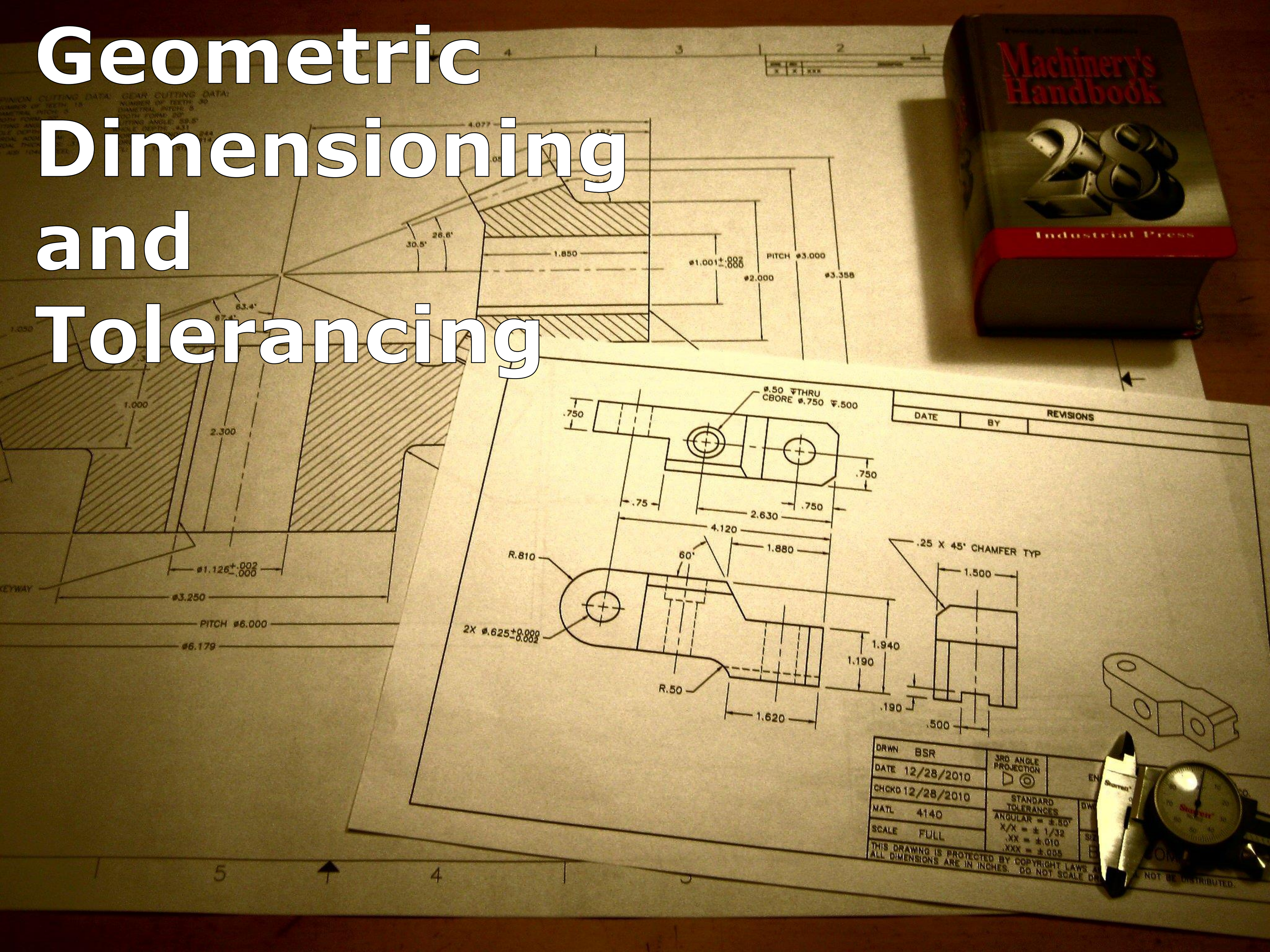
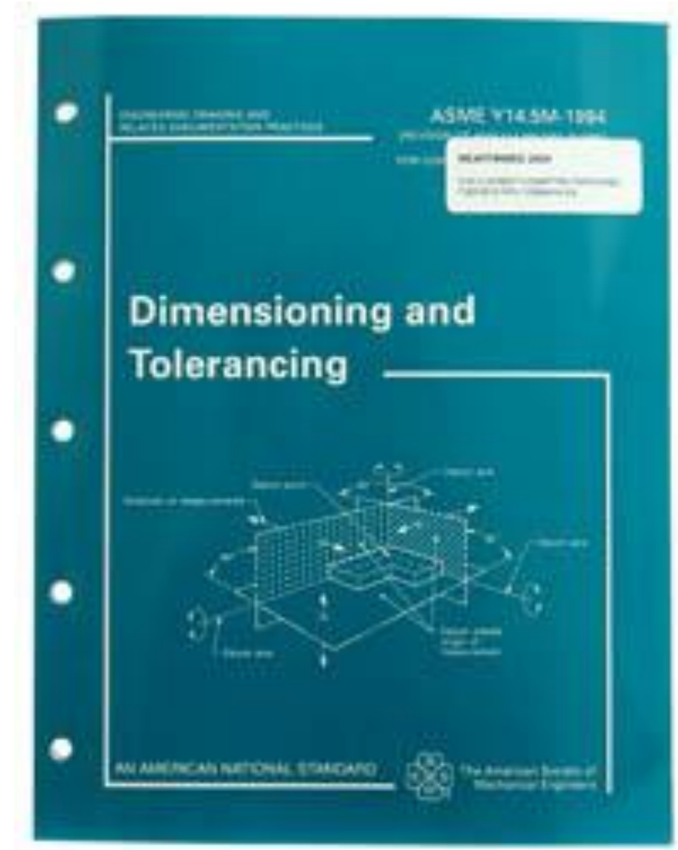
Geometric Dimensioning and Tolerancing



Why GD&T?

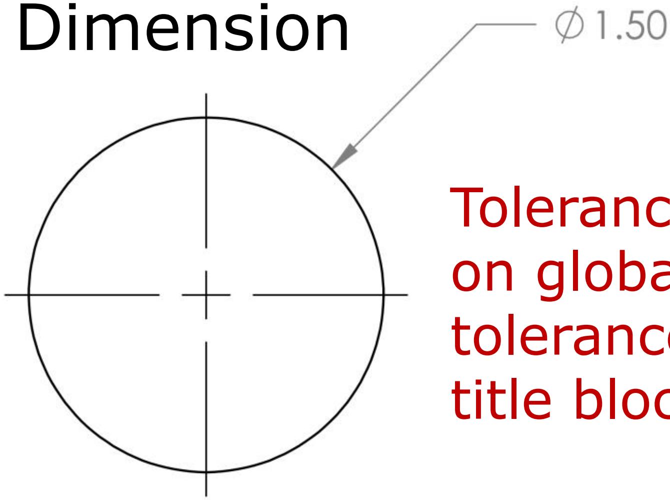
- Ensures interchangeability of parts during mating / assembly
- Saves money by avoiding unnecessary over-tolerancing
- Avoids (legal, machining, inspection) ambiguity
- Contributes to functional gauging of surfaces and features by establishing datums of importance
- Influences order of manufacturing steps

ASME Y14.5M



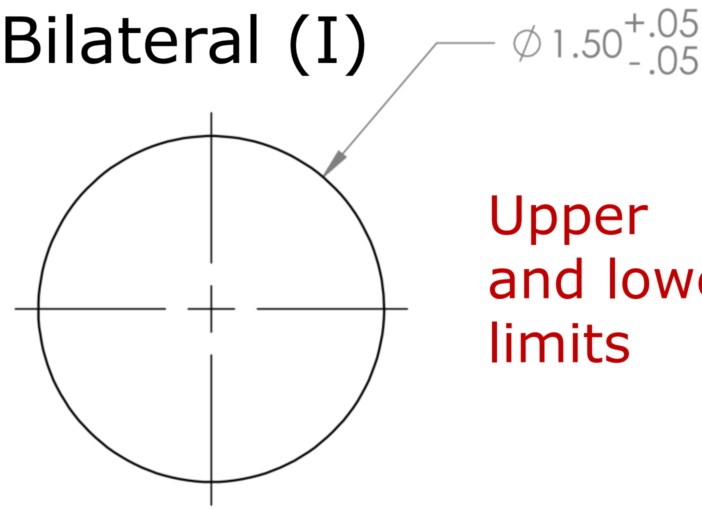
Dimensions

Dimension



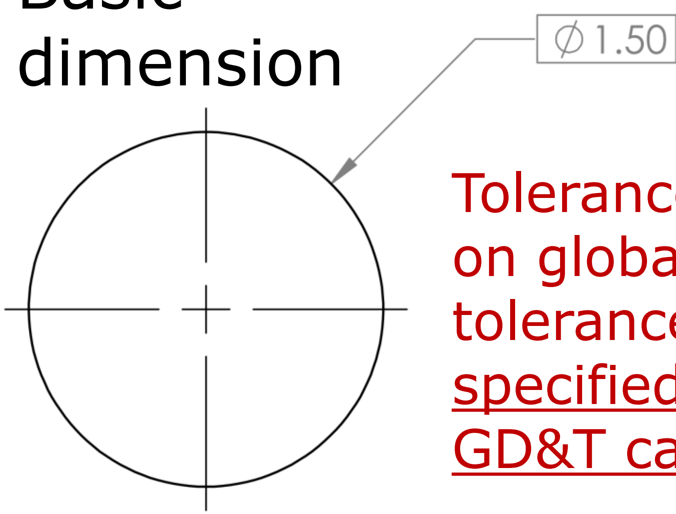
Tolerance based on global tolerances in title block

Bilateral (I)



