REMOVING STRING-FOLLOW USING HEAT

By

Dennis La Varénne

For some while now, I have been collecting old wooden bows made either commercially or privately from before the advent of the use of fibreglass in the manufacture of bows. These bows, made by such commercial makers as Ben Pearson, Bear Archery, York Archery, Indian Archery, American Archery and The Outdoor Sports Manufacturing Co., were made from Lemonwood and from both Lemonwood and Hickory by Ben Pearson.

All of them numbering around 150 including the many I have from non-commercial bowyers have varying degrees of string follow. Apart from Hickory and Lemonwood, they are also made from Yew and Osage Orange by the non-commercial makers. The Yew and Osage bows fared no better than the Lemonwood and Hickory so far as the development of string follow or 'set' is concerned. Some had as little as just over 1 inch and a few had close to 4 inches, but the preponderance of them had string follows varying from 1 ½ inches to 3 inches, with those from Yew and Osage somewhere in the middle of that range.

1. Ten bows from my collection showing varying degrees of set. The bow fifth from the left has just over 4 inches of set.

During the past year, I have been trying to restore most of the commercial bows back to ex-factory specs. Old frosted and crazed finishes needed to be removed and re-applied; separating handle risers needed to be popped off and re-glued and handle wrappings needed re-applying if they could be found.

The handle wrappings of the 1930s to the late 1940s were mostly 5/8" edge-skived leather wooden golf club handle wrappings. A few were of 1 inch depending upon the manufacturer. The privately made bows had almost anything from old pre-synthetic fishing line to various kinds of leather sheet wrapping. Many were very dilapidated because the leather had been allowed to dry out badly.

For most of these, I was able to obtain modern 1 inch edge-skived leather bicycle handle bar wrapping or tennis racquet handle overwrapping. The handle wrappings were usually finished top and bottom by either being whipped with 'silk gut', leather lacing or some kind of coloured narrow plastic-looking tape.

The main problem of removing set however, turned out to be the simplest to solve.

Was there anything I could do to remove some, most or all of the string follow or 'set' which these bows had so that they could be got back to their original draw weights pre-set or as close to it as reasonable? Some of the bows pictured I will leave with their set, as examples of what happens, but not the better quality ones which I intend to restore as much as I can, including their maker's decals, many of which I have already redrawn in Adobe Photoshop or Adobe Illustrator. I have located a printer who does decal printing.

Quite some time ago, I had experimented with cold-bending bows into very heavy reflex in an attempt to try to remove some of the set. I cold-bent one particular ELB into reflex and slowly increased it until I had the bow into 12 inches of reflex.

It was left it in that state for about one week on the bending jig I devised. What I did was totally against all the ancient wisdom about the catastrophic effects of reverse bending a wooden bow once it had been broken in. I have been doing just that since I first started making my own bows by reverse bending and holding them in about 3 inches of reflex after shooting and unbracing them. Generally, the effect seemed to be beneficial and not a single bow broke or was damaged in any way whatsoever.

I have done the same on every one of my collected bows, the oldest of which are from the 1930s. None of these old bows has been damaged, be they made from Yew, Osage, Hickory, Lemonwood, Red Oak or woods unknown. They have all been reverse bent to no adverse effect and I have around 150 of them now.

After reading Robert Elmer's book "Target Archery" written in about 1946[1], I found a section which discussed 'refreshing' bows by placing them in some kind of tube whilst strapped down to a board with their backs downward and belly upwards. Heat was applied by external source to one end of the open tube so that hot air would flow over the bow by convection and out the other end of the tube. Elmer described this method as having a very beneficial effect on the Yew target bows of his day by taking most of the string follow out and bringing the bow back to close to its original draw weight and greatly improving its cast.

However, the technique was not necessarily permanent and some bows needed repeated or annual refreshings. The bows did not seem to suffer from repeated reheating.

