Sharpening Handbook

Because *sharp enough* … usually is not

Chapter 11

Metal Lathe Tools

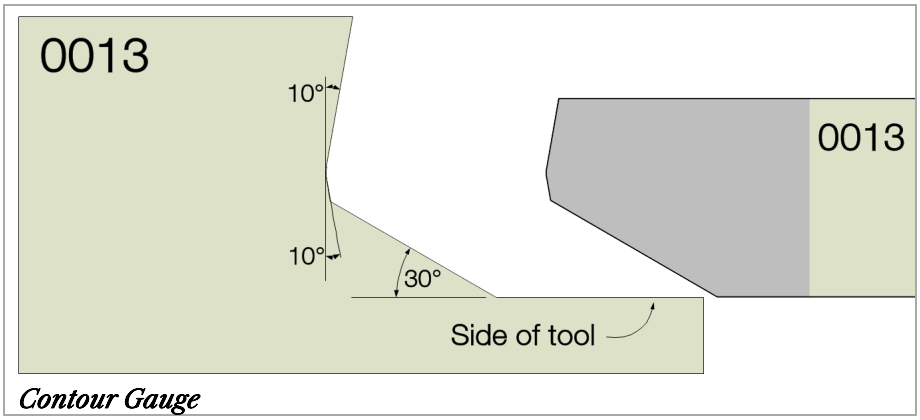
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SharpeningHandbook.info

The full handbook, and the latest version of this chapter, are on the web at **SharpeningHandbook.info**. This chapter: November 2026.

Notes for All Metal Lathe Tools

If grinding this on a high speed grinder, be sure to manage the temperature so that the temper is not lost due to overheating. If there is a carbide insert, **DO NOT cool by dipping in water**. This will cause the carbide to crack due to shocks. Otherwise, cool by dipping as needed in water.



Contour Gauge

For resharpening, a contour gauge like shown to the left is recommended. One should be made for each tool, and it should be numbered to match the tool's number.

More Information

Books & Papers

- The definitive source is Leo J. St. Clair's book from 1952 titled, “Design and Use of Cutting Tools”. He was working in the industry as it was changing from HSS to carbide, so both are covered well. His experimental data helps validate or disprove many theories. Unfortunately, this book is hard to find.

Videos & Presentations

- Tormek Tool Rest SVD-110 (YouTube video)
- Tormek AngleMaster WM-200 (YouTube video)

Web Sites

- Conversion of Brinell vs. Rockwell hardness measurements (engineersedge.com).

> **Ongoing maintenance** - see Chapter 4, *Metalworking Tools*.

Metal Lathe Tools: Boring Bars

Angles shown are good for hobbyists; grinds for production shops should consult a specialist.

When both a relief and a clearance angle are outlined (e.g., Side Relief and Front Relief), this is done to facilitate easier resharpening. It is analogous to Secondary Bevels on woodworking chisels (see Chapter 18).

Resharpening should be done when the wear land reaches 1.5 mm ($^{1}/_{16}$ inch) high.

Angles shown are the effective angles, not the ground angles (see Chapter 1). Effective angles are increased or decreased, based on the angle by which the tool is presented against the work. Additionally, the vertical alignment of the tool (vs. the center line of the work) can also change the effective Front Relief Angle.

Sharpness Scale **3**

All angles are given the nomenclature designated by the American Standards Association (ASA).