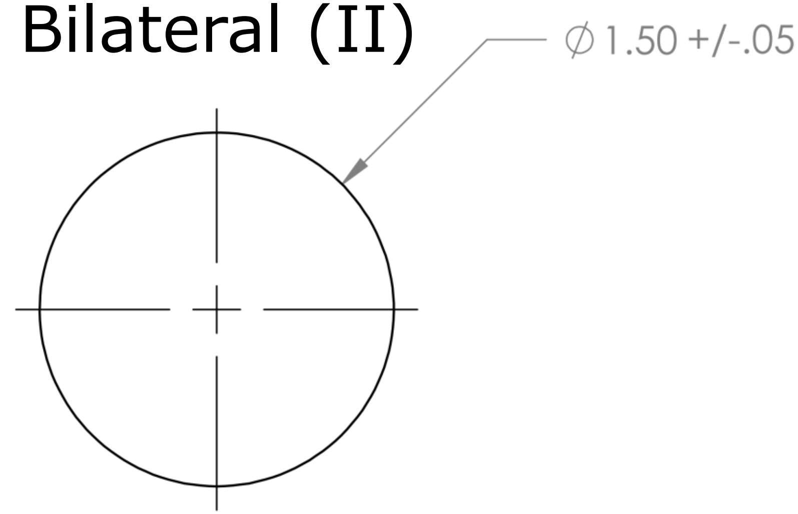
Upper and lower limits

Basic dimension



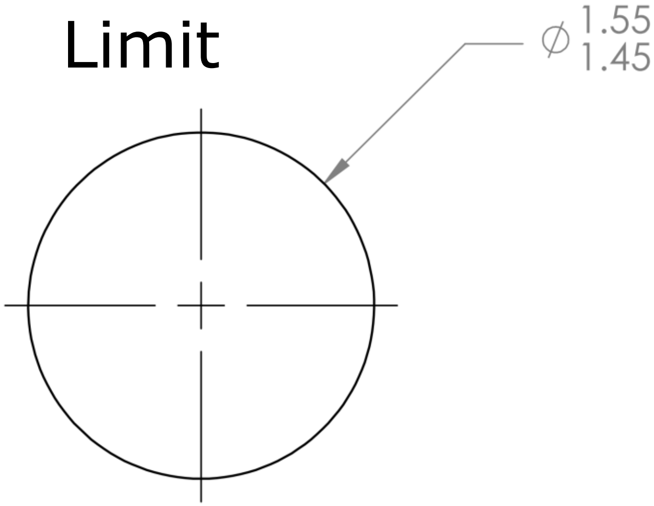
Tolerance based on global tolerances or specified by GD&T callout

Bilateral (II)

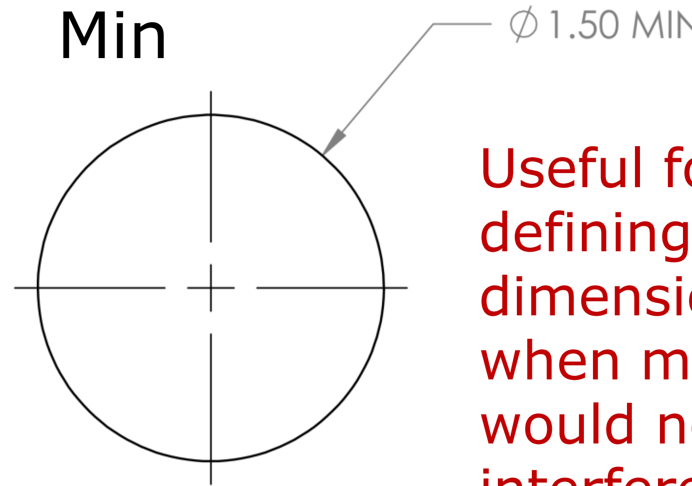


Dimensions

Limit

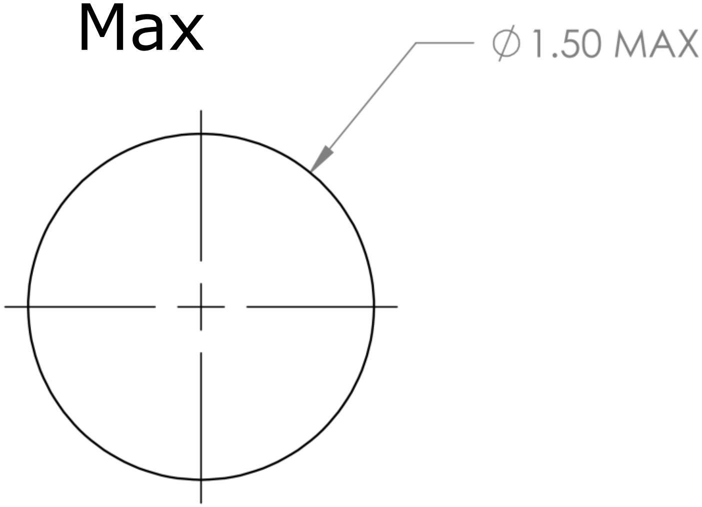


Min

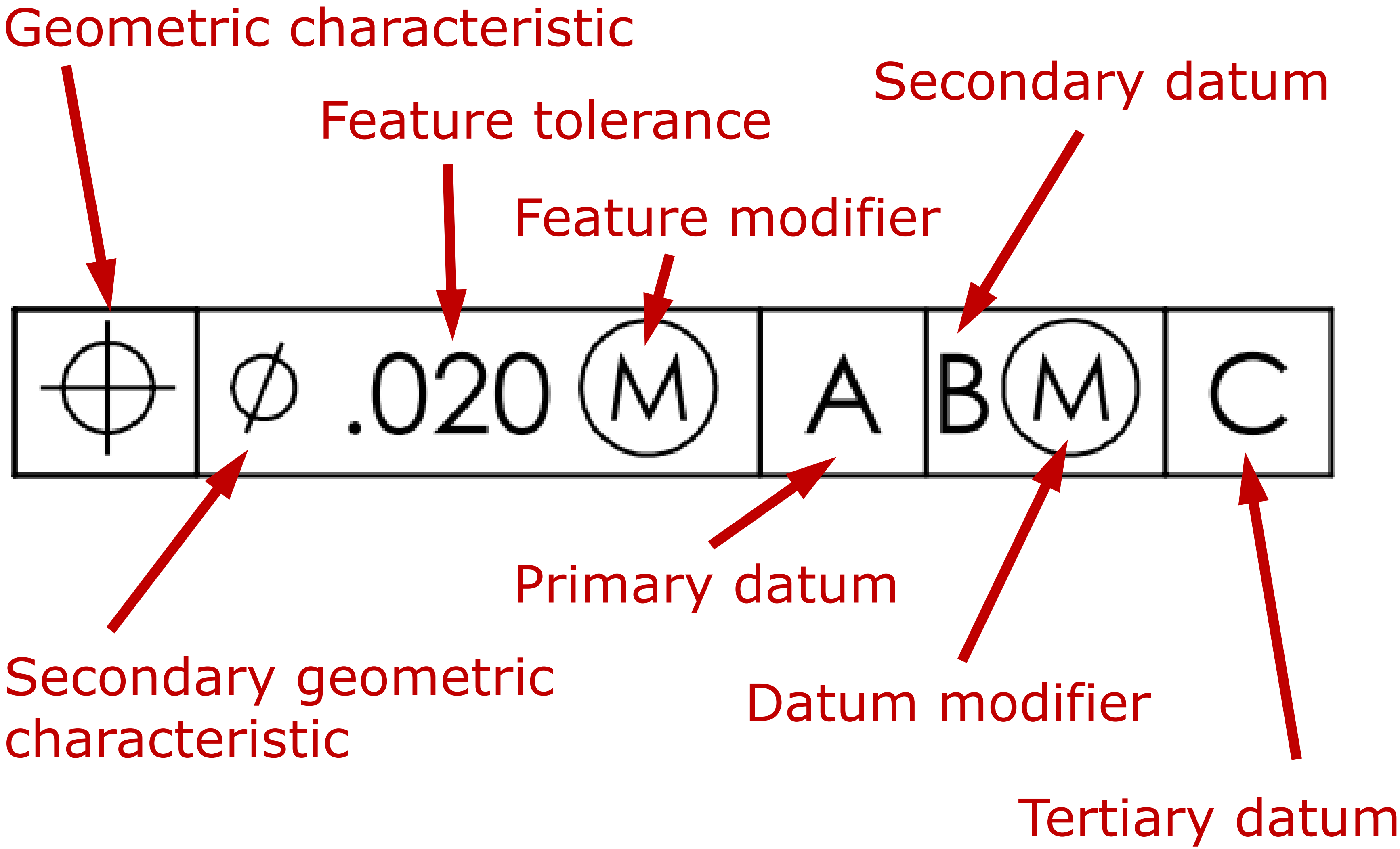


Useful for defining min. dimensions when max. would not interfere with feature / part utility

