Making a Double Bass

by

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Schwanewede

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PART I - CONSTRUCTING THE BASS

Introduction

About twenty years ago a dealer came to my workshop with a truck load of tone wood. I bought one or two nice violin backs, but while I was searching through the pieces I noticed several sets of bass wood at the back. 1 2

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Normally I would not have given them a second glance, but as they were clearly very special, I asked him to take them out and place them in the sun for closer examination. I suppose, in the back of my mind, I think I was thinking about one-piece cello backs. These sets were Bosnian maple and totally spectacular. I had never seen such fine grown bass wood. In addition, the flame was very similar to several Cremonese instruments I know well, including the 1690's flat backed cello by Antonio Stradivari that is pictured in the book 'Antonio Stradivari in Japan[1]. 3 The flame was narrow, but strong and well defined across the entire width. Moreover, these spectacular backs had matching ribs and head blocks that were undoubtedly from the same tree. I fell in love and bought all four sets, which it turned out, included four beautiful matching bellies that had been tucked away behind the backs.

Although I have always felt it incumbent on violin makers to construct a bass, at some time in their working lives, like most violin makers I had always pushed such thoughts to the back of my mind, where I hoped they would be forgotten entirely, or that I would mercifully die before the request came. I use the word 'construct' knowingly. It implies plans and assembly rather than design and creativity. Basses are the half forgotten, half cousins of the violin family; overly large, embarrassingly cumbersome and badly mistreated. They don't even warrant a decent gag, the ones we hear are usually second hand viola jokes.

In the early 1990s, I was working with my friend Duane Rosenguard on the Biddulph Guarneri book. [2] Duane, who plays bass in the Philadelphia Philharmonic, kept badgering me about making a copy of his Ceruti bass. More recently I had been asked to judge basses at the Violin Society of America competition. These basses were inspirational and I began thinking again about the sets of bass wood in my store. The final incentive came when my friend and colleague, the bass maker René Zaal [3], turned up with a stunning bass by Hieronymus Amati II. Being a lifelong Amati fan, this bass wound me up like a clockwork toy. Basses that have survived from classical times are already extraordinarily rare, but this example was also exceptionally well preserved. 4 5 6 7

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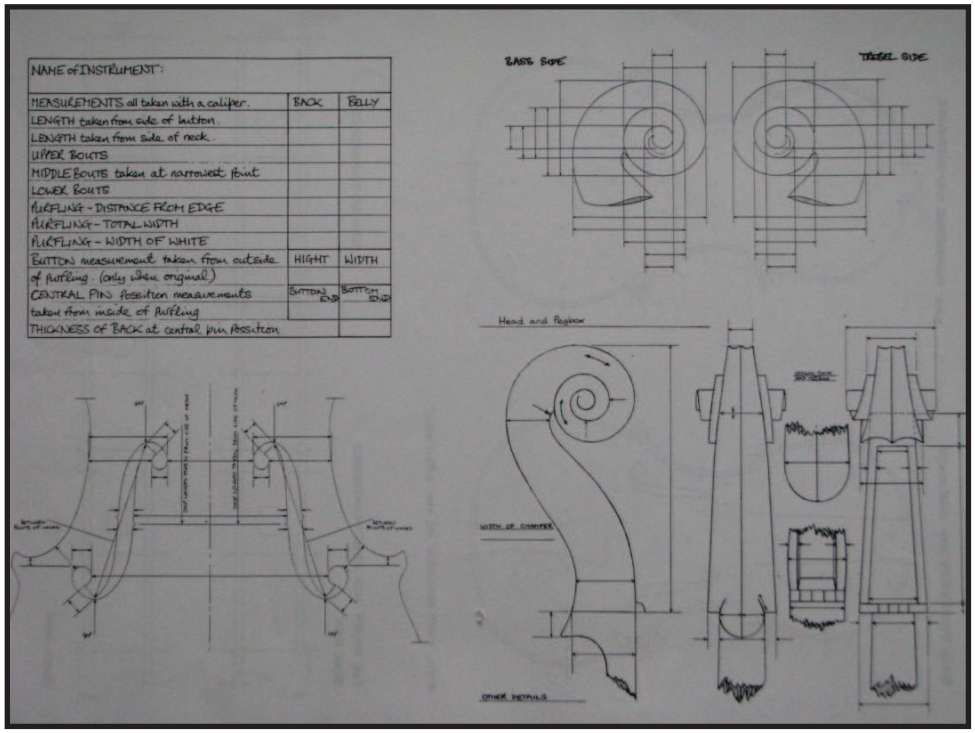
So in my 66th year, having sworn never to make another cello, using my spectacular bass wood, René and I began a copy of this beautiful Amati bass. And, in spite of the many difficulties we experienced, it became one of the most fascinating projects of my career.