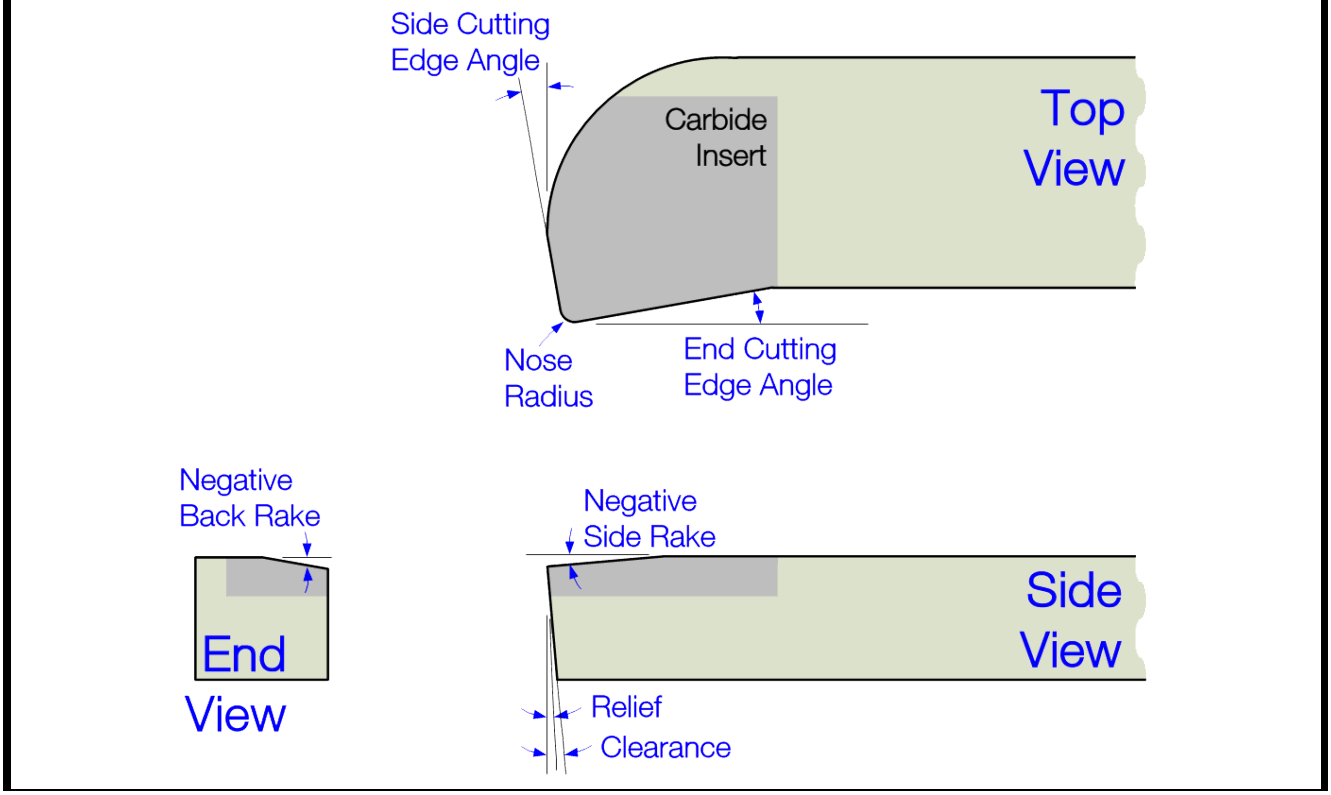
Carbide vs. HSS

Material	Compressive Strength	Shear Strength	Max Usable Temp*
Carbide	Higher	Lower	1,800 ˚F
HSS	Lower	Higher	950 - 1,100 ˚F

* Temperature at which the tool material begins to soften appreciably. For HSS, it depends on the level of cobalt in the HSS.

You know what it's supposed to look like when you're done. Do what you have to do to make it look like that.
Unknown Old Machinist

Tool Shape - Boring Bar



Back Rake	Side Cutting Edge Angle	Nose Radius	End Cutting Edge Angle	Side Rake Angle	Side Relief Angle	Side Clearance Angle	Comments
-10°	10°	1.5 mm ($^1/_{16}$")	10°	-5°	5°	7°	Angles shown are the recommended effective angles, not the ground angles.

Sharpness Scale - see Chapter 1.
Notes for All Metal Lathe Tools - at the start of this chapter.
Ongoing maintenance - see Chapter 4, *Metalworking Tools*.
Grindstones and Other Sharpening Media - see Chapter 2.

Metal Lathe Tools : Cutoff / Parting Tools

Angles shown are good for hobbyists; grinds for production shops should consult a specialist.

When both a relief and a clearance angle are outlined (e.g., Side Relief and Front Relief), this is done to facilitate easier resharpening. It is analogous to Secondary Bevels on woodworking chisels (see Chapter 18).

Resharpening should be done when the wear land reaches 1.5 mm ($^{1}/_{16}$ inch) high.