Max



Feature Control Frame

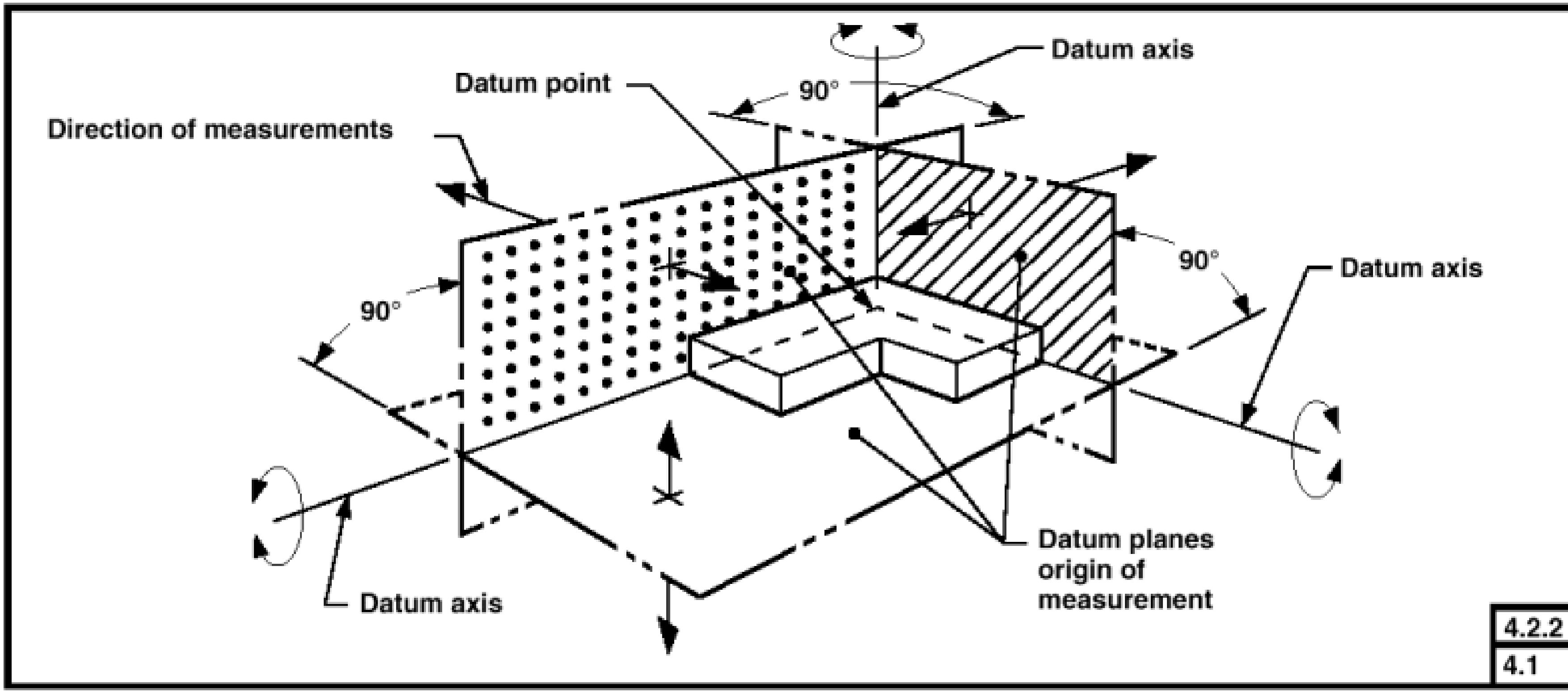


Geometric Control Symbols

Type	Symbol	Geometric Characteristics	Pertains To	Basic Dimensions	Feature Modifier	Datum Modifier
Form	⏤	Straightness	ONLY individual feature		Modifier not applicable	NO datum
	○	Circularity				
	▱	Flatness				
	⌭	Cylindricity				
Profile	⌒	Profile (Line)	Individual or related	Yes if related		RFS implied unless MMC or LMC is stated
	⌓	Profile (Surface)				
Orientation	∠	Angularity	ALWAYS related fea-ture(s)	Yes	RFS implied unless MMC or LMC is stated	
	⊥	Perpendicularity				
	//	Parallelism				
Location	⌖	Position		Yes		
	◎	Concentricity			Only RFS	Only RFS
	⌯	Symmetry				
Runout	↗	Circular Runout				
	⌰	Total Runout				

Adapted from Oberg's Machinary Handbook

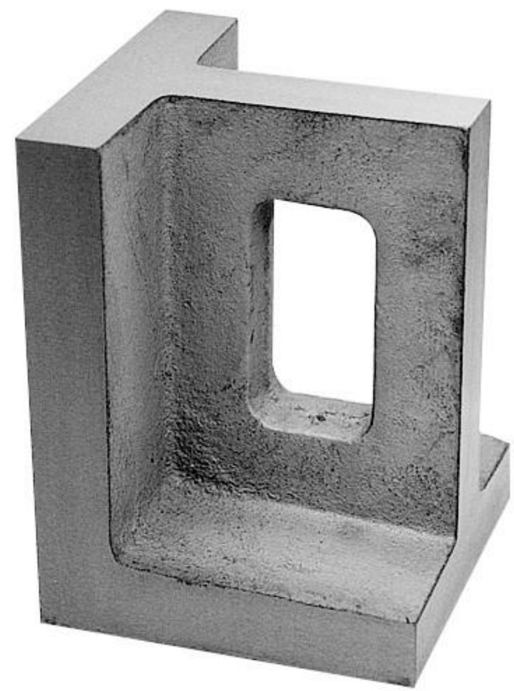
Establishing Datums



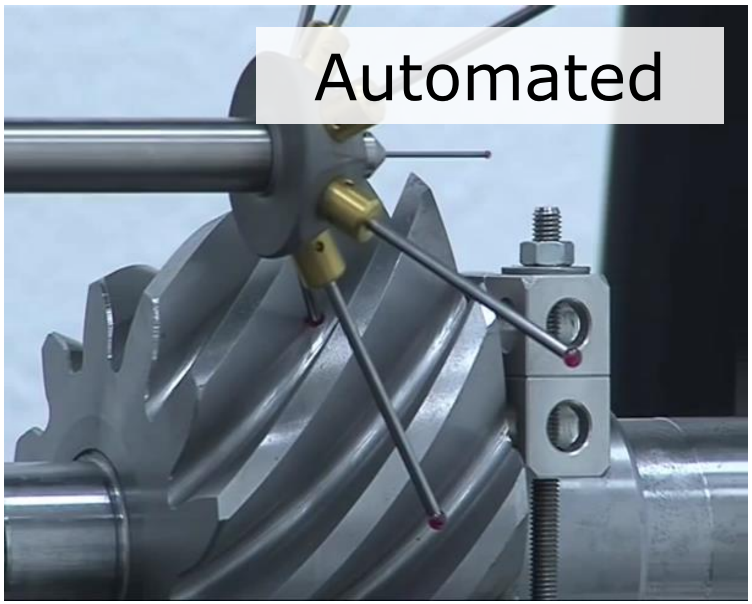
Establishing Datums

Surface Plate

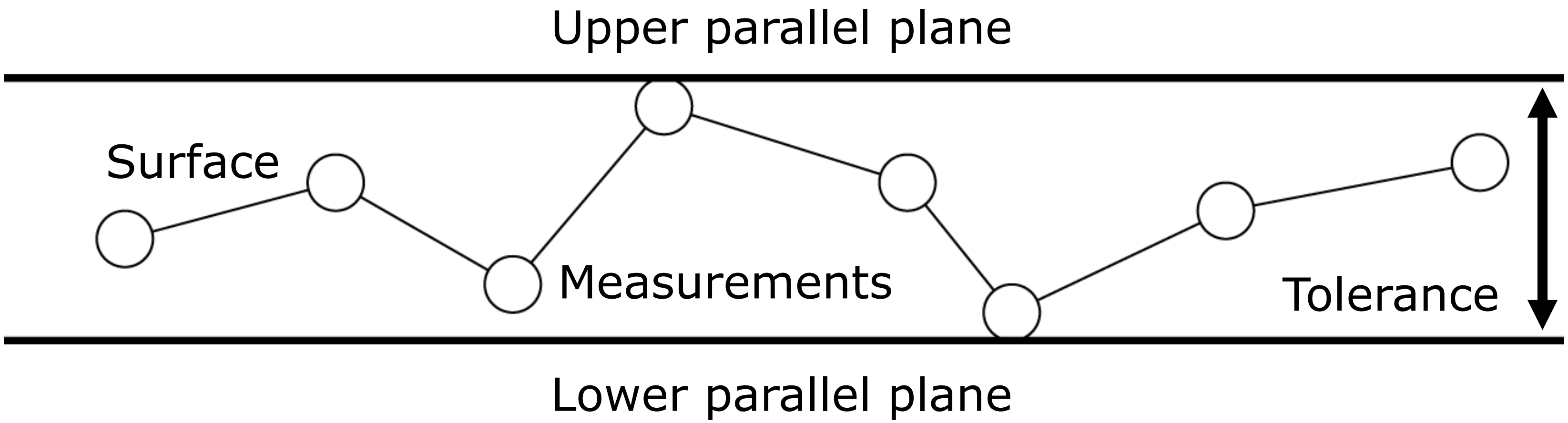
Right Angle Plate



Coordinate Measuring Machines (CMMS)



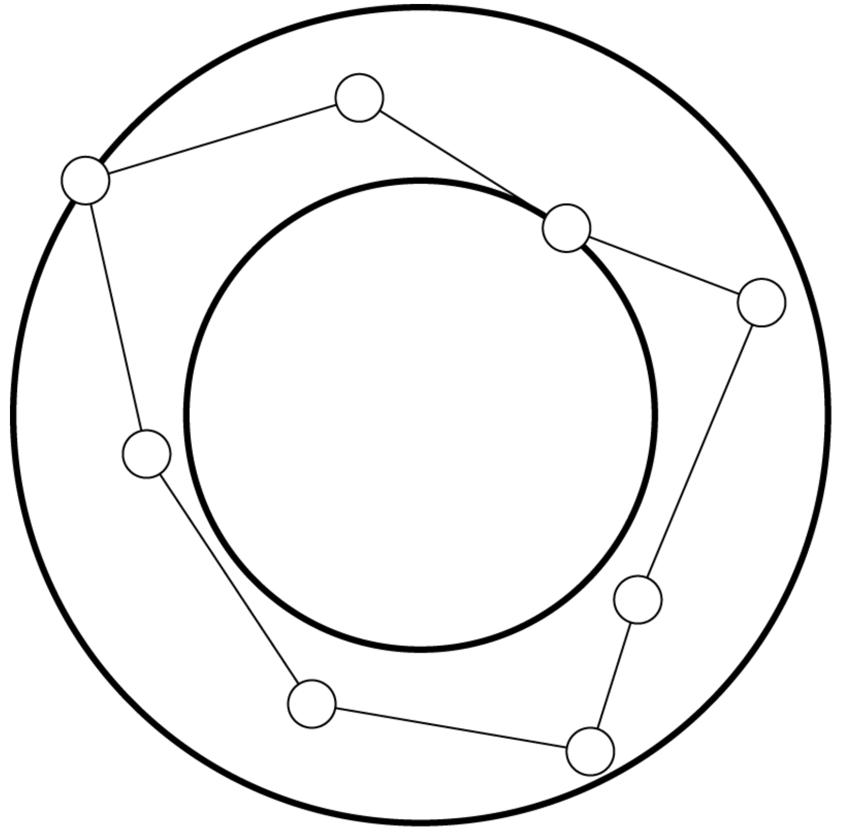
Form (Straightness, —)