The Scroll

Using the recording sheets that I designed for the Strad magazine and the Biddulph Guarneri book, René and I began by taking measurements of the body. We also took outlines, and rubbings of the sound-holes. 8 9 10 11



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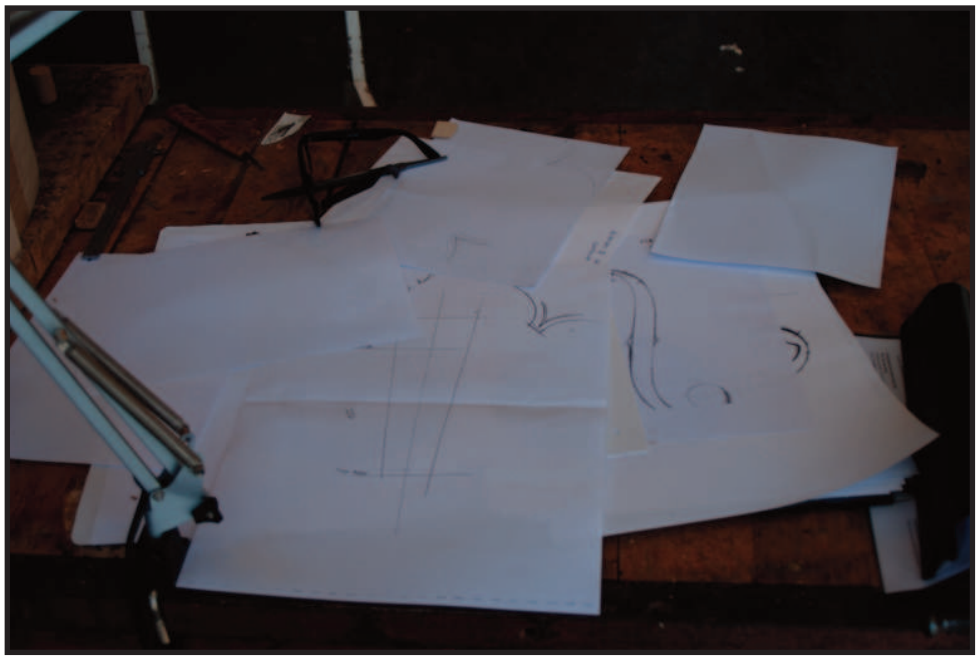

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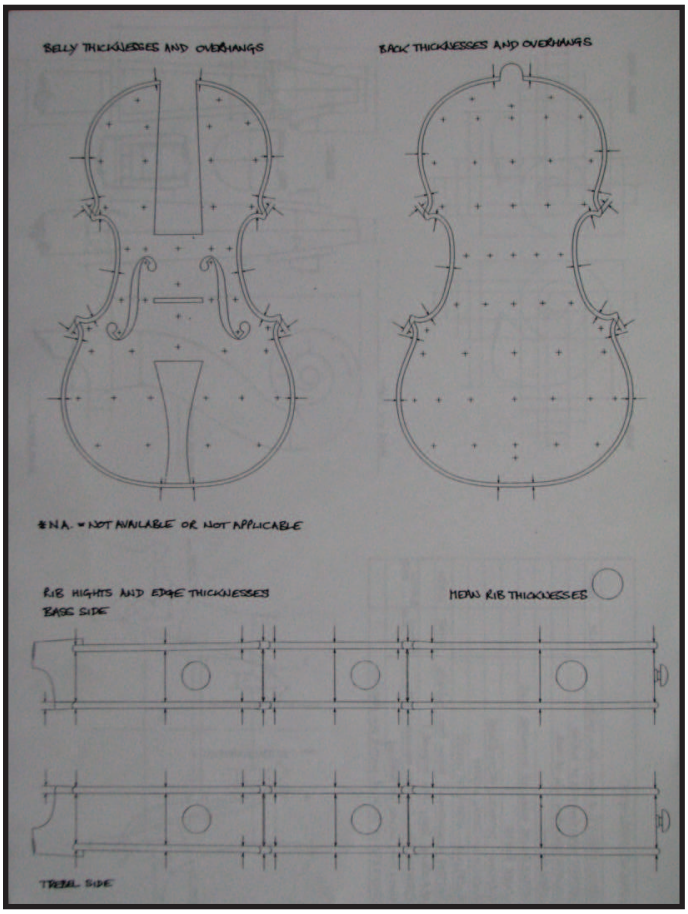

