Steam-bending fronts – a practical demonstration

Lecture/Demonstration given to the conference of the British Violin Making Association at Dartington Hall, Devon on 14 September 2008-09-26

Helen Michetschläger

1. Introduction

Giving this talk here at Dartington is very appropriate, as without the BVMA, I might never have given any serious thought to the idea of bending fronts. The idea came to me when I read Jane Julier's article about steam-bending viol fronts in the autumn 2003 BVMA newsletter (reference 1). I'd been making Brescian-inspired violas and it looked as if the technique might be a good way of getting the sort of arching I was looking for. Although whether any of the early violas were bent rather than arched is another story! I'd like to thank Jane for her generosity in helping me along in the early stages and answering my many questions.

As I've used this process mainly for violas, that's what I'll talk about, but it can be equally applied to violins.

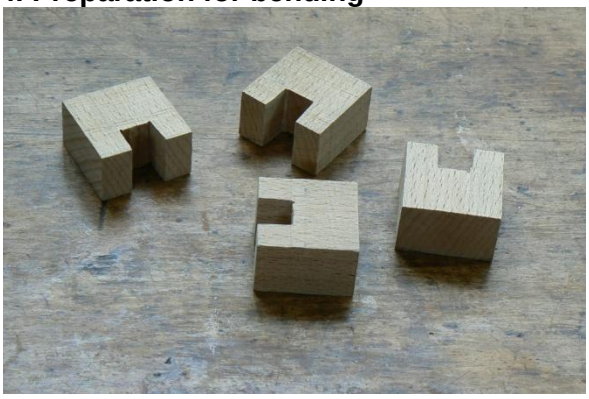
2. Wood selection

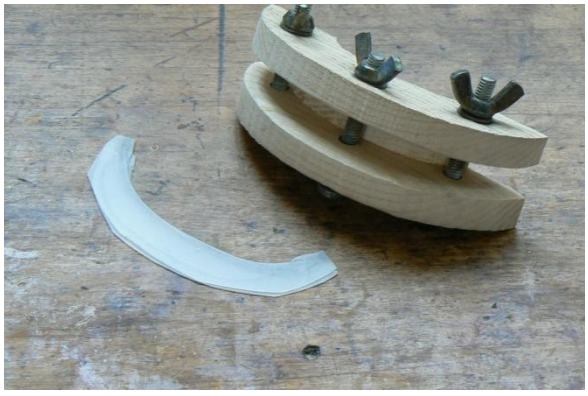
It's important to choose the wood carefully. It needs to be sawn exactly parallel with the growth of the tree, i.e. with no run-off of the grain, and well on the quarter. I prefer to work from split logs, so that I can see that the grain is not twisted. The boards are then sawn from the split logs. It's also wise to avoid wood with knots or other defects, as these may cause the bend to fail.

3. Preparation of wood

I use two pieces jointed at the centre, and prepare the boards to 5mm thick. You need to be accurate with the thicknessing as irregularly thicknessed wood does not bend evenly. I cut out the two halves of the viola working from an outline template, leaving an extra 2.5mm at the centre line and 2mm at the ends and in the corners and Cs. The idea is that the bent and jointed plate will be just large enough to make the finished outline.

4. Preparation for bending



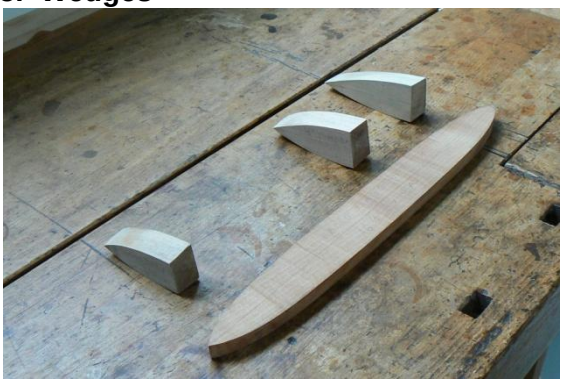


The two halves of the front need to be held together while they are bent. For the upper and lower bouts, I use simple wooden blocks with a 10mm x 10mm slot cut out to receive the wood for the front.

These are not strong enough for the Cs where the pressure of the bend is greatest, so I use instead a cramping block made from wooden formers held together with bolts and wing-nuts.

