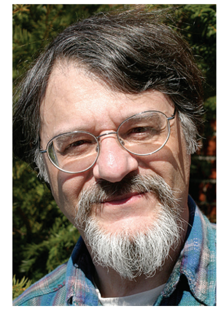
part 1 – tool point geometry

Sharpening Woodturning Chisels



Woodturning chisels are subjected to more wear and tear than any other kind of hand held chisels used in woodworking. Because the wood is passing the chisel at 20 miles per hour for prolonged periods of time, a turning chisel will traverse more wood in a few minutes than any carving chisel could in years. Just look at the pile of chips that accumulate around a wood lathe and you will be convinced of this fact. For this reason, sharpening is a more important issue for turning than any other branch of woodworking.

Sharpening is not handled well in most of the turning books I have read, because the authors try to cover too much at once. I will divide the subject into two distinct parts: *Tool Point Geometry*, which will be covered here, and *Sharpening*, which will be in the next issue.

TOOL POINT GEOMETRY describes the shape of the tool. To understand this topic thoroughly, we need to explore WHY the tool is shaped the way it is, and how the shape affects the way it behaves.

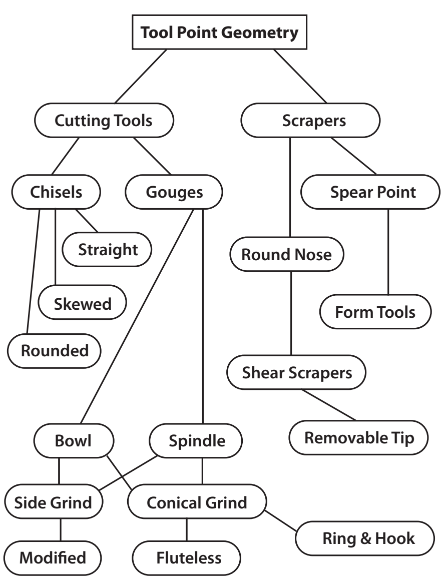


Fig 1 – Two main groups

SHARPENING is the routine maintenance of the perfect edge. This operation assumes the correct geometry has previously been achieved, and we aim to keep it that way as we sharpen the chisel hundreds or even thousands of times.

Basics of Tool Point Geometry

An edge is formed at the intersection of two planes – these planes may be flat, curved or a complex conical surface. The angle of intersection is called the DIHEDRAL ANGLE, usually referred to as the EDGE ANGLE. It is measured as the angle between two lines which are perpendicular to the edge at their point of intersection and lie on the respective planes.

Looking at the chart (Fig. 1), you see two main groups of woodturning chisels — cutting tools and scrapers. Cutting tools are divided into two main groups — gouges and chisels. As we discuss these types, we will examine two aspects of tool point geometry — the edge angle and the shape of the line which forms the edge.

The best edge angle for woodturning chisels is 35 to 40 degrees (Fig. 2) although turners differ greatly in working practices. I have seen angles between 25 and 55 degrees used. Many people think that since their cabinet chisels and carving chisels are ground

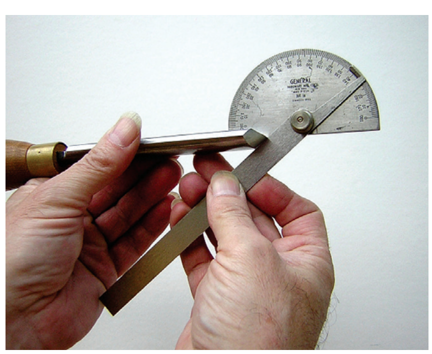


Fig 2 – Measuring edge angle

at 25 to 30 degrees, that this must be good for turning chisels also. However turning chisels are subjected to much more brutal conditions than hand chisels. For this reason, a more blunt angle is preferred because it produces an edge which is more robust, stays sharp longer, and is less likely to overheat.

Also, unlike carving tools, turning chisels are usually used at a shear angle. This means that the edge is not perpendicular to the direction of travel. This produces an EFFECTIVE CUTTING ANGLE which is much less than the measured edge angle. To understand this concept, think about a switch-back road which ascends up a mountain. The effective angle of climb is reduced because the road does not go straight up the mountain, but angles across the face of the slope. So when we use a turning chisel at a shear angle, the actual cutting angle of the edge is much less than the angle at which we ground the bevel on the chisel. For these reasons, I do not think it is necessary to grind turning chisels to a more acute angle than 35 to 40 degrees.

