Friction Folders

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As promised last month, what follows is a description of my approach to friction folders. If you're interested in these and other 'primitive' folders, you ought to be aware of Gene Chapman's books (see references).

I start with selecting an antler tip - what I look for is one that is as close as possible to round in cross section, with a decent curve (which defines the blade plane) and that is symmetrical as possible on either side of the curve. The thickness of the tip and the projected blade length controls where to cut it (see Fig,1). The cut mark is about 4" from the end.

Figure 1: Antler tip

The next stage is to saw the antler along the blade plane. It isn't easy to hold the piece rock steady when sawing, so (of course), I built a jig (Fig.2). It consist of a wood base, two edge blocks with long bolts that press on the two sliding clamps. Those clamps are held down by two bolts that slide along slots cut in the base. The blade plane is marked and the side clamps adjusted until the tip is held in the correct orientation.

Figure 2: Sawing jig

Sawing is done on a wood cutting bandsaw. Since the tip is being compressed by the clamps, it's only a short matter of time before the blade binds. To prevent that, as soon as the blade is fully inside the tip, a small wooden wedge is inserted into the slit (Fig,3) to keep it from closing and to maintain the clamp force which keeps the tip from creating more excitement that you really want. I typically saw until there is approximately 0.75" left unsawn. This is a definite judgement call - leave too much and the blade will be shorter, saw too deep and the tip might fail. Let the dimension of the tip and the quality of the material dictate the decision. My band saw has about a 0.04" kerf and the usual blade material is close to 0.125", so I usually make three passes. To maintain the setup, the saw is turned off, the blade is moved back until it's back edge is about to touch the tip of the wedge. A second wedge is tapped into the slit in front of the blade and the first wedge is removed. The 2nd (and eventually, the 3rd) cut is started and the process described above is repeated.

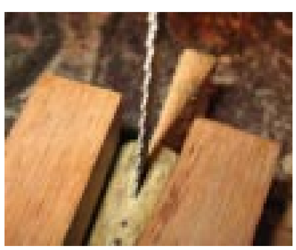

Figure 3: Wedge in use

Unless you are far better at sawing the me, the slit is anything but smooth, especially after multiple passes. While you can either use a file or sandpaper stretched over some scrap sheet steel to sand the walls of the slit, I've found that slipping it over the belt on my Bader (Fig.4) and rubbing it back and forth works. Since the Bader turns over at 2800 SFPM (31 MPH), this is done with the motor OFF. Because I get real lazy at times, I did try it on my variable speed 2x72 grinder at dead slow and was able to (1) sand the slit and (2) kept all my finger tips. If you want to try this with a motor running, first envision what will happen when the tip slips out of your fingers and goes for a ride.

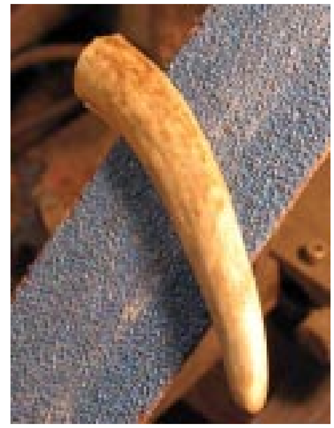

Figure 4: Smoothing the slit

Since the blade has to pivot in the slip, it is critical that the hole that the pivot pin rides in has to be perpendicular to the slit. Given the irregularity of the usual antler tip, this is NOT easy to so free handed. Yup -- another jig is coming.

I made a drill plates from pieces of scrap 16 gauge steel about 3" square and drilled a 1/2" hole on the center line, close to one edge (Fig,5). Slip as many plates needed to approximate the thickness of the blade (probably 2) into the slit and positioned the tip over the hole. On a drill press, clamp the assembly in a cross-slide vise with the plate resting on a set of parallels. This gets you close to making the hole in the correct orientation. Unfortunately, there is a flaw....when the drill bit hits the other side of the tip below the sheet, the other side of the tip will be pushed away. To stop that from happening and to lock the tip in the correct orientation on the drill plate, I fabricated a small clamp from some scrap angle iron and a couple of bolts (Fig. 5 - the blue object). The clamp has two drill ports to allow drilling through the clamp, top and bottom.

Figure 5: Drill jigs

Once the tip is locked to the plate and the plate is locked in the drill-press vise, the pivot hole can be drilled accurately. Because of the dimensions of the pivot tube to be used, the hole is drilled with a #22 bit (0.157”).

Figure 6: Drill jigs in use

If you don’t want to fabricate the clamp, you might want to pick up a 6” hardwood handscrew clamp (Harbor Freight; 6986-1VGA; ~$6) which ought to work with a bit of modification.

Since I want to use a 6x32 stainless button head cap screw, I also need to drill a recess for the screw head. It turns out that the head is just about 0.25” in diameter, so a 0.25” two-flute center-cutting end mill will do the trick. After drilling the hole and before moving the assembly, I swap the end mill for the drill bit and make the recess (about 0.125” deep). I then flop the whole assembly over, replace the drill bit and use the cross slide to reposition the assembly so that the drill bit will slide into the pivot hole. The vise is locked and the end mill employed again to make the second recess.

Figure 7: Blade tip pocket

The last step on the actual tip is to create a blade tip pocket (Fig.7). Eventually, the blade must store in the tip without exposing the edge. An easy way to achieve this is to grind a slope at the end of the slit with a micro die grinder. I use a 1/8” carbide bit (because I have it, that’s why!) and try for about a 45 degree slope.

The next item is the pivot tube. I could have used a rivet rather than the semi-elaborate scheme I’m about to describe, but what fun is that? Besides, the pivot tube allows the user to adjust the level of friction to whatever they prefer.

