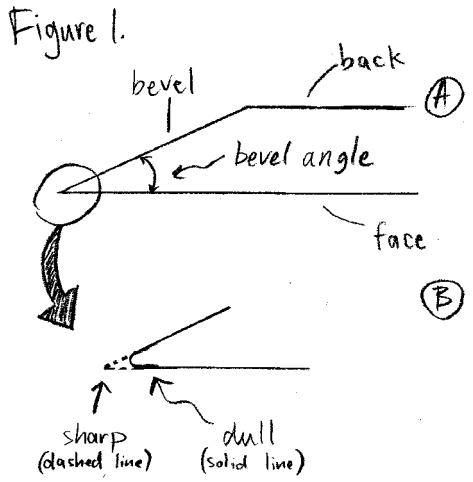
Sharpening Beveled Blades With Abrasive Sheets

by Spencer Hochstetler and Bill Tindall

Whether a novice or an experienced woodworker, you may find that tool sharpening is one of the most frustrating tasks in all of woodworking. Many people who make the attempt and use the tool with a sub-optimal edge sometimes "get by", while others may yield to frustration and give up on the idea of using hand tools altogether. However, a properly sharpened hand tool can lead to unimagined speed and enjoyment of woodworking. The purpose of this article is to provide straight-forward instructions for sharpening tools with flat bevels, such as chisels and plane irons, and guide the sharpener in the choice of sharpening equipment. The use of jigs and honing techniques using affordable, commonly available abrasive sheets will be discussed.

Definition of Sharpness and General Overview

Basically, an object is sharp when two geometric planes intersect with relatively little radius at the line of intersection. For woodworking, the angle at which the two planes intersect is important. If the angle is too small, the blade will require less cutting force, but the edge will crumble under the cutting forces. If too large, the edge will be very sturdy, but will require a cutting force that makes using the tool difficult or impossible. For blades such as plane irons and chisels, the basic shape is shown in Figure 1A. Figure 1B shows the difference between a sharp edge (near-zero radius) and a dull edge (significant radius). The two geometric planes that are flattened during the sharpening process are the bevel and face. The angle that includes the bevel and face is called the bevel angle. The appropriate bevel angle depends on how the tool will be used, as well as the properties of the metal. In general, the smallest bevel angle that will hold up is best. For plane irons, a bevel angle of 25° is a good starting point. For chisels sharpened for general use in hardwoods 25 to 30° bevel angles are common. Mortise chisels require bevel angles closer to 35° for durability. Additional information on selecting bevel angles and most everything else about sharpening various tools can be found in an excellent sharpening book, The Complete Guide to Sharpening, by Leonard Lee.



Traditionally, sharpening was done with stones. Abrasive sheet sharpening is a faster and cheaper alternative to stones. (Because the abrasives that are glued to abrasive sheets consist of a variety of synthetic materials rather than sand, we prefer the term "abrasive sheet" rather than sandpaper.) The main goal of this article is to instruct how to make the bevel intersect with the face with near zero radius using abrasive sheets. Although the techniques are the same that would be used with stones, abrasive sheet sharpening has several advantages over sharpening with stones. First, abrasive paper is cheap and readily available in a variety of grit sizes and materials. Therefore, it is practical to use the optimum selection of grits to achieve sharpening and optimizing grit selection results in very fast sharpening. In addition, rolls of abrasive enable relatively long lengths of abrasive to be used, particularly in comparison to the relatively short water stones available. This factor is particularly important when using a sharpening jig, because the jig occupies several inches of the abrasive surface. When using a jig the effective length of a water stone can be as little as 5". A 13" length of abrasive sheet doubles this effective length. In either stone or abrasive sheet sharpening the

abrasive surface must be flat to achieve a sharp straight cutting edge. A third advantage of flexible abrasive sheets is that they only need to be affixed to flat surface to be used. Worn abrasive sheets are simply removed from the flat surface and thrown away. Conversely, a stone will wear and develop curvature with use and must be flattened regularly to yield a flat sharpening surface. Cost and speed are final considerations. With proper selection of grit sizes, metal removal progressing from a rough to a mirror-smooth surface is accomplished far faster with abrasive sheets than with a series of stones. Start-up costs for low-headache sharpening are also significantly lower with abrasive sheet-sharpening. A good set of Japanese water stones can cost as much as several hundred dollars while with some creativity, abrasive sheet sharpening can cost as little as five dollars to get started.

