-SPECIAL REPORT-

Easy Alignment of Recurve Bows

Jim Thorne

www.BuildYourOwnBow.com

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EASY ALIGNMENT OF RECURVE BOWS

A step-by-step guide for aligning fiberglass recurves

By Jim Thorne
Bowyer and author
at BuildYourOwnBow.com

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About the Author...

My name is Jim Thorne and I can help build your own bow! You may already know me as "jwillis" on the internet archery forums where I often share ideas about making bows.

I made my first bow from a green stick that I found in the yard when I was a boy. I bent it over my knee and tied on a twine string. It was simple and primitive but really fun to shoot. The next few days were spent chasing my brothers around the yard and shooting twig arrows at each other while we pretended to be cowboys and indians.

I really caught the bow making bug in the 1980's. I made fiberglass-laminated recurves using a limb design that I traced from a french curve. I spent several years building and testing these bows, improving the limb and riser designs and refining my skills as a bowyer. At this time, every time I wanted to change the design, I had to redraw the plans by hand. As a graphic designer, it didn't take long for me to begin drawing bow plans on a computer. This really sped up the refinement process, because using the computer I could change a blueprint and get it into production very quickly. I could now accomplish in minutes what used to take hours. This process led to the creation of what I call the **Classic Take-down Recurve.**

When my son asked me to make a longbow a few years later, I began building reflex/deflex "hybrid" longbows. I wasn't satisfied with so-so performance, so I studied all of the best designs. I copied all of the best features and combined them in my design. I drew out the profiles in Adobe Illustrator and tweaked the limb profiles using Supertiller, a computer modeling program for "stick bows." After several prototypes, I settled on the design I call the **HAMMER Hybrid Longbow.** I call it that because it "hits like a hammer and drives nails" (grin). Over the years, I've continued to improve the design, making it into a pretty sweet shooter.

At some point it occurred to me that I should share my blueprints and teach others to make these bows. It has been a lot of work! I've spent hours and hours building and testing the bows, and drawing improved blueprints.

I hope that you can learn from my successes and failures, and use my blog posts, booklets, and blueprints available at www.buildyourownbow.com, to help you **"Build Your Own Bow! —** Jim

Here's What You'll Learn...

- Discover three (3) best ways to check the alignment of the riser and limbs.
- Learn how to check and fix problems with the string nocks, including how to make symmetrical and identical limb tips and string grooves.
- Learn how to cut the string nocks using the "two-cut" vs. the "one cut" method to allow proper string clearance.
- Learn how to fix riser and limb misalignment due to misaligned limb bolt and alignment pin holes.
- Learn the value of long string tillering and short string tillering so you can avoid twisting and bow profile problems before they occur.
- Learn how to measure the tiller on each limb and determine which should be the upper and lower limb.
- Quickly and precisely align and tiller your bow using my my **"four step procedure for centering the nocks."**
- Learn to say my "mantra" to help you remember which side of the nock to file deeper in order to eliminate limb twist.
- Learn when to "center the nocks" vs. when to "sand the sides."
- Discover the difference between the "dimensional" centerline and "torsional" centerline and how they affect the way a limb will pull.
- Learn how to mark and file the center string groove so any string will fit your bow and the string will return to the correct position at brace.
- Discover eight (8) primary causes of limb twist and how to avoid them.

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Introduction

When I started making bows, I quickly discovered that there wasn't much good instructional material available. The internet wasn't developed yet, and there were very few printed instructions available either. Yeah, there were a few magazine articles and books around, but the directions I found were all missing the information that I needed the most. It seemed that most instructions said to *"cut out the parts, glue them up into a blank, shape it...and there...you have a bow."*

Without a doubt, the most important missing information was **how to shape the limbs and nocks, and how to make the limbs pull straight.** I had no idea where to start. I didn't know whether to file the nocks, or to sand the sides of the limbs, or what to do. It was very frustrating!

Obviously, knowing how to align the limbs is incredibly important when making a fiberglass recurve! How could this information be missing? To make a long story short, it took me several bows and lots of trial and error to figure it out so I could do it quickly and with the confidence that I was doing it right.

In addition, after I had been making bows for awhile, it became obvious that some of the directions I had been following were just plain wrong. One resource in particular said to file the nock on the wrong side of the limb tip! You can guess why I was so confused and frustrated. It was also during those beginning experiences that I decided that one day I would create a how-to guide with the correct instructions so other beginning bowyers wouldn't have to experience the confusion and frustration that I had felt. This report is the result of that decision.

While learning by trial and error, I made mental notes about what a new bowyer really needs to know to get it right the first time. While preparing this report, my goal was to provide that missing information and create the best limb alignment process possible, with simple, step-by-step instructions that you can follow to help you align even your first fiberglass recurve with ease and confidence.

I hope you enjoy this report and are able to use it to "build your own bow!"

— Jim

Chapter 1: Preparing the bow

Before you can align, tiller, and balance your bow, there are several things that should have been built and shaped correctly up to this point in the process. This report will start with the assumption that these things have already been done. I will only review them in this chapter so you'll be able to get your bow ready.

Make sure the limbs and nocks are ready

Check and fix any problems with the string nocks:

- Visually inspect the string nocks and grooves to see if they are symmetrical and identical. If it is a take-down bow, take the limbs off of the bow and hold them side-by-side for comparison.
- If they are not identical, then carefully reshape the nocks with a chain saw file until they are cut to the same depth from each side, they are the same distance from the centerline of the limb, they are shaped exactly the same, and they are rounded into a teardrop shape. They should be finished at this point except for final sanding. The string nocks should be smoothed all of the way around the back of the limb tip so the string loop cannot grab and hold onto a high spot and cause the limb to twist.

How to make symmetrical and identical tips and string grooves:

Making symmetrical and identical string nocks and grooves is vitally important when aligning a fiberglass recurve bow. The shape of a recurve limb makes it very sensitive to torque and twist, so the nocks and grooves must be smooth and symmentrical so the string cannot catch on a flat spot and cause torque on the limb. Not only are well-crafted limb tips, string nocks and grooves functional, but they are also quite beautiful! Perfectly shaped tips, nocks, and grooves are easy to make if you are systematic in your approach in shaping the tips and filing the grooves. The following procedure reviews how it is done.

Start out by marking pencil lines for the grooves on the tips:

1. Mark a straight line across the back of the tip, but first take a moment to use a measuring tape to make sure the line is the correct distance from the center of the riser so the bow so each limb will be the right length for your design.
2. Continue the line from the back side down the side of the limb, across the belly, and back up the other side. The line will go completely around the limb.
3. Measure about 5/8" towards the riser and make a second line across the back,