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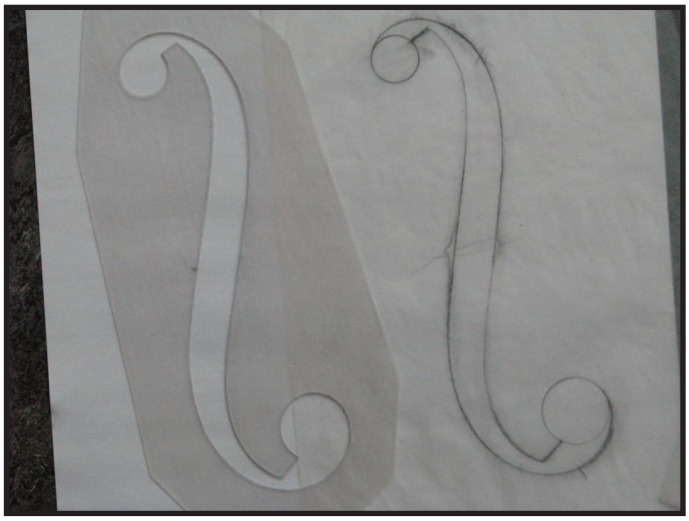

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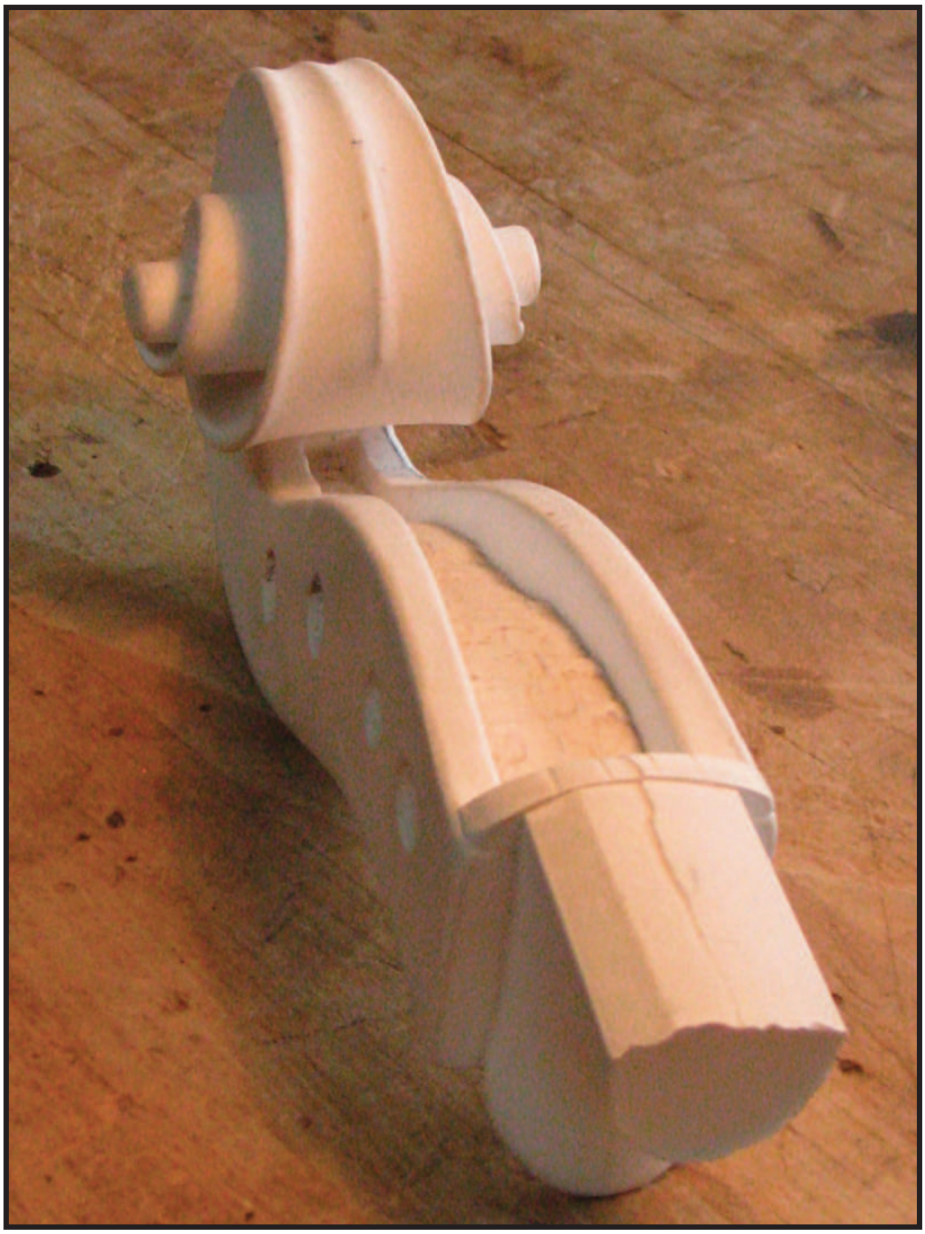
Unfortunately the head was a problem. The delicate scroll on this bass had been grafted onto a wider peg-box. Although undoubtedly more user-friendly, this peg-box is somewhat ungainly. In addition, over the centuries the softer (than maple) wood of the scroll has received several knocks and bruises. This superficial damage, coupled with the unfortunate peg-box graft, undoubtedly caused many experts to reject the authenticity of this scroll. On closer examination it gradually became clear that, although considerably altered by the grafting process, the elegant lines of this scroll are consistent with the work of the Amati family. This was supported by reference to a fine plaster cast of a Brothers Amati cello that I have in my collection. Having compared the two, I believe that the scroll on this bass is actually the remains of an original Amati bass head.