My early attempt at cold-bending bows, particularly the ELB referred to above, were moderately successful in so much as the ELB held about ½ inch of reflex for quite some time before gradually beginning to take a set again, but not nearly as bad as it had originally from its English maker who sent it to me with close to 3 ½ inches of set. When last I saw it before donating it to a friend, it had taken close to 1½ inches of set which was not bad really for an initial attempt.

Elmer's idea gave me the idea that perhaps not only holding the bow flat whilst applying

[1] **Target Archery**, Alfred Knopf pub. 1946, Elmer, Robert (no ISBN)

heat, but perhaps also that holding the bow in reflex would likewise work just as well because when heated properly through the whole limb, perhaps the plastids holding the wood fibres together, much like the function of epoxy in bow fibreglass, would maintain the new lay of the wood fibres by a sort of remoulding process once the limbs had properly cooled.

That became my working hypothesis anyway. How to apply the heat and how to position the bow and the limbs was the next question. This gave me the idea for a very simple jig to hold the bows in the desired amount of reflex (pic 2. below).

My original jig consisted of just a flat board onto which I strapped the bow, back down. Heat was applied by the simple expedient of using a normal heat gun and directing the heat up and down the limbs whilst the limbs were held in place by string lashing. To prevent scorching of the wood, I wiped them over using cooking oil which I had found previously effective when straightening out unwanted curvatures in self-bows. However, because of the way I applied heat, oiling was completely unnecessary.

2. 1940s Ben Pearson 7056 Lemonwood fibre-backed target bow mounted on bending jig.

Greybeard on Ozbow.net had sent me some pictures of his adjustable jig which he used for reflexing bows as well as applying backings. I adapted his idea into an even more simple design using moveable blocks of wood on which the bow was positioned close to the handle area whilst the limbs were drawn down into different amounts of reflex.

The mounting blocks could be turned around to lay on a different side depending upon the amount of reflex needed to remove the set or induce reflex. I used the original long 3000 x 100 x 50mm pine board with which I started the process.

I controlled the degree of bend simply by measuring how much I pulled the limb tips into reflex depending upon the amount of original set they had. I measured the height of the mounting block with the bow mounted on it, then measured the vertical distance from the limb tips down to the board. That told me how much to bend the limbs to straight. I had yet to work out how much to bend them so that the limbs stayed straight after ‘cooking’.

I quickly found out that simply by pulling and holding them into a straight position was not enough because there was always a degree of 'spring back' after the limbs were sufficiently cooled and released. Several variations in the amount of reverse bending were tried and it worked out that to keep the bow straight after bending required the tips to be reverse bent by a factor or 2 ½ times the amount of original set. So, if the original bow had a set of 2 inches, I had to reverse bend it by 5 inches. If I wanted the bow to have a 1 inch of reflex, I had to bend the tips 3 inches x 2.5x = 7 ½ inches. The formula varied a little depending upon the quality of the wood and its inherent resilience, but was and is a pretty sound working calculation.

REQUIRED AMOUNT OF BEND = (ORIGINAL SET + DESIRED REFLEX) x 2.5

If no reflex is desired, then the formula becomes –

REQUIRED AMOUNT OF BEND = ORIGINAL SET x 2.5

I have reverse bent very many of my old collector bows into as much as 9 inches using this formula without a single mishap so long as the limbs were sound and had no splits or other obvious previous damage.

POSITIONING THE BOW

This is perhaps the most important factor in keeping the bow in tiller after the set has been removed. The old bows from the pre-fibreglass era were built with the centre of the handle well below the geographic centre of the bow. Generally speaking, most limbs on bows with 3 ½ to 4 inch long handles had the bow centre only 1 inch below the top of the handle – thus the bow was laid out with its handle having 3 inches below the bow centre and one inch above. A few went 2½" below -1½" above, but not many.