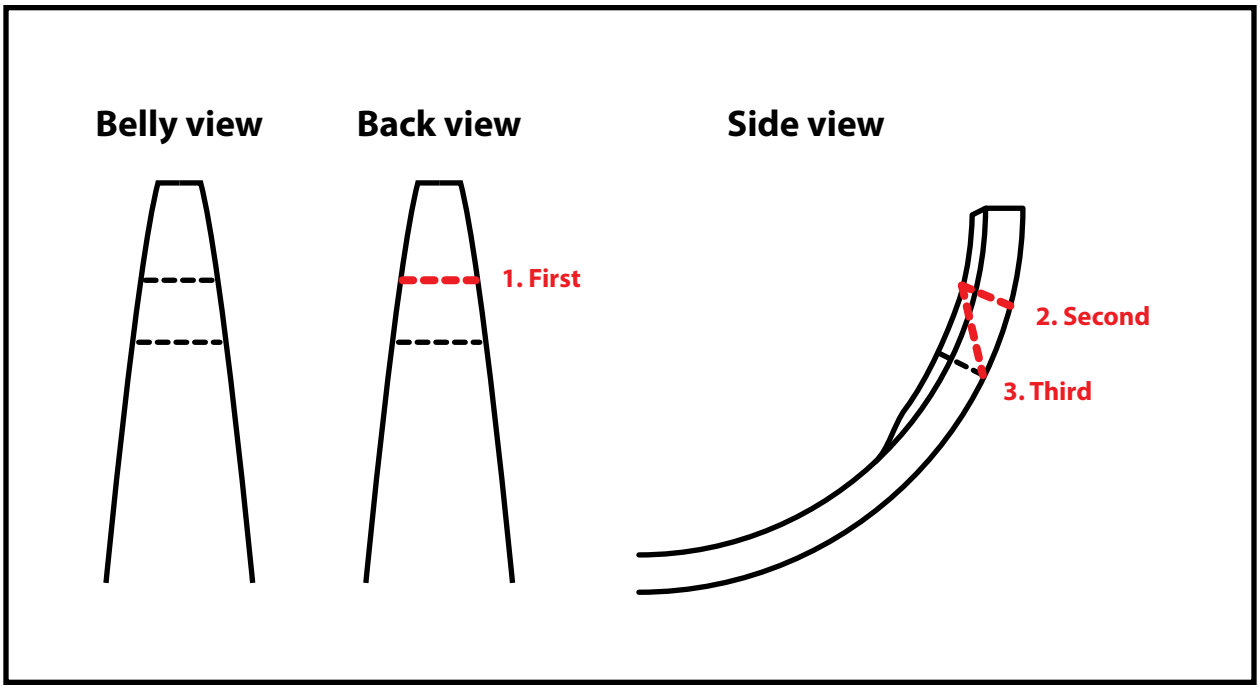


Diagram of the guide lines for the nocks. The dotted lines are pencil lines. Mark the straight lines completely around the back, belly, and sides, then mark the angled lines on the sides. The red lines will be filed.

down the sides, and across the belly.

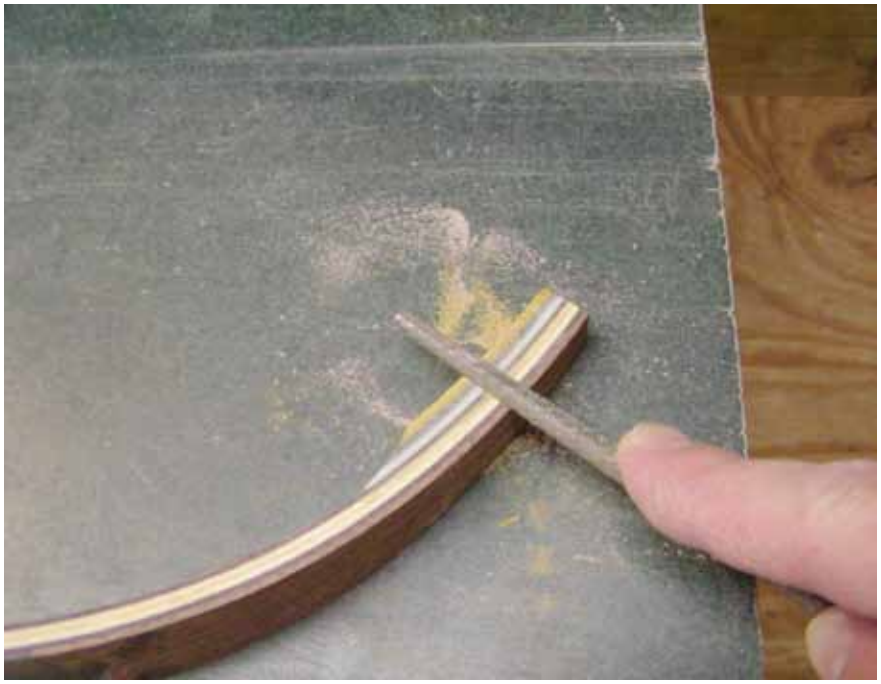
4. Mark a third line on each side at about a 45 degree angle that connects the top and bottom lines (see diagram above).

File the string grooves using the "Two Cut Method:"

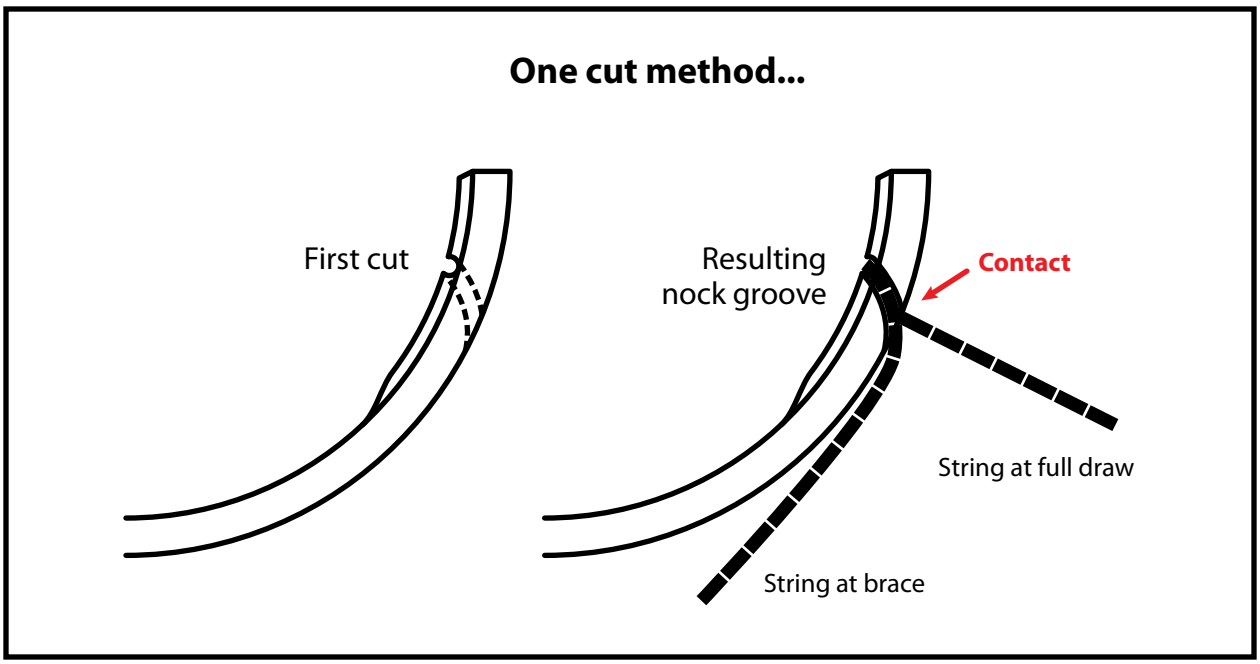
1. First, file the groove straight across the back (the red line marked "First"—see the diagram above and the photos on the following pages). It is helpful to make a shallow cut first with a fine hacksaw blade before using the round nock file. This makes it easier for the file to get started.
2. Second, file the straight grooves on the sides (the red line marked "Second").
3. Third, file the angled grooves on the sides (the red line marked "Third"). Be careful to make the grooves on the lines so they will be symmetrical on the back and belly of the limb. Join these angled grooves with the groove on the back, round off the edges, and shape it into a teardrop shape. The goal is to make the string groove with a smooth transition around the edges so there are no flat spots that might catch the string and cause the limb to twist.
4. File out the area between the second and third lines to allow room for the string to rotate freely as the bow is drawn.
5. Last, roll a thin strip of fine sandpaper into a 1/8" "rope" and use it to sand the string groove into a teardrop shape.

I call this method of cutting the nocks the "Two Cut Method" because you are filing two cuts on each side. Look at the following photos and illustrations. The "One Cut Method" only has one narrow groove on each side and allows the string to bind in the grooves as the bow is drawn, but the "Two Cut Method" makes a wider area for the string and eliminates contact between the string and the top of the grooves.