Because of the dramatic changes to the original head, caused by the replacement peg-box, René and I decided to use the cast of the Brothers Amati cello head as the prototype for our copy. 12



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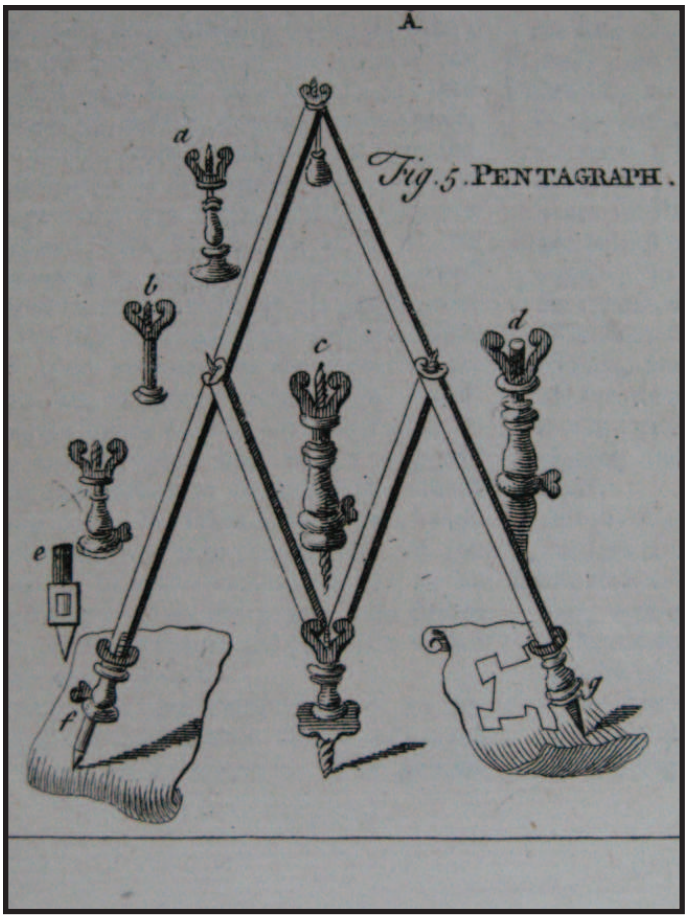
Using a cello head as inspiration for a double bass head may seem strange, but the thing about Amati family is their instruments are often remarkably similar in concept. Moreover, in many instances, they appear to have used interchangeable designs. A fine example of this is the Brothers Amati viola that was owned by Harry Danks. [5] Although this is a normal sized viola, somewhat unusually it has violin-sized sound-holes. Indeed it seems that the Amati family regularly reduced or enlarged designs as required. It is almost as if they had access to a photocopy machine, capable of enlarging and reducing sound-hole outlines. In fact they were probably using a pantograph, an ancient and ingenious mechanical device for enlarging and reducing drawings. The illustrations show a pantograph from a 1760 encyclopaedia 13 and my own modern version.14



