Souping Up the Block Plane

Its a matter of geometry, plus perception

by Richard S. Newman

Imagine trying to hand-plane a strip of curly maple sawn to one-sixteenth inch thick, or a one millimeter ebony veneer. This is daily work for luthier Robert Meadow, who creates exquisite lutes of exotic and highly figured woods. As every musician knows, some instruments must be forced to make sound, while others sing at the slightest touch. So it is with tools. Meadow's planes consistently take shavings you can see through, the full width of the iron and the full length of the board.

This is not just extraordinary skill at work. Meadow has spent years investigating how edge tools work. His desire to share his experiences has led to the formation of a school providing intensive instruction in hand-tool work, and to frequent workshops across the country where he impresses audiences with his ability to plane the nastiest wood. I visited Meadow at his school and workshop in Saugerties, N.Y., and discovered that he has evolved to almost exclusive use of Japanese edge tools, both in his own work and at his school. He is convinced that these tools are the ultimate solution to cutting wood. I wasn't ready to take that plunge, so I asked him to share his earlier work with metal planes. In this article I'll describe how Meadow would turn an ordinary block plane into a fine finishing tool.

This tuned block plane easily smooths a curly maple strip that showed severe tearout after a pass over the jointer.

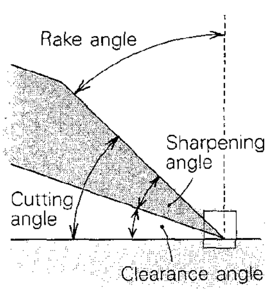
To begin with, Meadow claims that for fine work, hand tools are a practical, even superior, alternative to machines and abrasives. Planes remove wood a lot faster—and cheaper—than sandpaper. The surface is clearer, feels better and is far more beautiful than an abraded one. Of this last I have no doubt, as Meadow later planed half of a $\frac{1}{16}$-in. curly cherry veneered tabletop for me on a visit to my own shop, in order to relax after a trying workshop. His surface was so much better than the adjacent sanded surface that I was inspired to tune up my own planes in order to complete the job. You can test this by applying a coat of oil to a wood surface sanded as smooth as you can get it. The oil will soak into the minute scratches that were left by sanding, leaving a dull surface that will require many coats of oil to improve. Apply oil to a planed surface and even the first coat will gleam.

Meadow says, "Tools, hand and power, are really only kits as they come from the manufacturer." Getting the most from a tool means not only mastering its use, but understanding how its design works and tuning it, or even reworking it, to do its job. A razor-sharp edge won't take a good shaving if the plane's bed is warped, nor will a perfectly lapped sole help a plane if its blade is sharpened at an inefficient angle. All the components must be balanced.

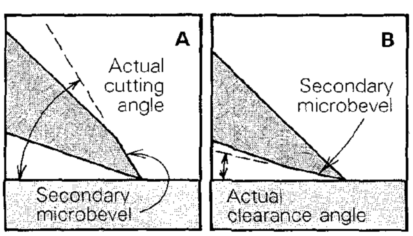
In order to soup up a plane, we must try to understand what happens between the cutting edge and the wood. Textbooks contain complex formulas on the subject, but Meadow bypasses the mathematics and goes directly to the results, talking in terms that craftspeople can understand.

A balance of forces—There is a complex balance of forces and resistances when you plane wood. *Back pressure* is the sum of all forces acting to keep the cutter out of the work. Some back pressure is due to the resistance of the wood to being cut, and some comes from friction generated by the plane's sole. Too much back pressure requires excessive effort. *Cutting pressure* is the force the blade exerts as it cuts the wood. A sharp blade working at the correct angle exerts only a small amount of cutting pressure, just enough to sever the wood fibers right at the cutting edge. If the pressure at the edge overcomes the fiber strength of the wood very far ahead

Fig. 1: Plane geometry



A secondary microbevel deliberately honed onto the face or back of the plane iron will increase its cutting angle (A) or reduce its clearance angle (B). This can help you in dealing with ornery woods, reduce deflection and chatter, and prolong the life of the edge.



Honing the iron with a soft strop or a buffing wheel is liable to add an unwanted, rounded microbevel. On the face of the iron (C), a rounded bevel will increase the cutting angle. On the back of the iron (D), it may so reduce the clearance angle that the iron can't cut at all. Bearing down too hard while sharpening is liable to reduce the sharpening angle and leave a fragile edge (E).