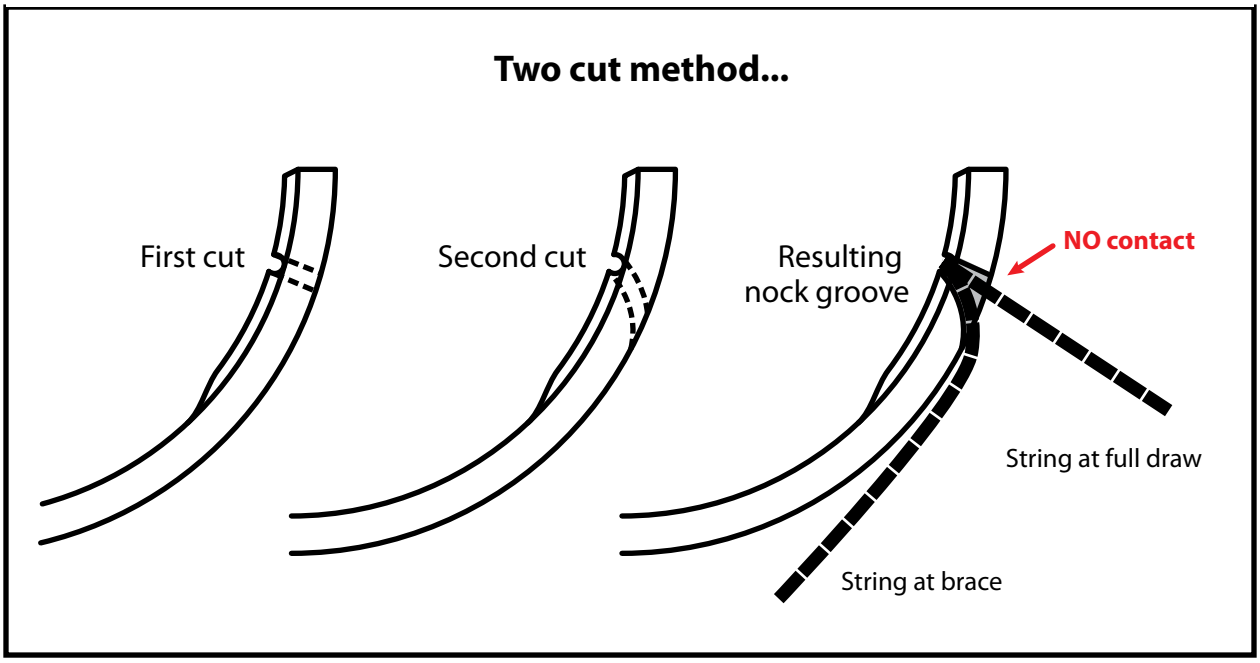
Start the string groove on the back with a fine hack saw (top photo), then file the string groove on the back of the tip (bottom photo).



Next, start the second and third cuts with the saw then file them with the round nock file. Join the angled grooves on the sides, then join them with the straight groove across the back. Then file out the area between the cuts so the string can rotate freely without contact.



The "One Cut Method" creates a narrow area for the string which allows the string to contact the string groove at full draw.



The "Two Cut Method" is better because it creates a wider area for the string on each side, so the string does not contact the string groove at full draw.

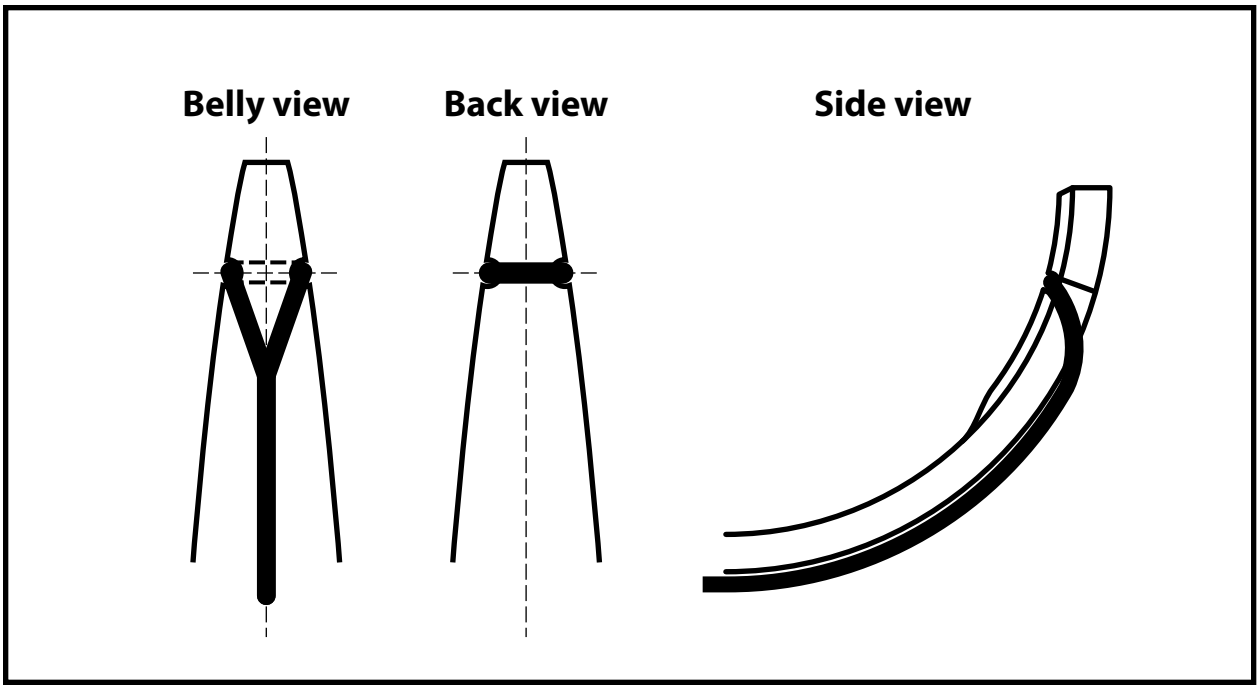
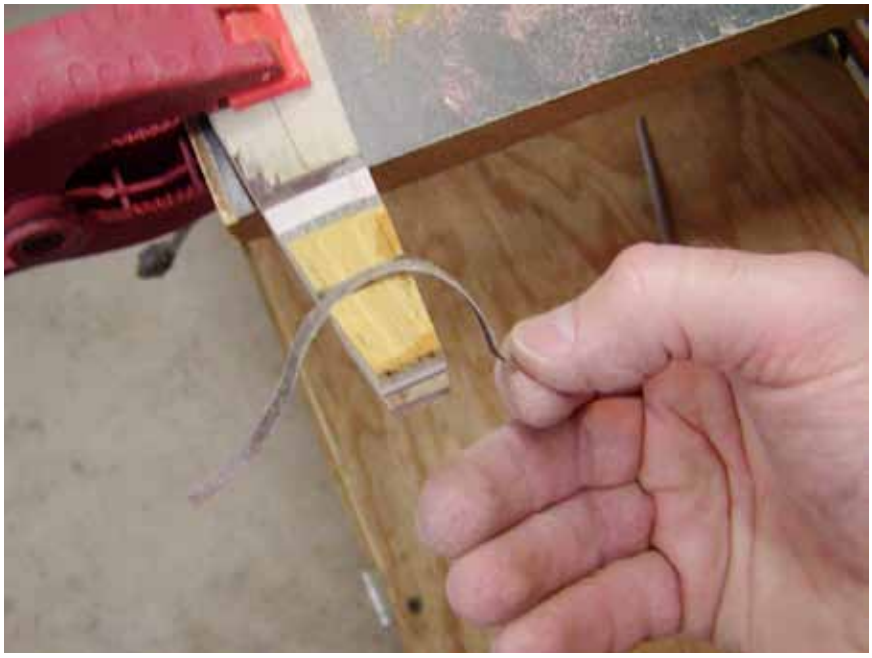


Diagram of good string nocks. All of the nocks and grooves should be the same depth and the same distance from the centerline, and the string loop should form the shape of a teardrop. The heavy, black lines indicate the bow string.