The method for using abrasive sheets for sharpening has been made popular on the internet (http://www.shavings.net/scary.htm) and most people refer to the method as the "Scary Sharp" system. Unlike the original posting of the Scary Sharp method, this article also aims to provide information on selecting grit size and composition as well as descriptions of various equipment to use with abrasive sheets.

Sharpening Jigs

A sharpening jig is a great aid to quick and consistent sharpening regardless of the abrasive format used. A few examples of sharpening jigs can be seen in Figure 2. In our

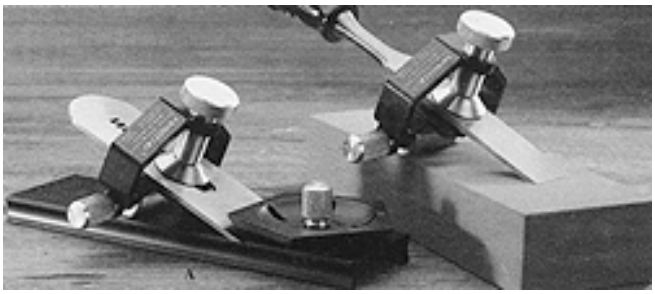


Figure 2A. Lee Valley Tools "Veritas Sharpening System

opinion, the Lee Valley "Veritas Sharpening System" is definitely worth the $30 price tag. The angle jig, which is a pentagon that can be turned to allow blade-jigging at commonly used sharpening angles, allows one to easily and repeatedly find the same angle when resharpening. The Veritas jig also helps with aligning the blade edge perpendicular to the honing guide motion. Another type of jig clamps the blade from the sides. It is more difficult to align the blade in this jig and the smaller roller makes it more difficult to keep the blade aligned with the abrasive during sharpening. However, this jig can be used to sharpen spoke shave blades.

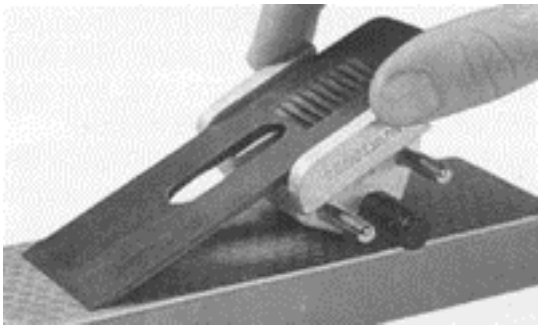


Figure 2B. Woodworker's Supply side clamping jig.

Flat Surfaces

A flat, rigid surface is an essential component of abrasive sheet sharpening. Flatness to within 0.001 to 0.002" over a foot is acceptable. Further, to minimize the number of strokes one must use on a particular grit, a minimum of a twelve inch length is best. Glass, polished marble tile, Corian, granite surface plates, and, in a pinch, shop machinery beds are all excellent choices for flat surfaces. Glass plates should be at least 3/8" thick to minimize flexing. Occasionally, home improvement stores like Lowes or Home Depot will have close-out sales on 12" x 12" polished marble floor tiles. Bringing a good straight edge, such as a Starrett combination square, to the store can help you select sufficiently flat tiles. By placing the straight edge on edge orthogonally and diagonally across the tile and holding the tile up to the light, you can determine which tiles are flat by looking for light shining through the straight edge and the tile. Tiles with light shining through are rejected. Corian, a synthetic material commonly used in kitchen countertops, has also been used. It is

machinable with shop tools and some people have gone so far as to drill an array of holes in a Corian slab, then mount the slab in a box that has a vacuum port on it to make an inverse plenum. When the vacuum is turned on, suction generated at the holes in the Corian is used to hold the abrasive sheets onto the surface. Machinists frequently use granite surface plates for layout and jigging in metalworking. Tool room, or Grade B, 12" x 18" surface plates with overall accuracies of ±0.0001" can be purchased for about $30 plus shipping (~$35). While this surface is relatively expensive, it is very durable and could be used for other things that may require an exceptionally flat surface. Finally, a flat machinery surface can be used for experimenting. Jointer beds and iron table saw tops are good surfaces to use, but not very convenient for a long-term sharpening setup. Ideally, one would like to have the whole series of abrasive sheets attached to a readily accessible surface so that touch-ups are quick and easy.