3. Positioning of bow on base-board.

My mounting base-board has been marked with a centre mark and 2 inch graduations from its centre toward each end which I use to position the bow on its support blocks by aligning

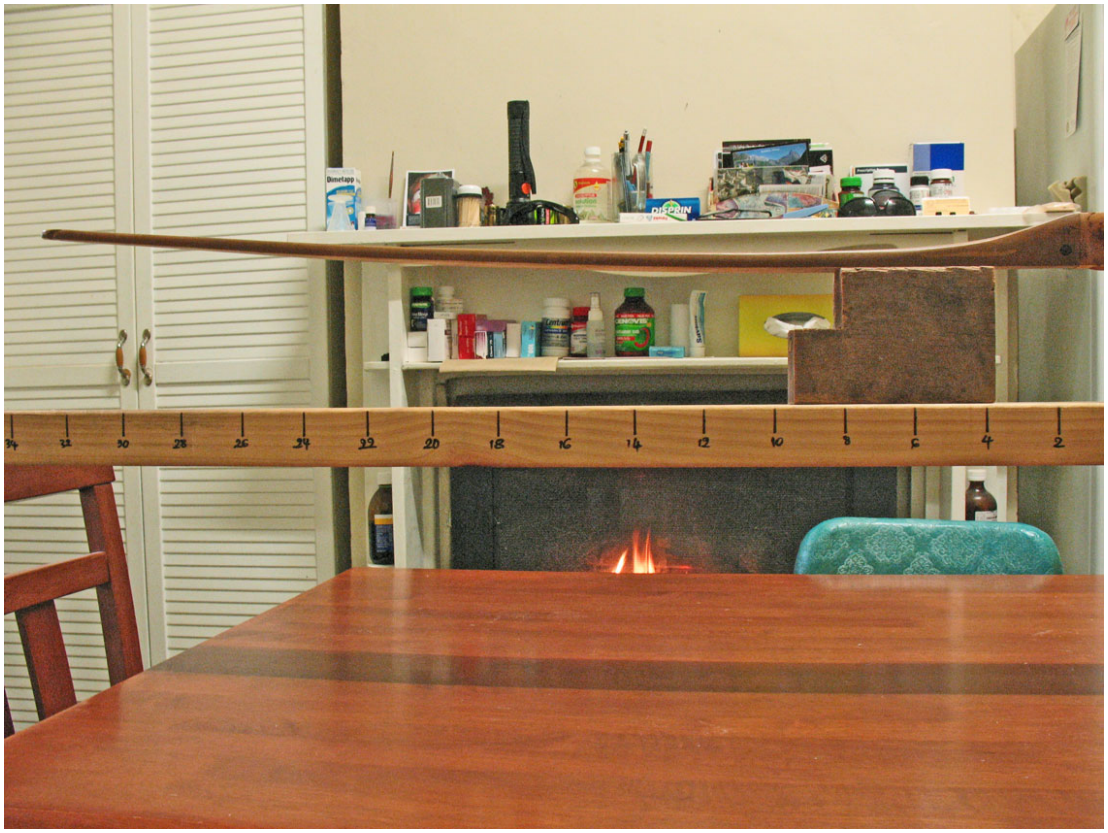
the ***centre of the bow*** (not the centre of the handle) above the centre of the base board. The black mark on the bow's handle in pic. 3 above is the centre of the bow, not the centre of the handle. You can see the extent of the original grip area and the inletted compressed leather 'dot' which marks the arrow pass on these bows. The arrow pass is 1 ¼" above the bow's centre.

When positioning the support blocks under the bow, make sure that they are placed exactly the same distance apart from each limb tip, NOT from the middle of the handle. Positioning them this way looks wrong because it looks like the support blocks are not centred on the riser block. But, that is how they SHOULD be placed to keep the bow in tiller.

Placing the blocks so that they centre on the middle of the handle means that a different length of limb protrudes at each end and if bent by the same amount, more stress is placed on the lower limb and less on the longer upper limb.

Effectively, I found that the upper limb is bent less over its length than the lower limb, which means that the lower limb is much stiffer than the upper limb by a considerable margin meaning that the lower limb moves out of time with the lower stressed upper limb. I found this out the hard way.

