Version 2.1

SHARPENING TURNING TOOLS

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INTRODUCTION:

Sharpening might be the most confusing topic a new turner faces. Perhaps this is why so many newcomers ignore it, put up with dull tools, and have a lot less fun than they should be having at the lathe. In this session, we will go over some of the basic information a turner needs to make decisions about how to sharpen tools. When to sharpen is easy. Sharpen before you think you need to. It will save you time on the grinder, steel on the tool, as well as time and aggravation when sanding.

To be covered:

- Tool steels and their working properties.
- Types of grinding wheels and sharpening systems.
- How the tool shape effects tool performance.
- Mechanics of sharpening and what is sharp.

Tool Steel:

Why is steel such an important topic for woodturners? Cutting a one-inch diameter piece tuning at 1,000 rpm, a turning tool will travel over one mile of material in 10 minutes. Imagine trying to plane a mile-long board, even with a good quality plane iron. Turning tools have to be both tough and resilient.

The American Iron & Steel Association divides all iron and steel into three large groups:

Pot metals are made by melting smelted iron and producing a finished steel specification by adding non-metallic elements (carbon and sulfur for the most part) in a single pot.

Alloyed steels are made by melting iron and adding both metallic and non-metallic elements to reach a specific composition. Almost all steels fall somewhere in this classification.

Powdered metal alloys (or sintered steels) are specialty steels that are made by combining base steel and alloys then producing a powder form by forcing the molten metal through an aperture creating an aerosol which hardens to a powder. The powdered metal is compressed into a shape, then heating it under a controlled gas environment to produce the desired composition. The point of this process is to control the size of the metal carbides formed. Carbides are an essential part of the hardness of the steel. Too big, and the steel is brittle and hard to sharpen, to small and the steel is soft. The sintering process produces reproducible and controllable carbide particles. This process is expensive, requiring significant expertise, but it creates remarkably resilient fine grained materials. M4 is probably the most commonly seen powdered metal tool steel.

Woodturning tools are made from all three types of steel. Older tools were often made from a pot metal referred to as “carbon steel”. This pot metal is doped with graphite to produce small steel crystals which allows the formation of a very sharp edge but these alloys lack hardness, wearing

quickly. These steels are also easily burned by friction during sharpening on grinders. Once burned, the temper is gone and the burned metal must be ground away, reducing tool longevity.

Modern lathe tools are made from tool steel; a subset of which is referred to as High Speed Steel (HSS). These are all alloyed steels. Carbon is generally cooked out and metallic elements are added to once again control the size of the crystal. *Smaller crystals = sharper edges.* The alloys make steel harder, so it holds an edge longer. Manganese and Molybdenum are the most common alloy in tool steel, but small amounts of vanadium and tungsten are also used. Type M2 steel (Sorby, Taylor, and others) and M4 (Oneway) are the most commonly used steels in this class, although A2 and D2 tool steels are also used now and then in scrapers.

CHINESE HIGH-SPEED STEEL IS AN OXYMORON

Carbon steel and alloyed steel tools can be sharpened with traditional aluminum oxide ceramic wheels. They are frangible enough not to burn carbon steel, if you keep your wits about you, and hard enough to mill the harder, alloyed steel tools.

Powdered metal tools are reasonably new in the market place. Crown and Hamlet have made powdered metal tools for about 10 years. The Pro-PM (Crown) and 6030/6060 tools from Hamlet have outstanding edge holding capacity because the powdered metal method produces tiny steel crystals and the additional vanadium and tungsten make them very hard. M4, 10V, 15V, 42V and M42 (rare) also fall in this category. You can expect the edge on a powered metal tool to last three to six times longer than an M2 tool. Powered metal tools should be sharpened with CNB wheels.

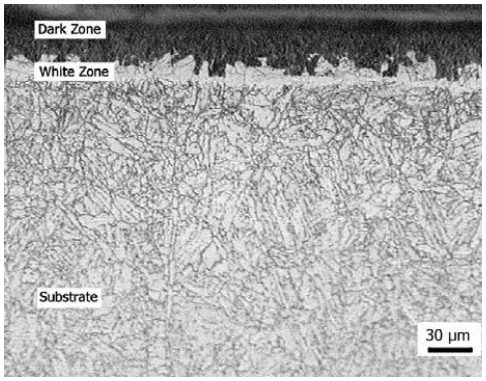
Tool steel makers work to strike a balance between properties of toughness and strength, or hardness. Tool steels have very small crystals which are achieved through a combination of alloy composition and how the material is handled. The smaller the crystals in the steel, the sharper an edge the steel can produce, but this comes with hardness, which makes the steel brittle. Annealing and quenching processes help the steelmaker attain a structure in which the crystals of steel are smaller.