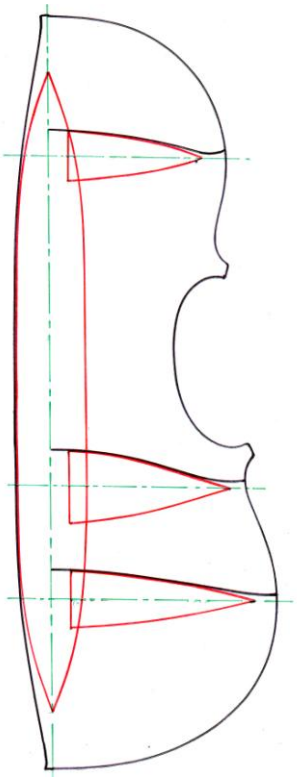
In order to avoid the risk of this block tipping in use and crushing the edges of the front, the outer edges of the formers are separated by 10mm-deep spacers. I also round over the inner edges of the formers to prevent them from digging into the spruce.
Before fitting the cramping block for the Cs, I separate the two pieces for the front with one or two spacers made from thin strips of plastic. This leaves the Cs in a slightly higher plane than the bouts, which is helpful for the arching in that region – we'll come back to that later.

5. Wedges



The arching of the front is made by driving wooden wedges between the two halves of the front. I make these from any suitable hardwood that's easy to work; fruitwood, lime or maple are all fine. The two main wedges form the cross-arching of the widest part of the upper and lower bouts. A third wedge just below the lower corners prevents this area from sinking. The final wedge, graphically described by Jane as the "boat deck" gives the shape of the long arch.

6. Wedge shape

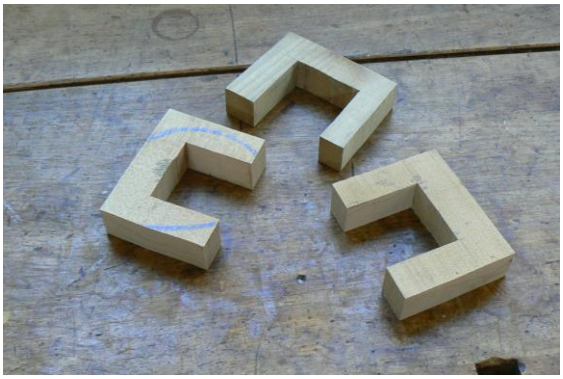


As you can expect the wood to sink once it's been bent and dried, you need to over-bend the wood. I find that a good rule of thumb is to make the width of the "boat deck" wedge at its widest point equivalent to the maximum arching height so that in the central area it follows the external arching of the finished instrument. In effect you're bending the wood to about 5mm higher than the finished instrument.

The black lines on the illustration indicate the finished arching shape, and the red lines indicate the wedge shape. First I draw the long-arch wedge, or "boat-deck". In the central areas it's the same height and shape as the outer long arch of the finished instrument; for a viola with a final arching height of 20mm you'd make the maximum height 40mm. It is about 60mm shorter than the length of the front. The ends of this wedge need to well tapered to avoid the finished front becoming too thin when the fluting is blended into the arching. The underside of the wedge is tapered to follow the flow of the cross-arching. The wedge itself is around 12mm thick.

The cross-arch wedges are determined in a similar manner. The length is that of the maximum widths of the wood you have prepared for the front minus about 15 mm at the outer edges and the thickness of your boat-deck wedge at the centre joint. The wedge for the lower corners is a little shorter, about 20mm in from the edge.
The maximum width of the cross-arch wedges corresponds to the depth of the back of the boat-deck at that point, and then they taper down following the shape of the arching. They also need to be tapered quite a lot in their thickness so that they do not create a bulge in the arching.

7. Counterforms



The final piece of equipment you need is three u-shaped blocks of wood to act as counterforms to hold the front against the boat deck wedge. These are made from hardwood, about 15mm thick. The width of the slot corresponds to the maximum height of the boat-deck plus the thickness of the two halves of the front.