Photos of good string nocks.



Take a thin strip of fine sandpaper or sanding cord, twist it up into a 1/8" thick "rope" of sandpaper, and use it to file the string nocks and grooves into a teardrop shape. Pull on both sides to sand the groove like you are polishing your shoe. (I took this photo myself so it only shows me holding one side. You do this procedure by pulling on both sides of the sanding rope.)

Make sure the limbs are mounted and straight

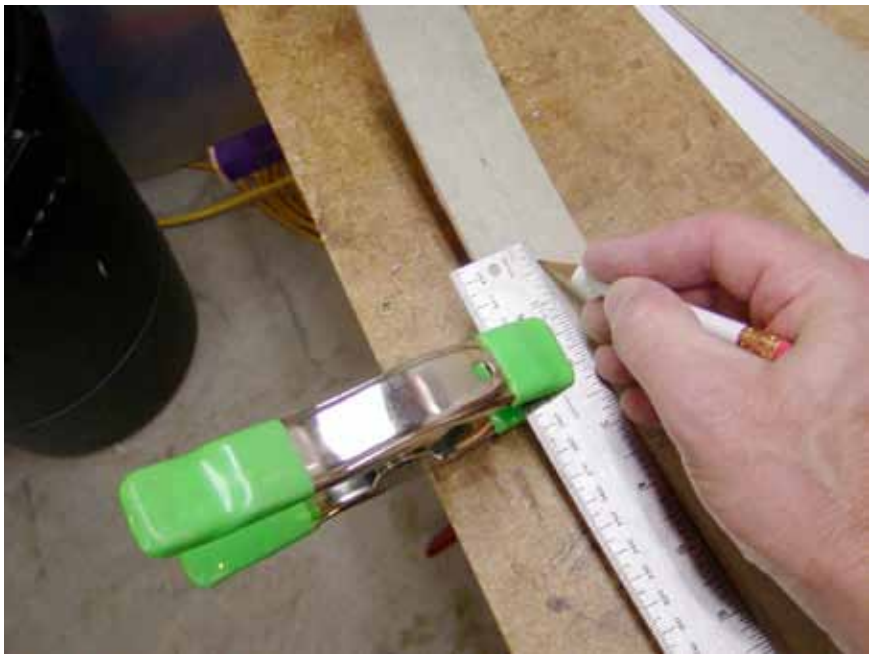
Before you do any bow alignment, the limbs must be cut and sanded to the template lines and mounted straight and true on the riser. The limb tip overlays must be glued on and shaped, and the string nocks must have been filed deep enough to hold a string loop and rounded into a teardrop shape.

Wear safety glasses and leather gloves!

You should always wear safetly glasses when stringing and pulling a bow, but it is of utmost importance when stringing and pulling a bow for the first time. If you have any fear that your bow will break, then wear a full face shield and crash helmet as well! Just kidding...lol! Before a bow is sanded, it is very common for a splinter to lift up from the back or sides when the bow is strung and pulled. If a splinter lifts, it can lead to the entire limb shearing apart, causing a catastropic failure of the bow, sending pieces of razor sharp fiberglass and laminations all over your shop, and possibly getting into your eyes and cutting your skin. Wearing leather work gloves is also a good idea to protect your hands from fiberglass splinters and cuts. Thin work gloves with rubber fingers and palms are really good for stringing and pulling unfinished bows.

Tape and mark the limbs

If the limbs are not taped, then do it now (or redo it if the tape is now ragged or



Taping and marking the centerline of each limb.

has gotten dirty so it is hard to read the centerlines drawn on it. Put 2" painter's masking tape on the back and belly of each limb. The kind that peals off easily is best. Everyone seems to like something different, but I like to use plain ol' light tan when I can find it. After the limbs are taped, mark the longitudinal centerline of each limb from the butt to the tip on both the back and belly with a single fine line. This will be very useful when aligning the limbs and centering the nocks. Make sure to get it perfectly in the center.

Sand the sides and edges to prevent splinters

Lightly sand the sides and edges of the limbs with 150 or 220 grit sandpaper to prevent splinters. Since the limbs have already been ground down to the profile lines, this sanding is just to smooth off the sides and edges. Use long, smooth strokes and try to shape the limbs as even and symmetrically as possible.

Avoid rubbing your fingers or hands along the sides and edges or you will get fiberglass splinters in your hands. Not good! These hurt like crazy and are hard to get out of your skin! If this is your first bow, you will discover this very quickly. If and when you get fiberglass spinters, try pulling them out by sticking masking tape on and off of your hands. They are hard to see and the tape will usually pull them out of your skin.

Chapter 2: Checking bow alignment

Before stringing and pulling the bow, check it for alignment. Several methods for checking the alignment of the riser and limbs are listed below.

Three ways to check riser and limb alignment:

1. **With a string.** Stretch a long string from limb tip center to limb tip center. The string should bisect the riser along it's center. Tie a heavy washer or nut on each end of the string so it can be draped over the limb tip and it will stay in position.
2. **On a flat surface.** Lay the bow on it's side on a flat surface such as a flat work bench to see if the limbs and riser are aligned in the same plane. If the riser and both limbs touch the table surface, then they are aligned. If you see any gaps between any part of the bow and the table surface, then you know that the bow is misaligned. Turn the bow over to check the other side.
3. **With a laser level.** Hold a laser level so it shines the laser line down the centerline of the bow from limb tip center to limb tip center.

This will comfirm if the limbs are cut out in reference to the sides of the riser. If they are not, regrind and sand the limb sides until they are symmetrical. Any problem with limb shape must be fixed before you center the nocks.

A long string with weights on each end is draped over the riser and limbs to check for limb alignment. The bow in this photo is aligned!

Riser and limb misalignment

One-piece bows must be glued up in a straight form and shaped into a straight blank with parallel sides. It is best to sand a one-piece bow in a thickness sander or between a fence and a spindle sander to make the sides parallel.

Take-down bow risers and limbs should also be sanded into straight and square blanks with parallel sides. The best tool for sanding a take-down bow riser and limbs is definitely a thickness sander. If possible, make a sled to hold all of the pieces so they can be sanded together in one pass through the sander.

On take-down bows, riser and limb misalignment usually happens because the limb bolt holes and alignment pin holes were drilled off center. It is best to use a drilling jig that allows precise drilling. When the holes get drilled in the wrong place, the best way to fix the problem is to leave the limb bolt hole alone and simply change the position of the alignment pin. I think that a take-down bow with only one alignment pin is easier to fix and realign than a bow with a two pin mounting system. Four ways of fixing a misaligned take-down are listed below.

Four ways to fix a misaligned take-down riser and limb:

1. **Fill and redrill the pin hole in the limb.** Probably the easiest solution is to fill the pin hole in the limb with epoxy, let it cure, then sand it smooth again so it is ready to be redrilled. Next, put some ink or paint on the alignment pin that is mounted in the riser. Place the riser and limb on a flat surface and screw the limb bolt in until the alignment pin touches the limb and marks the pin hole location on the limb. Then redrill the pin hole in the limb from the belly side.
2. **Fill and redrill the pin hole in the riser.** Another solution is to pull the alignment pin out of the riser (usually pliers will work), refill the hole with epoxy, let the filler glue cure, sand it smooth, then drill the pin hole again slightly to one side so it allows the limb to align. Like the previous procedure, you can stick a pin into the limb hole with tape or rubber cement, and put some ink or paint on the pin to mark the position of the new pin hole on the riser.
3. **Fill and redrill the pin hole in the riser while using the limb as a template.** Another method is to pull the pin from the riser, fill the old pin hole with epoxy, let it cure, and resand it into shape. Next, drill out the existing pin hole through the back of the limb and use the limb itself as a template to drill the pin hole into the riser. Drill the pin hole into the riser using the "drill through" method by bolting the limb to the riser with the limb bolt, aligning the riser and limb, clamping them into an aligned position, then drilling through the pin hole in the limb into the riser. This method places the pin hole in the riser where it needs to

be in order for the limb to align. The only problem with this method is it leaves a visible pin hole on the back side of the limb. This hole must be patched over or covered with an overlay. Be advised that if the limb is thin enough to bend at all in this area, the overlay will delaminate and pop off. The wedge must typically be 5/16" or thicker to keep this area of the limb from bending.