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Sharpness Scale **3**

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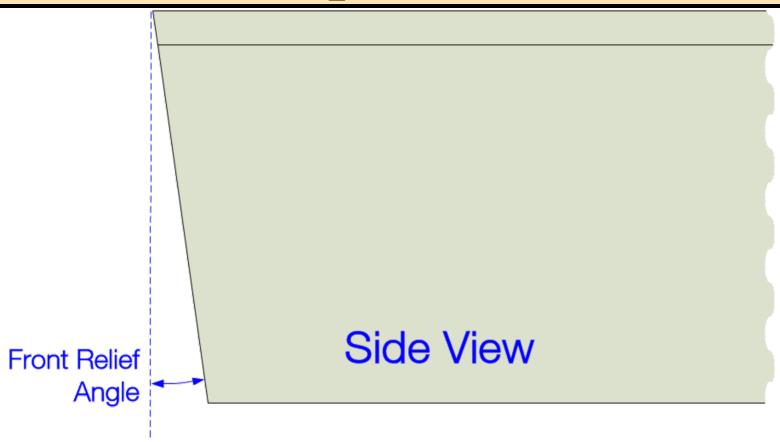
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Material	Compressive Strength	Shear Strength	Max Usable Temp*
Carbide	Higher	Lower	1,800 ˚F
HSS	Lower	Higher	950 - 1,100 ˚F

* Temperature at which the tool material begins to soften appreciably. For HSS, it depends on the level of cobalt in the HSS.

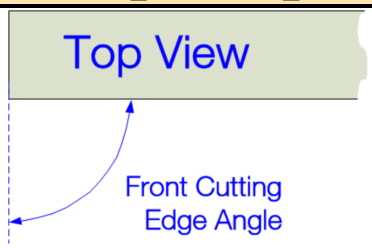
If he wasn't afraid of burning his fur, I could teach a monkey to MIG weld.
Unknown Old Machinist

Tool Shape - Side View



Use	Front Relief Angle		Comments
	Recom.	Range	
General	**7˚**	5˚ - 10˚	Angles shown are the recommended effective angles, not the ground angles. Greater relief angle will be needed when an upward-facing angle of presentation of the tool is used.

Tool Shape - Top View



Use	Front Cutting Edge Angle		Comments
	Recom.	Range	
General	**90˚**	70˚ - 110˚	**90˚ is recommended**, but some like to skew the cutting edge. I've found that problematic on T-shaped cutters as they will tend to drift to one side.

Sharpness Scale - see Chapter 1.
Notes for All Metal Lathe Tools - at the start of this chapter.
Ongoing maintenance - see Chapter 4, *Metalworking Tools*.
Grindstones and Other Sharpening Media - see Chapter 2.

Metal Lathe Tools: Cemented Carbide

Angles shown are good for hobbyists; grinds for production shops should consult a specialist.

When both a relief and a clearance angle are outlined (e.g., Side Relief and Front Relief), this is done to facilitate easier resharpening. It is analogous to Secondary Bevels on woodworking chisels (see Chapter 18).

Resharpening should be done when the wear land reaches 1.5 mm ($^1/_{16}$ inch) high.

Angles shown are the effective angles, not the ground angles (see Chapter 1). Effective angles are increased or decreased, based on the angle by which the tool is presented against the work. Additionally, the vertical alignment of the tool (vs. the center line of the work) can also change the effective Front Relief Angle.

Sharpness Scale **3**

All angles are given the nomenclature designated by the American Standards Association (ASA).

Carbide vs. HSS

Material	Compressive Strength	Shear Strength	Max Usable Temp*
Carbide	Higher	Lower	1,800 ˚F
HSS	Lower	Higher	950 - 1,100 ˚F

* Temperature at which the tool material begins to soften appreciably. For HSS, it depends on the level of cobalt in the HSS.

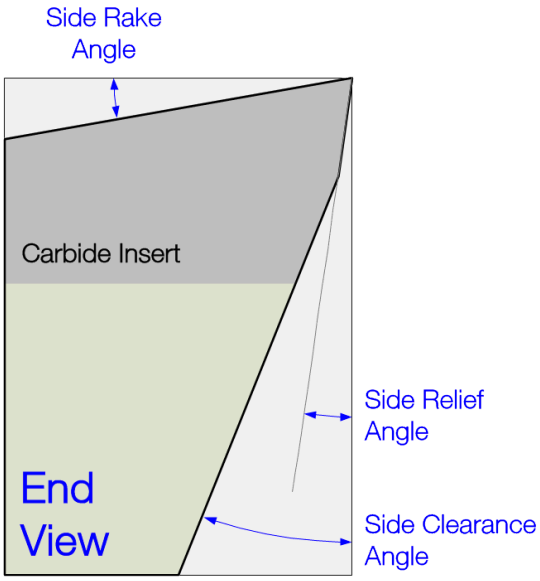
Some guys, the best day they have at work is when they aren't screwing anything up.
Unknown Old Machinist

Tool Shape - End View

Side Clearance Angle should be 4˚ to 6˚ greater than Side Relief Angle.

