Refining the Edge
Skews and Gouges

Improve Turned Surfaces with Simple Sharpening Techniques

Alan Lacer with Jeryl Wright

I have heard many discussions and fielded a lot of interesting questions while traveling amongst woodturners. A common assertion is that some steels don't get as sharp as others or that high carbon steel (HCS) tools get much sharper than high speed steel (HSS) tools. Another common view is that honing is a waste of time: the burr will "strop off" in the wood; honing takes so much time it's inefficient; or woodturners don't need a really sharp tool. Often, such views about steel and honing are spoken as fact, not just opinion. My experiences run counter to these viewpoints, so I knew something more was needed to test these "facts" in an objective, scientific manner.

Methods of honing

To place the bevel of a skew chisel correctly on a diamond hone, hold the handle securely and use an up-and-down motion, starting at the back of the bevel. Move the hone to simultaneously touch the area just below the cutting edge and the back of the bevel.

The flute of a gouge must also be honed. The curved radius of a slipstone or a tapered diamond cone is held flat in the flute and worked with a back-and-forth motion.

Polishing flutes

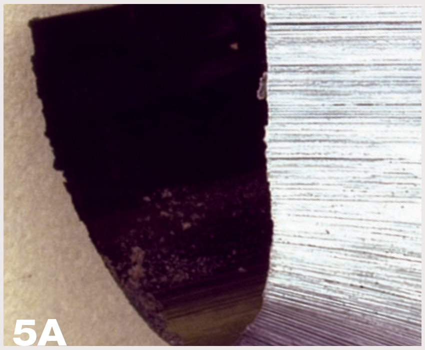
To polish or refine the flute of a gouge, use a wheel made of MDF, turned to a convex shape that fits the profile of the flute. Coat the wheel with an emery stick. Work only the last 1" or so of the flute. The wheel should spin away from you.

(4A) **Gouge flute with milling marks (100X).**

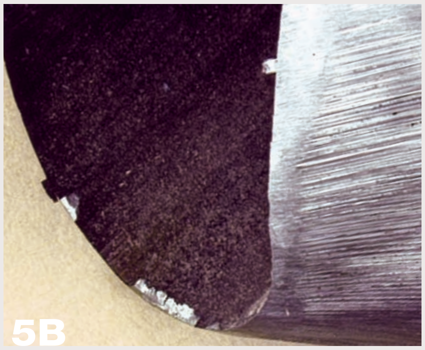
(4B) **Gouge flute after polishing (100X).**

How do you test for sharpness? There are tests used in the cutlery trade to measure the amount of force needed to cut rubber bands or to measure a knife's penetration into various objects. While this can be an easy test for a flat knife blade, testing for sharpness is a bit harder to do with gouges and thick skew chisels. With the help of Jerry Wright, I decided to conduct empirical sharpening and turning tests and let readers judge which sharpening methods produce the best turned surface. Images of highly magnified cutting edges and turned surfaces are provided as objective data. From these images one can judge the degree of sharpness of an edge and the impact that edge has on a piece of wood, cut in the way a woodturner would be using the tool. The surface finish that a tool creates on wood has significance: Does one need to start with 40-grit abrasive or is sanding even needed, a decision that will have an impact on the turned object's shape and detail, amount of dust produced, surface finish, and time spent sanding.

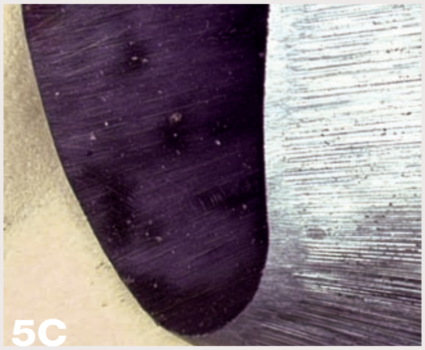
Polishing flutes: progression of honing and polishing



5A
Gouge edge, ground only (20X).



5B
Gouge edge, bevel honed (20X).



5C

5D

(5C) **Gouge edge, bevel and flute honed (20X).**

(5D) **Gouge edge, bevel honed, flute honed and polished (100X).**

Tool preparation

We tested skew chisels and bowl gouges from major tool manufacturers. First, we ground the edges using a dry wheel grinder, adhering to standard methods of sharpening. We ground them freehand, using a rigid platform for support. The grinder ran at 1,725 rpm and had a 60 grit SG, 8"-diameter wheel. Grinding was conducted until the sparks came evenly over the top of the tool's edge. For each tool's bevel, we produced a single facet, slightly hollow ground. Bevel angles were uniform from tool to tool.