Abrasive Sheets – The Nitty Gritty

Recently, one of us (BT) had a conversation with an abrasive specialist about sharpening with abrasive sheets glued to a flat surface. While this individual's company does not conduct research on sharpening, they do study smoothing and polishing metals. Making the assumption that smoothing and polishing are functionally the same as sharpening, in that two surfaces are smoothed and polished in sharpening, the following information can be used to make the best choices in buying abrasive for sharpening.

Abrasive Composition

For metal working, there are three materials to choose from- silicon carbide, aluminum oxide and alumina-zirconia. Silicon carbide fractures easily with use, so it wears out by breaking into smaller particles. It cuts rapidly and makes a consistent scratch pattern during its life, but it has a very short life in the coarse to medium grits when grinding hard metals. Therefore, is not recommended for coarse, fast metal removal. However, it is the only material readily available in very small grit sizes (~600 – 2000) so it is the only choice for final polishing. Aluminum oxide is exceptionally durable and it wears by rounding the grains so the effective grit size becomes smaller with use and cutting efficiency decreases. It is the recommended material for grinding and polishing hard metal in the medium/fine grits (~220 – 600). Alumina-zirconia tends to combine the best qualities of the other two materials, but it is more expensive. It provides particularly fast material removal in the coarser grits (~80 – 220) and, therefore, it is recommended for this use. It is only available in coarser grits because these grits offer a cost-effective advantage over aluminum oxide not found with the finer grits.

Grit Grade Choice

It is often possible to proceed from a coarse ground surface to a polished surface with as little as 5-10 strokes on each grit size when the sizes are wisely chosen. Abrasive sheet sharpening can be very fast because it is possible to start sharpening with coarse, aggressive grits and proceed in small steps to smaller grits and their corresponding small scratches. The abrasive sheets cost pennies each, so unlike stones, it is practical to have at hand the optimum progression of grit sizes so that each smaller grit has but a small task to remove the previous scratch size.

For metal finishing, or wood finishing for that matter, abrasive companies typically recommend skipping not more than one grit size in the smoothing and polishing process. In some metal finishing operations no sizes are skipped in the final stages of polishing. In terms of the actual particle size of the abrasive particle, this rule of thumb translates to about a 33% reduction in grit size for each step in the coarser grits, decreasing to about a 25% reduction per step in the finer grits.

Complicating the grit selection process is the difference in grading scales between Europe and North America. The European scale is defined by the Federation of European Producers Association, or FEPA. The FEPA scale uses a "P" prefix in its numbering scheme. The North American scale is defined by the Coated Abrasives Manufacturers Institute, or CAMI. The CAMI scale uses no prefix in its numbering system. Other than the "P" prefix,

the numbers look the same, but in the fine grits the grit size for the same number differs substantially. Up to 220 the FEPA and CAMI scales are essentially the same particle size. So, for example, P220 and 220 are the same 66 micron particle size, but FEPA P1000 is an 18 micron particle size and CAMI 1000 uses a 9 micron particle.

The following is one possible recommended series of FEPA grits that results from the 33 to 25 % grit particle size reduction rule- P100, P150, P220, P320, P500, P800, P1200, and P2000. (Another possibility would be P80, P120, P180, etc.) This series would efficiently produce a good polished finish on metal. In the CAMI scale, one would use the following series- 100, 150, 220, 280, 360, 500, 800, 1000. The sharpening paper available from Klingspor is German and therefore graded with the FEPA scale (see "Sources" at the end of this article).

Presuming the experience of metal smoothing and polishing is relevant to sharpening, then the above suggested grit series would be a place to start in optimizing grit selection for sharpening. While the cost of abrasive paper is not high, there still is a large number of sizes to keep on hand. It is reasonable to question if they are all necessary. Unfortunately, there is not a simple answer to this question. The first concern is what grit size to start with. An 80 or 100 grit abrasive paper is very aggressive in removing metal, especially with alumina-zirconia. Sharpening with these sizes is a reasonable alternative to using a bench grinding wheel for nick removal as well as initial preparation of the cutting tool. In the grit range of P100 to P600 it is easy to follow sharpening progress with a 10X magnifying glass. If only one grit size is skipped in this range, the next smaller size rapidly removes the scratches of the preceding size. As little as 5-10 strokes on a 12" length of paper is all that is required. In addition, the abrasive can be reused several times. However, if two grit sizes are skipped, it takes a long time to remove scratches from the previous grit size and the abrasive wears out after only one or two uses. Therefore, for both time and cost efficiency, one should have on hand P100, P150, P220, P320, P500, P800 abrasive paper, and perhaps P80 for flattening plane irons and chisels, or for serious nick removal.