But decisions of tool point geometry should be based on how they affect the behavior of the chisel in actual use. I have found that chisels which are too acute are harder to control than those ground at about 40 degrees. Some top woodturners, teachers and writers, such as Mike Darlow disagree with this and use more acute angles.

Flat Grind Versus Hollow Grind

I am absolutely convinced that wood turning chisels should NOT be hollow ground — this does not apply to scrapers which can be either flat or hollow. I learned this from trial and error, and decades of experimentation. When I switched to flat grinding, woodturning suddenly became much easier. The reason is because the flat grind defines the bevel as a straight line — at least in the longitudinal plane. This allows better control of the chisel. If you want your chisel to go in a straight line, you need a straight bevel. If the bevel is curved in a hollow shape (concave), then the chisel is always trying to follow this curve, and it is a struggle to keep it going straight.

Nose Radius of Gouges

No factor of tool point geometry affects the behavior of a gouge more than nose radius because a smaller radius produces a narrower chip and results in a smaller cutting force. Figure 3 shows five different shapes possible from the same chisel profile (or cross section). These differ only in their nose radius. The first example is a "straight across" grind (radius = infinity). This is the way we grind a roughing gouge for spindle work; it has no nose and has sharp outside corners. Until recently this is the way most English turners ground their bowl gouges too. (See Frank Paine – *The Practical Woodturner*, or Peter Child, – *The Craftsman Woodturner*) The remaining four examples in the illustration show a decreasing nose radius from about one inch down to 1/16 inch.

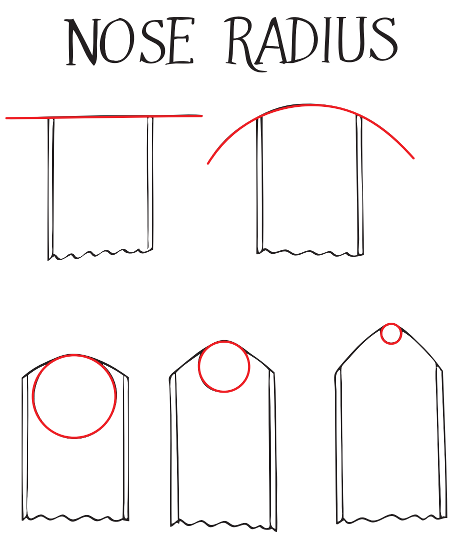


Fig 3 – Different nose radii are possible from the same chisel profile

Besides the straight across gouge already mentioned for roughing and working into corners, each of these variations has certain strengths and weakness for applications of various kinds. For example, the smaller nose radius allows for easier piercing of the surface for initiating cuts (coves) at very high vertical angles, while the wider nose chisels generally make it easier to produce a smooth cut on flat surfaces or the bottom of coves.

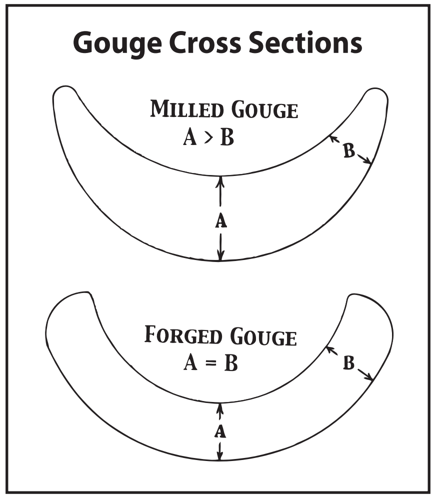


Fig 4 – Two distinct types of gouges

During sharpening it is important to maintain the nose radius to the shape you prefer. Note that there are two distinct types of gouges — those forged from a flat piece of steel which has be bent into the "U" shape common to all gouges, and those created by milling a groove into a piece of round steel (Fig. 4). The milled gouge is the modern convention. Gouges made from round steel present a cross section which is thicker in the middle than at the edges. Because there is more material in the middle, this part resists the grinding process more. As a result there is a TENDENCY for these chisels to become more pointed (toward a smaller nose radius) as they are sharpened. You must be conscious of this, and dwell on the grinder longer in the middle to counteract this tendency, and thus maintain the correct nose radius.