4. **Reshape and fill the pin hole in the limb.** Yet another method is to reshape the alignment pin hole in the limb until the limb aligns with the riser, then fill in the extra area in the hole with epoxy. To do this, enlarge the hole with a dremel tool until the limb aligns, fill the extra area around the pin with epoxy, cover it with plastic wrap, then reattach the limb and leave it mounted to the riser overnight until the filler glue is cured. After the limb is cured, take it off the riser and clean it up with sandpaper around the hole.

After any of these procedures, check the bow again for proper limb and riser alignment before continuing.

Chapter 3: Stringing and pulling the bow

Long string tillering

String the bow with a long string

Put a long string on the bow so it has a very low brace height of zero to two inches. This doesn't have to be an exact brace height...just don't brace it very far yet. Self bowyers call this process "long string" tillering. It makes it easy to check the initial action of the bow without having to bend the limbs very much at first. Even though fiberglass composite limbs can probably withstand immediate pulling to full draw, I like to start slowly and bend the limbs a little bit at a time in order to avoid potential problems. If a splinter starts to lift or the tiller is uneven, it is much better to fix the problem now before the limbs get pulled very far, overstessed, and possibly ruined.

Hold the bow in your hands, pull the string at the center an inch or two. Watch the limb tips to see if the string loops are staying in the string grooves and how the limbs are initially bending. If everything looks good, then you can proceed to pulling the bow on the tillering tree. If anything looks wrong, then fix it now.

The tillering tree is set up with a pulley mounted to the wall below the tree. Begin pulling the bow with the pulley mounted directly below the center of the bow.

Pull the bow on the tillering tree with the long string

Next, put the bow on the tillering tree with the center of the riser on the center of the tillering tree. Secure the riser with a clamp or rubber inner tube strap to keep the bow in position so it won't tilt or fall off the tillering tree.

Watch the limb tips as you pull the string at string center. It is much easier to watch the bow and limbs while you are pulling if you use a rope with a pulley mounted on the wall below the bow (see photo on previous page). This setup allows you to stand back from the bow about six feet, pull the rope, and watch the bow at the same time. If the bow and limbs are pulling evenly, then continue pulling the string one inch at a time, constanting watching the limb tips to see if they are pulling the same distance, and watching the tiller shape of the bow to see if the limbs are bending evenly. If the bow tilts severly or if one limb is bending way more than the other, immediately stop pulling and fix the problem before pulling the bow any further. Make a mental note about which inch you stopped at so you can pull to this inch again when you return.

If the limbs have been cut out, sanded to the profile lines, and mounted together properly on the riser, they should pull pretty straight and bend pretty evenly. If they do not, then this needs to be fixed before the bow is pulled any farther.

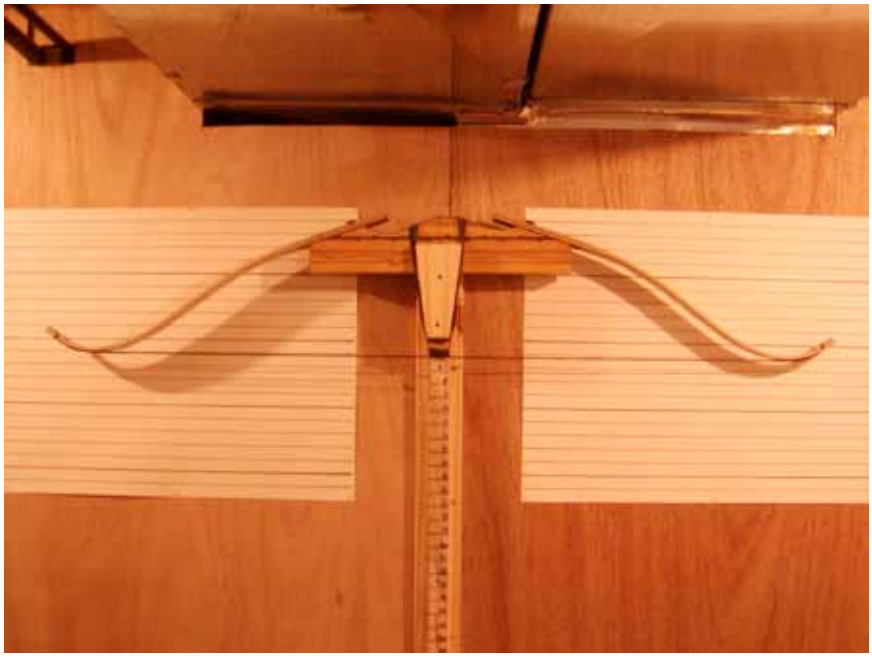
The way to fix any bending problems is to mark the sides of the limbs at the stiff spots with a pencil, unstring the bow, and check to see if the edges are sanded to the template lines and look to see if both sides are symmetrical. If they are not, then sand them now until they are fixed. If you sand the sides, make sure to round off the edges again before pulling the bow again to avoid splinters.

Put the bow back on the tillering tree, pull it a couple of inches with the long string again, and check again for alignment and even tiller. If the limbs are pulling evenly, you can pull the string another one inch increment at a time, constantly watching to make sure the limbs are still pulling evenly as the bow is drawn farther. When the limbs are bending evenly, and the tips are pulling the same distance while you pull the string down to about 6" to 8", then it is okay to string the bow to normal brace height.

First brace

String the bow with the correct AMO string size. Check to see that the string loops are positioned evenly in the string grooves at the nocks. Exercise the bow a few times by pulling the string a few inches. This will help seat the string loops in the string nocks and grooves.

For now, don't worry about the brace height unless it is way too low or way too high. It should be about 8” for a typical recurve. I usually leave the riser as a block and don't cut and shape it until the limbs are aligned, tillered and balanced, so it is hard to measure the brace height without first marking the deepest point of the grip on the riser block and measuring from there to the string. The point is...if the brace height is way too low or way too high, then the limbs have been mounted wrong or the string is the wrong size. If this has happened, then it should be fixed before you continue pulling the bow. If the brace height is too high, then the bow is too long and/or the string is too short. If the brace height is too low, then the bow is too short and/or the string is too long.



First brace on a bow. Once the limbs are cut and sanded to the profile lines, the limb tips should pull pretty close to the same distance and have similar shape when bending. If they don't, that needs to be corrected before your continue. Don't pull the bow any farther until the limbs pull evenly.

Measuring and adjusting tiller

Measure the tiller on each limb

Use a ruler or bow square to measure the tiller of the bow. I just use my tape measure. Measure from where the limb exits the riser to the string on each limb. Write the measurement for each limb on a scrap of paper. For now, we want these measurements to be close to the same. It is normal and expected for them to be slightly different. For the first brace, if they are within 1/4" of each other, then leave them alone. If they are more than 1/4" different, then adjust the limbs by sanding the back and belly fiberglass until the measurements are within 1/4" difference. Make sure the limbs are cut and sanded to the ideal profile shape: the same width at each one inch increment along the limb, the same length, and the same width at the nocks. If they are not, then this should be fixed before you continue. Make them identical and symmetrical before sanding the back and belly glass.

Determine which is the upper and lower limb

At this point, a decision should be made about which limb will be the upper and lower limb based on the shooting style of the intended archer.

Split finger shooting style

Assuming that the deepest point of the bow grip will be cut out at bow center, then the goal will be to finish the limbs with about 1/8" to 1/4" (positive) tiller for a split finger style shooter. Positive tiller means that the upper limb is weaker and has a larger tiller measurement than the lower limb. If the shooting style of the intended archer is split finger style, then put the stronger limb on the bottom of the riser.