Where one starts in this series depends on how much material needs to be removed to establish a straight, smooth, nick-free edge. One might start at 80 or 100 to remove coarse grinder scratches on a new chisel or plane, or to flatten the face of a plane iron or chisel. As a point of comparison, a soft 80 grit aluminum oxide grinding wheel at 3600 RPM leaves scratches approximately equal in size to those left by P120 grit alumina-zirconia. If the tool is simply dull, one can start at least as fine as P320.

There is little disagreement that one should sharpen to at least P800 (for comparison, a 1000 grit Japanese water stone equals FEPA P800 and CAMI 500 in abrasive sheets). Not everyone agrees how much beyond P800 is necessary. As a point of comparison, a 6000 grit Japanese water stone is equivalent to CAMI 1500 abrasive paper which is a third the particle size of FEPA P2000 paper. Some people recommend continuing to P2000 in abrasive paper and then stropping, while others stop at grits coarser than P2000 and then strop. (The strop will be covered in the next section.) Many go to P2000 because it is cheap and easy to do, and this approach is the best available when using abrasive sheets. The cost or time of potential over-kill is not high.

Above P800 grit it is harder to follow progress with the magnifying lens so it is more subjective to determine whether there is much to be gained by using the series P1000, P1200, P1500, P2000, or whether some of these sizes could be skipped. The metal finishing people would use all these grades. A case could be made for skipping P1200.

You will note that these recommendations are different from the "Scary Sharp" system. We believe the "Scary Sharp" recommendations were based on what grits were available in common stores and not what made the most sense for efficient sharpening. Major suppliers of abrasives, such as 3M or Klingspor, can supply abrasive sheets in any grit size, so choices can be made for optimum performance.

To summarize, sharpening with P100, P150, and P220 alumina-zirconia is

recommended, followed by P320, P500 and P800 alumina, followed by P1200, and P2000 silicon carbide. In the CAMI grade, it is possible to continue to 1500 and 2000 but we have insufficient experience to know if these additional grits are necessary. A table with the recommended grits and abrasive particle diameters is included in Appendix A.

The suggested abrasives can be purchased with an adhesive already applied. This format is called PSA (pressure sensitive adhesive) sheets. Alternatively, spray adhesive can be applied. Both 3M T75 and Elmer's Spray Adhesive have been tested and found to be appropriate for this use.

When worn-out abrasive sheets are removed from glass or other surfaces, a film of adhesive sometimes remains. It must be removed before attaching a fresh sheet of abrasive, otherwise the residue could make lumps under the fresh sheet. A paper towel wet with acetone will remove old adhesive. Mineral spirits are useable, but much less effective.

The Strop

A strop is a flat piece of leather attached to a board. The leather is oiled and a fine abrasive is rubbed into it. The strop is the last step in sharpening and it puts the fine final touches to a newly sharpened edge. If a blade is stropped occasionally while in use, a good quality blade will retain its edge indefinitely, unless the blade has acquired nicks during use. Usually, green sticks of chromium oxide are used, but some people use red sticks of jeweler's rouge as well. Essentially, the chromium oxide serves as the abrasive affixed to the oiled leather strip. In days gone by, a barber would use a strop to keep his straight-blade razor sharp for shaving. A good size for a leather strop is about 3" by 16". The strip can be glued to a flat block of wood and trimmed. When it's metal polishing properties diminish, you simply rub more chromium oxide into the leather and it is recharged.

