Chapter 23
Machining Processes Used to Produce Round Shapes: Turning and Hole Making

Processes

- Turning (outside surface)
  - straight, taper, facing, contour, form, cut-off, threading, knurling
- Boring (internal holes)
  - taper, form, drilling, threading, reaming
- Drilling (internal)
- Reaming (internal)

Machining Surface Roughness

Drilling Holes

“Drilling” Operations

Drilling Video

Various types of drills and drilling and reaming operations.
Drilling Machines

Figure 23.24  (a) Schematic illustration of the components of a vertical drill press.  (b) A radial drilling machine. Source: (b) Courtesy of Willis Machinery and Tools.

Various Types of Drills

Figure 23.26  (a) Terminology for a helical reamer.  (b) Inserted-blade adjustable reamer.

Drills

Reamers

General Capabilities of Drilling

Feed, \( f \)

Speed, \( V \)

Depth of cut, \( d \)

Diameter, \( D \)

RPM, \( N \)

Speeds and Feeds in Drilling
Drilling Design Considerations

- Design for clamping
- Flat surfaces preferred
- Tolerances requirements
- Machinability of materials
- Allowance for tool
- Depth of hole (walking)
- Diameter of hole

Boring Process Characteristics

- Single point tool
- Enlarges or straightens an existing hole
- Produces accurate holes (better tolerances than drilling)
- Able to produce large internal holes
- Can be performed on a lathe, boring mill, or jig bore machine tools

Boring

- Single point tool
- Enlarges or straightens an existing hole
- Produces accurate holes (better tolerances than drilling)
- Able to produce large internal holes
- Can be performed on a lathe, boring mill, or jig bore machine tools

Boring and Boring Mill

- Creates cylindrical external or internal shapes
- Creates flat surfaces on part ends (faces)
- Uses a single point tool
- Wide variety of shapes
- The machine tool is called a “lathe”

Boring Design Considerations

- Through holes, not blind holes
- Greater length to diameter more difficult
- Avoid intermittent cuts

Turning Process

- Creates cylindrical external or internal shapes
- Creates flat surfaces on part ends (faces)
- Uses a single point tool
- Wide variety of shapes
- The machine tool is called a “lathe”
Lathe Cutting Operations

- **Turning**: produces straight, conical, curved, or grooved workpieces
- **Facing**: produces flat surfaces at the end of the part and perpendicular to its axis. Also used to produce grooves.
- **Parting or Cutting Off**: cuts a piece from the end of a part
- **Threading**: produces external or internal threads
- **Knurling**: produces a regularly shaped roughness on cylindrical surfaces, as in making knobs

Lathe Cutting Operations

- **Form tool**: produces axisymmetric parts
- **Boring**: enlarges a previous hole or to produce circular internal grooves
- **Drilling**: produces a hole

Cutting Screw Threads
Figure 23.2 General view of a typical lathe, showing various components. Source: Courtesy of Heidenreich & Harbeck.

Figure 23.3 Schematic illustration of the basic turning operation, showing depth-of-cut, d; feed, f; and spindle rotational speed, N in rev/min. Cutting speed is the surface speed of the workpiece at the tool tip.

Table 23.1 Summary of cutting parameters and formulas:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed rate</td>
<td>f</td>
</tr>
<tr>
<td>Depth of cut</td>
<td>d</td>
</tr>
<tr>
<td>Spindle speed</td>
<td>N</td>
</tr>
<tr>
<td>Cutting speed</td>
<td>Vc</td>
</tr>
</tbody>
</table>

Note: The selected parameters are for reference only. The appropriate values must be selected for the specific parts.
Turning Parameters

Feeds & Speeds for Tool Materials

Cost Elements

Safety Factors

Example from Book

- Rotating parts or tools
- Hot, sharp chips
- Eye and skin irritation from cutting fluids

- Equipment
- Tooling
- Setup time
- Load/unload time
- Direct labor
- Indirect labor
- Cycle time, idle time
- Overhead rate

A 6-in long, 0.5 in diameter 304 stainless-steel rod is being reduced in diameter to 0.48 in by turning on a lathe. The spindle rotates at N=400 rpm, and the tool is traveling at an axial speed of 8 in/min. Calculate, the cutting speed, material removal rate, cutting time, and power.