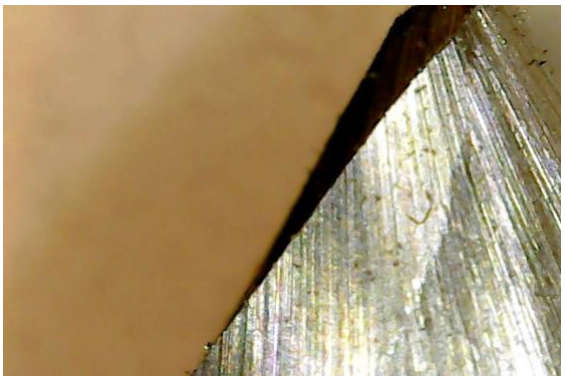
Cryogenic hardening is a process where the material is cooled to approximately −185 °C (−301 °F), usually using liquid nitrogen. It can have a profound effect on the mechanical properties of certain steels. Presently this treatment is being used on tool steels, high-carbon, and high-chromium steels. Recent research shows that this treatment imparts very high wear resistance to the steels. Cryogenically treated turning tools are roughly 150% the cost of HSS tools, but they offer as much as five times the edge life. Because they have finer grain, cryo tools, as they are sometimes called, can also attain a sharper edge if sharpened with the appropriate equipment. Cryo treatment can make good steel into very good steel. It can't turn very good steel into super steel. It's one more method to balance the cost of making steel with the benefit derived. Cryo-treated M2 tools are better than M2 tools for edge holding but not as good as M4, M42, 6030 or 6060. However, the cost is not as great either.

The Pinnacle Cryo treated tools are a good bargain. They are made in China (cheap production methods) and Chinese High-Speed Steel is an oxymoron (see note above) but the steel is made and treated in England by Crown Tools.

As with most things in life, you pay your money and make your choices.

"Nitriding" is another method of improving low cost steel for tool use. M2 steel can be treated with metal nitride salts (titanium nitride is the most common, it gives the yellow color seen on drill bits) to make smaller crystals at the cutting edge. The very fine crystals in the "Dark Zone" (above) produce a very sharp, durable edge. Keep in mind that only the cutting edge needs to have superior steel qualities. The metal-nitride layer is very thin and sharpens away quickly. But the edge where the steel has been removed by sharpening retains the nitride effect. The second micrograph is a nitride-treated M2 gouge sharpened on a 180 grit CBN wheel. Compare it to the 600 grit CBN sharpened gouge on page 9. Uniform teeth show a very hard cutting edge. Nitride treated turning tools are becoming more available. Sorby and Robust sell nitride treated tools at a price a little higher than the comparable M2 tool. Gouges are really the only tools that benefit from nitriding.

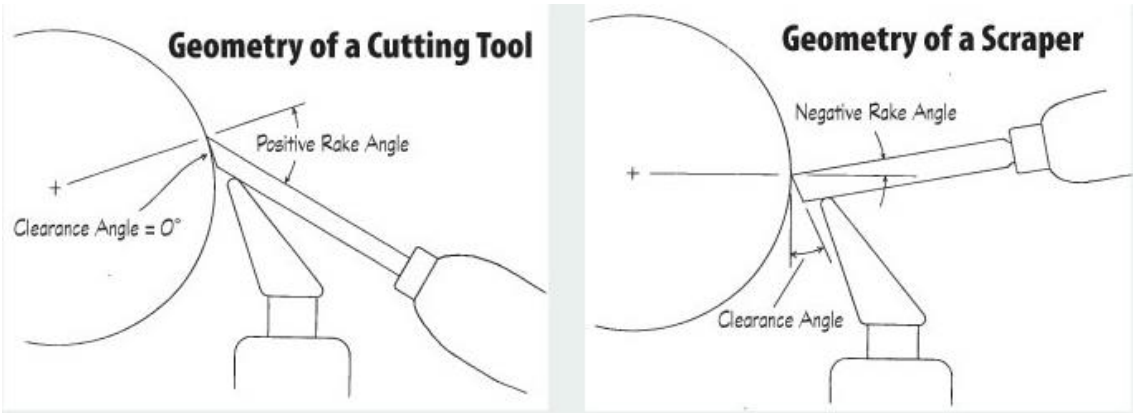




Sharpening Scrapers:

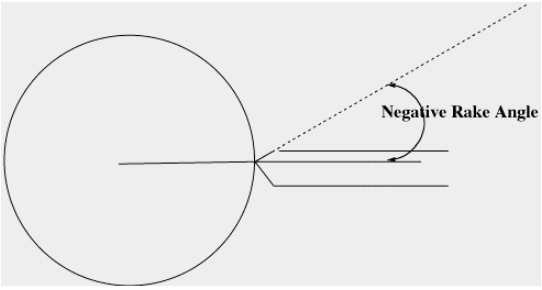
The scraper is probably the easiest tool to sharpen. The shape is simple and the steel is thick so heat buildup is dissipated. Sharpening a scraper produces a cutting edge, a burr, by either pushing the steel back when sharpening in a standard orientation or pushing the steel down when sharpening inverted. Either way, a thin cutting edge is produced that will give a clean cut for a very short time (Figure 3). A more durable cutting edge can be produced by burnishing the edge of a scraper which is just like sharpening the edge of a card scraper. The curled edge is formed by stroking the tool edge with a harder metal tool (Figure 4). A conventional stroke burnisher can be used, or one can also purchase a "ticketing gauge", as the tool is called, from any of several sources; Don Derry Tools in Ellensburg, WA and Veritas (through Craft Supply, Packard Woodworks and sometimes Woodcraft).

What is a negative rake scraper? By the strictest definition, any tool cutting with a negative rake angle is a negative rake scraper (since it is not actually possible to cut with a negative rake angle).



A negative rake scraper now describes a tool with metal cut away from the point of compression

A “negative rake scraper” can be held in a horizontal position with better tool support and still generate a large clearance angle for easier wood removal with less force.



***Sharpening Gouges**:*

The family of gouges is differentiated by the depth of the flute. From the shallowest, the detail gouge, to the spindle gouge, to the bowl gouge, to the deep spindle roughing gouge, the depth of the flute defines function and impacts sharpening significantly.

The spindle roughing gouge is the only one not routinely ground with a sweep, so it is pretty easy to do. Because the flute in the spindle and detail gouge is so shallow, the variance in wall thickness doesn’t really present a problem.

The fingernail grind on the bowl gouge is the most challenging to sharpen. Part of this challenge has to do with the shape of the flute. Bowl gouges are made with one of three basic shapes: V-shaped, U-shaped, and parabolic (sometimes called elliptical) shaped flutes. One Way, Sorby, Hamlet (the Glenn Lucas line at Craft Supply is a good example), and Henry Taylor Super flutes are parabolic. D-way and Thompson can be U, parabolic or V-shaped.

The choice of one flute shape over another depends on what you want the tool to do. Your workhorse bowl gouge ground to a 40 to 55-degree bevel needs to move wood and cut clean. Grinding swept wings with a V-shape flute means a lot of metal must be removed from the sides while leaving a thin section at the nose of the tool. It is easy for the wings to “get ahead” of the bottom of the flute as you focus on grinding the thicker wings back, leaving a dangerous prow on

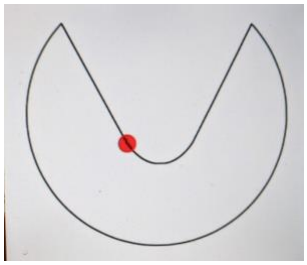
either side. A gouge sharpened to more than a 60-degree bevel angle, typically used for cuts across the bottom of a form, needs to be stable on its side, so a V-shape might be a better choice.