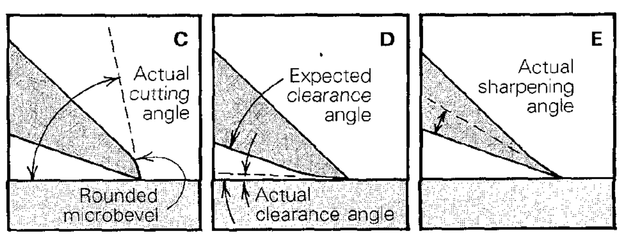
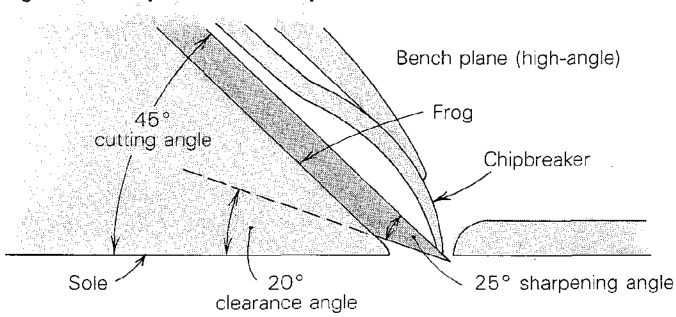
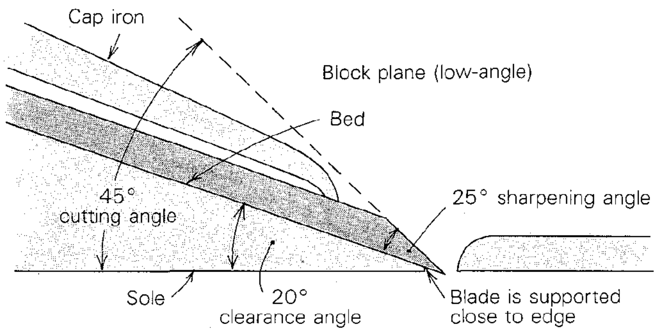


Fig. 2: Bench plane vs. block plane



A high-angle plane and a low-angle plane can both have the same clearance angle, the same sharpening angle and the same cutting angle. But the low-angle plane suffers less from deflection and chatter because its blade is better supported at the cutting edge.



The block plane's cutting angle can be adjusted by honing a secondary microbevel on the face of its iron, and this change does not affect its clearance angle. But a secondary bevel on the bench plane's iron reduces only its clearance angle, without affecting the cutting angle.

of the blade, hardwoods will tear out, and softwoods will compress and crush. *Leverage* refers to the tendency of the cutting pressure to bend or deflect the blade at the cutting edge. Leverage varies according to the bed angle, the cutting force and how well the plane body supports the blade.

Edge geometry—The geometry of the cutting edge—its cutting angle, sharpening angle and clearance angle—are familiar concepts, but they can be deceptive (figure 1, p. 65). Slight changes in the angles right at the cutting edge, made by microbeveling. or stropping, can yield actual working angles that are very different from those built into the plane. These angles can easily be varied and balanced to suit particular jobs.

The *cutting angle* affects the amount of cutting pressure and the way it is applied to the wood fibers. Softwoods generally require a lower cutting angle than hardwoods, otherwise the wood can crush ahead of the blade. On highly figured hardwoods, a low angle introduces a riving action that causes tearing out. Western planes have a variety of cutting angles ranging from bench planes at 40° to special scraping planes at 115° or more. For a block plane, the cutting angle is actually determined by the *sharpening angle,* as shown in the comparison between the bench plane and the block plane in figure 2. By varying the bevel angle or by adding a microbevel not much wider than the shaving is thick, you can, in effect, change the design of the plane. On a bench plane, the sharpening angle is a compromise. The lower it is, the sharper the edge (but thinner, more fragile and more subject to deflection); the higher the angle, the sturdier the edge, but increasing the sharpening angle simultaneously reduces the *clearance angle.*