Methods of honing

We honed the bevels of the skews and gouges with the flat side of a 600-grit, diamond slipstone and used the curved edges of the slipstone to hone the inside flutes of the gouges. A flat hone for the skews and the outside bevel of gouges, combined with a tapered diamond hone for the flutes of gouges, would have worked equally well. To avoid rounded over cutting edges, we maintained a two-point contact of the bevels (hone touching at the back of bevel and just below the cutting edge). When honing the inside of gouges, we held the rounded edge of the hone flat inside the flute. For tools freshly ground, the honing process took under three minutes. Less than one minute is normal for honing between grinding. (*Photos 1 and 2*)

Polishing flutes

We polished the flute of one of the gouges to determine if this additional preparation had any impact on the sharpness. To polish the flute, we turned a disc of medium density fiberboard (MDF) and then created a bead to fit the profile of the flute. The MDF can be mounted on a faceplate or an arbor as shown in Photo 3. (Either work from the back of the lathe, or if you intend to run the lathe in reverse, secure the faceplate or arbor to the spindle.) *With the direction of rotation spinning away from you,* charge the bead area with a stick of emery. We polished only the last 1" of the flute to remove the milling marks. Depending on the hardness and toughness of the steel, this usually takes less than five minutes. (*Photos 4A and 4B*)

The cutting edges of gouges are shown as they are refined from an initial ground state through the pro- ▸

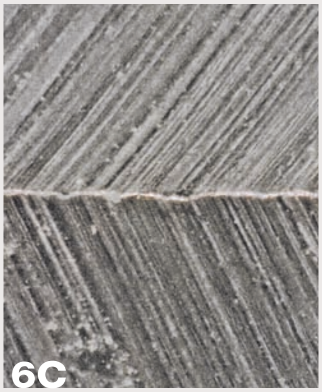
Polishing flutes: edges of skew chisels

6A

Skew chisel edge, bevel ground only (20X).

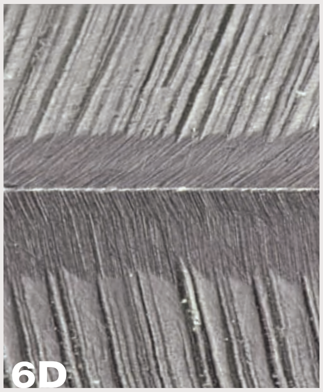
6B

Skew chisel edge, ground and honed (20X).



6C

Edge view of skew chisel edge, ground (200X).



6D

Edge view of skew chisel, ground and honed (200X).

gression of honing and polishing. Note the removal of grinding burrs. (*Photos 5A-5D*)

Cutting edges of skew chisels are shown as they are refined from the ground state to the honed state. Note the reduction of edge roughness after honing. (*Photos 6A-6D*)

Methods of cutting wood

To provide a challenge, we chose dried redwood (8% moisture content) for our tests, since it's not particularly desirable for turning. To test the gouges, we mounted the wood on a screw chuck, grain orientated as for bowl turning. When testing the skew chisels, the wood was mounted between centers, grain direction parallel to the axis of the lathe. Bowl gouge cuts were from smaller to larger diameters, with the flute pointed in the direction of cut. This is a common method of using a bowl gouge and never approached a finishing-type method of cutting.

Grinding wheels

With the advent of modern HSS and high-wear steels for turning tools, choosing the right grinding wheel is a must. First of all, gray wheels are out. They grind slowly or hardly at all, require constant dressing, go dull quickly, and generate too much heat. A premium friable aluminum oxide wheel in 60 or 80 grit for sharpening and 46 grit for heavy grinding in an I, J, or K hardness (I is the softest, K harder, and J is my preferred choice) will work well. Expect to pay between $45 and $75 each for an 8" quality wheel.

The newer seeded gel (SG) wheels work even better and have a longer life. Constructed of submicron crystalline particles that constantly reveal sharp edges, these wheels grind aggressively and have a long life. The Norton Company produces a high-end 8" version that sells for around $100 and a new line of 3X wheels for about $50. They perform quite well. The less expensive wheels do not have as high a percentage of the crystalline material as the premium wheels, yet they grind well on modern tools.