In selecting the Side Relief Angle, the sharpener should:

- carefully chose the correct angle, as a deviation of even 2˚ (plus or minus) will lower tool life appreciably.
- chose the lower angle from the table below for heavy cutting
- chose the higher angle from the table below for finish cutting.
- decrease the angle by 2˚ when making high impact cuts (e.g., work with significant gaps or hard inclusions).



Special Notes :

1. When grinding the Side Clearance Angle, the sharpener should leave the top 1.5 mm ($^1/_{16}$ inch) unground. This is because the rough grinding of the carbide introduces cracks and makes it more brittle. By stopping short of the top, this is minimized. Then, when grinding the Side Relief Angle, a high grit wheel should be used to make the edge smooth with minimal cracks.
2. When grinding the Side Rake Angle, the sharpener should be sure the top surface is finished with a very high grit. The roughness of this surface affects the chip damage to the tool, and rough surfaces are more susceptible to damage than smother ones.

Tool Shape - End View

Material	Side Rake Angle	Side Relief Angle	Side Clearance Angle	Comments
Aluminium	10° - 20°	8° - 10°	Side Relief + 4° - 6°	
Aluminum Bronze	6° - 12°	7° - 9°		
Manganese Bronze	4° - 10°	6° - 8°		
Bronze Castings	6° - 12°	7° - 9°		
Cast Iron - Soft (170 Brinell)	6° - 12°	6° - 8°		
Cast Iron - Medium (250 Brinell)	4° - 9°	5° - 7°		
Cast Iron - Hard (400 Brinell)	0° - 5°	3° - 5°		
Cast Iron - Chilled	-10° - 0°	2° - 4°		
Copper	10° - 20°	7° - 9°		
Monel	4° - 9°	6° - 8°		
Magnesium	15° - 25°	8° - 10°		
Maleable Iron	5° - 10°	5° - 7°		
Plastics	10° - 25°	9° - 11°		
Steel - SAE 1020	8° - 15°	6° - 8°		
Steel - SAE 1040	6° - 12°	6° - 8°		
Steel - SAE 1095 or 52100	4° - 8°	5° - 7°		
Steel - SAE 2340	4° - 8°	5° - 7°		
Steel - SAE 6150	3° - 5°	3° - 7°		
Steel - Heat Treated to 350 Brinell	4° - 6°	0° - 4°		

Tool Shape - Side View

Front Clearance Angle should be 4° to 6° greater than the Front Relief Angle.

The Back Rake Angle, as shown in the picture to the right, is positive.

- 5° - 8° to simply control chip direction
- -5° to protect the finishing point of the tool

If a combined Negative Back Rake Angle and a Back Rake Angle is used (as shown in the picture), the width of the land for the Negative Back Rake Angle is 1.5 - 2 x the feed per revolution.

Another reason to introduce a Negative Back Rake Land is to reduce the ability for introducing breaks or cracks on the intersection between the Back Rake and the Front Relief. This is sometimes called "stoning off" or "dubbing" the edge.

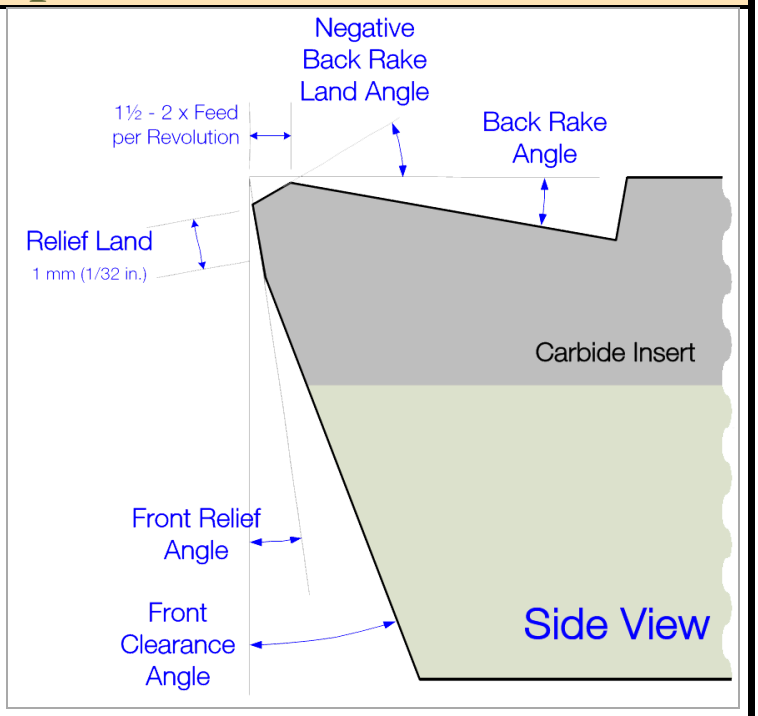
Special Notes :