Three under shooting style

Assuming that the deepest point of the bow grip will be cut out at bow center, then the goal will be to finish the limbs with 0" (equal) tiller for a three-under style shooter. Zero tiller means that the limbs are equal in strength and have the same tiller measurements. If the shooting style of the intended archer is three under style, then sand the back and belly glass of the stronger limb with 220 sandpaper and recheck the tiller measurements until the limbs have equal tiller at brace height.

When sanding the limbs, wear a respirator mask and eye protection, and sand the back and belly surfaces of the limb from end-to-end with long, continuous strokes. Count the number of strokes and make the same number of strokes on each side of the limb. Make about 20 strokes per side, then restring and recheck the tiller measurements until they are the same. Remember to sand the limb edges again

The tiller measurement on the upper limb.

The tiller measurement on the lower limb.

so they are rounded and not sharp. This process may take a few times of sanding and checking, but be patient and continue using 220 grit sandpaper until the tiller is equal. You might be tempted to use a power tool or a coarser grit of sandpaper, but don't do it! The fine 220 paper will remove fiberglass faster than a coarser sandpaper and will leave the limb smoother and easier to final finish later. Use a new piece of sandpaper often as it will plug up quickly with fiberglass dust.

After the limbs are located as upper and lower, and the tiller is set, use a marker to write "upper" or "lower" on the masking tape on the back of each limb.

Short string tillering

Now the bow is ready for short string tillering. With the bow strung with the correct AMO string size, put the bow back on the tillering tree and pull it like you did previously with the long string. Like before, pull the string one inch at a time, constantly watching to make sure the limbs are pulling evenly as the bow is drawn.

If the limbs bend evenly and the tips pull to the same distance as each other according to the marks on the wall, continue pulling the bow one inch at a time to the intended full draw of the bow. If at any time the shape of the limbs look uneven or the tips pull to different distances, then stop pulling and adjust the limbs before continuing. Assuming that the limbs are cut and sanded to the ideal profile lines, then the way to adjust their tiller shape is by sanding the back and belly fiberglass with fine sandpaper.

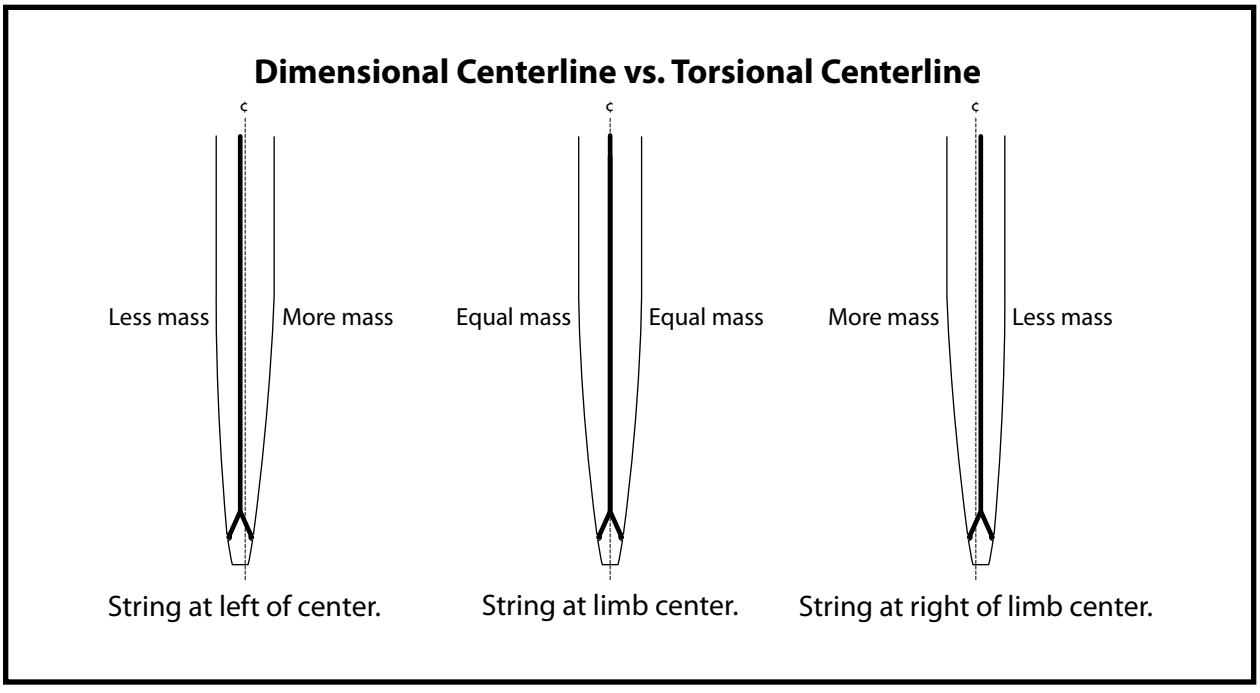
If there is a flat spot in the tiller shape, then mark that area with a pencil, unstring the bow, sand the flat spot with fine sandpaper on the back and belly glass, restring the bow and check it again on the tillering tree. If there is a “hinge”— a spot where the limb is bending too much — then leave that area alone and do not sand it!

Continue checking the tiller shape of the bow at each one inch of the draw all of the way to full draw. Remember, if the shape is uneven, then you must stop and adjust the limb to make it symmetrical with the other limb before pulling the bow any farther.

Once the bow can be pulled to full draw with the limbs pulling evenly, then the bow is ready to check for twist in the limbs.

Chapter 4:
Centering the nocks and sanding the sides

At this point, the bow is ready to be checked for limb twist and adjustments to be made by "centering the nocks" and/or "sanding the sides." Centering the nocks is the process of cutting the nocks to the torsional centerline of the bow. I call the "torsional" centerline the position where the nocks must end up in order for the limbs to pull straight. Ideally, filing the nocks the same distance away from the "dimensional" centerline should allow the limb to pull straight, but sometimes the limb will not pull straight. If the limbs have been made with uniform laminations, they are mounted straight and flat on the riser, and they have been cut out to be symmetrical, then the dimensional centerline and the torsional centerline should be the same. They will only differ when there is a structural inconsistency within the limb that causes it to bend unevenly and pull to one side.



Centering the nocks and sanding the sides moves the string relative to the mass of the limb. A limb will always pull towards the weaker side. The left limb twists to the left because there is less mass on the left side (it is weaker). The right limb twists to the right because there is less mass on the right side (it is weaker). The center limb pulls straight because there is equal mass on both sides of the string (both sides are equal strength).

My four step procedure for centering the nocks and sanding the sides

1. String the bow and lay it on a low table with the belly up.

The belly of the bow is the string side. On a three-piece take-down bow, I find it easiest to leave the limb butts untrimmed so the bow will stand up by itself. On a one-piece bow you may want to prop it up. Put a 12" tillering stick into the bow between the riser and the string. This pulls the limbs a bit and makes it easier to see if there is twist. Also, if it helps you to see the alignment, place a small straight edge ruler across the belly of the limb and at the end of the riser. You can use a 6" machinist's rule and place the center 3" mark in the middle of the limb so you can also see if there is more material on either side of the limb. It really helps during this procedure to have masking tape on the limbs with the centerline clearly marked.

2. Look for twist.

Look down the limb from the tip to see if the belly surface aligns with the edge of the riser (or if the rulers align). With this method, you'll see if the limb tip is tipping to one side. Repeat the following "mantra" when you see a twist...

"If the limb twists to one side, "mark that side."

(Mark it with an "X" on the side of the tip next to the nock.)