Regardless of the type of grinding wheel you use, you *must* regularly dress it to clean, sharpen, level, and true it. For SG wheels, a diamond dresser is a must, but diamond dressers also work great on any wheel. Avoid the cheaply made plated wheel dressers, opting for either a jigging system with one large diamond (Oneway www.oneway.ca and Geiger www.geigerssolutions.com make good systems) or a T-shaped system for freehand dressing (Packard, www.packardwoodworks.com, and MSC www.mscdirect.com). Dressing grinding wheels frequently and lightly keeps them in top shape.

Hardness of materials

To see why traditional hones and grinding wheels may have trouble with HSS and high-wear steels, compare the different hardness values below. All HSS and high-wear steels contain significant quantities of vanadium carbides, which exceed the hardness of many abrasives.

Relative Knoop hardness values:

- Diamond = 7000 to 8000
- Cubic boron nitride (CBN) = 4700
- Vanadium carbide = 2500
- Silicon carbide = 2400
- Aluminum oxide = 2100
- Tungsten carbide = 1900
- Hardened steel (65 HRC) = 825
- Quartz (silica) = 700 (Arkansas and Washita stones are classified as silica-quartz.)

Wood cutting basics

Much has been written about the process of chip formation and resulting wood surfaces, because of its importance to commercial wood processing. The most important variables affecting milled or planed wood surfaces (other than wood species, moisture content, and grain orientation) are cutter velocity, feed rate, depth of cut, and cutting edge sharpness. Higher cutter rpm, slower feed rate, shallower cuts, and higher degrees of sharpness all improve surface finish. Within the limits available to woodturners, tool sharpness is the strongest variable. It has been shown in commercial milling operations that very minor improvements in cutting edge sharpness cause fourfold reductions in surface roughness.

Cutting edges are formed by the intersection of two surfaces. The refinement of the cutting edge determines its sharpness. Intersections of rough surfaces create blunt or jagged edges while intersections of smooth surfaces create sharp edges. This is commonly accepted for those familiar with chisels, plane irons, and knives. It is routine to bring these linear edges to high degrees of refinement using a series of stones of increasing fineness. On the other hand, woodturning tools can have complex, curved shapes, often ground from two sides. Admittedly, these edges can be difficult to grind and hone.

Methods of examination

The variously sharpened skews and gouges and turned redwood were examined and photographed using a 54 megapixel optical imaging microscope, at magnifications up to 200X. The field of view at this magnification is approximately 3/64" wide. This high magnification, unusually high depth of field, and color photography make possible the easy observation of the cutting edges and the relative smoothness of the cut surfaces.

Gouges: effects of grinding and honing

Gouges manufactured from M2 HSS were chosen to demonstrate the impact of different edge-preparation methods on the appearance of the cutting edge as well as the appearance of the cut wood surfaces. Then gouges manufactured from 2030, 2060, CPM 10V (A11) and CPM 15V were chosen to determine whether fine-edge preparation techniques would be successful on these highly alloyed steels.

We prepared the gouges to test three ways: only the bevel ground, the bevel ground and honed, and the bevel ground and honed and the flute honed. Photos 7A, 7B, 8A, 8B, 9A and 9B show the progression of edges from coarse to refined as the burrs are removed by honing, as well as improvement in cut-wood surfaces. The edges become smoother as the intersecting surfaces become more refined. As a result, there is a huge difference in wood surfaces cut with a gouge that was only ground and one that was ground and honed. (*Photo 10*)

Results from the highly alloyed materials are shown in Photos 11A-11D. We also noted that similar results are possible with 2030, 2060, CPM 10V (A11) and CPM 15V, grades that are often thought to be difficult or impossible to sharpen.