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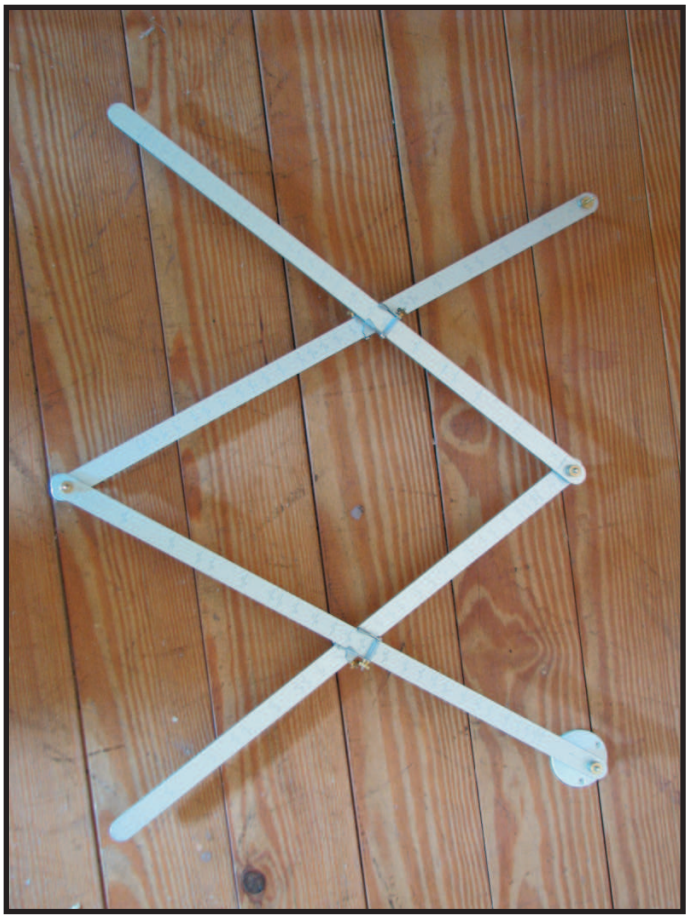

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Because I have little knowledge of basses, I took my Amati head cast to René's workshop, to establish what size we should make the head. Anyone that has repaired an Amati head or made a copy will know that they are probably the most aesthetically beautiful heads of all. They do however have one slight drawback. The elegant taper of the peg-box creates particular problems for those pegs that are located at the narrow end, directly under the scroll. (Violin A - Viola and Cello D - Bass A)

It may be that this bass started life as a 3-string instrument, in which case fitting of the strings would have been considerably easier. [6] The photograph of the cello plaster cast clearly shows how narrow the inside of the peg-box becomes. This restricted space left very little room for the string to wind around the shortest peg, (or machine), a problem further exacerbated by the heavier gut strings of classical times.