All points that lie between two lines (upper and lower boundary) when measuring a line profile

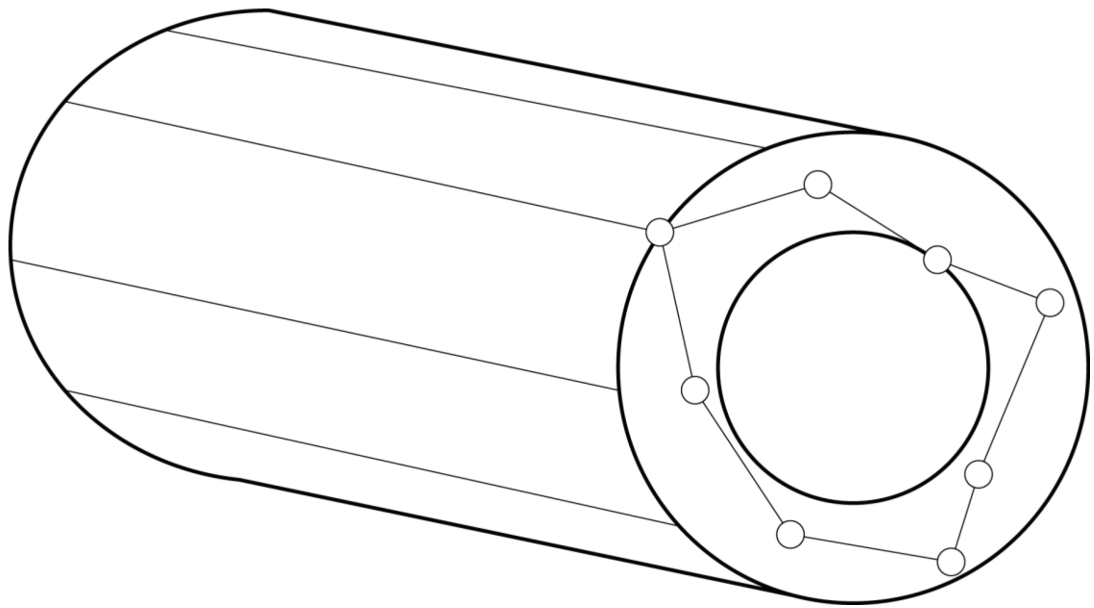
Form (Circularity, ○)

All points of a plane perpendicular to a common axis are equidistant from that axis



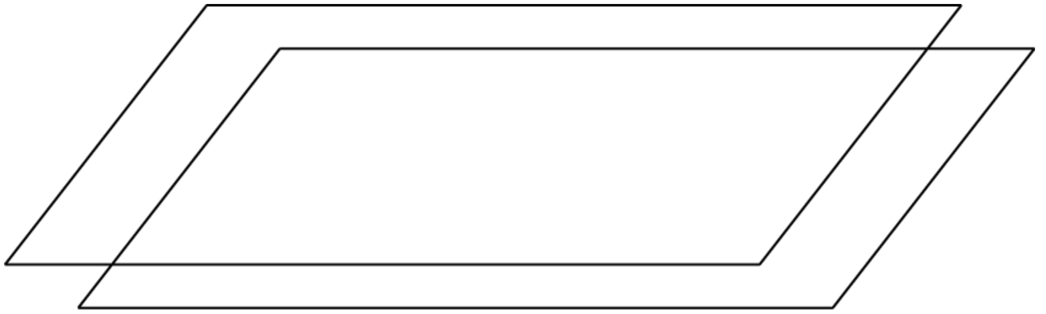
Form (Cylindricity, ⌭)

All points of the surface of a surface of revolution are equidistant from a common axis



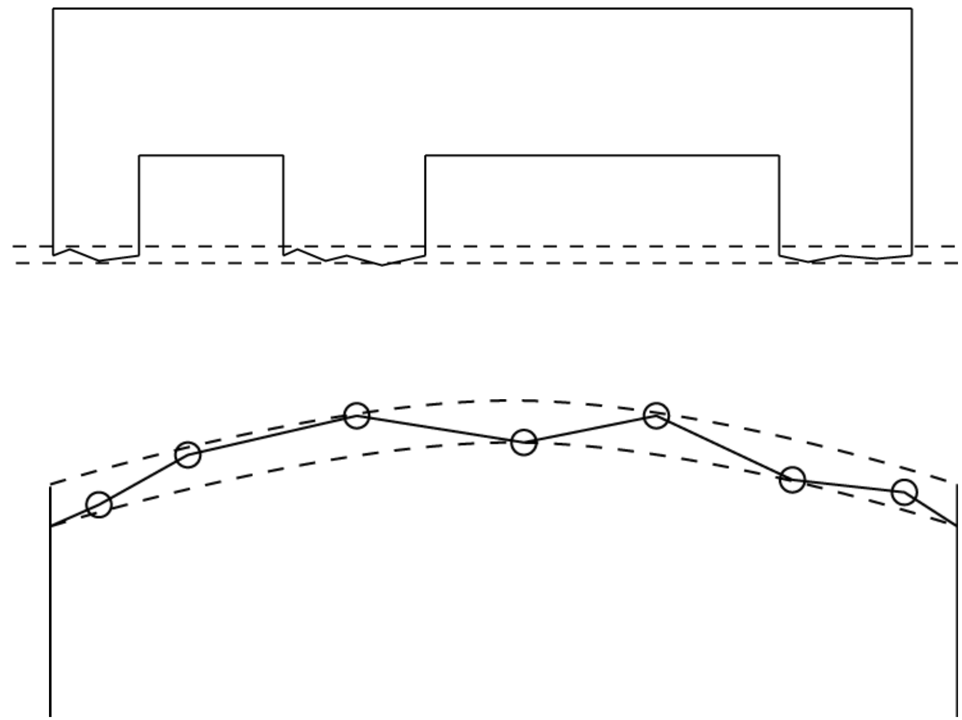
Form (Flatness, ▱)

The distance between all elements in one plane when measured with reference to a reference plane



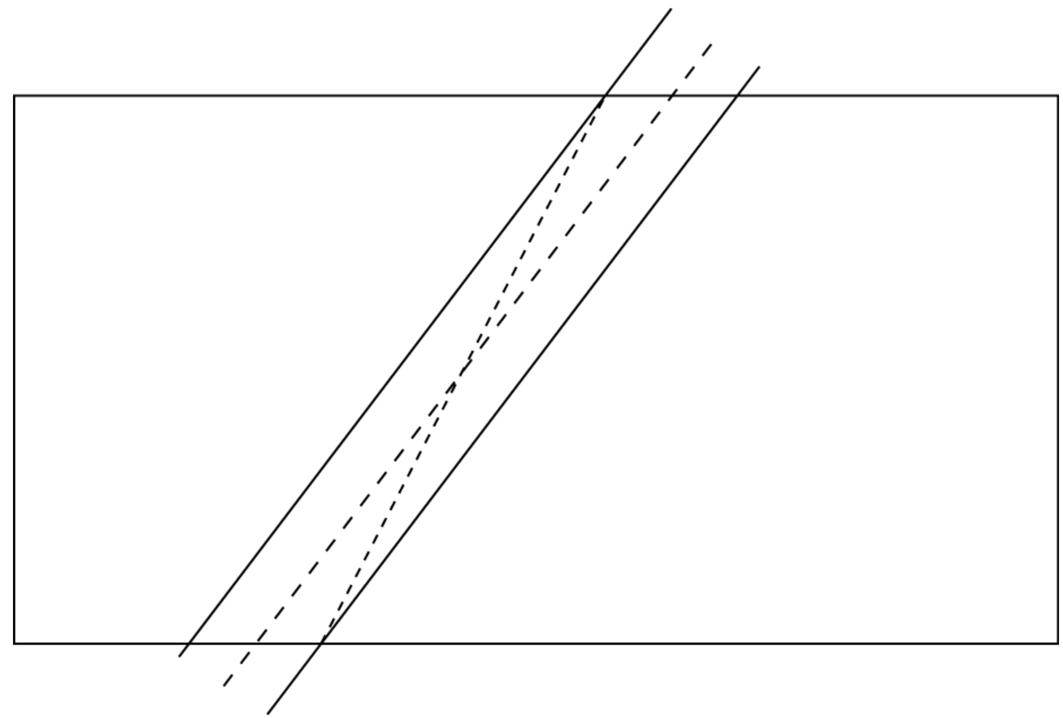
Profile (Line, ⌒ or Surface, ⌓)

This distance between all points of a line profile or surface profile between two surfaces of the shape of the idealized surface



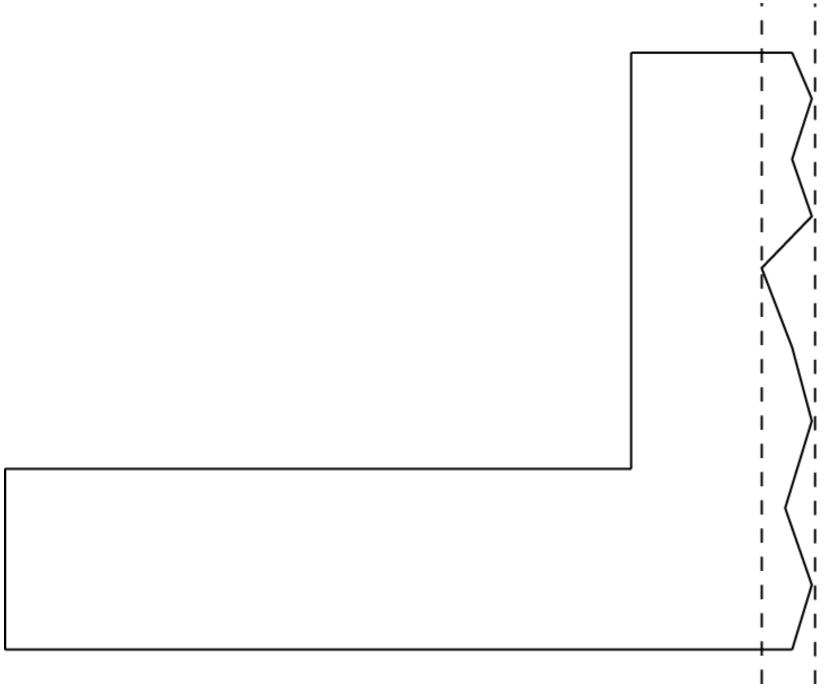
Orientation (Angularity, ∠)

