

STATE OF THE BOW: When we get to this point in the process, you should have a potential bow outline cut or chopped out of a board, with a margin of extra wood left outside the lines. It should be straight, or straightened with heat and/or steam enough so you can pull a tight string from the middle of one tip, over the center, to the middle of the other tip. Your bow design should be drawn (or redrawn after straightening) so the centerline lines right under the string. We've purposely left the tips wide for now, so they don't have to be perfect. But make sure your straight line has at least 1/4" of wood on either side at both tips for final adjustments. When you're ready to proceed with your bow, it's now ready for you.

But first, let's go over tools and techniques for safely and precisely removing wood. Because removing too much is a costly error on a bow project, we'll emphasize controlled cuts. Our clinic may spend some time turning scrap pieces into sawdust. Let's look at some tools and equipment you might use. You'll be able to use some of these on scrap wood so you can find what works for you before buying everything.

HAND TOOLS (from rough work towards finer):

- **Hatchets, Axes, Adzes, Mauls, Mallets and Wedges:** for staves split from logs, these are great. For boards, not so much - but if they are what you have, you can make them work.
- **Chisels** are narrow (less than bow width), edged, impact-cutting (away from user) tools that cut through wood fibers and raise a substantial single chip. They can work fast if you are expert in their use, and can also destroy a bow project almost as fast as power tools (discussed below). I find these of limited use, except for one specialty application - removing wood partitions between saw cuts. From woodworker, hardware, home stores.
- **Filing and Rasping Tools.** These are essentially multi-toothed metal surfaces that act like sandpaper, taking lots of small wood particles at once leaving a reasonably smooth surface. Because this is spread over an area, you're much less likely to cut off too much with a single stroke- something you can easily do with a chisel. Woodworking files come in many grades from fine to coarse, and with flat and or rounded surfaces. *Hint: don't do bow work with a file from your basement also used on metal. It's been dulled and won't cut consistently the way we need. Save it for refreshing scraper edges (described below). Get yourself a good quality file and keep it for wood only.* Specialized versions of interest:
 - Chain Saw File *this small diameter, round file is useful for cutting string notches and rounding tight corners. get anywhere.*
 - Riffler Files *very small round, triangular, and flat files for detailing arrow shelves, bow tips, cleaning string notches. You can do most anything a riffler does with small pieces of sandpaper over pieces of metal or wood shaped as necessary.*
 - Surform Tools *have rounded handles holding replaceable, perforated metal cutting surfaces. Inexpensive form of rasp, available with rounded and flat surfaces, in many configurations. You might like them, I tend not to use mine much on bows. From hardware and home stores.*
 - Farrier's Rasp: *These are the brutes of the rasp world, made for shaving down horses' hooves. They are long (18"+), massive, and usually have a coarse and medium (by comparison) cutting side.*
 - Nicholson Files: *Dave likes these quality tools - look at the #49 and finer #50 Patternmakers' Rasps.*

- **Planes, Shavers & Scrapers:** are bladed tools designed to remove small depths of material to even out irregularities over longer and/or wider surfaces. Planes are usually pushed, shavers and scrapers usually drawn toward you. Woodworkers have invented countless designs for specialized applications. Here are some that work for us....
 - **Block Planes:** smooth lengths of wood to a flat surface. Most useful before staves are bending, for example to prepare the back surface for another lamination. Very long ones aren't helpful if the wood isn't perfectly flat - like a board. But boards don't usually need planing.
 - **Thumb Planes:** at the opposite end of the spectrum are these tiny tools which can be used to work out tool marks or ripples in the surface; there are many varieties suitable for flat or curved surfaces.
 - **Drawknives:** these have a wide blade and are pulled toward you with two handles. You control the angle of the blade, and it takes experience to avoid cutting into the stave too deeply. Useful for rough shaping logs, removing bark, and "chasing rings" when taking a rough stave bow down to a single back ring.
 - **Spokeshaves:** combine aspects of drawknives and planes; the soleplate sets the angle of the blade so material removal is controlled by setting the blade, not manually maintaining a certain angle. Less dangerous to use.
 - **Scrapers:** favored by cabinet makers for centuries (or millennia, perhaps) these are flat metal surfaces with one edge held down onto the wood and pulled toward you. That edge needs to be "burnished" or "dressed", to create a small, consistent burr that actually cuts a sliver of wood from the bow surface as you pull. I use scrapers as much as any other tool while tillering a bow. "Sandvik" cabinet scrapers are usually very fine quality.
 - **"Bowyer's Edge"** designed by famous bowyer and author Dean Torges, this combines a scraper-type blade in a spokeshave, making a particularly effective tool for tillering. since it leaves a finished surface requiring little or no sanding before pulling again. Mine takes a bit more wood per pass than my cabinet scraper, so I generally shift to the latter when getting close to final tiller.