Being a pragmatic man Stradivari corrected this minor difficulty by making the backs of his peg-boxes slightly wider just before they reach the first turn of the scroll. Undoubtedly, this practical solution provided more room in the peg-box, but aesthetically, the resulting heads were no longer as elegant as those of the Amati family. 15 16

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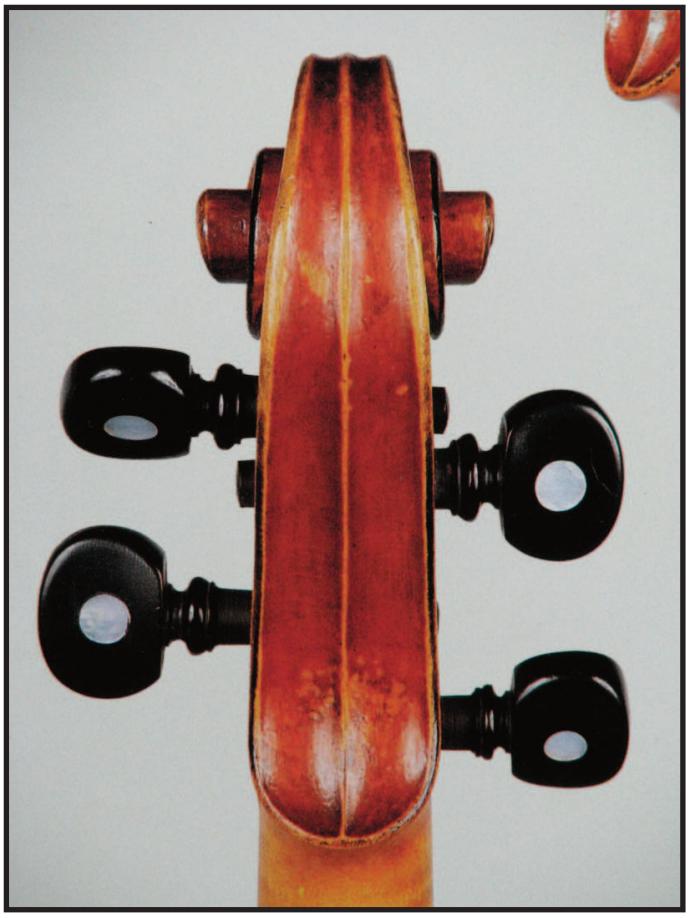

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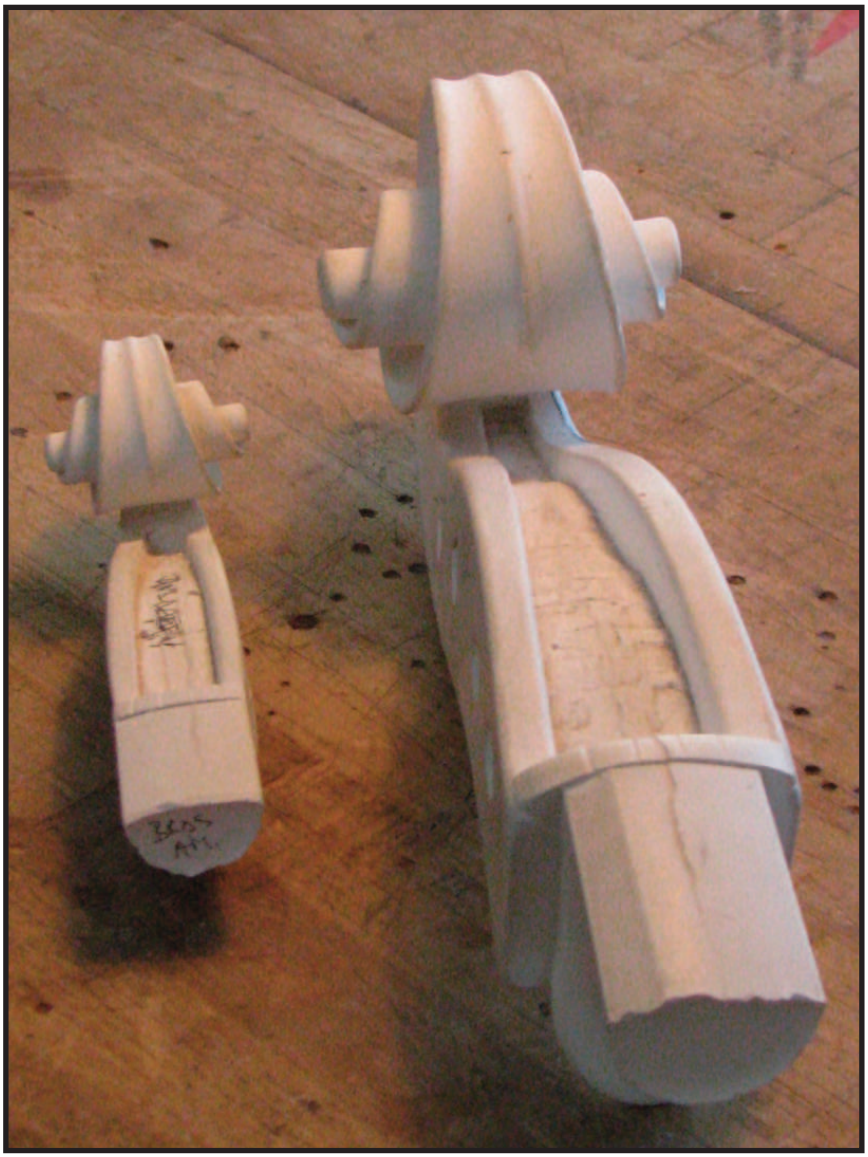
While designing a head for our bass I wanted to improve the pegbox and yet retain something of the elegance of this original scroll. Simply enlarging the Brothers Amati cello head would not have been a serious option. As Stradivari had already discovered the peg-box would have remained too narrow.