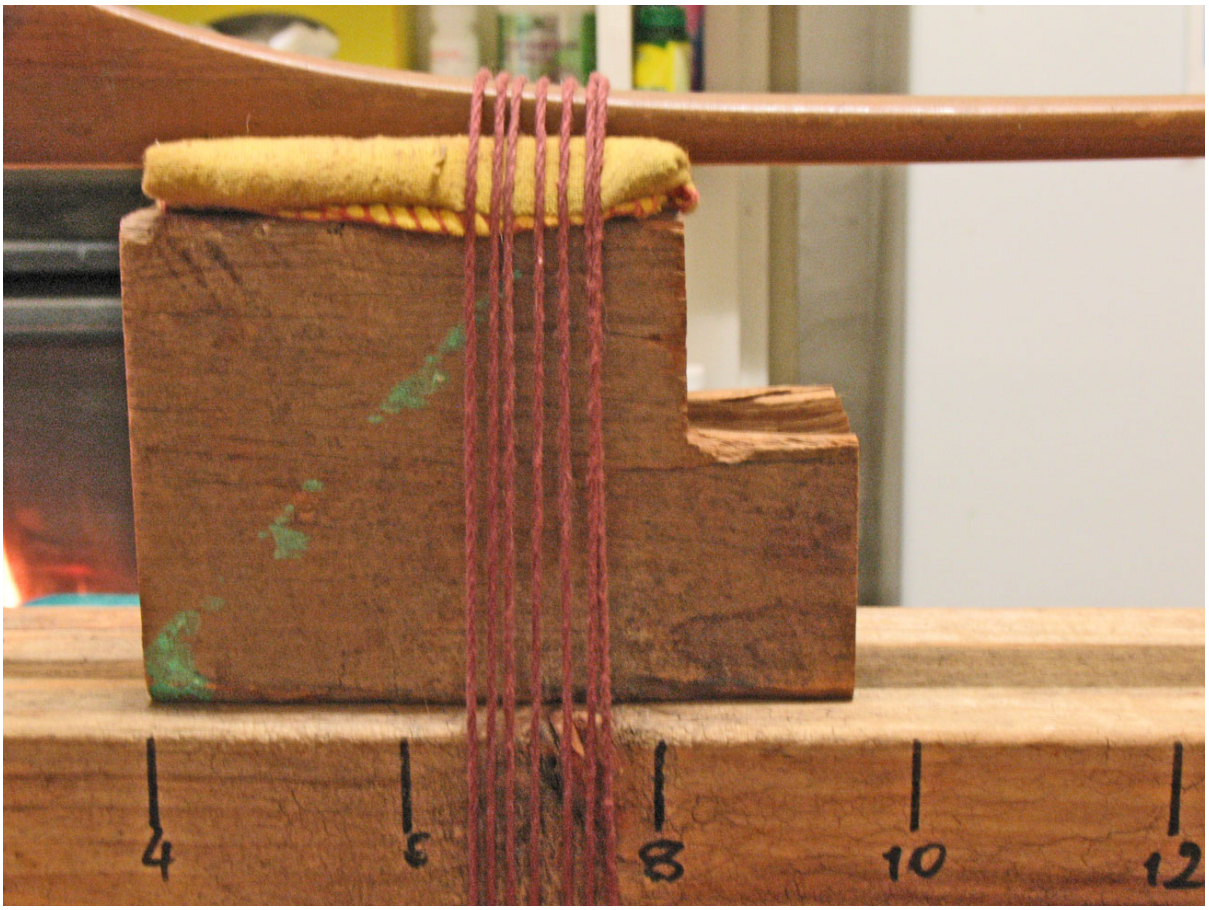
It is ***the length of the actual bendable part of the limbs which needs to be equal*** (See pic 4. below).