General Instructions

Bevel shaping

The first steps you want to take in sharpening a beveled edge is to either flatten the face (the plane that meets the bevel to make the cutting edge) or put a rough edge on the bevel. Which step is performed first is not critical, but grinding the bevel first may make the face-flattening step faster if there are any deep nicks near the cutting edge. Putting a rough edge on the bevel can be performed carefully with a bench grinder or with an aggressive grit alumina-zirconia abrasive sheet mounted on a flat surface. Some have found that a belt sander clamped upside-down also works. Techniques used for rough bevel shaping are identical to honing and are covered in the section entitled "*Honing the bevel*". When a bench grinder is used, the preferred grinding wheel is an 8" white aluminum oxide wheel, 80 grit, turning at 1800 RPM. If you are starting from scratch, this is a setup that we recommend buying. However, a 6" x 3600 RPM grinder is acceptable. The gray silicon-carbide wheels that typically come with grinders have a tendency to cut too hot, causing a tool-steel blade to lose its temper and leave it too soft to hold an edge. If you see blue color on the metal, the temper has been lost and no matter how perfect an edge that you put on it, it will not be tough enough to hold that edge. Even with a cooler, more friable wheel material such as aluminum oxide, it is still possible to overheat the metal. The only practical solution to repair an overheated blade is to completely remove the metal that has turned blue with better grinding technique. A rule of thumb is that when the metal becomes uncomfortably hot to hold with bare hands, stop grinding and continue after the metal cools down. With practice, a bench grinder quickly removes deep dings on the edge of the blade that might make face-flattening or bevel angle changing a near impossible task. It is worth mentioning that obtaining an accurate and repeatable bevel angle on the blade is most easily achieved with a good tool rest. The tool rests that come with most grinders are too flimsy and not large enough to use for accurate sharpening. Replacement rests can be made easily or purchased. A commercially available jig from Lee Valley Tools (that might inspire one of your own designs made from wood) is shown in Figure 3. The angle of the jig should be adjusted to equal the angle that will be used to hone the bevel. An inexpensive metal-working

protractor is of good help here. The squareness of the blade edge to the blade side can be checked with a square.

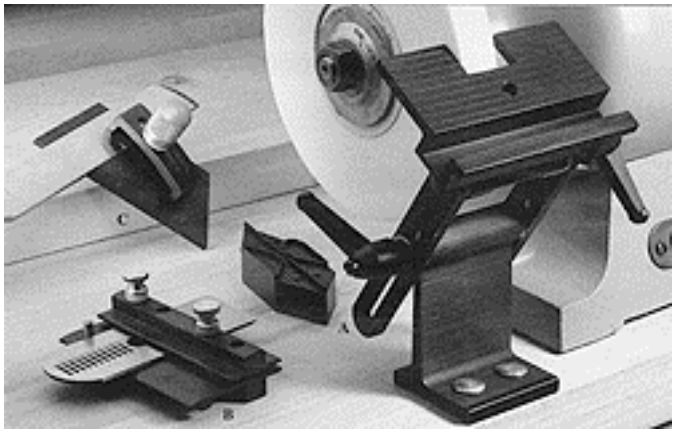


Figure 3. Grinder Sharpening Jig

Face flattening

Flattening of the blade face only needs to be performed once, but it is critical that the face is extremely flat. *In other words, the blade's cutting edge can only be sharp and smooth-cutting if both the bevel **and** face surfaces are pristine.* Beginning with an aggressive grit alumina-zirconia sheet attached to an edge of a flat-surface the blade can be sharpened with the bevel up and facing the interior of the flat surface with a side-to-side stroke or it may be moved with an in-line ("stabbing") stroke on the abrasive sheet. The motion should be slow, with even pressure applied. The important point to remember is that the resulting face surface should be perfectly flat. With the side-to-side stroke, there is a greater tendency to produce a convex face, but if you are careful, it can be more rapid than the in-line stroke. Flatness may be checked with a Starrett-quality straight edge as you experiment with whichever motion you prefer. Some people have found that applying pressure on only one direction of the stroke is easier to control and helps prevent rounding of the face. Approximately 1/2 – 1" from the cutting edge is all that needs to be flattened; *there is no benefit from flattening beyond this distance.* Intermittently brushing or vacuuming the metal filings from the abrasive sheet will help prevent overloading the sheet and speed the process. When the scratches on the face, especially those that are within about an 1/8 – 1/4" of the bevel edge, are uniform and all low spots in the same area have been removed, you are ready to move up to the next finer grit. It should be noted that that **all** of the flattening process **must** occur with the first grit size. **The most common error in using abrasives is not starting with a sufficiently coarse grit to efficiently do the necessary material removal to prepare the tool for sharpening. This grit must do all the necessary shaping or flattening and edge defect removal. The task of all subsequent grits is simply to remove the scratches of the previous grit.**

The blade should be wiped free of any debris or abrasive particles that may have clung to it before putting it down on the next grit size. With the same motions used in the first flattening step, work out all of the previous grit's scratches. This can easily be followed visually with the aid of a magnifying glass, or better yet, a 10X jeweler's-style loupe. A glance right before you start on the next finer grit will allow you to see when the coarse scratches have been removed.