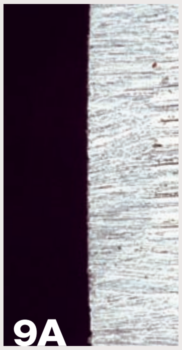
Gouges: effects of grinding and honing

(7A) **Cutting edge of a M2 HSS gouge, ground only (200X).**

(7B) **Resulting cut wood surface (100X).**

(8A) **Cutting edge of a M2 HSS gouge, bevel ground and honed (200X).**

(8B) **Resulting cut wood surface (100X).**



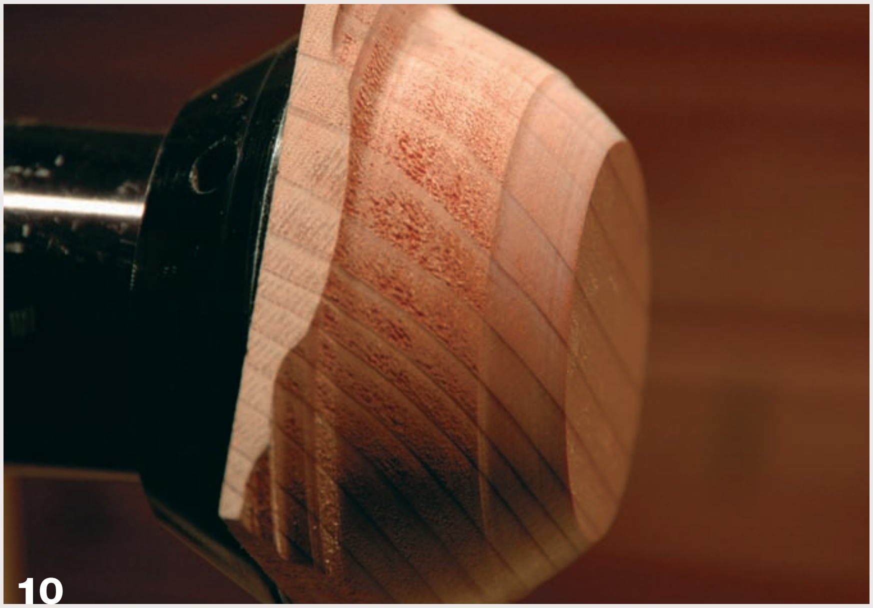
(9A) **Cutting edge of a M2 HSS gouge, bevel and flute honed (200X).**

(9B) **Resulting cut wood surface (100X).**

Skews: effects of grinding and honing

Skews manufactured from M2 HSS were chosen to demonstrate the impact of different edge-preparation methods on the appearance of the cutting edge as well as the appearance of the cut wood surfaces. We then chose skews manufactured from ▸

Gouge comparison



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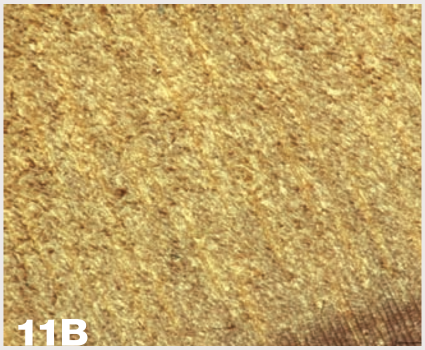
Even with an unmagnified view, huge differences are observable in surface finishes. The upper half was cut with a freshly ground M2 bowl gouge, while the lower half was cut with a 2060 bowl gouge, bevel and flute honed.

Effects of gouges

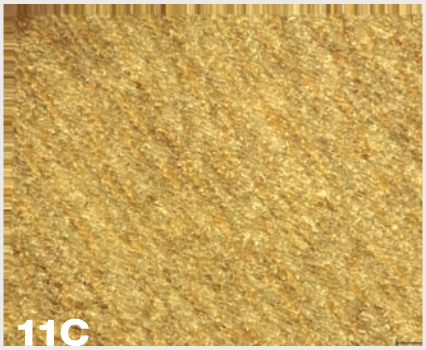
11A

Magnification 100X, wood surfaces cut with PM 2030 gouge.



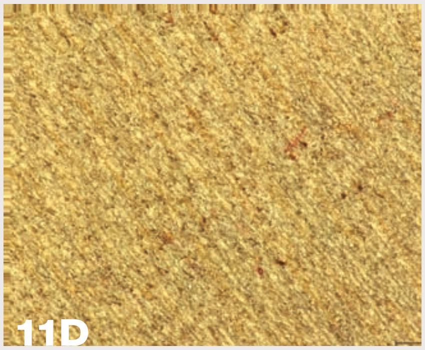
11B

Magnification 100X, wood surfaces cut with PM 2060 gouge.



11C

Magnification 100X, wood surfaces cut with CPM 10V gouge.



11D

Magnification 100X, wood surfaces cut with CPM 15V gouge.

