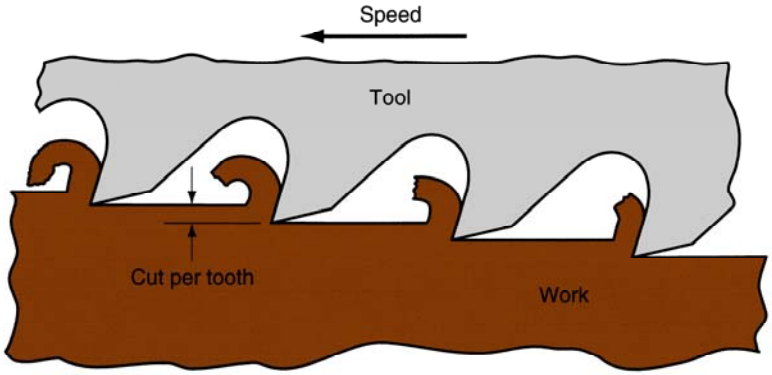
5. Other Machining Operations

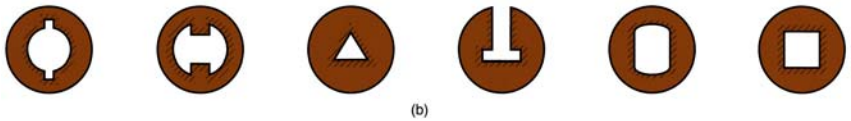
- Shaping and planing
  - A single-point tool moves linearly relative to the work part
  - Shaping - A tool moves
  - Planing – A workpart moves



- Broaching
  - Performed by a multiple-tooth cutting tool by moving linearly relative to the work in the direction of the tool axis.
- Sawing
  - Hacksawing, Bandsawing, and Circular sawing

Broaching


Speed
Tool
Cut per tooth
Work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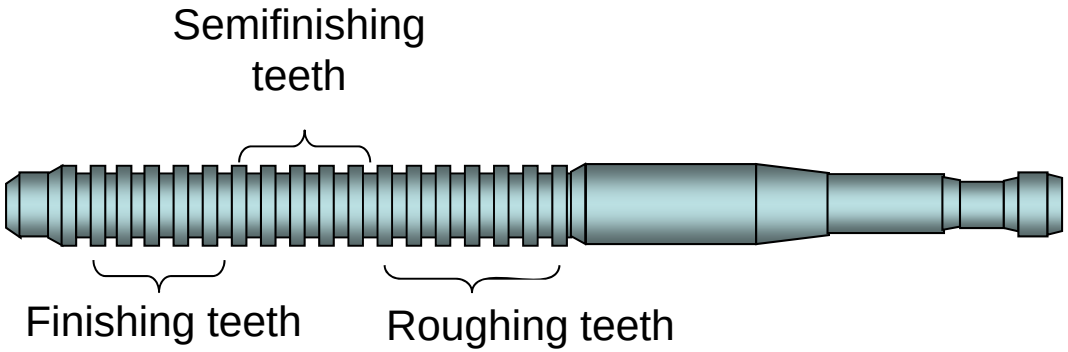
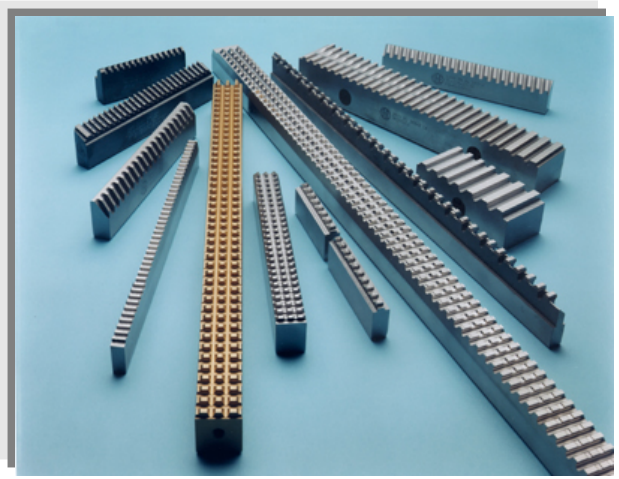
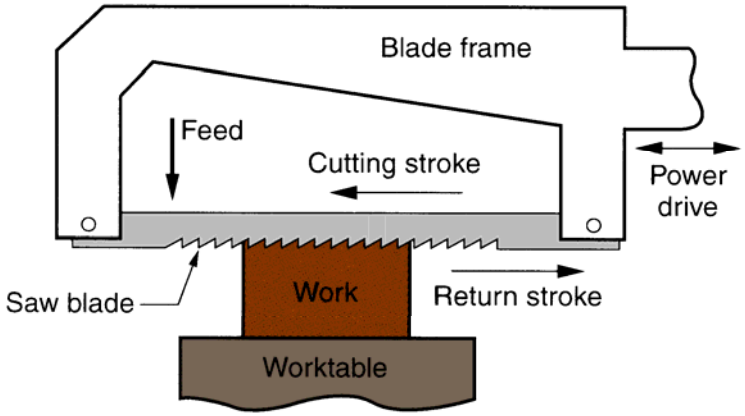
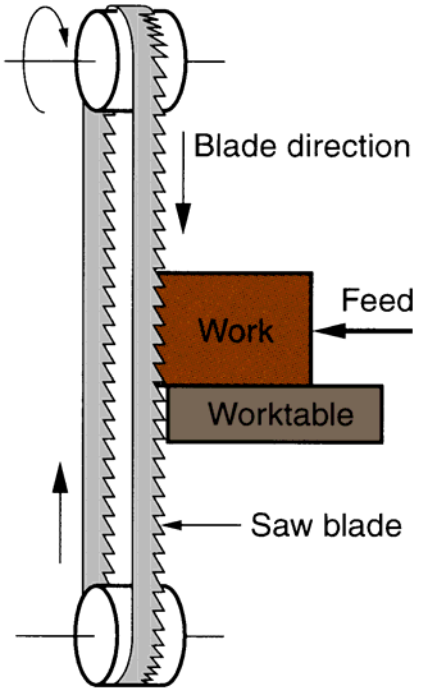