8. Bending

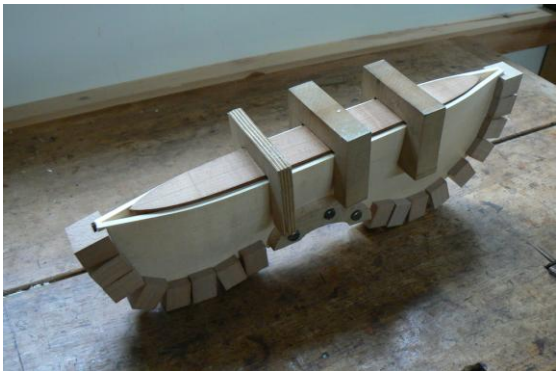
Steaming softens the fibres of the wood and makes them flexible. Lignin, which is one of the major components of the structure of cell walls, becomes plastic at about 90 degrees C. It's necessary to steam wood for long enough to make it pliable but not for so long that it causes permanent damage. The standard measurement is 2 minutes per millimetre thickness of wood so for our 5mm thick boards, 10 minutes is the correct time.

Once the wood for the front is prepared and the blocks and wedges made, bending can begin. The wood can conveniently be steamed in a large fish kettle with a small amount of water. The water must be at a full boil before the front is put in. If the available wood is well seasoned, it can ease the bending to soak it in water for a couple of hours before bending – this moisture will soon dry out after the front has been bent.

9. Driving in the wedges

The front, complete with all the cramping blocks, is put in to the fish kettle for an initial steam of ten minutes. Once it comes out, I drive in the cross-wedges as far as they will comfortably go, hitting them with a mallet. Usually they will go in to about three-quarters of their length.

The front is then returned to the fish kettle for another steam – as the wood is still warm, five minutes is sufficient for this and subsequent steamings. The wedges can then be driven fully home, and the "boat deck" wedge fitted. Finally, the three counterforms are fitted over the "boat deck" to hold the front against it.



Once all the wedges are in place, the wood is returned to the fish kettle for a last five-minute steam. The wood needs to be steamed in its final form to set the shape. As the wood is cooling all the time that the wedges are being fitted, it is losing its plasticity, so might lose the memory of the final shape once the wedges are removed. By steaming it a final time in its finished state, the wood is "set" and will have the minimum loss of shape.

The front is then left for two or three days to dry out. It's ready when it feels very dry and the cramping blocks become loose.

10. Jointing the front

The joint is quite easy to make using a jack plane and a shooting board.

11. Gluing the centre joint

The front is glued and cramped up on a clingfilm-covered wooden board. The board has four screws at the widest point of the upper and lower bouts, and the front is held tight using wooden wedges. Then there's a stretcher cramp to hold the centre and two quick-release cramps at the ends to stop them lifting off the board.

For this joint, I prefer to use isinglass glue rather than normal hide glue. It is a very strong glue with a slow gel-time, which is helpful as it takes a few moments to get the front cramped up.

12. Flattening the front

Once the centre joint has dried, you can run round the underside of the front with a block plane to make a flat platform that will eventually be glued to the ribs. This won't of course be completely flat – the area of the top and bottom blocks needs to be built up later with half edging, and you may need to take more out of the Cs than the bouts to get a wide enough flat area for eventual gluing to the ribs.

Once this can be done, the outline can be finalised. Purfling is done in the usual manner, and the main work in the arching is to blend the fluting into the main arching.

13. Thicknessing

Because the bent front is so strong, it should be left a bit thinner than a carved front. I'd usually make a 16 inch (40.5 cm) viola with a front thickness of around 2.4mm, and the weight before fs and bass bar would typically be around 80g. You notice when you're working on it that the tap-tones seem clearer and more focussed than those of carved fronts – it feels a bit more like the sound of tympani.

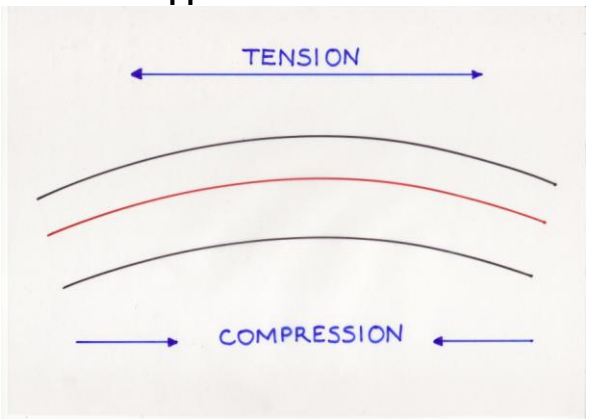
14. Half-edging

The way the front is bent means that there is not enough wood in the area of the top and bottom blocks to make a flat surface for gluing. So it is necessary to build up these areas by half-edging.