The tolerance zone defined by two parallel planes or a cylinder at a specified angle from the datum plane



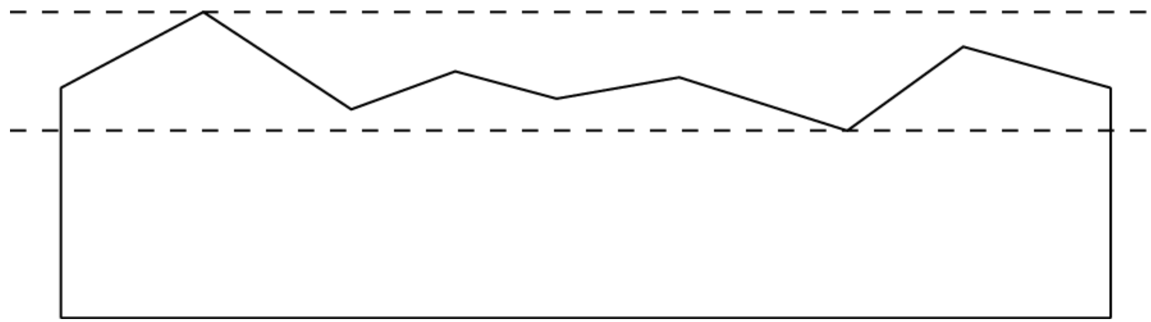
Orientation (Perpendicularity, $\perp$)

The tolerance zone of two parallel plates perpendicular to a datum within which a feature must lie



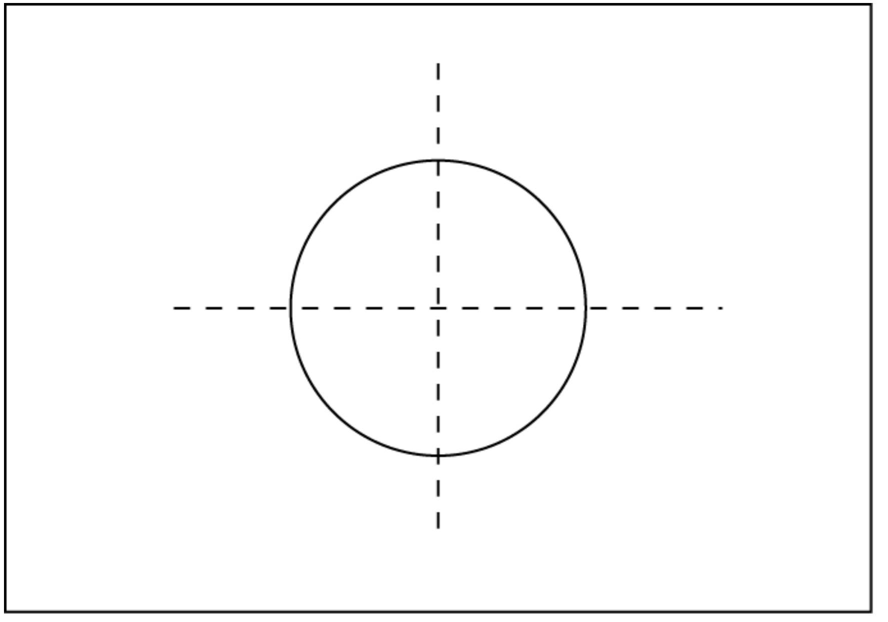
Orientation (Parallelism, ⫽)

The tolerance zone of two parallel plates parallel to a datum within which a feature must lie



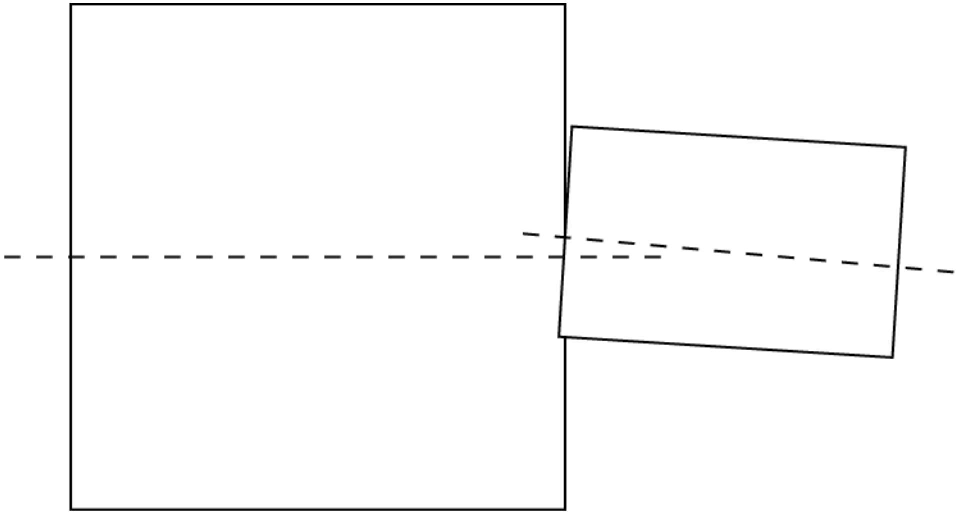
Location (Position, ⌖)

The exact location of a point, line, or surface in relation to another datum



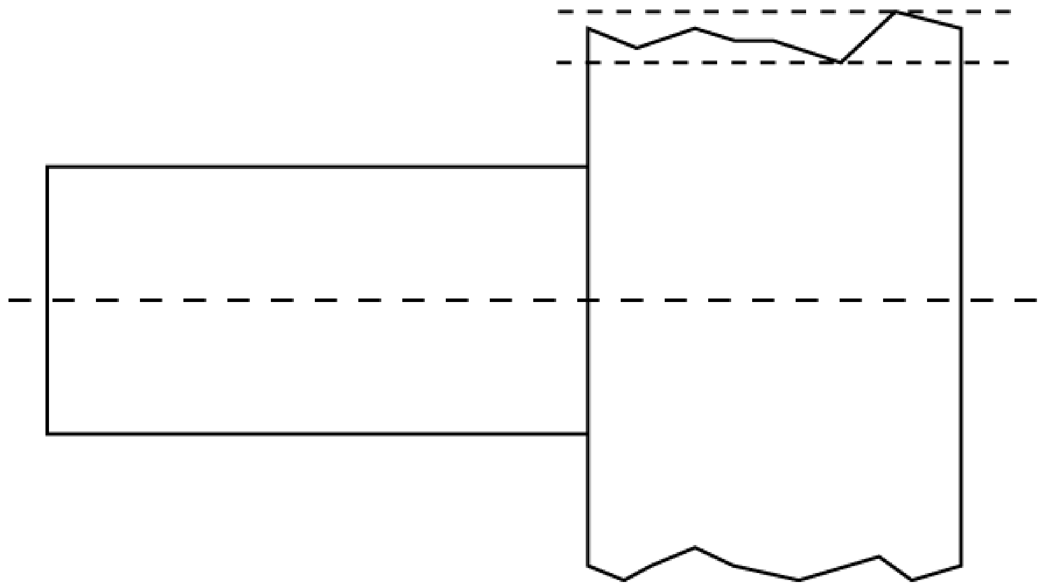
Location (Concentricity, ◎)

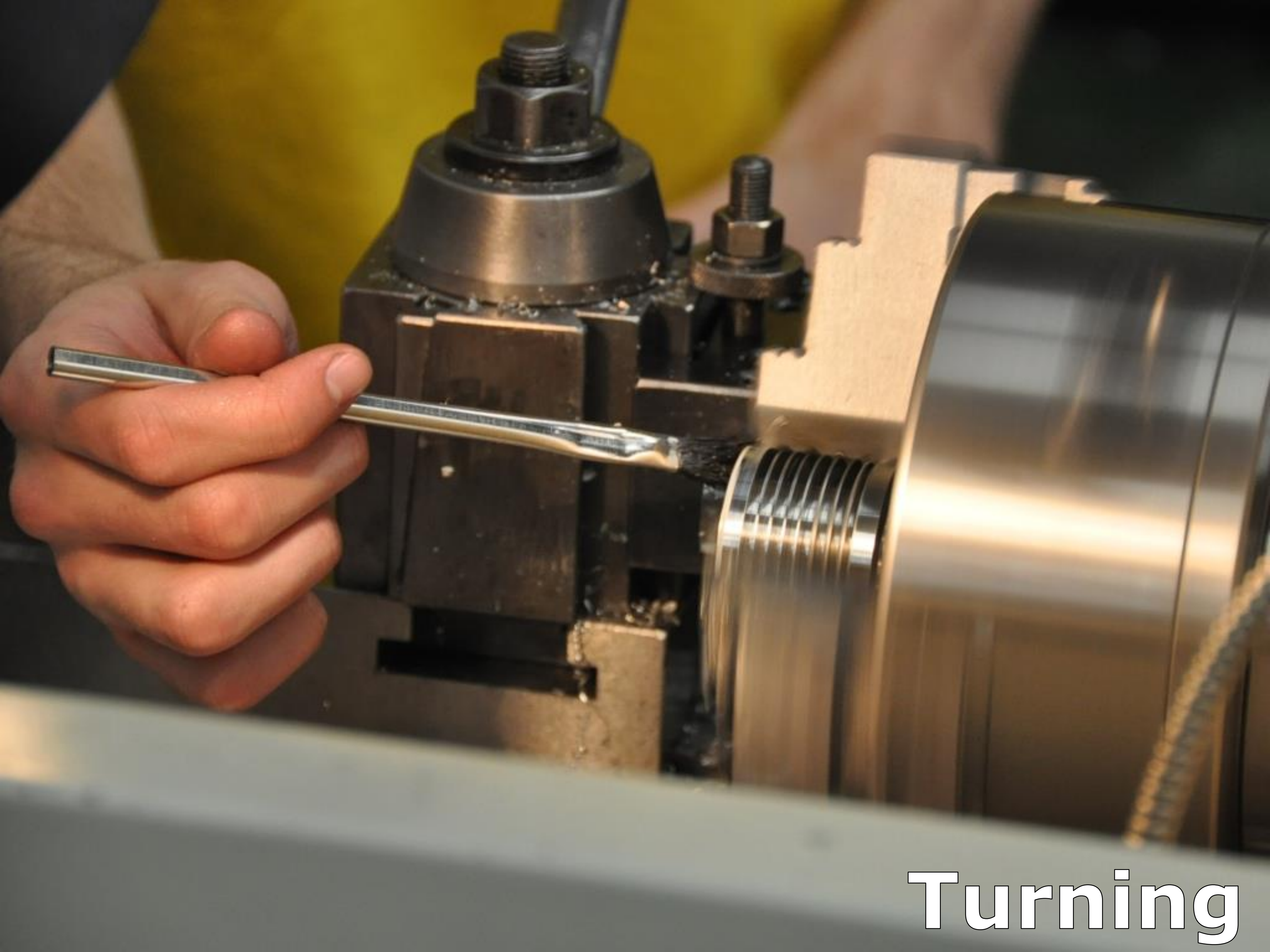
The position of an axis in relation to another datum axis