A U-shape flute works well for heavier roughing cuts because the open flute allows a higher volume of shavings to move away from the edge faster. The distribution of steel around the flute is more uniform, which can make sharpening less difficult around the toe (see below). The bottom can be thinner than a V- and parabolic shapes, which can lead to chatter. Care must be taken not to allow the wings along the sides of the flute to get too long,

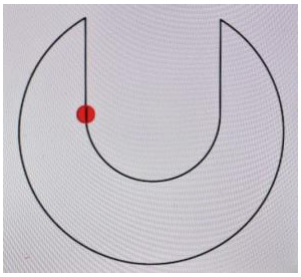
An elliptical (parabolic) shape clears wood from the cut well while still retaining sufficient material to support the edge. The elliptical shape is a hybrid of both V- and U-shape, earning it a reputation for ease of use and versatility at the lathe and at the grinder.

Flute shape influences sharpening of gouges. Distribution of steel in the V and U-shaped flute produces areas of thicker (U) or thinner (V) material around the perimeter of the flute.

The V-shaped flute has a thin spot close to the tip.



This can result in a dip in the line of the wing, sort of a toothed look to the tip, if this area is ground too long. Sharpening both wings first, then minimal time grinding the tip to blend the edges can avoid this problem. The U-flute has the same problem, though not as acutely. The parabolic flute has a more even distribution of metal and is less likely to produce these sharpening problems.



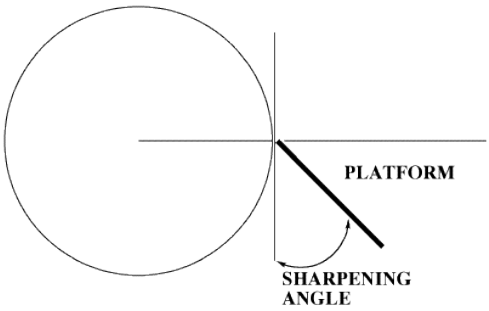
How to Begin with a New Tool

First, if this is a new tool (always shape and sharpen new tools before you use them) or a major regrind, tune the sweep of the wings. This is done by setting the tool rest on the grinder so that you can shape both wings simultaneously. Using a light touch, form the wings of the tool so that the shape of the flutes are uniformly symmetrical when viewed from the sides. The finer grit wheel will suffice for this step, while the coarse wheel can cut too fast and waste steel. The end result of this step is a "flat" on the edge where you want to have a sharp cutting edge. This flat will guide you to a newly formed, sharp edge.

Fig 2 – Measuring edge angle

Next, set the tool rest of the grinder to your desired bevel angle. 50 degrees is a good starting point for all-around bowl turning. If you already have a tool you like and want to replicate its cutting performance, set the angle of the tool rest using that tool.

This can be done by placing the tool on the rest with the bevel against the stationary wheel and adjusting the rest until the tool makes full contact on both bevel against the wheel and bottom of the tool against the rest. Adjust the platform until you get what you want. Expect it to take several tries to match an angle with this approach. The Heisenberg Principle is in effect here.



Setting the platform can also be done by use of some unchanging reference standard such as the two devices described below. We will cover the use of both.

The Darlow gauge (left) allows you to set the grinding platform to the same position every time (see Mike Darlow's DVD on sharpening in the club library for templates and instructions for making your own Darlow gauges). The desired sharpening angle is between the angle of the platform and the tangent to the wheel at the point that the platform touches the wheel. The Darlow gauge touches the wheel at two points so it is not dependent on the size of the wheel. There is a separate gauge for each angle.

The Stuart Batty Angle Gauge (right) is another way to set the grinding platform. Each gauge has several angles milled into it and allows reproducible setting of the base grinding angle.

Raptor makes a set of gauges for eight inch wheels that work in similar fashion to the Darlow gauge. They allow angles to shift as the wheel wears away, so they are better suited to CBN wheels than frangible wheels.

Forming the Bevel

Bowl gouges can be sharpened freehand or by using a sharpening jig. The jig is by far the easiest to master; however, freehand, once mastered, is far quicker. Most freehand grinders will check their gouges against a gauge or jig to "tune up" the bevel angle every so often.

Once satisfied with the settings on the grinder's tool rest, you are ready to begin grinding the bevel. This starts by flattening a small segment on the nose of the gouge at the angle you have set. Be careful with a new tool, or reshaping an existing one, that you do not grind past the reference flat you made when forming the profile for the wings on the gouge. The small flat section of bevel at the nose sets the bevel angle at the center of the flute and gives a reference bevel by which you can establish the angle and set of the jig.