- **Sand Paper and Sanding Blocks:** used much more than you'd expect, many times these provide just the limited amount of wood removal you need, especially near the finish. Thousandths of an inch make a difference then. I find a thin layer of cork glued onto the bottom (working surface) of the sanding block helps improve the wood finish and makes sandpaper last longer.
 - **Quality Sandpaper** from 3M lasts far longer, and provides better results. You'll use 60/80, 100, 150, and 400 grades.
 - **Sanding Belt Cleaner:** these sticks pay for themselves by removing sawdust and other debris from your sandpaper surface. Keeping sandpaper unclogged lets each stroke removes about the same amount of wood.

- **Sharpeners** whatever edged tools you use, sharp edges will help you control your cuts - dull edges require more effort and tear rather than slice through wood fibers. The result is unpredictable under- and over-cuts as well as dangerous slips. Have a sharpening or blade replacement plan for every tool. I use a diamond "stone" with medium and fine surfaces for most all sharpening.

- **Burnishers** are the difference between pieces of sheet metal and efficient scrapers. They can be rods with handles, or simply the hardened round shaft of a screwdriver. Use your metal file to cut a fresh, smooth edge on your scraper, then run the burnisher over the filed surface to create a clean, even burr. It's this slight burr that does the scraper's work. Dean Torges also recommends first "consolidating" each scraper side by your filed edge by running the burnisher over it until shiny - that will make a more consistent burr. Some bowyers also swear by burnishing the bow's back with burnisher or glass bottle to prevent splinters from raising.

POWER TOOLS (Again, from rough to fine work)

- 🔪 **Chain Saws** are crude, but for some tough logs like hornbeam and elm, they save a lot of splitting work.
- 🔪 **Sawzall** reciprocating saws are useful for trimming limbs from rough logs and cleaning up splintery splits.
- 🔪 **Table & Circular Saws** help with trimming boards to initial outlines, and when set up with jigs can do reasonable tapers. A circular saw can also be used to cut starting grooves for wedges when splitting tough, interlocked-grain logs like hop hornbeam and elm.
 - * *Note: The following tools generate considerable sawdust, and some bow woods can cause lung and allergy problems. These should only be used with adequate ventilation, good dust control and breathing protection.*
- 🔪 **Band Saws** THE champion time-saver for bowyers. Great for cutting curved bow outlines from boards, doing initial limb tapers (leave one side flat for this), and so much more. 14" and above can resaw laminations for backed bows. With simple fixtures it's easy to cut curved handles and do high-quality limb splices.
- 🔪 **Planers** for laminated bows, these provide much more consistent thicknesses and smoother gluing surfaces. With taper sleds, they can produce matched limb cores with constant tapers from tip to fade. **Thickness sanders** can provide similar precision and improved finish - but they are much more limited in how much material they can remove at one pass. **Hand Planers** can provide good glue surfaces, but are a lot more limited compared to the machine.
- 🔪 **Drum Sanders** (special purpose machines, or abrasive sleeves on drums mounted on drill presses, or hand drills) These can be very helpful smoothing the many curved profiles on bows, and tempting to overuse. You're taking your bow in your hands - a few seconds too long in one place and you'll ruin your tiller. It is perilously easy, especially with hand drills, to remove more from one limb side than the other, or to go too deep in the fades creating a fatal hinge. But you can reduce pressure in pneumatic drums to help follow curved surfaces much like sanding with a foam block, only faster.
- 🔪 **Belt Sanders** can, with care, help smooth handle curves - but also can easily take too much. The safe alternative is a strip of sandpaper secured to wooden handles, a 1" narrow sanding belt held at each end, or foam sanding block.
- 🔪 **Dremels/Drills** can do detail sanding and shaping on handles, arrow shelves, and tip nocks. Look for carving bits. For heavier cutting, such as initial shaping of bulbous pistol grips, you can also use end-mills and "roughs" in hand drills.