Using the recommended grit sizes in Appendix A and applying moderate pressure on the blade, as few as 5 or 6 strokes may be all that is necessary to remove the previous grit's scratches. The finer silicon carbide abrasive sheets require wetting with water to prevent them from loading. Finally, the last step of face-flattening ends with a strop charged with chromium-oxide to put the final surface on the face. Care should be taken to only pull the blade edge on the leather; otherwise, the leather will cut very easily. Near the higher grits and the stropping step, the face should take on mirror-like qualities. This is a good indicator that when finished with the bevel, the blade will be one of the sharpest you have ever used!

Honing the bevel

The bevel-honing process is very similar to that of face-flattening except that a jig is used to hold the blade at a fixed angle while honing. After the blade is placed into the jig at the desired angle, the jigged blade is *pulled* across the largest-grit abrasive sheet with moderate pressure near the bevel edge and only enough thumb pressure on the jig body to guide the blade straight across the sheet. After the first

stroke, the bevel should be examined to determine if the blade is properly jigged. The bevel should be exactly parallel to the jig's wheel (perpendicular to the pull stroke). If the scratches from the first stroke are longer on one side of the bevel than the other, the blade should be carefully rotated (nudged while clamped) into position and checked with another pull-stroke across the abrasive sheet. After the blade is properly aligned, you are ready to go through the grit sizes as per the face-flattening procedure.

If a grinding wheel was used to shape the bevel, it is unnecessary to hone the concave shape out of the hollow-ground bevel. Because only the first few microns of the bevel is doing the real cutting work, only the first few microns really need to be honed. Because it is difficult to see only a few microns with the naked eye, honing a hollow ground bevel so that the first 1/64 – 1/32" of the edge is flat is sufficient. Honing only a small amount of a hollow ground bevel in this manner also speeds up the process of honing and re-honing because less metal has to be removed. As the bevel is honed at the smaller grits, less pressure is needed to removed the previous grit's scratches. Also, there will be a "wire edge" that forms along the face at the bevel as the bevel is honed. This is normal and it will eventually fall off at the highest grits. Some people remove the wire edge with their finger (pushing away from the blade!) after each grit size is finished. The formation of a wire edge on the next smaller grit is an indicator that the previous grit's scratches have been removed. Similar to face-stropping, it is essential that only pull strokes be used or the strop leather will be cut.

Testing sharpness

One way to determine if a blade is sharp is to pare across the endbrain of a softwood (e.g. a common 2" x 4"). If the blade easily and smoothly slices the wood fibers, the blade is sharp. Some people will shave some arm hair with their blade to determine if the edge is sharp. If the blade pushes the hair over, the edge is deemed less than optimal (but still may work!) and if the hairs are easily shaved, the blade is wonderfully sharp (USE CAUTION WHILE DOING THIS – shaving accidents have happened to at least one author of this article). A third way is to scrape the edge of a plastic ball point pen housing at an oblique angle. If the edge catches at low angles the edge is considered sharp. Ultimately, a blade is best tested by using it. If the blade is a chisel, you should be able to pare without excessive force and the cut should be very smooth both with and against the grain. If the blade is a plane iron and inserted into a well-tuned plane, it should cut smoothly and produce nice "curls".

Resharpening

Fortunately, when the tool becomes dull only a few of the above steps are necessary to restore the edge. A few strokes on the strop may be all that is necessary for a chisel. Often a plane iron will have tiny nicks that will require re-honing on the abrasive sheets. The Veritas jig makes this task much easier. The angle setting device enables the tool to be mounted into the jig exactly like it was when the tool was first sharpened. Furthermore, the jig has a cam that increases the angle either 1 or 2 degrees. This feature is especially useful for resharpening as it enables the tool to be adjusted, when necessary, to focus sharpening near the cutting edge. The starting grit will depend on how much material needs to be removed. The starting step must produce a wire edge. This wire edge is an indication that the dull rounded part of the old edge has been removed. The wire edge will not form until the old rounded edge is removed. For a plane iron approximately 320 grit may be a good starting place. It is better to start too coarse than too fine. Starting too fine wears out the abrasive prematurely and there may not be enough metal removed to establish a new sharp edge.