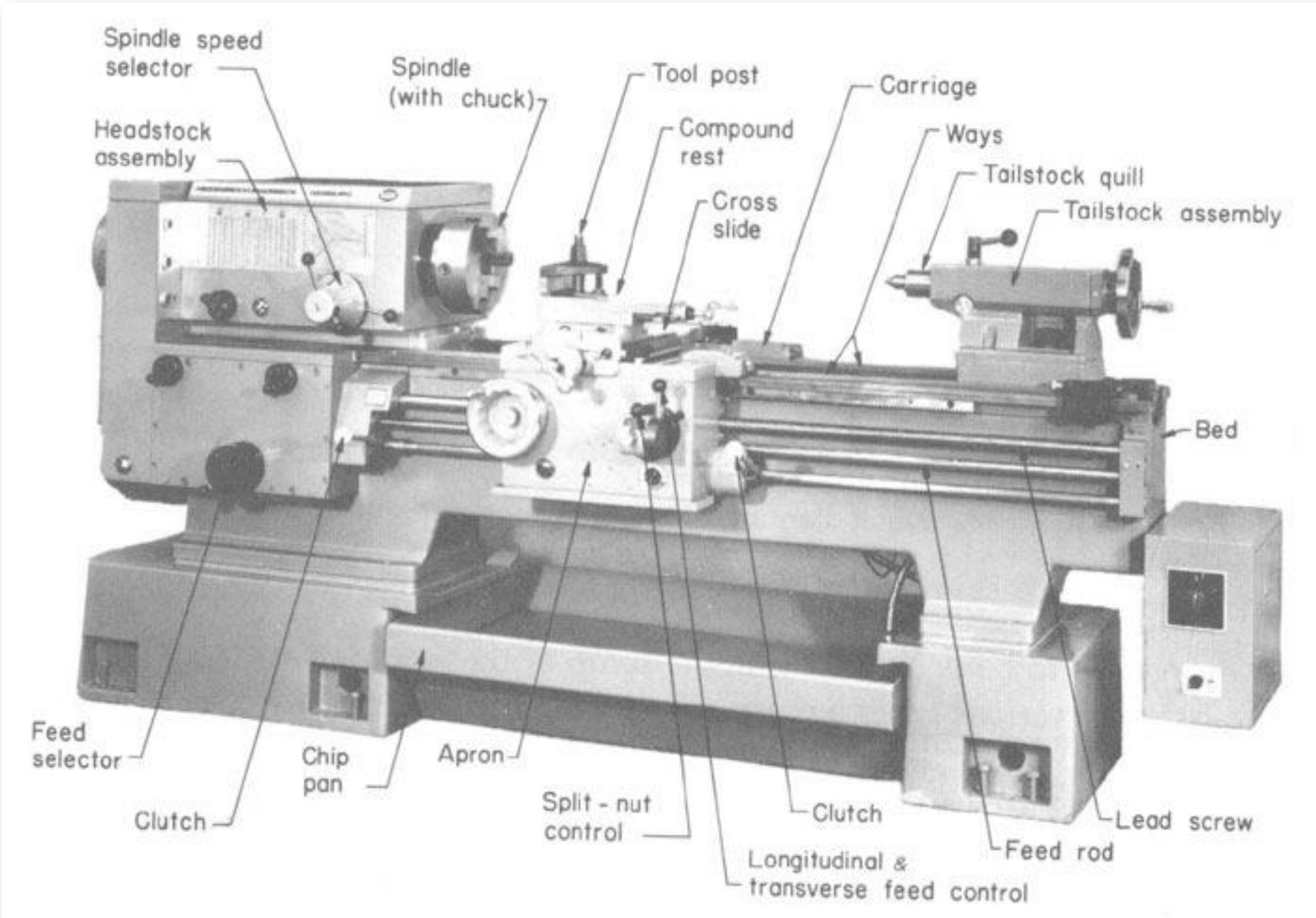
Runout (Circular, ↗ ,and Total, ⌰)

The deviation of the profile of an axisymmetric feature from a control (datum) axis

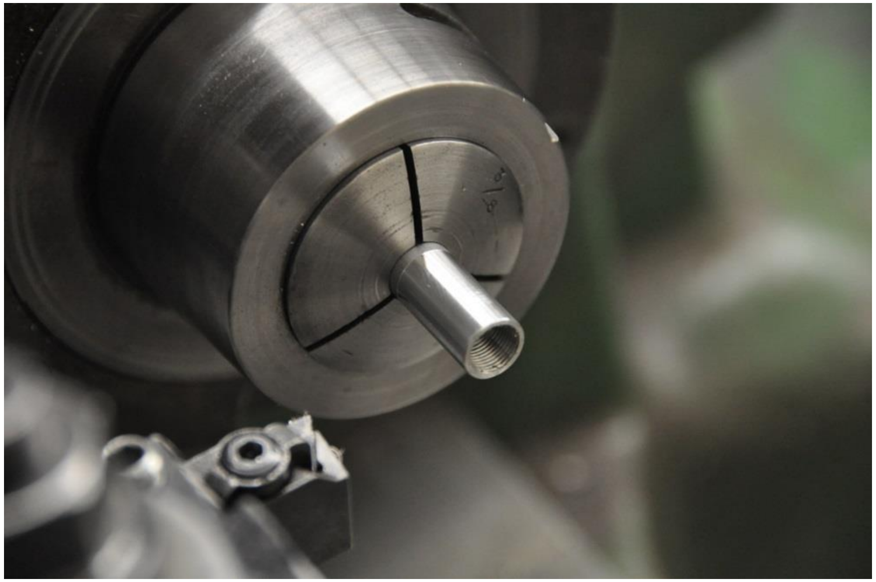



Turning

Lathe Terminology



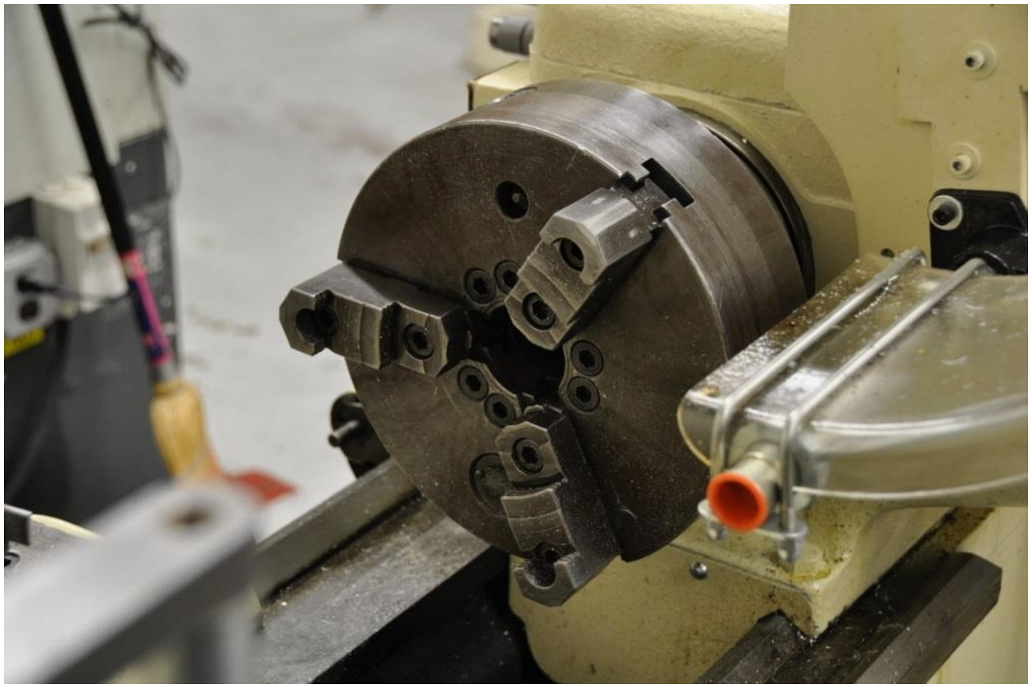
Workholding (Collets)



Collets are located in the drawer in (or next to) the lathe

Collets sizes are selected based on the stock size

Workholding (3- and 4-Jaw Chucks)