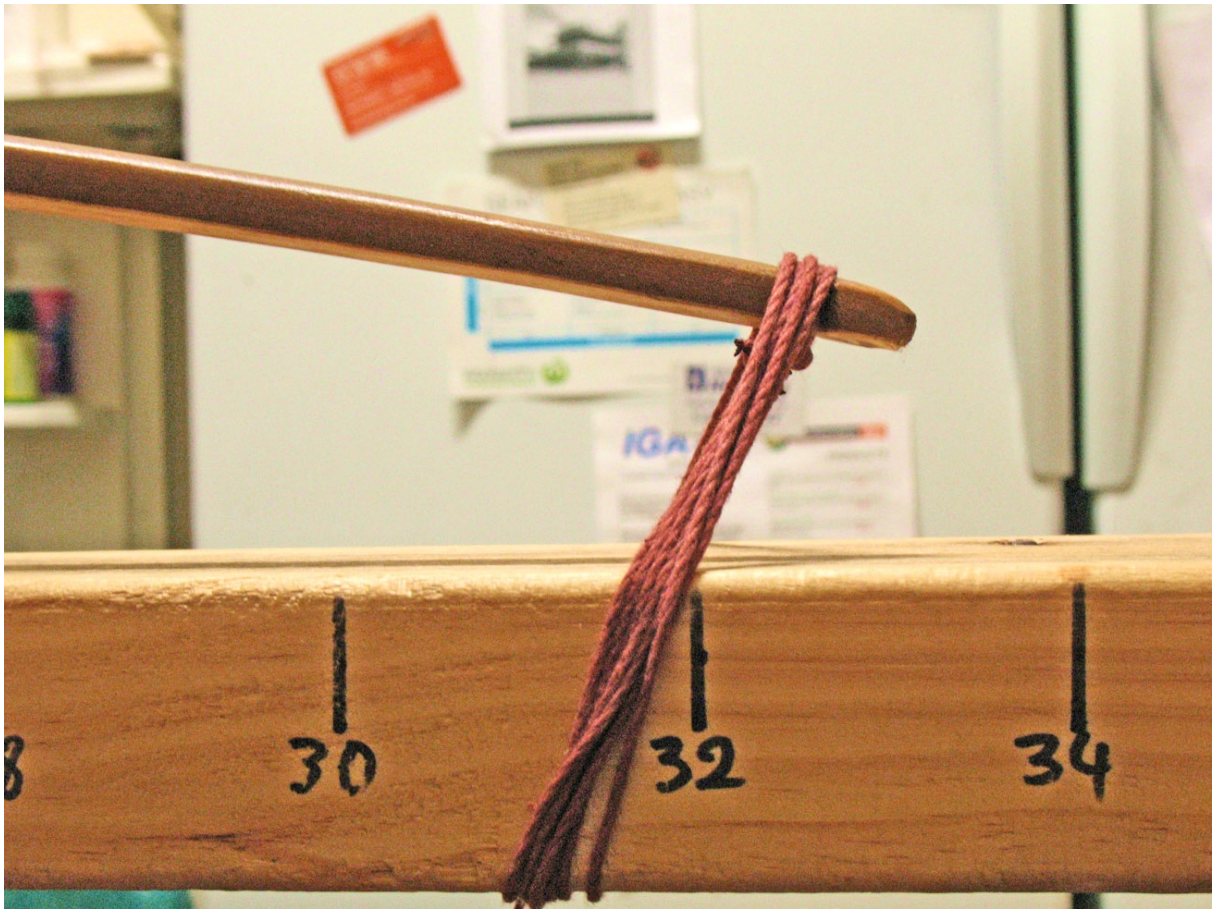
4. The amount of unsupported limb at each end of the mounting blocks must be of equal length; in this case 25" to the limb nock at each end.

METHOD

1. Using a long piece of stiff straight board which is about twice as wide as deep and longer than your bow (mine is 3 metres long - about 10 feet). I have two blocks of wood used to support the bow above the board which are 15cm wide (6") x 10cm deep (4") x 5cm (2") wide - enough for any bow to lay across and rotatable for greater height if necessary.



5. Bow positioned on mounting block with padding and lashing. The bow in this picture is 11cm above the mounting board including padding.