Scrapers

Scrapers are used in bowl turning, chuck, and faceplate work, where the grain of the wood is perpendicular to the axis. In this kind of work, the grain is constantly changing from end grain, to cross grain, to long grain, and a scraper is well suited to the task. SCRAPERS ARE ALMOST NEVER USED IN SPINDLE TURNING.

A scraper does not stay sharp very long even under the best conditions, but this disadvantage is outweighed by its ability to handle variable grain direction without lifting or tearing-out the grain.

A gouge (cutting tool) is the best choice for roughing because it has positive rake, which removes wood more quickly with less friction, and the tool stays sharp longer (Fig 5). However there are many situations where scrapers are necessary — smoothing and blending curves, fine details, and awkward situations where a gouge or

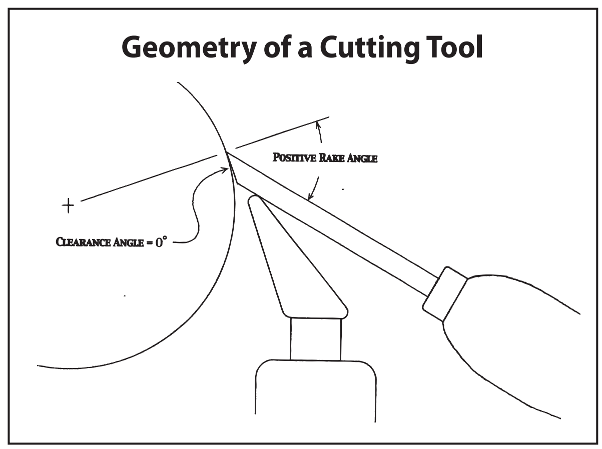


Fig 5 – Positive rake is best for a gouge

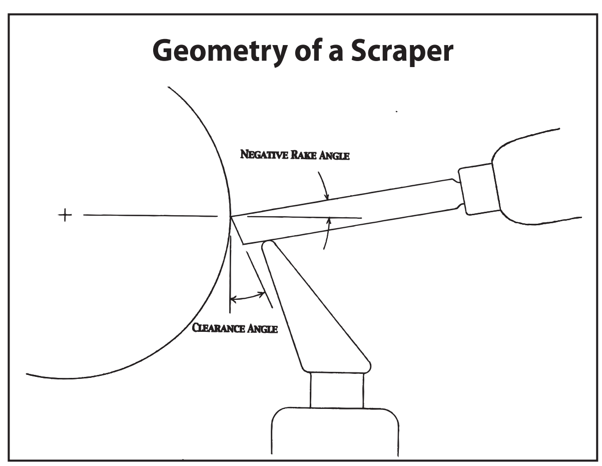


Fig 6 – Scapers are ground with a negative rake other cutting tool cannot be presented at the correct angle.

A scraper is used in a very different manner than a cutting tool, because the bevel of a scraper does not rub the work. Instead a scraper is controlled by pressure only, and the handle is held higher than the edge, giving the tool a negative rake. It is this negative rake and the ability of the scraper to take microscopically fine shavings that reduces tear-out and makes it the best finishing tool for difficult varying grain situations.

Because the bevel of a scraper does not rub, the exact angle or shape of the grind (flat or hollow) does not make much difference. Usually, scrapers are ground at a very blunt angle, corresponding to an included angle of 70 to 80 degrees. When the tool is used with a negative rake angle of 10 degrees, then the resulting clearance angle is 20 to 30 degrees (Figure 6).

Gouges — Axial vs. Oblique Grind

There has been a revolution in the way most turners sharpen their bowl gouges in the last 15 years. To some degree this has changed for spindle gouges too. The new geometry is usually referred to as SIDE GRIND, and is achieved by swinging the handle from side to side during grinding, instead of simply rotating it. What this produces is a conical bevel surface which is not referenced to the axis of the tool, but oblique to it. The obvious effect of this is that the gouge has longer edges on the sides (or wings) than a conventional grind (Fig 7).