Also clearly visible on the cello head cast, (and a Brothers Amati violin head cast), is the way in which the central spine between the two flutings stops under the throat, allowing the two flutes to merge into one larger flute. 17 This feature is typical of Andrea Amati and his two sons, the Brothers Amati. [7] It does not appear to have been a feature of Nicola Amati or his son Hieronymus II. However, because our copy is inspired by the Amati tradition rather than being a strict 'bench copy', [8] we decided to keep this rather elegant feature on our head.



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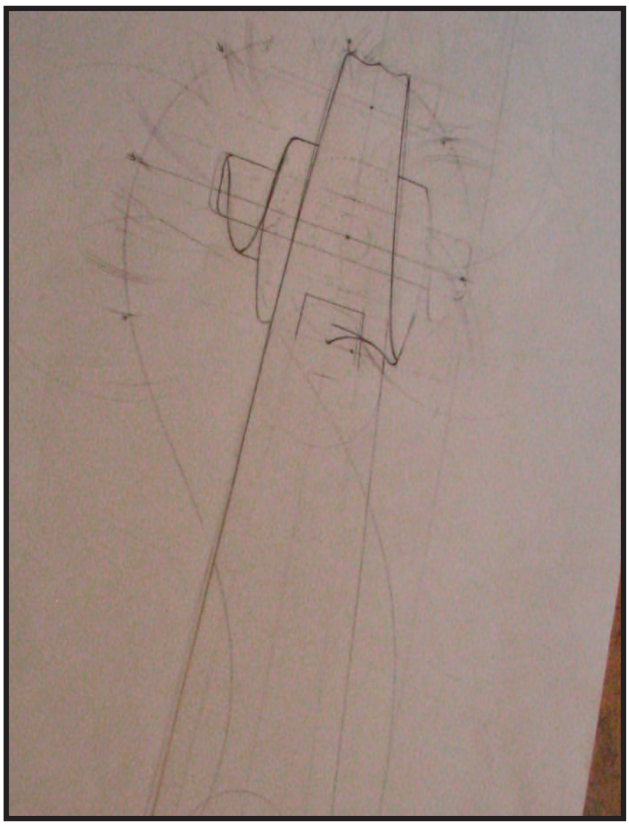
Drawings and Templates

The first task was to make full size drawings of the head, and from these to construct suitable templates. 18 19 20