Conclusion

If you are not experienced sharpening tools, all this information may appear intimidating. It should not be. If you try sharpening with a jig and abrasive sheets you will get an acceptable result the first time. It may or may not be perfect, but it does not have to be perfect to be useable. You tool will cut better than you could have imagined. While you are getting more experience using your sharp tools, you will be perfecting your

sharpening technique. Best of all, you will neither spend excessive time sharpening nor a lot of money acquiring the necessary materials.

Sources for Materials

- abrasive sheets: Klingspor (www.klingspor.com), Supergrit (www.supergrit.com)
- sharpening jigs: Lee Valley Tools (www.leevalley.com), Woodworker's Supply (woodworker.com)
- chromium oxide: nearly any mail order woodworking supplier
- granite surface plates (Grade B): Penn Tool Co. (www.penntoolco.com), Grizzly Industrial, Inc. (www.grizzlytools.com

APPENDIX A – Recommended Grit Sizes

FEPA grit (Europe)	micron	% of previous grit
100	156	
150	97	62
220	65	67
320	46.2	71
500	30.2	65
800	21.8	72
1200	15.3	70
2000	9.5	62

or alternatively...		
80	197	
120	127	64
180	78	61
240	58.5	75
360	40.5	69
500	30.2	75
800	21.8	72
1200	15.3	70
2000	9.5	62

CAMI grit (North America)	micron	% of previous grit
100	141	
150	93	66
220	66	71
280	44	67
360	28.8	65
500	19.7	68
800	12.3	62
1000	9.5	77

or alternatively...		
80	192	
120	116	60
180	78	67
240	53.4	68
320	36	67
400	23.6	66
600	16	68
1000	9.5	59

Appendix B - Quick Reference for
Abrasive Grading Scales for Sandpaper

	CAMI (U.S. Std) (See Note 1)	FEPA (P-Scale) (See Note 2)	Finishing Scale	Average Grit Particle Size	
				Microns	Inches
	1200				
	1000	P2000		9.6	0.00042
	800	P1500		12.3	0.00051
		P1200	A16	15.8	0.00060
	600			16.0	0.00062
		P1000		18.3	0.00071
	500			19.7	0.00077
		P800	A25	21.8	0.00085
	400		A30	23.6	0.00092
		P600	A35	25.8	0.00100
	360			28.8	0.00112
		P500		30.2	0.00018
		P400	A45	35.0	0.00137
	320			36.0	0.00140
		P360		40.5	0.00158
	280			44.0	0.00172
		P320	A60	46.2	0.00180
		P280		52.5	0.00204
	240		A65	53.5	0.00209
		P240	A75	58.6	0.00228
		P220	A90	65.0	0.00254
	220			66.0	0.00257
	180	P180	A110	78.0	0.00304
	150		A130	93.0	0.00363
		P150		97.0	0.00378
	120			116.0	0.00452
		P120	A160	127.0	0.00495
	100			141.0	0.00550
		P100	A200	156.0	0.00608
	80			192.0	0.00749
		P80		197.0	0.00768
		P60		260.0	0.01014
	60			268.0	0.01045
		P50		326.0	0.01271
	50			351.0	0.01369
		P40		412.0	0.01601
	40			428.0	0.01669
		P36		524.0	0.02044
	36			535.0	0.02087
		P30		622.0	0.02426
	30			638.0	0.02488
	24			715.0	0.02789
		P24		740.0	0.02886

FINISHING

SMOOTHING

ROUGHING

Notes:

1. CAMI = Coated Abrasives Manufacturers Institute (North America)
   (Allows a wide tolerance range of particle sizes within the definition of a particular grit)

2. FEPA = Federation of European Producers Association
   (More consistent sized grit particles than CAMI)

source: http://www.woodturners.org/new_gwg/ (Glendale Woodturners Guild)

APPENDIX C – Abrasive Equivalents

Stones, hones and micron belts.	Belts and wheels		Waterstones	Average grit size in microns
NOTE: Scotch-Brite table is below this table	CAMI (USA)	FEPA (Europe)	Japan	
	12			1842
		P12		1764
*American National Standards Institute B74.12.	12*			1600
	16	P16		1322
	16*			1092
		P20		984
	20*			940
	20			905
	24*			686
		P24		740
	24			715
	30			638
		P30		622
	30*			559
	36			535
		P36		524
	40			428
		P40		412
	50			351
		P50		326
	60			268
		P60		260
		P80		195