6. Limb tip lashed and drawn down by required amount of bend to 3.5cm above base.

2. Place these blocks apart on the board centred on either side of the bow's geographic middle and equidistant from each of the limb tips. Lay the bow on them with the back surface down and the belly surface up.

   Make sure that there is an equal amount of unsupported limb on each side of the support blocks. With some of the older bows, the handle is not in the middle of the bow, so place the blocks equidistant from the exact middle of the bow – not the middle of the handle.

3. With pieces of string, lash the bow onto the supports and board by looping the string around the whole bow, support block and baseboard. Put a bit of padding between the support block and the bow's back to protect that surface from being marked by the blocks.

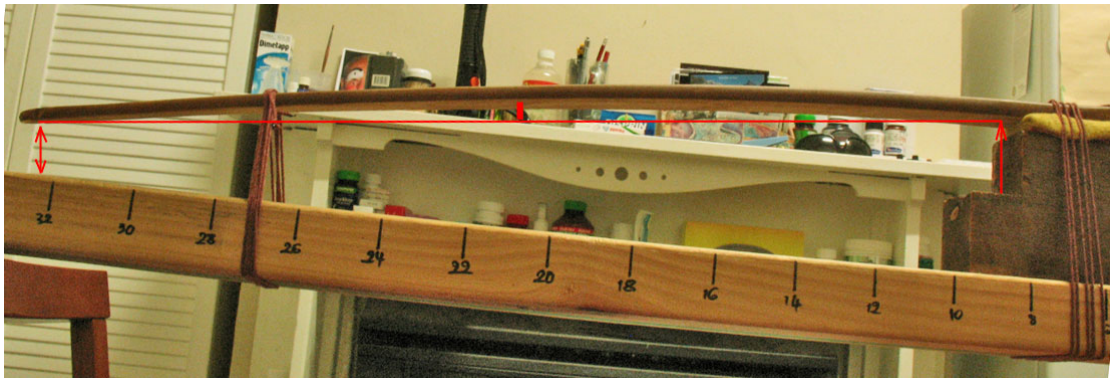
4. With the bow lashed to this form, using two more lengths of string, catch one around the bow's limb nock with a noose and then loop it around the baseboard and back up to the bow and around the nock again.

5. Then, gently pull on the string end and watch the bow tip be pulled downwards toward the base board. Use care here. Pull the bow tip downward to about 2 ½ times the amount of the required amount of bend. Then repeat at the other end using a ruler to check that both tips are equally bent.

   Check also that the amount of curvature in each limb is the same by measuring vertically from the markers on the base board up to the bow's back surface. Moving the support blocks further toward the tip or back toward the handle can alter the degree and severity of curvature. Moving it toward the tip increases the severity of the curve and vice versa.

   Too much curvature will tend to pull the tip end down more than the middle of the free limb causing a slight static curve effect which has no benefit at all. It just increases the bending stress on the inner part of the limb exposing it to the likelihood of unwanted set.

6. To ensure that the bends in the limbs for treatment are of mirror-image bends, I use the following technique.



7. Pic showing mid-point of the bent limb between the 20" and 22" markers being deepest point of curvature of limb. The vertical distance at the limb tip is the required amount of bend.

(a) First, I tie the limb tips down to their intended degree of reflex.

(b) Second, I place a straight edge so that it contacts at the limb nock and the limb where it leaves the mounting block – 25" on the bow in the pic above (see red line in pic 7).

(c) Thirdly, I then check to see that the highest point in the curve above the straight edge is as close as possible to the mid-point between those points. I then compare the two limbs to see if both have the same middle point directly above a convenient 2" marker on the base board.

(d) If that mid-point is not in the middle of that span, I move the limb tip tie-down string further inboard on the limb which is at fault until both its mid-point is the same as the other limb AND its limb tip is at the original height above the base board. This requires that the limb tip tie-down string needs to be loosened, shifted and retied incrementally until both limbs match in curvature.