HOLDING, MEASURING & MARKING

- 🔗 **Bowyer's Bench** (also known as a "Shave Horse") is a superb setup for holding long uneven work pieces - like wooden wheel spokes, barrel staves, and bows. You sit on the end of the bench and press your foot against a lever that provides clamping force while you pull a drawknife down the work. Dave Martin has made one we have used on the range.
- 🔗 **Vises** fasten to a solid surface, and providing clamping force to hold the work. While I use flat rubber inserts to protect the wood from the vise jaws, leather and plastic jaw inserts also work. You'll want a jaw capacity larger than 2", so you can hold a stave and inserts during the early stages - go for 4" + if possible. There are portables which clamp onto tables; swivel models will be helpful.
- 🔗 **Bench Stand** I find it very helpful to have a small stand on your workbench or table the same height as your vise - this secures the middle and one end of the bow while you're working on it. I have a couple which can hold the bow during finish coating.
- 🔗 **Tripod** a photographers field tripod can do double duty as a support for the end of the bow that isn't on the bench or table. I bolt a short length of leather-padded wood onto the top of the tripod - without some length of support you have to move the tripod every time you flip the bow from one side to the other.
- 🔗 **Clamps** of all varieties can find applications in bow making. Large C-Clamps are used while heat bending, and smaller ones are often used to hold layers together while glueing up laminated bows (I prefer lengths of bicycle inner tubes - they maintain constant pressure on the lamination).
- 🔗 **Rulers and Tapes** a 4' steel ruler will be handy in laying out bows and checking straight edges. A 2' is handier for common tasks. An 8'-12' tape measure will be used frequently - at the wood stacks, for example. A self-adhesive tape measure on the front of the workbench will come in handy all the time - mine has torn off and while waiting for it's replacement I really miss it.
- 🔗 **Bow Weight Scale** or inexpensive 70# luggage scale will come in handy during tillering, as will a **Tillering Stick** with string-holding notches, and a cutout on one end to hold the bow handle while you pull down on the **Tillering String** (an extra long, strong bowstring used in the early stages of tillering).
- 🔗 **Outside Calipers** these simple and ancient devices are invaluable as you're shaping a stave, to ensure that the taper is always from fade to the tips, and the both sides are the same thickness. Look for screw adjustable ones, rather than friction hold.
- 🔗 **Pencils & Erasers** carpenters pencils hold up better - and forget about pencil-mounted erasers. On wood they wear out in minutes. Get large erasers from office or drafting supply stores.
- 🔗 **String** there are many times during the making of a bow that you'll want to check straightness and alignment- have some string around.
- 🔗 **Work Lighting** you must be able to see what you're doing. A gooseneck lamp will help you see bumps and dips in bow surfaces.

•🏹• WOOD REMOVAL STRATEGY - HOW TO AVOID MISTAKES

•🏹• **Mark Your Target Line**

- 🏹 **Make it Conservative** - no need to do the entire thing in one pass. We suggest you make one or two intermediate lines as you work down to the final dimension.
- 🏹 **Make it Match** - double check that your lines measure equally on both sides
- 🏹 **Make it Visible** - use a soft enough pencil or marker to make sure you can see the line easily, even when moving the bow puts it in shadow.

•🏹• **Chamfer Sides to your Line:**

- 🏹 Use a tool you're confident you can control - hand tools preferred. I prefer the medium side of the farrier's rasp.
- 🏹 Start on one side of the work, starting about 1/4-1/3 width from the edge, and remove the corner down to your line. 3/4 to 2/3 of your starting surface shouldn't yet be untouched. And you should always leave the line.
- 🏹 Now do the opposite side, from 1/4-1/3 width from the other edge, down to that side's line. Remember - **Leave the Line!**
- 🏹 When done with this, you should have an untouched center section, between two angled sides. If the two angled sides aren't the same width, try to match them - we want the bow limbs symmetric.
- 🏹 **Remark** your line with the flat of a pencil - you can even mark up the entire angled surface on either side. Be sure you can see a heavy mark down to your original line.

•🏹• **Remove the Center Section**

- 🏹 Using the tool(s) of your choice, take down the center flat.
- 🏹 Watch the marks on both sides, be especially careful as you approach the lines.
- 🏹 Consider changing to sandpaper as you get close.