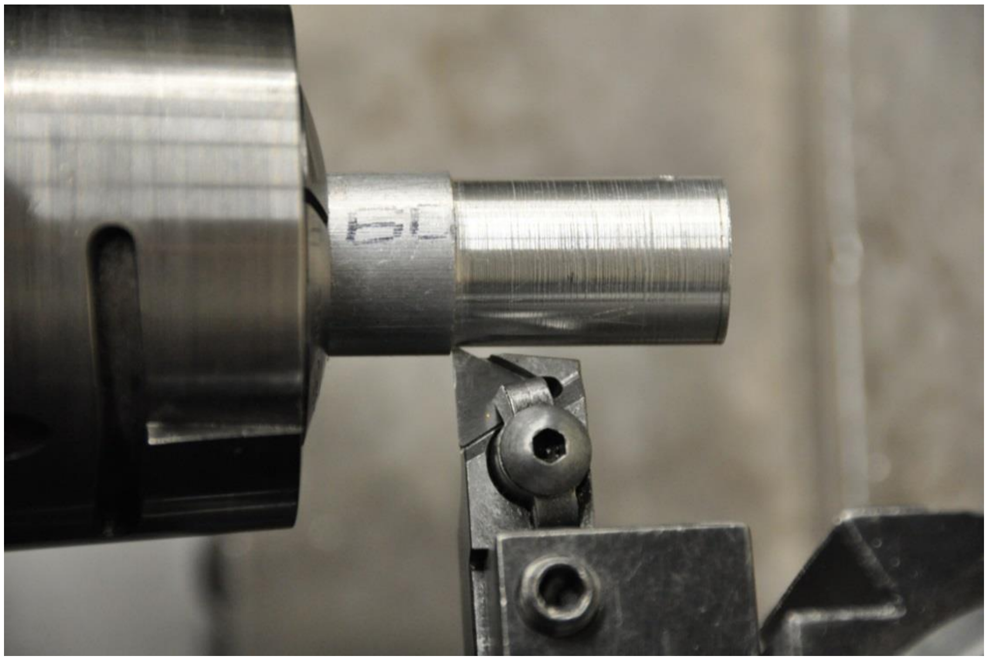
4-Jaw Chucks
- Admits square stock
- Off-center turning
- Mounting subject to eccentricities

3-Jaw Chucks
- Self-centering and quick clamping
- Cannot hold irregularly shaped work pieces

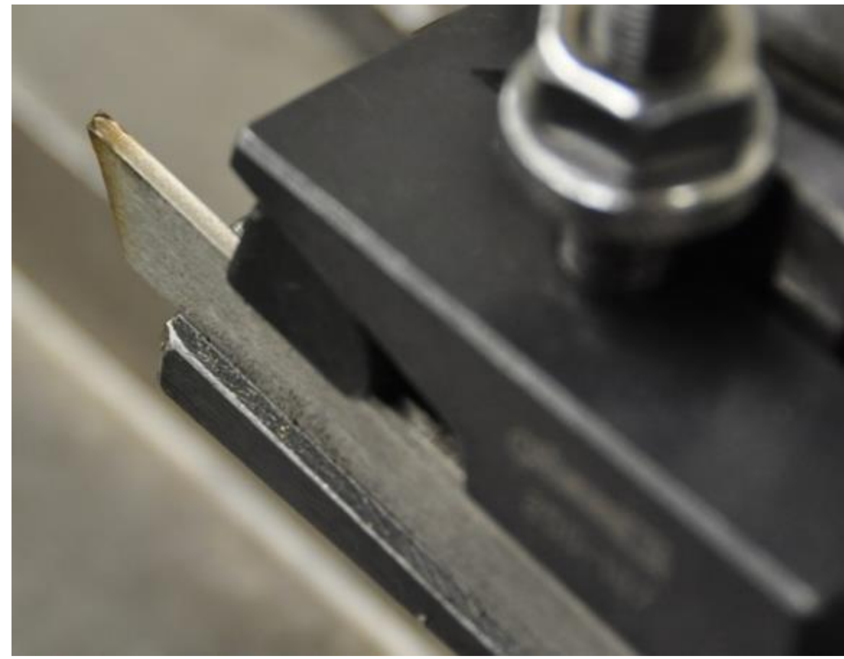
Workholding (Tailstock)

The tailstock is used to hold the workpiece with a guide or to drill holes

Tooling

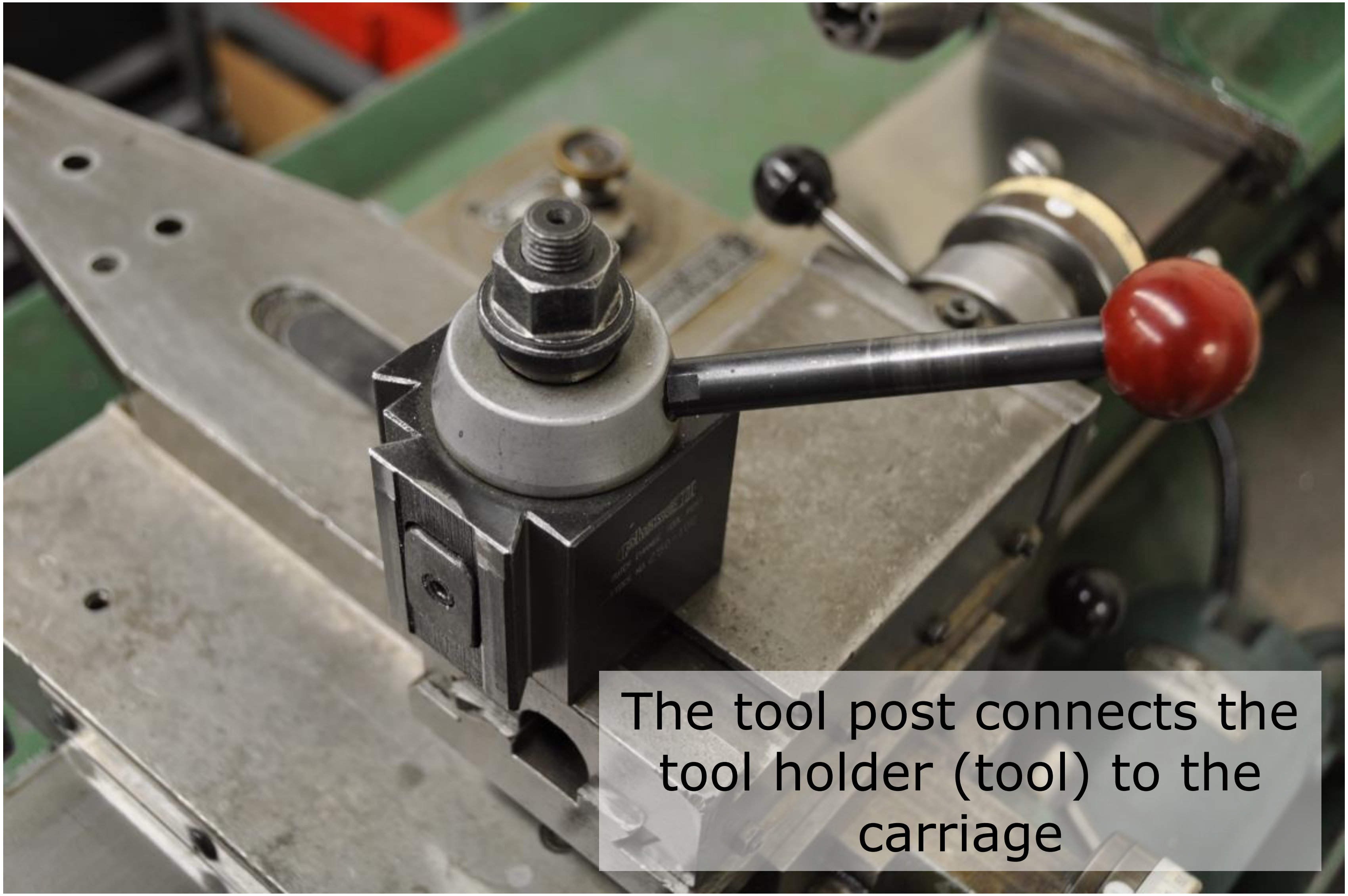


Facing/turning
(carbide insert)



Part-off tool

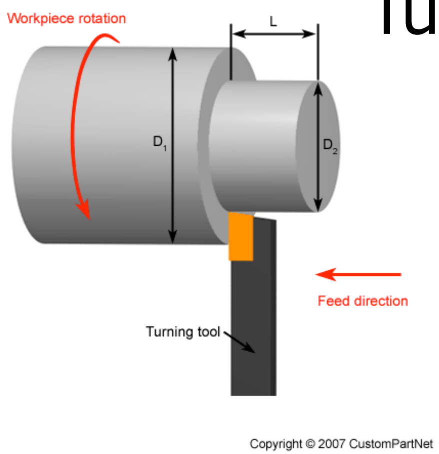
Tool Post



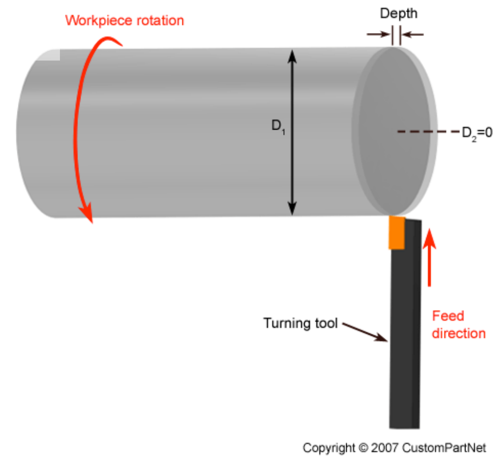
The tool post connects the tool holder (tool) to the carriage