1. When grinding the Front Clearance Angle, the sharpener should leave the top 1.5 mm ($^{1}/_{16}$ inch) unground. This is because the rough grinding of the carbide introduces cracks and makes it

Tool Shape - Side View

more brittle. By stopping short of the top, this is minimized. Then, when grinding the Front Relief Angle, a high grit wheel should be used to make the edge smooth with minimal cracks.

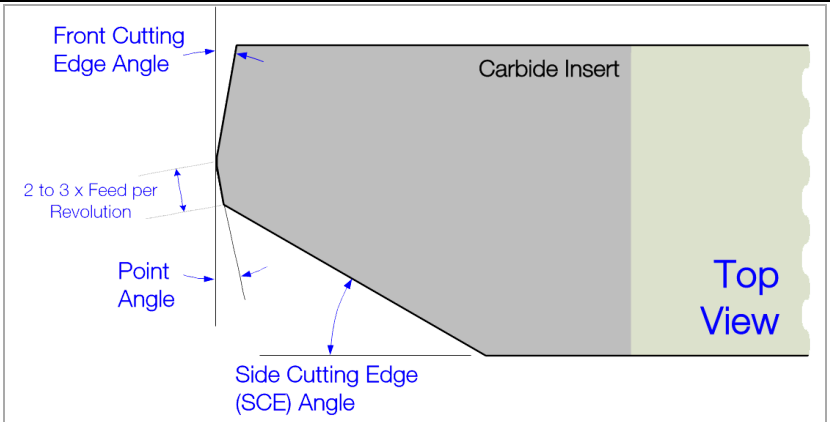
2. When grinding the Side Rake Angle, the sharpener should be sure the top surface is finished with a very high grit. The roughness of this surface affects the chip damage to the tool, and rough surfaces are more susceptible to damage than smother ones.



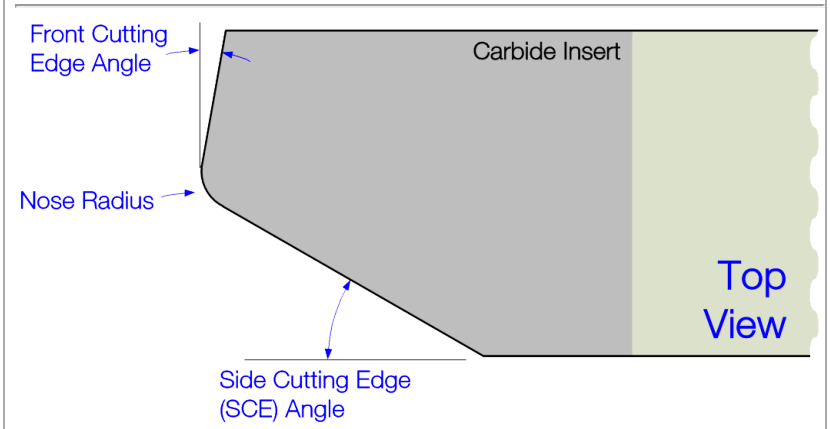
Material	Front Relief Angle	Front Clearance Angle	Back Rake Angle	Negative Back Rake Angle	Comments
Aluminium	8° - 10°	Front Relief + 4° - 6°	5° - 8°	90° angle to Front Relief Angle *(can be more than 90°)*	
Aluminum Bronze	7° - 9°				
Manganese Bronze	6° - 8°				
Bronze Castings	7° - 9°				
Cast Iron - Soft (170 Brinell)	6° - 8°				
Cast Iron - Medium (250 Brinell)	5° - 7°				
Cast Iron - Hard (400 Brinell)	3° - 5°				
Cast Iron - Chilled	2° - 4°				
Copper	7° - 9°				
Monel	6° - 8°				
Magnesium	8° - 10°				
Maleable Iron	5° - 7°				
Plastics	9° - 11°				
Steel - SAE 1020	6° - 8°				
Steel - SAE 1040	6° - 8°				
Steel - SAE 1095 or 52100	5° - 7°				
Steel - SAE 2340	5° - 7°				
Steel - SAE 6150	5° - 7°				
Steel - Heat Treated to 350 Brinell	4° - 6°				