7. When you have checked that both limbs are equally bent in reverse to their normal position by 2 ½ times the amount of required bend, use a normal hot air heat gun at low setting to apply heat to the belly surface of the bow by passing the heat gun up and down the limb 100 times where up and back count as 2 passes. I move it at a rate of about 6 inches per second on average.

8. Keep the heat gun no closer than 1 to 1½ inches above the wood so it doesn't scorch. The amount of heat should be such that you cannot hold the bow with bare hands.

9. After that, leave it stand to cool thoroughly before stripping it down from the jig. Depending upon the ambient temperature, the bow will have cooled enough to come out of the jig after 3 – 4 hours, but I normally leave it until the next day before bracing it. It will now be much straighter, or even have a slight reflex which is even better.

Note: Reflex is NOT the same as recurve. Reflex is a gradual bend over the whole length of the limb, whereas recurve applies only to the ends of the limbs, generally the outer 1/3 only.

CAUTION: Some limb tips on the bows in my collection, particularly the York Archery Lemonwood bows have tips which measure 3/8" wide x ¼" thick – barely. These are York's target bows and are meant to be a bit whip-ended. Being so small in cross section, that whip-endedness makes them prone to whipping in the reverse direction when heat is applied, taking on additional bending in the last 4 - 6 inches and forming a sort of shallow static recurve. This phenomenon was a bit of a surprise to me.

This does not straighten out when the bow is braced, meaning that the outer 4 – 6 inches is not working and thus throwing more bending stress on the inner limb leaving both more prone to resuming set than otherwise. I have done it often during my experimentation and I have had to remove this when it has occurred. But it can be avoided if anticipated by NOT heating this last part of the outer limb thus preventing this kind of thin tip from recurving.

10. The following day, brace the bow and leave it in repose for a couple of hours, then unbrace it. You will see that the limbs may have taken a slight set again, but most of that will come out with rest.

The amount of set, if any, taken by the limbs again after 2 hours in repose will be minor. Because there is greater stress on the limbs in repose than when at full draw after 2 hours of repose, I have found no observable increase in any set after follow up shooting[2]. This does NOT seem to be associated with the difference in time the limbs are in each position, but a matter of the amount of applied maximum stress at each position.

The bow will have a lot more power, but it may still take some set eventually, although mine have not done so, probably because I can't shoot them all as often as needed to see if set will redevelop. There are simply too many of them, but the bows I shoot most are not resuming any set so far. If set does re-occur, then you can simply retreat the bow using the 2.5x formula. I have done repeat treatments up to six times on the one bow to no ill effect before I was satisfied.

[2] **Archery – The Technical Side**, North American Press, 1947, Hickman, C.N. et al., pp19 – 21 (no ISBN)

11. To induce reflex into the same bow only requires that the bow be bent further into reflex than to merely straighten it. This can be done in a later stage when satisfied that all string follow has been removed. When both limbs are straight, the amount of bend necessary for reflex is effected by using the same formula of 2.5 times the desired reflex for each limb rather than guess how much to allow for limbs which are not equally straight.

    It can still be done in a single stage using the same formula. If the bow has 5cm (2") of set and I want 2.5cm (1") of reflex, the amount of bend required is 7.5cm (3"), so applying the formula –

    7.5cm x 2.5 = 18.75cm
    or 3" x 2.5 = 7.5".

12. Unbalanced tillering can also be corrected to some degree by the same method. After ascertaining which limb has too much bend compared to its mate, use the same 2.5x formula to increase the amount of bend in that limb which has excessive bend to bring it back closer to its mate.

    Many of the old wooden bows I have in my collection have taken on an excessive amount of bend or set in the lower limb and therefore move out of timing with each other. Using the above method can restore limb synchrony without the need to remove wood in the stronger limb.

13. If you tell wood bowyers that you straightened a bow this way, most will throw their hands up in horror and tell you that bending the bow in reverse will blow it up and other such nonsense. I have lost count of the number of bows I have straightened permanently this way, so I don't take too much notice of such beliefs any more. If the bow is not broken in some way already, this technique will not do it.