Semifinishing teeth
Finishing teeth
Roughing teeth



Sawing



Hacksaw - linear reciprocating motion



Bandsaw - linear continuous motion

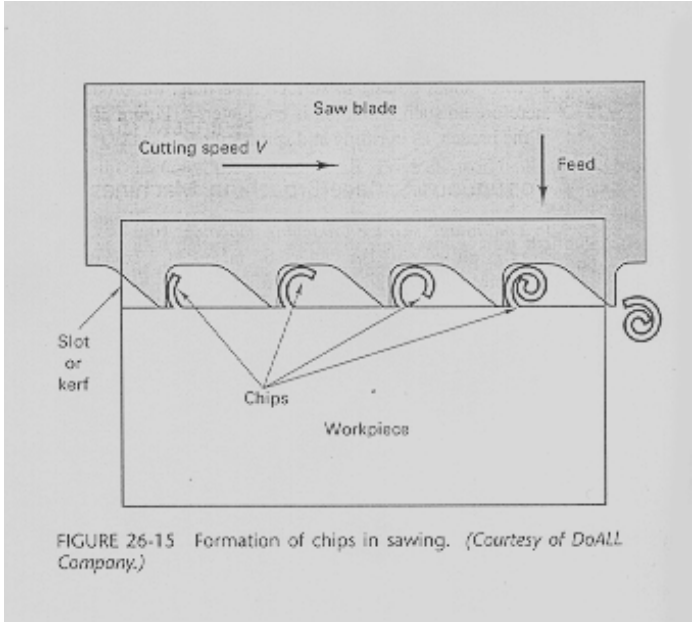


FIGURE 26-15 Formation of chips in sawing. *(Courtesy of DoALL Company.)*

Saw Blade (Straight & Undercut tooth or Straight & Raker sets)