Tool Shape - Top View

The shapes on the right show finishing tools with both a Point Angle, and a Nose Radius. For roughing out, the use of a Point Angle over a Nose Radius has been shown by Leo St. Clair to increase the life of the tool by 100 to 300%, and to reduce chatter (chapter 12 of his book; see also, Notes and Comments at the end of this page).



Top View - Point Angle



Top View - Radius

- **Point Angle**
  - For carbide, the width of the Point Angle should be:
    - Soft materials: 2 x the feed rate
    - Hard materials: 3 x the feed rate
  - The Point Angle and the Front Cutting Edge Angle should be the same.
- **Nose Radius**
  - If the sharpener wishes to use a Nose Radius, the Point Angle values should be ignored.
  - For carbide, the radius of the Nose Radius should be the greater of the following two values:
    - 2 x the feed rate
    - depth of cut / 8

Increases in the **Side Cutting Edge Angle** will:

- decrease chip thickness and increase chip width (retaining the same area of the chip)
- decrease power usage

Use	Side Cutting Edge (SCE) Angle		Point Angle	Front Cutting Edge Angle	Comments
	Range	Recom.			
Roughing Out	10° - 60°	30°	5° - 10°		It is recommended that the Point and the Front Cutting Edge Angles match.
Finishing - if a square corner is required	n/a	0°	n/a	5° - 10°	If a square edge is not needed, a point angle (or a nose radius) can be used.

Sharpness Scale - see Chapter 1.
Notes for All Metal Lathe Tools - at the start of this chapter.
Ongoing maintenance - see Chapter 4, *Metalworking Tools*.
Grindstones and Other Sharpening Media - see Chapter 2.

Metal Lathe Tools : High Speed Steel (HSS)

Angles shown are good for hobbyists; grinds for production shops should consult a specialist.

When both a relief and a clearance angle are outlined (e.g., Side Relief and Front Relief), this is done to facilitate easier resharpening. It is analogous to Secondary Bevels on woodworking chisels (see Chapter 18).

Resharpening should be done when the wear land reaches 1.5 mm ($^{1}/_{16}$ inch) high.

Angles shown are the effective angles, not the ground angles (see Chapter 1). Effective angles are increased or decreased, based on the angle by which the tool is presented against the work. Additionally, the vertical alignment of the tool (vs. the center line of the work) can also change the effective Front Relief Angle.

Sharpness Scale **3**

All angles are given the nomenclature designated by the American Standards Association (ASA).

Carbide vs. HSS

Material	Compressive Strength	Shear Strength	Max Usable Temp*
Carbide	Higher	Lower	1,800 °F
HSS	Lower	Higher	950 - 1,100 °F

* Temperature at which the tool material begins to soften appreciably. For HSS, it depends on the level of cobalt in the HSS.

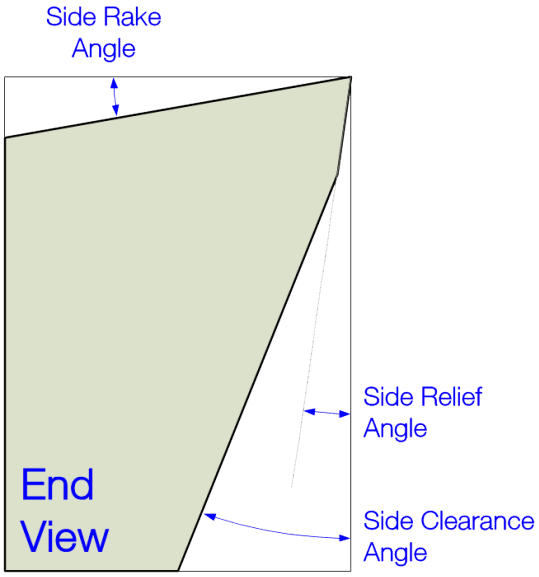
Look, there's a lot of ways to do things in machining; some people do things my way, and other people do it wrong.
Unknown Old Machinist

Tool Shape - End View

Side Clearance Angle should be 4° to 6° greater than Side Relief Angle.