TWEAKING

I have also found that minor differences in tiller can be corrected by applying heat to the belly of the stiffer limb whilst the bow is braced. Being braced keeps the stiffer limb under load whilst the heat is applied.

Care needs to be taken not to overdo it because a little heat goes a long way. I keep a ruler very handy and check the tiller between both limbs very often. As soon as the limbs come into tiller again, *I unbrace the bow immediately and let it cool*.

The reason for that is because any residual heat in the limbs will continue to affect the limbs for some time after its initial application and keeping the bow braced during cooling will weaken the stiffer limb into an opposite tiller.

AND FINALLY -

Using the method above, I have brought nominal 30lb bows up to close to 40lbs, and heavier bows can increase draw weight by as much as 10 to 15lbs over their nominal draw weight, especially if reflex is put into the limbs.

It does not seem to matter if the limbs are reverse bent in the jig *before* or *after* they are heated. I have done it both ways and cannot tell any difference except that with pre-heated limbs, you have to work more quickly while each limb is hot.

The greatest amount of reflex bend I have used without problem so far is 8 inches in an old Ben Pearson 66 inch Hickory flatbow. After stripping from the jig, the spring-back was close to 5 inches leaving the bow with 3 inches of reflex.

I have also treated backed and laminated bows this way and there has not been the slightest sign of the glue letting go. I can only suggest that the amount of heat involved in this process is not enough to soften the glue.

I have also used it on bows which are backed with Fibre, Rawhide, Hickory and Bamboo and none has failed yet or marred or unglued the backing.

I have also used it on Hickory, Yew, Osage, Red Oak and Lemonwood self-bows, with and without backings. It has worked with all of them.

Just recently, I have come across Marc St. Louis' excellent article in Traditional Bowyers' Bible, Vol. 4, pp 59-74 entitled ***"Heat Treating Bows"***[3]**.** To all intents and purposes, both he and I have worked out a process of removing set or string follow using very similar principles.

My ideas developed from the process described by Robert Elmer in his seminal 1946 book, Target Archery, which is arguably the best work ever published about the scientific development of bows during the first half of the 20th century, up until the development of the development of fibreglass skinning of the backs and bellies of bows. Quality bow-wood in bows became almost irrelevant overnight.

In my copies of old archery magazines from the 1940s and 1970, you can see the dramatic decline in the classified ads for sales of traditional bow woods over only 5 years. By 1960, they were gone except in rare cases.

Although Mr. St Louis and I have arrived at similar principles, techniques and findings via independent pathways, they do support each other. My method holds the bow securely whilst having a moving heat source and his holds the heat in a fixed position whilst moving the bow. My method is based on 66" and longer straight ended bows exclusively, for which I have worked out a formula which has proven pretty reliable – my ***2.5x*** formula described above. He uses water to rehydrate his bows – I do not.

Using the 2.5x formula is not exactly predictive, but close enough within the variations found within most wood of same species to be useful. So far, I have not found any huge differences between predicted outcomes and final results to alter it. Any differenced between prediction and result are a matter of fine tuning on specific bows rather than general principles.

Mr. St Louis method of applying heat is much slower than mine with the intention of also tempering the surface wood of the belly against compression which is something I have heard of in other reading. My technique does not intend any kind of heat tempering and my apparatus is somewhat simpler, but his findings pretty much match mine in purpose and result. But, there is no reason why the belly of bows using my technique could also be tempered by applying heat more slowly as Mr. St Louis describes, although, having a fixed heat source has obvious advantages of heat control.

The important principle underlying both techniques is that the method applies only to bows which have been tillered, and arguably should also be broken in to shooting to a point where the limbs have settled into their final tiller. Either technique could be utilised as a technique before the final stage of finish application and I would recommend this.

I also recommend that readers of this paper read Mr St Louis article as further reading on this interesting and very useful subject.

Dennis La Varénne
March, 2014

[3] **Heat Treating Bows**, Marc St. Louis, Traditional Bowyers' Bible, Vol. 4, pp 59-74, ISBN 0-9645741-6-0