The pivot tube starts as a 5/32 brass tube (OD=0.156”, ID=0.128”, K&S Stock#128 - at many ACE Hardware stores) A #6-32 screw has a major and minor diameter of 0.1380 and 0.1312” respectively, so there is enough room to tap threads in the tube (0.104 is a 75% thread, so 0.125 is a bit loose). The trick to tapping a fragile, small tube is the same one used for cutting mosaic pins. Get a small block of hardwood - say 3/4” x 1” x 2” (oak is fine). Drill an undersized hole (in this case, a #23 bit) through the 3/4” side about 1/2” in from one end and on the center line. Bandsaw a cut through the hole and out the other side (leaving 3/4” uncut). You can now slip the tube into the hole and clamp the block in a vise. The tube won’t crush and won’t move -- well -- at least for me (Fig.8).

I measure the width of the tip at the pivot hole with something close to the blade thickness in the slot. I subtract the depth of the recesses and cut the tube to that length less a midge (that’s a metric midge, of course) using a micro-tube cutter. The cutter deforms the tubing inward but the tap doesn’t seem to care. I use a neat tool available from MSC (shown in Fig.8) to do the tapping. It consists of a tap holder which sleeves into a stabilization sheath. You hold the sheath with one hand while turning the holder with the other. It pays for itself by dramatically decreasing the number of broken taps. I run a 6x32 tap through the tube section, clean up the ends if needed and the pivot tube is done.

Figure 8: Tapping tools

To make the action a bit smoother, I use a pair of copper washers on either side of the blade. The washers are made with a precision punch set (basically two blocks of plexiglass with specific aligned holes and corresponding polished punches (Fig.9). I use a 5/8” strip of thin copper (0.010”) and punch a 3/16” . I then use the alignment tool shown in Fig. 9 to center that hole in the 1/2” well. The actual 1/2” punch is then inserted, driven home and another washer is born.

Figure 9: Washer creation

The last major step is the design of the blade. Since every antler tip is likely to be unique, so will every blade. I start by punching a hole in an index card and drawing a circle centered on the hole. The diameter of the circle is just a bit smaller than the height of the tip at the pivot point. I find that an old plastic template is a nice tool for this but a compass would work just as well.

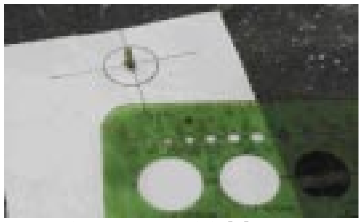

Figure 10: Initial layout

The next step is to trace the outline of the tip on the card (making sure the hole in the card corresponds to the pivot hole, then sketch in a edge inside the outline of the tip (see Fig.11). Sketch in a tip that will fit in the blade pocket mentioned above. Pick a spot outside of the tip and about midway between the pivot and the tip. Connect the tip to that point and draw a line from that point to beyond the circle. Add a fat tail and the layout is completed. Cut out the blade and slip in into position. I use an ‘L’ shaped 1/8” diameter wire as a stand in for the pivot tube. What results is shown in Fig.12. Move the blade until it makes a pleasing angle to the handle, then mark the paper along the upper edge of the handle. That process defines the shape of the tail. The final result is shown in Fig.13 - the model to be used for cutting out the blade.

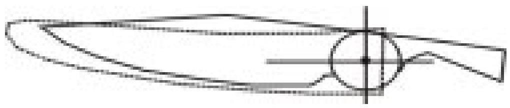

Figure 11: Completed layout

Figure 12: Paper blade in place

I used 624 layer random-pattern Damascus for my blades. The material was forged down to approximately 1/8” x 1” and annealed. The blade profile was scribed onto the bar and the was cut out using a vertical/horizontal bandsaw (a Harbor Freight cheapie with a decent bimetal blade). I used my precision surface grinder to take the material down to approximately 0.11” (translation - I keep grinding until the hammer marks were gone on both sides). The bevels were then ground taking care not to mess up the pivot area (the circle mentioned above). This process is greatly enhanced by making a blade holder (Fig.14). The holder is a strip of 3/16” x 2” aluminum about 8” long with a 1.5” piece drilled and tapped as shown. The pivot area is clamped (and is thus safe) and the blade can be ground by hand. The holder can also be used for sharpening after heat treating and etching. If you are not using Damacus, just buy some precision ground tool steel and saw away.

Figure 13: Final blade profile

Figure 14: Blade holder

Heat treat the blade appropriately. Of course, it’s not a bad idea to trial fit before heat treating - just in case the tip needs adjustment .You also need to decide what type of ‘bob’ you want on the tail of the blade. You can simple roll up the end (probably using a torch for heat - and remember to normalize!) . You can also solder on a couple pieces of mokume or nickel silver or just use a copper rivet. If you plan on doing this, be sure to drill the appropriate hole in the tail before the heat treat.

All that is left is to assemble the knife. Run a cap screw into one end of the pivot tube, slide it in just enough to catch a washer, the a touch more to catch the blade, then a tad more to catch the other washer and push it home. A tiny wood wedge to spread the sides and a thin push stick helps a lot here. Screw in the remaining cap screw and adjust the tension and you are done.

References

Chapman,Gene (1993). Penny Knife - A Colonial Style Folding Knife. 19 pgs.

Chapman,Gene (1994). Little Uglies - Blacksmith Folding Knives. 12 pgs.

Chapman,Gene (1995). Antler & Iron II - Building a Mountain Man Folding Knife. 40 pgs.

Chapman,Gene (1996). Country Knives. 26 pgs.

One source is http://www.oakandiron.com/