In selecting the Side Relief Angle, the sharpener should:

- carefully chose the correct angle, as a deviation of even 2° (plus or minus) will lower tool life appreciably.
- chose the lower angle from the table below for heavy cutting
- chose the higher angle from the table below for finish cutting.
- increase the angle by +2° when making high impact cuts (e.g., work with significant gaps or hard inclusions).



Material	Side Rake Angle	Side Relief Angle	Side Clearance Angle	Comments

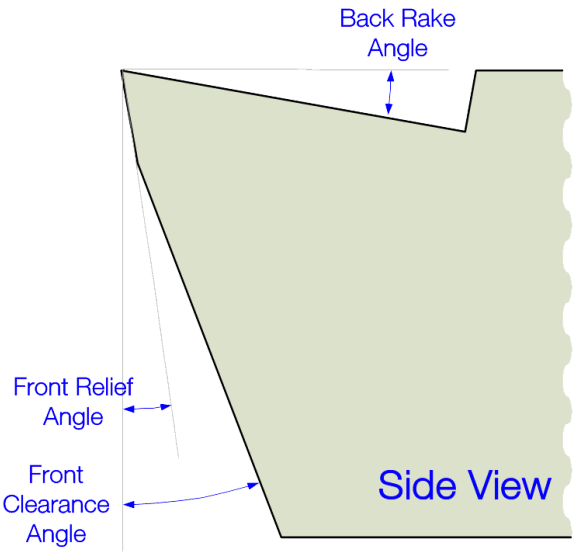
Tool Shape - End View

Aluminium	20° - 30°	12° - 14°	Side Relief + 4° - 6°	
Aluminum Bronze	15° - 20°	10° - 12°		
Manganese Bronze	10° - 16°	9° - 11°		
Bronze Castings	15° - 20°	10° - 12°		
Cast Iron - Soft (170 Brinell)	12° - 18°	8° - 10°		
Cast Iron - Medium (250 Brinell)	10° - 15°	7° - 9°		
Cast Iron - Hard (400 Brinell)	5° - 10°	5° - 7°		
Cast Iron - Chilled	-3° - +5°	3° - 5°		
Copper	20° - 30°	10° - 12°		
Monel	10° - 15°	8° - 10°		
Magnesium	25° - 35°	12° - 14°		
Maleable Iron	10° - 15°	7° - 9°		
Plastics	20° - 30°	14° - 16°		
Steel - SAE 1020	15° - 25°	9° - 11°		
Steel - SAE 1040	12° - 20°	8° - 10°		
Steel - SAE 1095 or 52100	10° - 15°	7° - 9°		
Steel - SAE 2340	10° - 15°	7° - 9°		
Steel - SAE 6150	8° - 14°	7° - 9°		
Steel - Heat Treated to 350 Brinell	5° - 10°	6° - 8°		

Tool Shape - Side View

Front Clearance Angle should be 4° to 6° greater than the Front Relief Angle.

The Back Rake Angle, as shown in the picture to the right, is positive.



Material	Front Relief Angle	Front Clearance Angle	Back Rake Angle	Comments

Tool Shape - Side View

Aluminium	12° - 14°	Front Relief + 4° - 6°	5° - 8°	
Aluminum Bronze	10° - 12°			
Manganese Bronze	9° - 11°			
Bronze Castings	10° - 12°			
Cast Iron - Soft (170 Brinell)	8° - 10°			
Cast Iron - Medium (250 Brinell)	7° - 9°			
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Steel - SAE 6150	7° - 9°			
Steel - Heat Treated to 350 Brinell	6° - 8°			

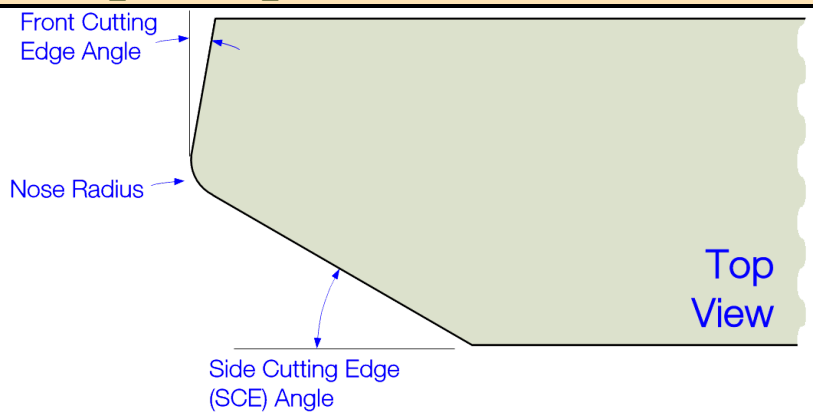
Tool Shape - Top View

Nose Radius

- For HSS, the radius of the Nose Radius should be the greater of the following two values:
  - 4 x the feed rate
  - depth of cut / 4