15. F hole fluting

You'll have noticed that I've not said anything about fluting the wings of the f-holes. One of the nice things about bent fronts is that this happens naturally. When the front was bent, the small plastic spacers I put between the Cs put them in a slightly higher plane than the upper bouts. So light pressure when gluing the front to the ribs pulls this area down and the f-hole lower wing drops nicely.

18. What happens when we bend wood?



When wood is steam-bent, the outer, convex surface is in tension (stretched) and the inner surface is in compression. In practice, wood can support an increase in compression of up to 30%, but can only support an increase in tension of about 2% before it fails. So most of the change takes place by the inside surface of the front compressing. The diagram shows this – the red line indicates the neutral axis, which is slightly above the middle of the plank. The wood above the red line is in tension, and below is in compression.

As green wood is more flexible that dry wood, it seems sensible to use fresher rather than older wood for bending. However, it's unsafe to use completely green wood. The wood must be partly seasoned – i.e. it should have dried sufficiently for there to be no free water in the cell cavities, only bound water in the cell walls. Remember that most of the deformation that takes place during bending is as a result of compression. If the wood is bent when the cells cavities themselves are still full of water, this water will have nowhere to go, so will prevent compression, and the wood will split.

But bending does make it possible to use quite fresh wood – wood that is recently cut but not still visibly wet. If you have access to a moisture meter, this would be a 25% moisture content or below.

If the available wood is well seasoned, it's fine to soak it in water for a couple of hours before bending – this moisture will soon dry out after the front has been bent.

The process of steaming washes out some of the dissolved minerals and nutrients from the wood cells. This may help the wood to stabilise more quickly and to decrease the time necessary to season the wood.

The spruce for the front of the finished viola I have here was made from a billet of wood that was wet to the touch in January of this year. Cut into 5mm planks, it had dried sufficiently by June to be bent and made into this viola.

19. How to recognise bent fronts

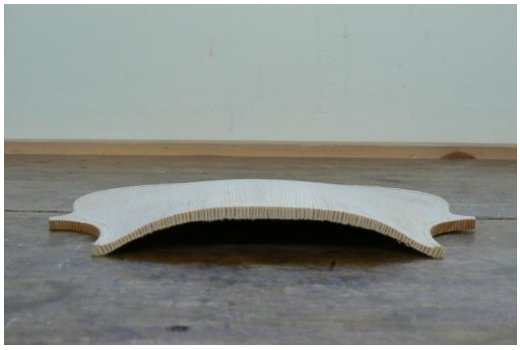
Obviously, you have a lot more straight-grained wood than you do on a carved front, both across and along the grain. There are four main pointers to recognising bent fronts:

Ray figure is visible over the whole width of the front, not just in the central area.

The grain lines converge at both ends of the centre joint.

The grain lines are at right angles to the arching across the whole cross section of the front. Looking at the edges of the front, the grain will be at right angles to the plane of the ribs at the top and bottom block areas, and then will tip out to follow the arching in the upper and lower bouts and Cs.

Looking at the front sideways on, the grain of the wood in the f-hole wings dips towards the edge more than for a carved front.



1.

20. How do bent fronts sound different?

I've now made 25 violas and one violin with bent fronts. I've found that these instruments are more powerful, more responsive, and have a greater spectrum of tone colour than those I've made with carved fronts. According to an article by Joseph Curtin in the Strad, (reference 2) the acoustically best wood is that which has the greatest stiffness-density ratio. Bending rather than carving wood increases the stiffness of any piece you have.

21. References and Bibliography

1. *Hands and Minds at Work* by Jane Julier, BVMA Newsletter Issue 33, Autumn 2003
2. *Tap Routine* by Joseph Curtin, The Strad October 2006
3. Isinglass glue: www.dick.biz/isroot/dick/Files/InfoDatei5E/Hausenblasenleim.pdf
4. *Understanding Wood – A Craftsman's Guide to Wood Technology* by R. Bruce Hoadley
5. *Wood Bender's Handbook* by Zachary Taylor
6. *Wood Bending Handbook* by W C Stevens and N Turner