	80			192
		P100		156
Coarse Crystolon	100		150	141
		P120		127
	120			116
100 micron belt				100
		P150		97
Medium Crystolon, coarse India	150			93
80 Micron belt				80
	180	P180	240	78
3M 74 micron diamond stone				74
	220			66
		P220		65
60 Micron belt, extra coarse diamond hone				60
		P240		58
Medium India, fine Crystolon			280	54
	240			53.5
		P280		52.5
Coarse Diamond		P320		46.2
Fine India	280		360	44
		P360		40.5
3M 40 micron diamond stone & belt	"400"			40
Medium diamond	320		500	36
35 Micron belt		P400		35
30 Micron belt		P500		30

Washita	360		600	29
Fine Diamond				26
		P600		25.8
	400			23.6
22 Micron belt				22
		P800		21.8
Soft Arkansas, 20 Micron belt			1000	20
3M 20 micron stone	"800"			20
	500			19.7
18 Micron belt		P1000		18.3
	600			16
		P1200		15.3
15 Micron belt, 15 micron SiC paper				15
Hard white Arkansas, extra fine diamond, and medium ceramic	700		2000	14
12 micron belt	800			12
3M 10 micron diamond stone	"1800"			10
	1000			9.2
DMT extra-fine diamond hone	"1200"			9
Hard black Arkansas, 9 micron belt	1000		4000	9
	1200			6.5
6 Micron belt				6
5 micron SiC paper				5
Extra fine white Ceramic, green chrome rouge, 3 Micron belt	1500		6000	3
1 Micron belt	2000			1
Japanese Waterstone			8000	?
Chromium oxide polishing compound				0.5

0.5 micron Chromium oxide paper				
Polishing compounds are available down to 1/4 micron. For a chart, click to http://www.gemsociety.org/info/chmesh.htm				
Crystolon is Norton Abrasives tm for Silicon Carbide stones				
India is Norton Abrasives tm for Aluminum Oxide stones				

Scotch-Brite Abrasive Belt Equivalent Grits

3M is not consistant in their use of color for a particular grit. This chart is based on Scotch-Brite surface finishing belt data.

Grade	**Equivalent abrasive grit**	**Color**	**Abrasive Material**	**Finish (micro-inches)**	
				Aluminum	**Stainless Steel**
Coarse	80 - 150	Brown	Aluminum Oxide	130 - 150	62 - 72
Medium	150 - 180	Maroon	Aluminum Oxide	80 - 100	32 - 40
Fine	180 - 220	Green?	Aluminum Oxide	50 - 70*	15 - 25*
Very fine	220 - 320	Blue	Aluminum Oxide	16 - 35	6 - 12
Super fine	320 - 600	Gray	Silicon Carbide	8 - 12	4 - 6
*Estimated. Scotch-Brite is a tm of 3M Corp.					

Scotch-Brite Hand Pads			
Grit Designation	**Color**	**Equivalent Grit**	**Abrasive**
Extra Coarse	Brown		Aluminum Oxide
Coarse	Tan		Aluminum Oxide
Medium	White, Gray or Maroon		Aluminum Oxide
Fine	Light Gray or Green	150 - 180	Aluminum Oxide
Very Fine	Maroon	220 - 280	Aluminum Oxide
Extra Fine	Gray	320 - 400	Silicon Carbide
Ultra Fine	White	600 - 800	Talc

BearTex (Norton) Hand Pads in Order of Agressiveness			
Grit Designation	**Color**	**Abrasive**	**Product code**
Very Fine	Maroon	Aluminum Oxide	777
Very Fine	Maroon	Aluminum Oxide	747
Very Fine	Green	Aluminum Oxide	796
Very Fine	Gray	Silicon Carbide	851
Ultra Fine	Gray	Silicon Carbide	635
Micro Fine	Gray	Silicon Carbide	748
Non-abrasive	White	None	456

The tables in Appendix C were compiled by Steve Bottorf and downloaded from his homepage. A link to these tables on his website is http://www.ameritech.net/users/knives/grits.htm.

Steve's homepage dedicated to knife sharpening can be found at http://www.ameritech.net/users/knives/index.htm.