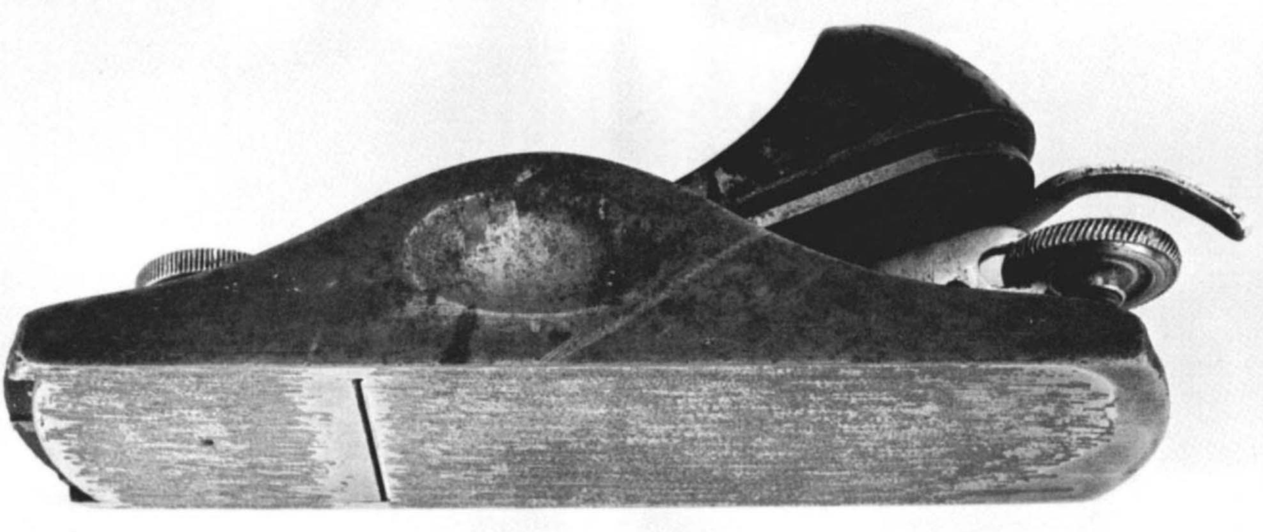
Clearance reduces back pressure. The cutting edge must press downward, thus compressing the wood as it works, but the wood springs back immediately after the cut. The clearance angle makes space for this expansion. Harder woods require less clearance, while softer, more compressible woods require more, but all woods require some. Insufficient clearance causes friction that heats the cutter, dulling it quickly. A plane iron loses clearance as it dulls. This tends to hold the blade out of the cut, so that the plane skids without cutting.

Why choose a block plane?—Metal planes can be divided into two basic types: bench planes (high bed angle, bevel down) and block planes (low bed angle, bevel up). These planes can look very different yet have essentially the same clearance angle and cutting angle. The ubiquitous Stanley and Record bench planes are a good example of high-angle design. The cutting angle is set at 45° by the frog, and the clearance angle varies according to the sharpening angle. These planes suffer badly from leverage problems and blade deflection, causing chatter and torn wood, because the blade is not supported close to its edge. This weakness is compensated for by the chipbreaker, a misnomer, as its function is more to pre-stress the cutting edge than to break the chip.

In a block plane, clearance is built into the design by the plane's bed angle. This angle is usually either 20° (Stanley No. 9½) or 12° (Stanley No. 60 or 65). Because the block plane's iron is mounted bevel up, clearance can be modified only by adding a microbevel to the back of the blade, or by stropping. The bed supports the blade right up to the edge, effectively eliminating leverage problems. The cutting angle is variable, determined by the sharpening angle. Meadow says that most woodworkers will find a low-angle block plane to be the best bet for tuning up as a fine finishing plane.

Tuning a plane—For this article, we modified an old No. 9½ block plane. Start by making sure that the back of the blade is perfectly flat, by truing it on a series of stones, on plate glass with carborundum powder, or on diamond-coated steel plates (EZE-Lap-Diamond Sharpening Products, Box 2229, Westminster, Calif. 92683). Then check the mating of the blade to the bed, especially right at the throat. Coat the back of the iron with machinists' layout dye or artists' oil paint (phthalo blue works well) and position it on the bed. When you remove the iron, blue dye on the bed will mark high spots that need to be filed down. If there is any space at all between the iron and the bed, it will fill with dust as you work, deflect the edge, and cause uneven shavings. Remove the burr left by hand-filing, then square up the front edge of the bed by filing a narrow land, just wide enough to see.

Now flatten the bottom of the plane, with the blade tightened in place so the plane body will be stressed as in use. Lap the sole flat or have it ground flat by a machine shop (*FWW* #35, p. 87). This cures the common problem of a store-bought plane that bears down most at its ends, leaving the plane body unsupported at the cutting edge and inviting chatter. The plane actually needs to bear only at its throat and at both ends of its sole. Meadow speeds the flattening process by using a ball mill in a Dremel tool to hollow out parts of the sole, much as the Japanese relieve the soles of their wooden planes. This looks terrible, but it reduces friction and back pressure without affecting the tool's stability.



