Machining

Precise material removal to bring a part to specified size

- Automotive machining examples
  - Boring cylinders
  - Honing cylinders
  - Grinding cranks and cams
  - Grinding or milling heads and blocks
  - Grinding flywheels
  - Drilling and reaming for valve guides

Drilling

- End cutting
- Used for roughing holes to size
- Reamers finish holes to size and surface finish

Turning & boring

- Turning – outside diameter with single pointed tools on a lathe
- Boring – inside diameter with single pointed tools on a lathe
Machining
Milling
- Vertical spindle
- Used to remove material from a flat surface

Machining
Milling
- Typical milling cutters
  HSS & carbide

Machining
Grinding
- Abrasive machining using millions abrasive grains
- Minimal stock removal
- High surface finish quality

Vertical spindle surfacing
- Used to grind flywheels, blocks, and cylinder heads
Machining
Horizontal spindle grinders
• Used for valve grinders, crankshaft grinders, and camshaft grinders

Machining
Broaching
• Chip removal is done with progressively larger cutting teeth
• Keyways in sprockets and gears
• Not done in auto machine shops

Machining
Tool materials
HSS (High speed steel)
• Drills, reamers, and milling cutters
• Tungsten, vanadium, and cobalt added for hardness
Tungsten carbide
• Boring bars and cutter of a face mill
• Attached to a tool holder
• Heat resistant and operate at high speeds (up to 3 times HSS)
• Cobalt increased for shock resistance
Machining
Tool materials

Tungsten Carbide (cont.)
- As cobalt % increases, resistance to shock increases, & resistance to heat decreases

Aluminum Oxide grinding wheel
- Used for steel & nodular iron (cranks & cams)

Silicon Carbide grinding wheel
- Used for iron (heads & blocks)

Machining
Lathe tool

- Rake angles form the surface that the chips pass over
- Back rake angle angles are greater for boring
Machining
- Relief angles prevent the cutting tool from bumping into the work

Machining
- Nose radius affects surface finish
- Large radius increases power required and tool chatter

Machining
Side cutting angle
- The greater the angle, the more tool deflection
- The smaller the angle, the bigger the chip and more the tool will wear
Machining
Cutting oils
• Extend tool life
• Cool cutting tool
• Cast iron can be machined without cutting oil
• Aluminum requires cutting oil
• All threading operations require cutting oil

Machining
End mills
• Used to remove chips from the end or the side of tool
• ‘Two flute’ cutters cut from the end
• Cutters with more than two flutes are used for cutting on the side

Machining
Spindle tilt
• The spindles of automotive surfacing machines are tilted about .004”
• This produces a ‘hollow cut’ of less than .0005”
Machining
Conventional vs. climb milling

- Conventional – Cutter rotates opposite direction of feed
- Climb – Cutter rotates same direction as feed

Machining
Drill bits

- Available in fraction, letter, or number sizes
- End cutting
- Helical flutes for chip removal
- Length & angle of cutting edges should be equal

Machining
Drill bits (cont.)

- Morse taper (5/8” per foot), drift needed for removal
- Center drill (60°), for pilots and machining centers
Machining

Core drills and countersinks

- Core drills enlarge holes only, will not cut in center
- Countersinks chamfer bolt holes (82°)

Machining

Hand reamers

- Cut material for a distance on the end (1/16” per foot)
- Cut only .003” to .005”

Machine reamers

- Cut material on a short 45° angle
- Cut only 5% material

Machining

Counter bores

- Spot-facing head bolt holes
Machining

Grinding
- Diamond dresser (trues wheels)
- Star wheel dresser (does not true wheel)

Machining
Hard grinding action
- No wheel breakdown
- Little material removal
- Burnt work
- Wheel needs dressing

Soft grinding action
- Too much wheel breakdown
- Stone material gets caught between wheel and work
- Rough surface finish

Machining
Honing
- Slower speed than grinding
- Honing stones must also break down
- Honing oils cool the work and flush away the grit