These long side edges are useful in many bowl turning situations, especially reaching into end grain boxes or goblets where the cut must be made in a pulling motion (working toward the mouth).

Fig 7 – Side grind produces a conical bevel

The disadvantage of side grind is that the angle of the bevel changes whenever you rotate the tool. This means that if you rotate the gouge during the cut (to alter the shear angle), the gouge reacts by changing its direction. On a conventionally ground gouge, the angle of the bevel is constant with respect to the handle, and you can rotate the gouge any way you like during the cut (to alter the shear angle) without changing its direction of cut. Also, it is much easier to start a cut when you know that its angle is not dependent on the rotation of the tool.

Skew Chisels

Skew chisels are part of a whole class of spindle turning chisels which are ground on both sides. Most skews are made from rectangular stock, and the corners are extremely sharp (Fig 8-A). The chisel cannot successfully be used in this condition, because the corners dig into the tool rest (not to mention your fingers). This will prevent the tool from sliding along the tool rest smoothly, and eventually will damage the surface of the tool rest.

Such a skew chisel can be put right by rounding over the corners (Fig 8-B). A new type of skew is now available which has its short sides completely rounded over; so the cross section takes the shape of a race track (Fig 8-C). These are called the "rolled edge" skews, and I highly recommend them. Also, some of the new skew chisels are made from round stock (Fig 8-D), and these are excellent in the small sizes. Avoid the "oval skew" (Fig 8-E) with the long sides rounded.

The shape of the edge of the chisel can vary. It may be a straight line which is square across (Fig 9-P) or slightly rounded (Fig 9-Q).

The standard skew (Fig 9-R) has a straight edge which is ground to an angle — usually 20 to 40 degrees. This is an extremely versatile tool which offers the choice of using the heel or the toe in different situations.

The edge may be a curve (Fig 9-S) which creates a narrower chip and behaves more like a gouge since it has a nose radius. Note however that a skew which is shaped to a curve does not have a distinct sharp point (the toe of the skew) and this is a limitation.

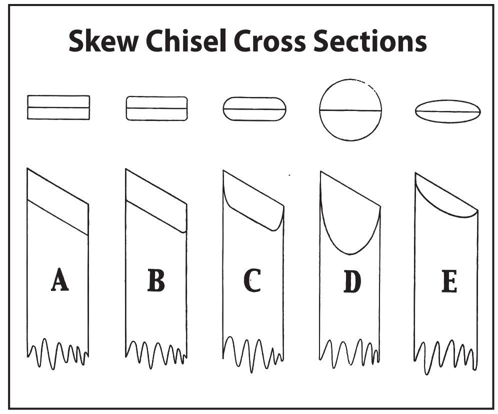


Fig 8 – Skew chisels are ground on both sides

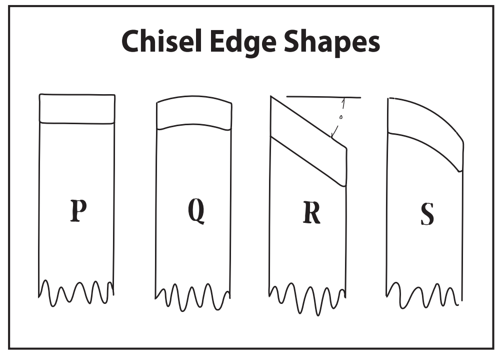


Fig 9 – Chisel shape can be straight, curved or angled

The Myth of the Original Grind

Many beginners think that they should maintain the geometry that the tool had when they bought it. While this may be true of the Ellsworth signature gouge and a few others, in general this is a dangerous assumption. The person who ground the tool at the factory probably never turned a piece of wood in his life. He is just grinding it the quickest possible way so it looks like it has been sharpened; and this is OK because it gives you a head start in regrinding the tool the way you want it.

With all the chisels available and all the possible ways to grind them, there are too many variations for anyone to master in one lifetime. So I will leave you with this final thought — *Take time to experiment.* If you do, you will soon realize that this article has barely scratched the surface of this subject. ■