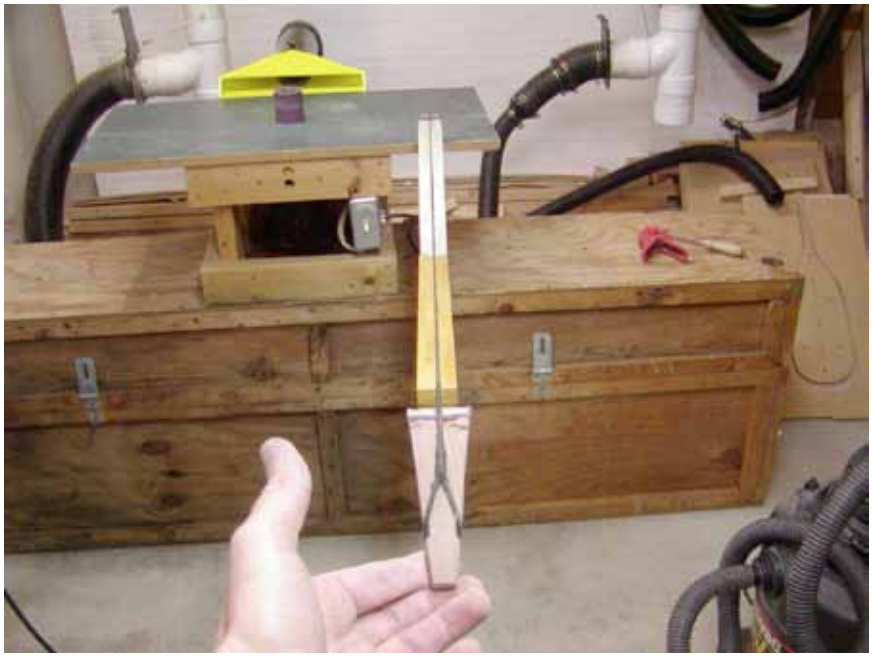
3. Unstring the bow and file that nock about five strokes deeper.

After filing the nock, sand that side (of the tip only...don't sand the entire side) to even up the depth of the nock so it matches the other side. Reshape the nock and groove as necessary so it looks just like the other one (make sure both sides are the same shape and the same depth). After it is shaped nicely, measure the width of the tip both inside and outside of the nocks to make sure it is not too narrow.

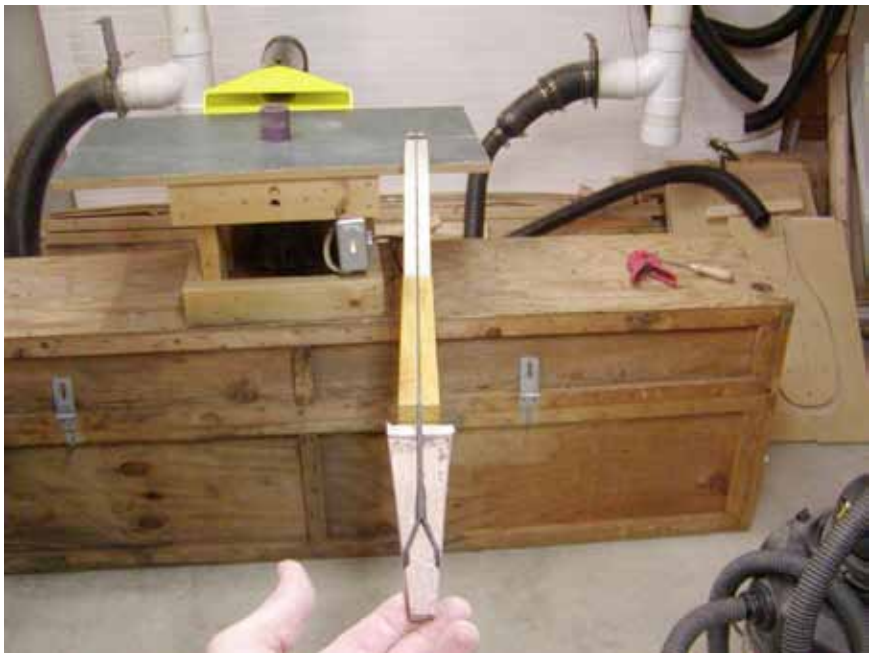
Repeat steps 1 through 3 until the limb is pulling straight.

This procedure can only be repeated a few times, and only if the laminations are uniform thickness, the limbs are mounted straight, the bow is aligned, the limbs are symmetrical, and the nocks are shaped well and identical. If repeating the procedure has not straightened the twist, then there may be a structural problem with the limb. If this happens, refer to "Chapter 6: Causes of Limb Twist."

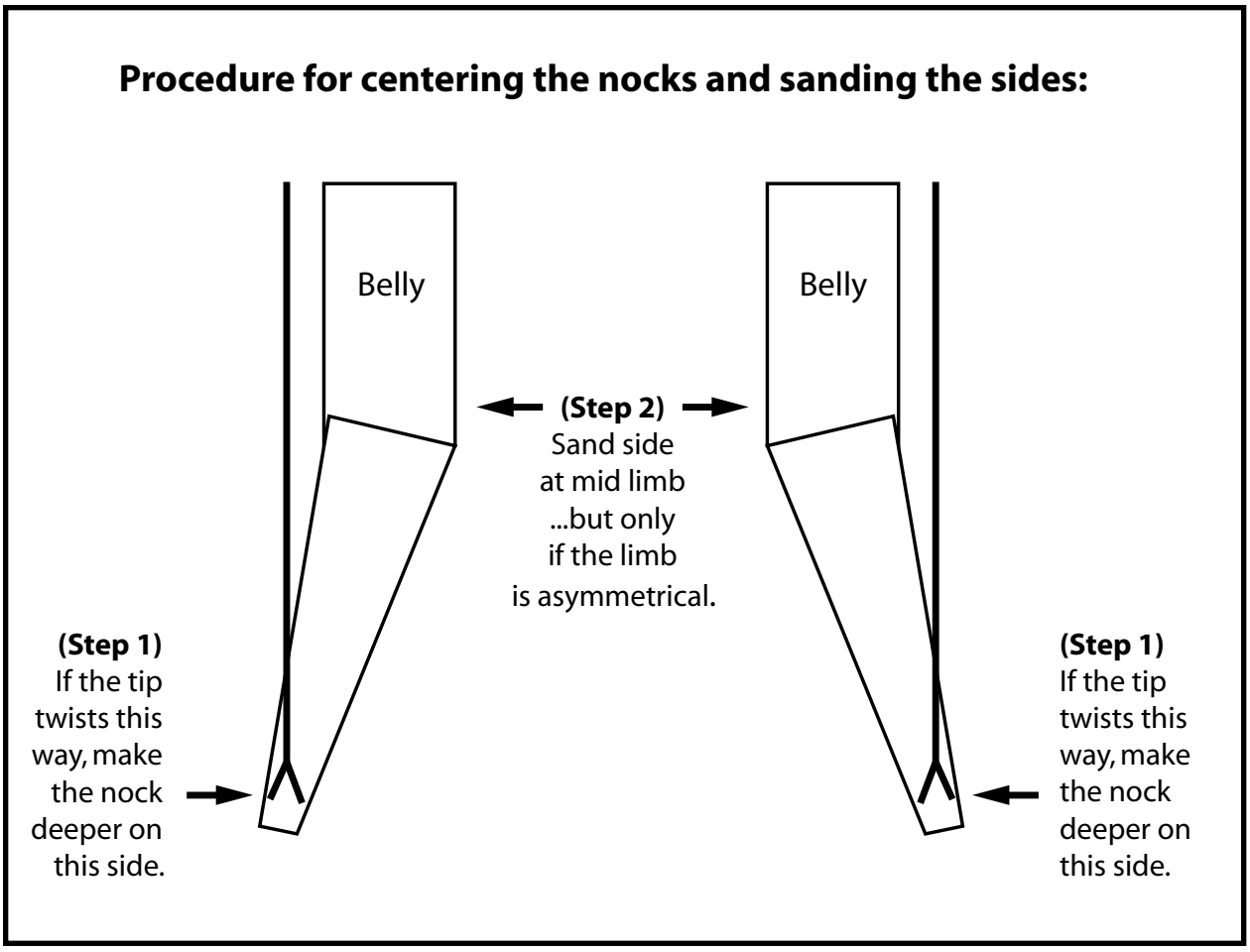
In addition, the string nocks can only be filed deeper until the distance between them reaches the narrowest width you are willing to allow for strength and safety.