Use of Grinding and Sharpening Jigs

The most common sharpening system is the Wolverine Sharpening Jig with the Vari-grind gouge jig from Oneway. The Vari-grind uses three parameters to shape the tool: 1. The protrusion of the gouge from the jig; 2. The distance of the V-base from the wheel; 3. The angle of the leg relative to the shaft of the gouge. An equation in three variables seldom has a single, finite solution. Sorry. The problem with sharpening is that nobody can tell you what you like. It takes experimentation to determine the best shape for you and the way you can get that reproducibly.

There is also a Vari-grind 2, which uses the Wolverine tracks but a different method of holding the gouge. Instead of rotating in the V-bracket, the jig is held in a slot and rotates around that central axis. This might represent a more stable base for the jig. The same parameters are in play here: protrusion, leg angle, and base distance. The advantage is that motion is restrained in two dimensions (side to side and pivot). The cutting edge moves in a cylindrical motion around the adjusting rod. According to Oneway this allows for a more accurate grind regardless of the bevel angle. As an aside, it also requires that the tracks be installed very accurately to keep the point of the tool in the center of the wheel.

The Sharp Fast jig is a variation on the Vari-grind 2. Rotation around the base is held securely by the ring. It will have all of the advantages of the Vari-grind 2. It comes with its own bracket but fits the Wolverine bracket also. It usually costs less.

An assortment of other jigs are available. If you only want one grind on one tool, you can easily make your own jig once you have understood the variables of a swept back, or Irish grind.

Sharpening With a Jig

It is important to understand that the jig doesn't control the final shape of the tool. It is up to you to control the process with regard to wing sweep and nose radius. There are a couple of suggestions to keep in mind.

Use a light touch. Look often at results, which means taking the tool away from the grinder frequently and examining what is happening. It will save a lot of steel and train you to sense quickly when you are going astray.

Sharpen the wings first. The wings will have more metal bearing on the wheel and will therefore grind down more slowly. Care must be taken in making the transition from wing through nose to the other wing. Inadvertently taking too much material off the nose means starting over.

The wings should be straight or slightly convex, ***never*** concave. That is a much too aggressive shape.

Make sure the jig is well seated. It is easy to let it slip out and disrupt the tool rotation. Dressing the tip of the leg where it seats in the V-bracket with a file to make it radiused so it can rotate smoothly will significantly improve results.

Don't forget to cool the tool during sharpening; even good steel can be disturbed by prolonged heating. Sharpening frequently, using a slow speed grinder, CBN wheels, and a light touch all combine to make cooling the tool less of a concern. If you can press the end of the tool between thumb and forefinger for five seconds without pain, it is probably okay.

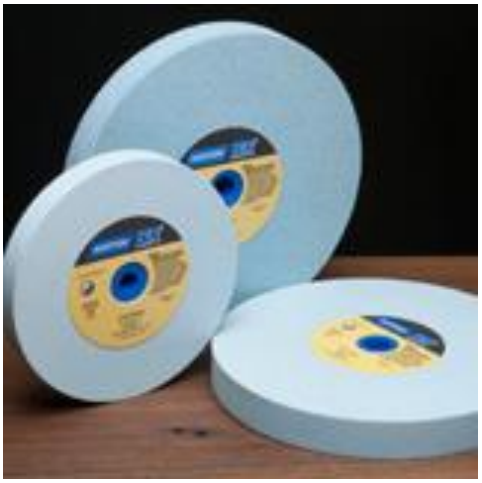
Sharpening Angles

There is no single best angle. Scrapers will always have larger included angles, 50 to 80 degrees, while spindle gouges will always have smaller angles of 25 to 45 degrees. Bowl gouges will be whatever is currently popular. The range is between 40 and 60 degrees, depending on the cut to be made. It depends on what you like, what species you are turning, what fits your turning style, and what you are making.

Grinders

Two types are seen commonly, the high-speed grinder running between 2500 and 3000 rpm, and the slow-speed grinder running at about 1750 rpm. Formerly, the slow speed grinder was the usual choice for turners to avoid burning tools. New metals sort of set that aside but the slow speed still seems to be favored. Both work just fine.