PM (powdered metal) M4, 2060, and CPM (Crucible Particle Metallurgy) 10V (A11) to determine whether fine-edge preparation techniques would be successful on these highly alloyed steels. A skew chisel made from HCS was also examined to judge the edge quality versus the base M2. Often, it is thought that HCS can produce a better edge.

Skews are deceptively difficult to sharpen. The cutting edge is the intersection of two ground surfaces. The relative coarseness of each surface has a decided impact on the edge as the surfaces interact with each other. As a result, the fineness of the grinds directly affects the edge sharpness.

Skews were prepared two ways: bevel ground and bevel ground and honed. Photos 12A, 12B, 13A and 13B show the edges of the skew and the cutting results of the wood's surface, using an M2 skew, ground and ground and honed. The cut wood surfaces show a marked difference from rough and torn, to much more level and uniform.

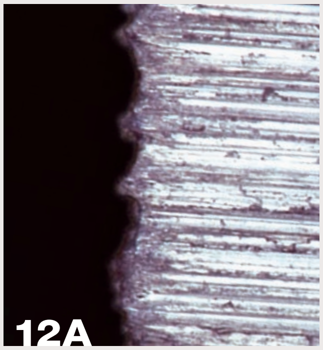
The results we received from HCS, as well as highly alloyed materials, demonstrate that similar results are also possible with low alloy HCS as well as PM M4, 2060, and CPM 10V (A11), again, grades that are often thought to be difficult or impossible to sharpen.

Observations

From a woodturner's perspective, there are a number of conclusions to be drawn from the examination of tool edges and the wood cut with those edges.

- All of the different steels got sufficiently sharp to cut the wood cleanly and that is what it's really all about, rather than some mystical

Skews: effects of grinding and honing



Cutting edge of a M2 HSS skew, ground (200X).

Resulting cut wood surface (100X).

Cutting edge of a M2 HSS skew, ground and honed (200X).

Resulting cut wood surface (100X).

concept of sharpness. The method of preparing the edge is the key to tool sharpness. Clearly, an edge that is not honed produces a torn surface when cutting poor-quality wood, regardless of the steel. Some woodturners believe that there is no need to hone, as the burr will simply "strop off" in the wood; however, experience with HSS and especially the higher wearing steels (10V, 2030, 2060, 15V) is that the burr is tough and does not readily strop off in the wood.

- Diamond honing materials can easily cut all of the steel alloys on the market. Traditional stones (Arkansas, Washita, India, crysolon, ceramic) are ineffective or require an inordinate amount of time to achieve an improved edge on HSS and also on the high-wear steels we tested. This is because the common HSS, like M2 and M4, super HSS such as PM 2030 and 2060, and the high-wear steels such as CPM 10V and 15V, contain significant quantities of hard carbides. These tungsten, molybdenum, and vanadium carbides far exceed the hardness of traditional sharpening stones. Jerry Glaser, who championed the use of highly alloyed PM materials, referred to traditional honing materials as "old methods" and diamond as "new methods" of honing—we have to learn to work with diamond. All of the different types of diamond (synthetic mono and polycrystalline, as well as natural) on the market will hone contemporary turning tools. However, the type of diamond, smoothness of plate, and how diamond is attached to a plate determine the longevity of a diamond hone.
- A cutting edge is the intersection of two planes—and both of those planes should be smooth to produce a fine edge. On skew chisels, this is not an issue once you have honed both surfaces. However, with gouges, the bevel is produced by grinding and honing, while the inside surface is a product of the manufacturing process. Honing does smooth inner flutes when done with a slipstone or cone, but for those who don't hone, or those with flutes that have very deep grooves from the milling process, there is a problem of sharpness.
- A well-manufactured flute, free of deep milling marks, is a big plus and can speed the honing process. Polishing the flutes is an option, but it would be admirable if was already done by the tool makers. Honing with diamond will, to a large extent, cut through most of the milling marks sooner or later, so polishing may not offer a huge increase in edge sharpness over regular honing.

To be fair to all of those who have argued that honing is a waste of time or that certain steels do not get as sharp as others, it seems as though those viewpoints are based on the honing material being used. Traditional honing materials work well on HCS tools but poorly, slowly, or virtually not at all on HSS and high-wear steels, so if you don't hone HSS and high-wear steel with a diamond hone, they will not be as sharp as HCS that has been honed. ■

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