Turning Operations

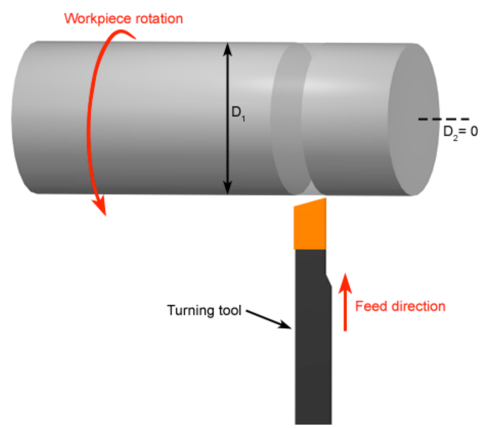
Turning



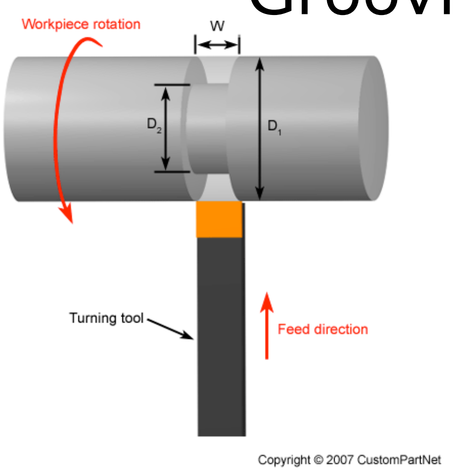
Facing



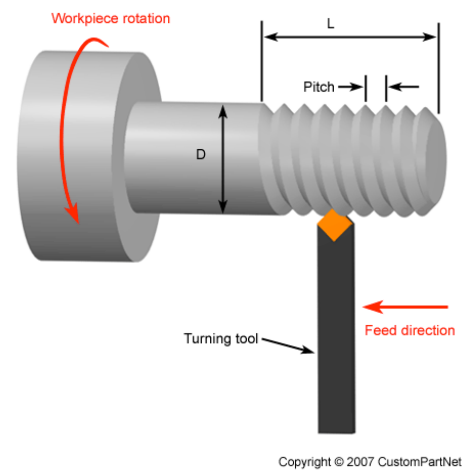
Parting off



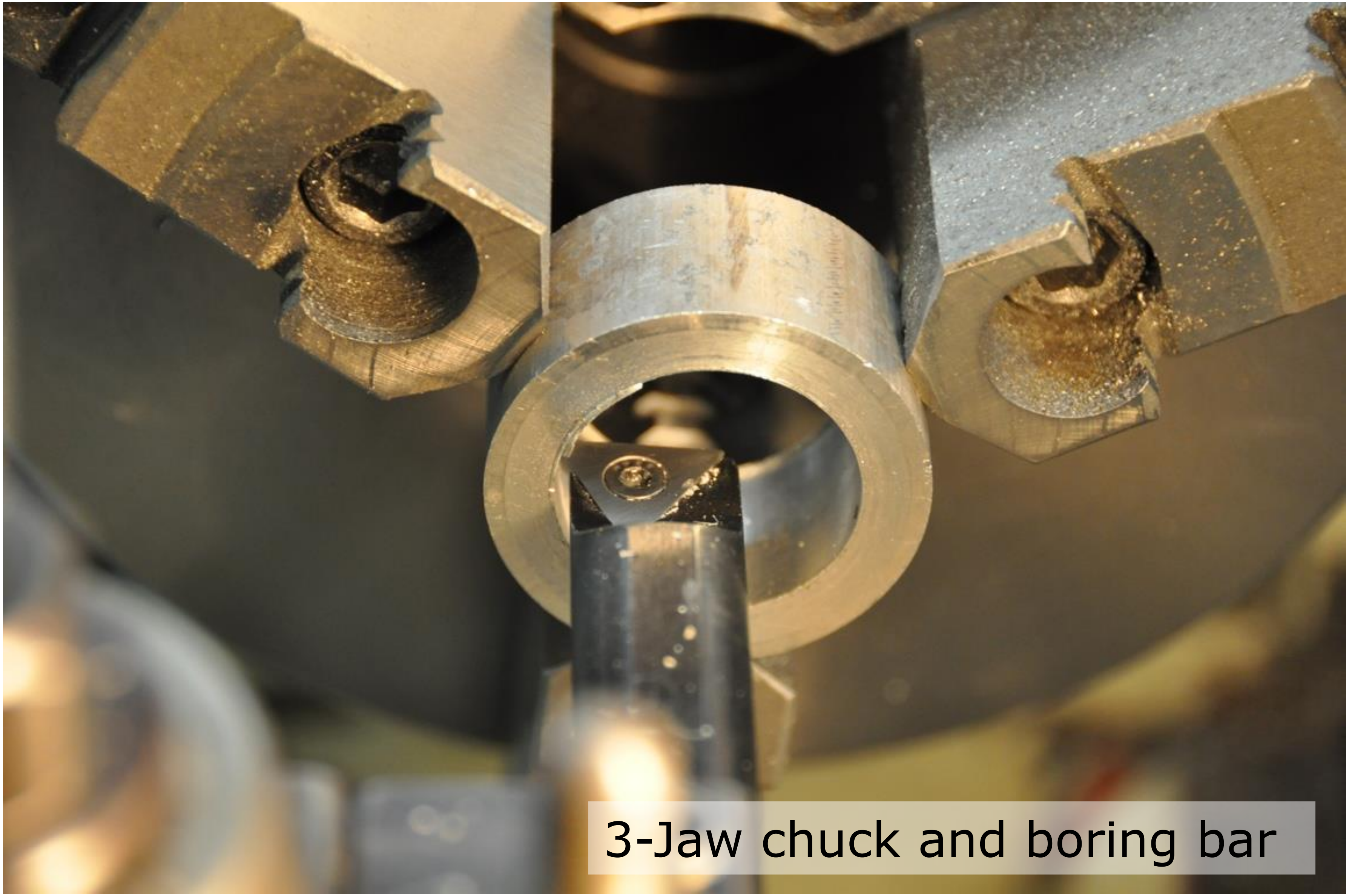
Grooving



Thread cutting



Turning Operations



Turning Operations

Peck drilling

Feeds and Speeds

Speed Equation for the Mill

You set this

Empirically determined parameter

$$\text{Spindle Speed[RPM]} = \frac{4 \text{ x Cutting Speed [SFPM]}}{\text{Tool Diameter [in.]}}$$

Provided or selected

Speed Equation for the Lathe

$$\text{Spindle Speed[RPM]} = \frac{4 \text{ x Cutting Speed [SFPM]}}{\text{Part Diameter [in.]}}$$

Feeds and Speeds

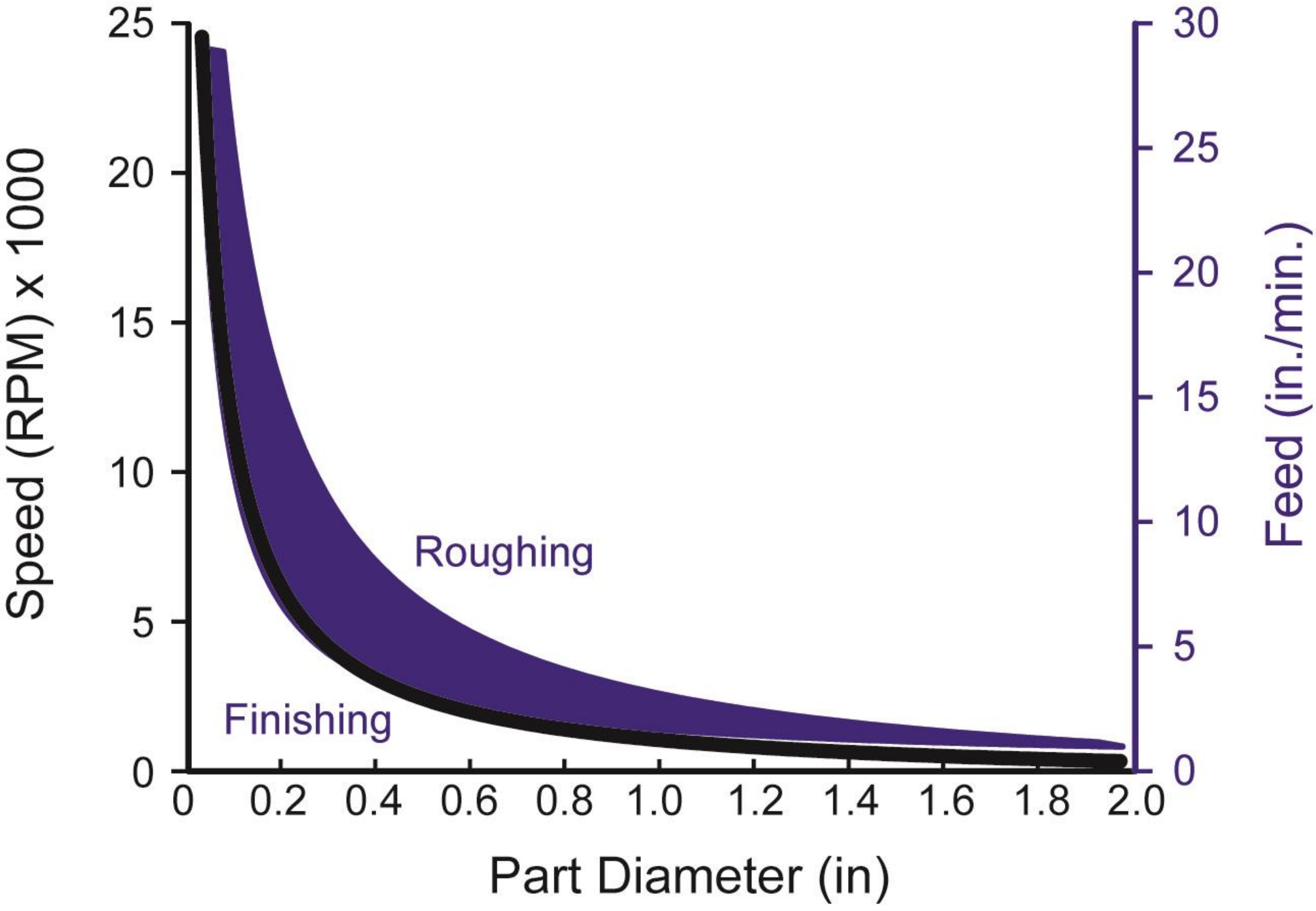
Roughing = 0.005”
Finishing = 0.001 – 0.002”

You set this

$$\text{Feed Rate}\left[\frac{\text{in}}{\text{min}}\right] = \text{Chip Load [in.] x}$$
$$\text{x Spindle Speed[RPM]}$$

Determined by the speed equation

Feeds and Speeds



Cutting Slots with the Mill