Wheels

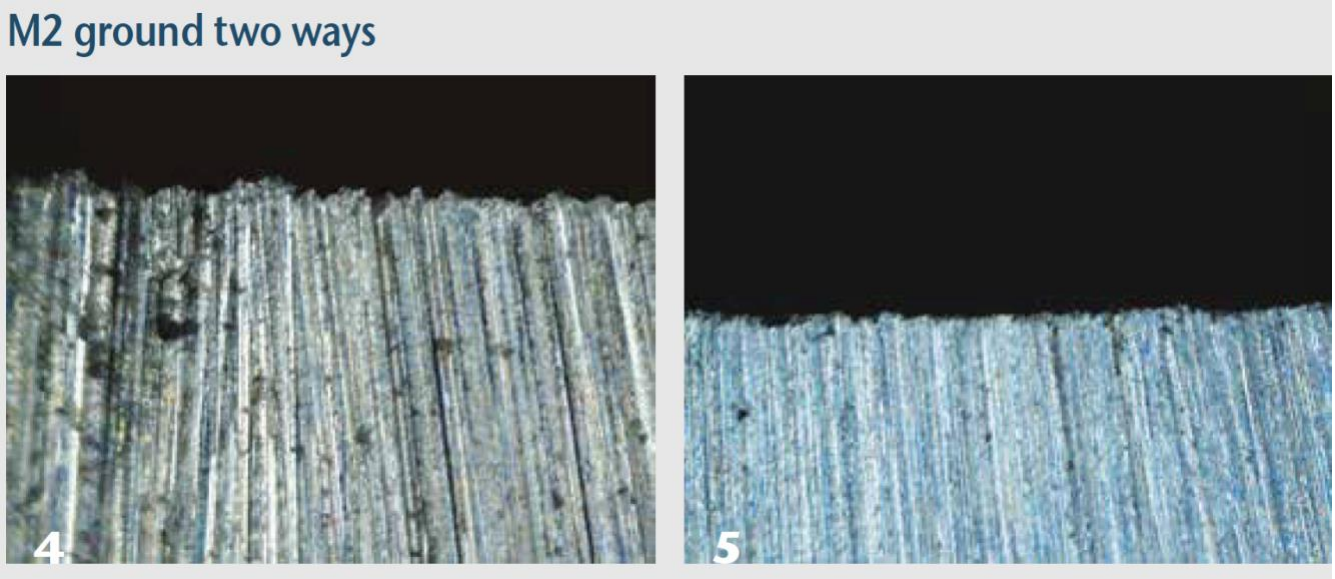


Wheels come in come in six and eight inch diameter sizes. Aluminum oxide is the most common ceramic grinding medium. There are many hardness and grit selections. A course wheel (40 to 60 grit) and a fine wheel (80 to 180 grit) is a common arrangement on a bench grinder. Wheels come in many colors, identifying different properties. *Make sure you know what you want.* Regardless of material, frangible wheels wear and must be flattened, trued, and sometimes balanced. They should always be used with a full guard to contain the pieces should a wheel fracture while the grinder is spinning. Dust management is also an issue to consider.

The most significant development in sharpening in recent years has been the availability of CBN wheels. Made to mill tool steel, these wheels will last far longer than the ceramic wheels and do a superb job. They are wider and prebalanced. They cut so cleanly that there are very few sparks, the metal doesn't get hot enough to burn. They won't last forever but you should get ten years of superior sharpening out of a set. They are now available from several sources. D-Way Tools is one of the earliest to market CBN wheels, Woodturners Wonders (http://woodturnerswonders.com/) has very good prices ($249.95 for a set of 80 and 180 grit 8"

wheels), and many of the better known online outlets are beginning to supply them as well. Choose carefully if you are lulled into thinking quality and price have no relationship.

The question is inevitable: Which is better? The picture on the left is an M2 tool sharpened on an 80 grit ceramic wheel. On the right, the same tool sharpened on a 600 grit CBN wheel. It would have been better to compare oranges to oranges but the CBN sharpened tool shows smaller, sharper more uniform teeth. This is a sharper, longer lasting edge.