Increases in the **Side Cutting Edge Angle** will:

- decrease chip thickness and increase chip width (retaining the same area of the chip)
- decrease power usage



Use	Side Cutting Edge (SCE) Angle		Front Cutting Edge Angle	Comments
	Range	Recom.		

Tool Shape - Top View				
Roughing Out	10˚ - 60˚	30˚	5˚ - 10˚	It is recommended that the Point and the Front Cutting Edge Angles match.
Finishing - if a square corner is required	n/a	0˚	5˚ - 10˚	If a square edge is not needed, a point angle (or a nose radius) can be used.

Sharpness Scale - see Chapter 1.
Notes for All Metal Lathe Tools - at the start of this chapter.
Ongoing maintenance - see Chapter 4, *Metalworking Tools*.
Grindstones and Other Sharpening Media - see Chapter 2.

Metal Lathe Tools: Threading Tools

Angles shown are good for hobbyists; grinds for production shops should consult a specialist.

When both a relief and a clearance angle are outlined (e.g., Side Relief and Front Relief), this is done to facilitate easier resharpening. It is analogous to Secondary Bevels on woodworking chisels (see Chapter 18).

Resharpening should be done when the wear land reaches 1.5 mm ($^{1}/_{16}$ inch) high.

Angles shown are the effective angles, not the ground angles (see Chapter 1). Effective angles are increased or decreased, based on the angle by which the tool is presented against the work. Additionally, the vertical alignment of the tool (vs. the center line of the work) can also change the effective Front Relief Angle.

Sharpness Scale **3**

All angles are given the nomenclature designated by the American Standards Association (ASA).

Carbide vs. HSS

Material	Compressive Strength	Shear Strength	Max Usable Temp*
Carbide	Higher	Lower	1,800 ˚F
HSS	Lower	Higher	950 - 1,100 ˚F

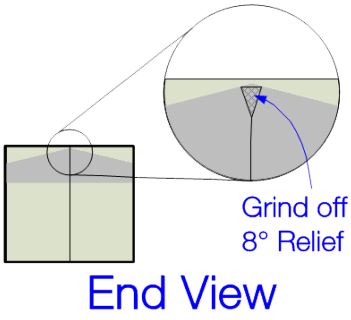
* Temperature at which the tool material begins to soften appreciably. For HSS, it depends on the level of cobalt in the HSS.

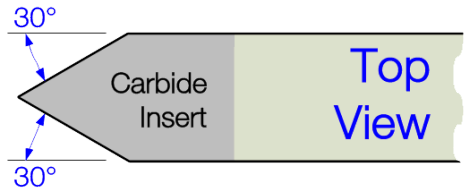
That mechanic couldn't put the cap back on his Four Roses without crossing the threads.
Kurt Vonnegut

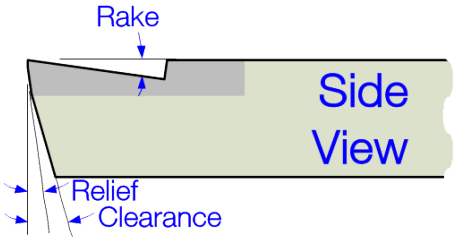
Tool Shape - 60° Threading Tool

The flattening off of the Nose is to allow for more support under the tip of the grind, helping to prevent shear in carbide insert. The width of that grind should be no wider than allowed for the defined thread.

This is not necessary in HSS, but could be a good practice to extend tool life as dulling will happen later.







Back Rake	Side Cutting Edge Angle	Nose Flat Width	Nose Flat Angle	Relief Angle	Clearance Angle	Comments

Tool Shape - 60° Threading Tool						
8°	30° (both sides)	based on thread pitch	8°	8°	16°	

Sharpness Scale - see Chapter 1.
Notes for All Metal Lathe Tools - at the start of this chapter.
Ongoing maintenance - see Chapter 4, *Metalworking Tools*.
Grindstones and Other Sharpening Media - see Chapter 2.