Its sole relieved with a ball mill to cut friction, the plane bears only at its ends and its throat, and leaves a smooth surface.

Now the iron must be properly sharpened. Meadow shapes his bevels flat, not hollow-ground, in order to limit deflection. He shapes the primary bevel to about 25° and then hones the secondary microbevel to whatever angle works best. Steels vary. For any blade, if the sharpening angle is too small, the blade will tend to chip. If the angle is too large, the blade will get dull a little more quickly. It's a lot easier to hone a blade sharp again than it is to reshape a chipped edge. So each time he hones a particular blade, Meadow gradually makes the sharpening angle smaller until the blade starts to chip, then he retreats. The ordinary alloy-steel iron in the No. 9½ plane is prone to chipping even when sharpened at 25°, so we thickened it up by putting a few degrees of microbevel onto its flat back side. This simultaneously reduced the plane's clearance angle, which is generally not a good idea. But the 20° clearance angle built into the No. 9½ is several degrees more than necessary for planing hardwoods anyway.

The edge of the plane iron should not really be straight but slightly convex, so that a full-width shaving will feather out to nothing at its edges. Meadow makes this curve by bearing down more at a corner as he sharpens. The amount of curvature is greatest on a roughing plane and least on a fine plane: it should approximate the thickness of the shaving.

Meadow cautions that too much pressure when sharpening distorts the metal at the cutting edge. When the metal springs back, the blade has an actual sharpening angle smaller than anticipated. This results in too thin an edge which, although sharp, will quickly break down.

Meadow does not use a leather strop because its surface is too soft. It rounds over the edge, changing the plane's geometry. Instead he makes a hard strop from fine-textured wood—cherry, pearwood, poplar or basswood—planed even and smooth, not sanded. He then rubs a little wet mud from his waterstones onto the wood. When the abrasive mud dries, the strop is ready. Meadow recommends the same procedure for honing carving gouges. Take a pass with the tool on a piece of scrap, and you've made a wooden slip-strop that matches its curvature. After stropping, Meadow washes the blade and his hands in clean water to remove abrasive particles, and then wipes the blade dry and laps it on the palm of his hand.

Adjusting the throat opening is the last step before making a shaving. The throat should be narrow enough to compress the wood ahead of the blade, but when the blade is sharp, the throat opening isn't critical—tearout will be prevented mostly by the geometry of the cutting angle. As the blade dulls, narrowing the throat will eliminate some tearout, but friction and heat will increase the rate at which the blade dulls, and may even draw the steel's temper. Again, a balance is necessary.

Now the plane should work perfectly. If he encounters problems with a plane, Meadow doesn't automatically blame the cutting edge, but rather looks to see if the planing action is unbalanced. The tightness of the cap iron, for instance, affects both the plane body and the blade. When your plane is set up perfectly, you will find that you can vary the thickness of the shaving just by tightening or loosening the cap iron.

Meadow quotes the Japanese saying, "A master is the person who sharpens least and has the sharpest tools." The real enemies of a sharp edge are friction and impact. Dragging a plane backwards across the work, between strokes for instance, dulls the blade, as does too narrow a throat or insufficient clearance. The most dulling part of the cut is the impact of forcing the edge into the wood in the first place. As long as the edge is firmly in the cut, and doesn't chatter, it dulls relatively slowly. A well-tuned plane helps keep edges sharp. Meadow adds that oiling the cutting edge reduces friction. A thin film wiped on with the fingers is enough, but it must stick to the blade and not be wiped off. Meadow uses camellia oil, but olive oil also works well.

The next step in tuning up a plane, Meadow says, would be to replace the standard blade with one made of laminated steel. Japanese plane irons are laminated, but practically impossible to fit into a metal-bodied plane. Another possibility is to use an old iron from an antique wooden-bodied plane. These heavy, tapered cutters are made of mild steel with a forge-welded edge of high-carbon steel. The qualities of the carbon steel and the forging process create an iron that is capable of taking and holding a much keener edge than the alloy steel used in modern irons, which compromise cutting qualities for ease of manufacture. It would probably be easiest to adapt a laminated iron to a bench plane rather than to a block plane; some ingenuity would be required, but in the long run it might be well worth the trouble.

In woodworking, as in any discipline, the best work can be done only when our tools inspire us. Whether they are antique or modern, Western or Japanese, the challenge is to use them to their fullest potential. But in the end, says Meadow, a craftsperson's most valuable tools are his or her own perception and understanding. □

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