This tip is twisting slightly to the right side (see how the belly side of the limb looks tilted and not aligned with the edge of the riser)...so I marked the right side with an "X" next to the nock, filed the nock about five strokes deeper, smoothed out the nock, and reshaped the side of the tip.



After restringing, the limb is now aligning nicely. Notice how the string appears to bisect both limbs and the riser, and the belly surface of the recurve is aligned with the flat face of the riser.



4. Sanding the sides.

Now the question arises... *"do I just deepen the nock and sand that side of the tip or do I sand the complete side of the limb?"* This is a question that is answered by examining the shape of the limb. Restring the bow and stand back and look for spots where the limb is wider on one side of the string. If there is a wide spot, then that is where you sand some material off. If centering the nocks was not enough to straighten things out, the limb is probably too wide on the opposite side from the tip that was marked. If this appears to be the problem, mark the wide portion on the side of the limb with a squiggly pencil line. Unstring the bow and remove some material from that side of the limb 10 to 20 strokes with a file. After filing, smooth off the side and edges again with 220 sandpaper to avoid splinters.

Some experienced bowyers sand the sides with a belt sander or other power tool to speed up the process, but I encourage you to do it by hand with a file and sandpaper. Using a power sander will quickly ruin a limb if you take too much off!

You will eventually get a feel for knowing when to center the nocks and when to sand the sides. On a fiberglass bow made with uniform laminations, the ideal goal

is for both limbs to look exactly alike and be perfectly symmetrical according to the dimensional centerline.

Mark the string postion on the recurve.

Straighten the limb tip by hand so the belly surface of the recurve is parallel with the rule. If the limb tip is pulling straight, then the string will be in the center of the limb. Make a pencil mark across the limb about 4-5" down from the center of the nocks and trace both sides of the string down to that mark. Measure from the string out to the edge of the limb at the mark to see which side has more material. The side that has more material is the strong side and that is the side that needs to be sanded.

Shoot the bow to settle the string.

Once you get the limbs to lay pretty close to flat and the tips are aligning straight, shoot the bow. This will settle the string into position. You've already marked the limb for the center string groove on the belly surface. So, after shooting the bow, the string should return to center and be laying in the middle of the pencil marks. Again, if it is laying to the left, the right side is the stronger/wider side somewhere on the limb. If it is laying to the right, the left side is the stronger/wider side somewhere on the limb. You need to find the wide portion and grind/sand it.

Work on both limbs a little at a time and shoot the bow between each adjustment. The goal is to get the sides of the limbs to be parallel with the sides of the riser, parallel with each other, the string to lay in the middle of both limbs, and to have the same amount of material on both sides of the string the full length of the limbs.

This may sound easy, but there are many optical illusions that may occur when you are looking at the limbs. If you are having trouble seeing the symmetry of the limbs, take the bow outside and hold it up against a clear blue sky as the background. This will help you see the shape without the distracting glare from indoor lights, lines on the walls, or other distractions in the room.

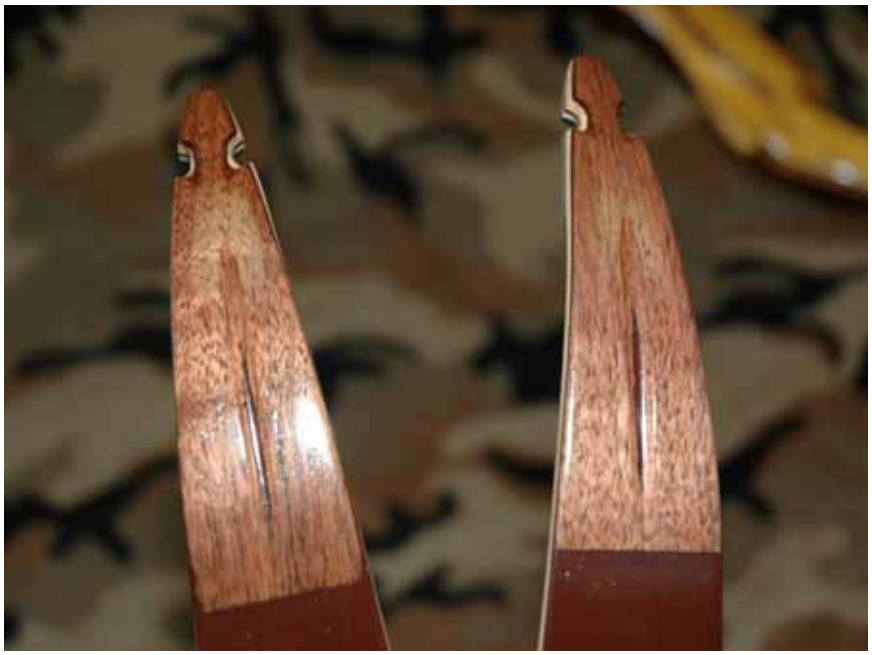
Centering the nocks and sanding the sides with files and sandpaper moves the tips to dynamic center slowly and keeps them from getting adjusted too far too fast (possibly creating a twist in the opposite direction). Remember to say the mantra when you discover a twist... *"If the limb pulls to one side, mark that side."* Work slowly, trust the procedure, and be patient. The limbs will eventually come into line. A stubborn, twisting limb will often continue to twist for one or two straightening routines before it will suddenly start pulling straight. As it starts to straighten out, take fewer and lighter strokes with your file each time you repeat the process.

Chapter 5: Filing the string groove

Once the bow is pulling straight on both limbs and the string is returning to the center of the limb, you can unstring the bow and file the string groove on the belly side of each recurve. The lines around the string should still be visible, so file a groove about 1/16" deep between the lines. **Just file a single groove in the center of the limb.** There is no reason to file a "Y-shaped" groove. Some bowyers file a Y-shaped groove that fits a particular endless string, but usually a flemish string won't fit into the "Y" because it has a smaller loop. The purpose of the center groove is simply to help the string return to center and stay there after the bow is shot. If you just make a single, center groove, then both endless strings and flemish strings will fit your bow.

There you go!

Your bow should now be perfectly aligned and ready for final finishing, and final tillering and balancing.



The string groove on the belly of the recurve. It is okay for the groove to cut slightly through the overlay or outer fiberglass lamination to the next layer below. Just don't make it overly long or it will weaken the limb.

Chapter 6: Causes of limb twist

If you are trying to align the limbs by centering the nocks and sanding the sides, but one or both limbs are being stubborn and continue to twist, then the problem may be more complex than just the position of the nocks and the shape of the limbs. Listed below are the eight (8) most common causes of limb twist.

Consider the following reasons that a limb might twist:

1. The laminating press was not straight and built twist into the limb.
2. One or both limbs are mounted crooked or tilted on the riser.
3. The string nocks and grooves are not shaped exactly the same on each side of the limb.
4. The string nocks and grooves on one or both sides are not cut the same distance from the centerline.
5. The limb profile is assymetrical on one or both sides of the centerline.
6. There are internal stresses within the core structure of the limb, causing the laminations to bend unevenly.
7. The grain of the wood core laminations is causing the limb to be stonger on one side of the centerline.
8. The thickness of the laminations is uneven, causing the limb to be stronger on one side of the centerline.

With so many potential causes of limb twist, a careful examination of the bow is the first step to take in order to identify the problem. We must correctly identify and isolate the problem in order to fix it. Use a tape measure, straight edge, alignment string, and limb templates to check for differences in limb shape, thickness, width, and alignment. Ideally, any and all of these common causes of twist must be avoided or fixed before “centering the nocks” or “sanding the sides” can be used to straighten the limbs.