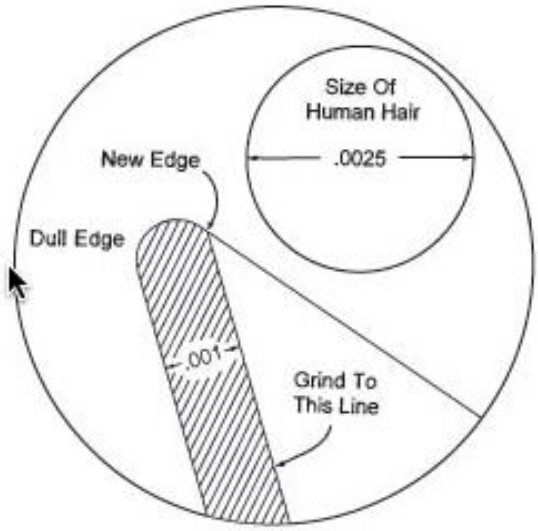


(from Tom Worsing's article referenced below)

The Tormek sharpening system is a different approach sharpening. This uses a wide, water-cooled wheel turning at a much slower speed. Tools are held in different jigs to sharpen. The Tormek is not the system for those who are reshaping tools frequently, but if you are not reshaping often, it is very fast, and provides reproducible results (a very important consideration once you find what you like). There are work-arounds that allow use of the Tormek jigs and gauges to be used with grinders. A little ingenuity is all it takes, or the TORBMG100 Bench Grinder Mount Kit . A variety of wheels are available for the Tormek systems, including CBN wheels.

Honing

Honing with a leather strop impregnated with a fine polishing compound is a highly recommended final step in the sharpening process that produces particularly clean edges. Many turners skip this step, but it is well worth doing when working with stringy grained species such as big leaf maple, cherry, and hard tropicals. Draw, don't push the edge across the strop, alternating sides of the edge with each stroke. The Tormek system includes an optional leather strop wheel that is very useful for honing.



A short discussion of what constitutes sharp is in order. If your tools are sharp enough to cut you without you knowing it (it happens), they are probably sharp enough. The edge of a tool is very fine and begins wearing away as soon as you touch the wood. It takes very little wear to begin to round the edge. Observe the drawing showing the tool edge relative to a human hair. If you wait until you feel the tool acting dull, you have waited too long.

SHARPEN EARLY, SHARPEN OFTEN

The last page is the sharpening guide published by Thompson Tools for use with a Wolverine sharpening jig. This set-up will give you a good starting point to determine what you want your grind to be like. The angles and jig settings will give you a good cutting edge and moderate wing length for gouges. Want more wing? Move the stand arm farther up jig body (make the angle between the stand arm and the shaft of the tool more acute).

One final note about shaping your tools is in order. Grinding and sharpening, especially using a jig, can leave a sharp heel on the trailing, or back side of the bevel. This sharp corner on the tool will rub against the surface of the work during the cut, leaving behind a bruise in the wood that is very difficult to remove. The solution to this marring is relieving the sharp corner buy rounding it on the grinder. The reduction in sanding time is significant.

For additional information on tool steel, grinders and grinding wheels, see *"Modern Tool Steels and Grinders"* by Tom Wirsing. American Woodturner, June 2018, pp38-41.

THOMPSON LATHE TOOLS

Sharpening

The tools come sharp and ready to use, to duplicate this grind here's what you need.

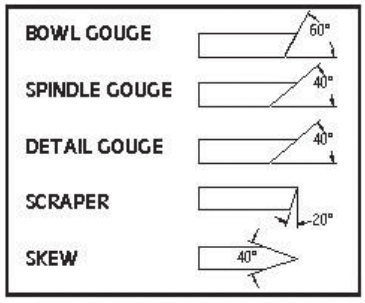
The Oneway Wolverine Grinding Jig and Vari-Grind attachment. This is the best sharpening system on the market and all the gouges will be sharpened with this system. If you don't own one go to www.oneway.on.ca or your favorite catalog and purchase one. Why? Because it works!

Use an 8 inch high speed or slow speed grinder.

Set the arm on the Vari-Grind to the same angle shown in the picture.

Extend the tool 1-3/4 inches out from the jig.

Set the nose angle.




Bowl Gouge


Spindle Gouge


Detail Gouge

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