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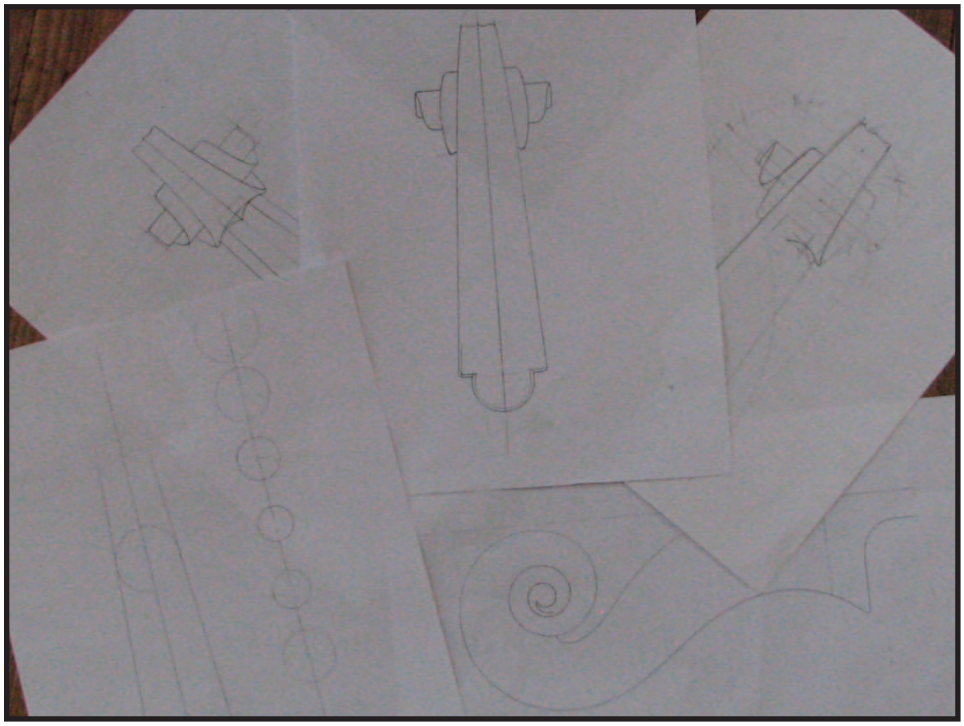

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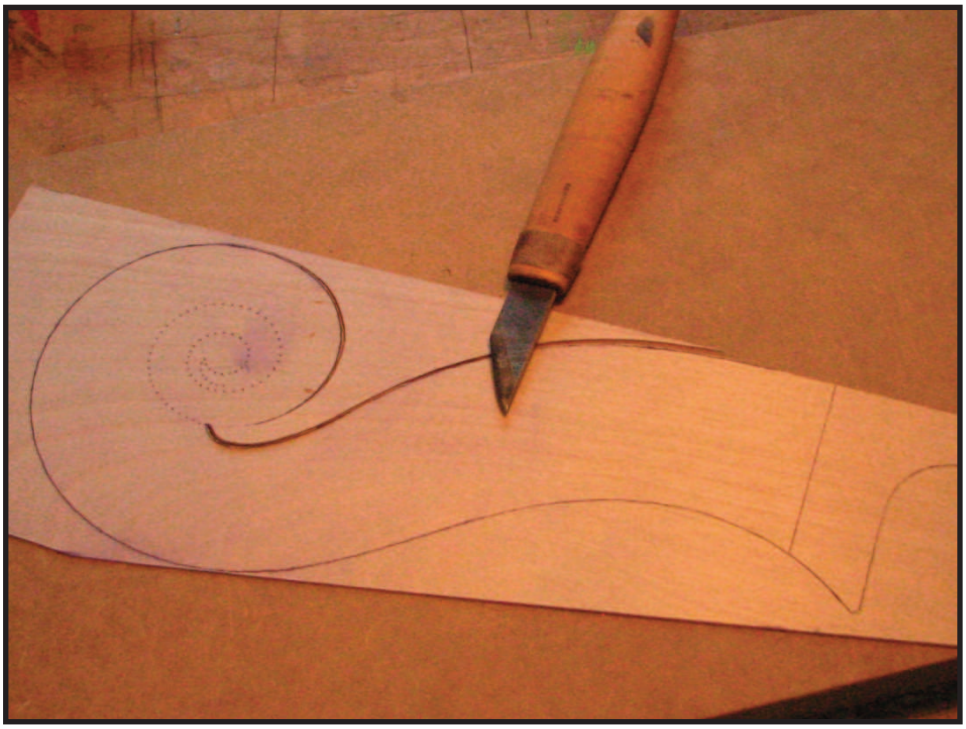

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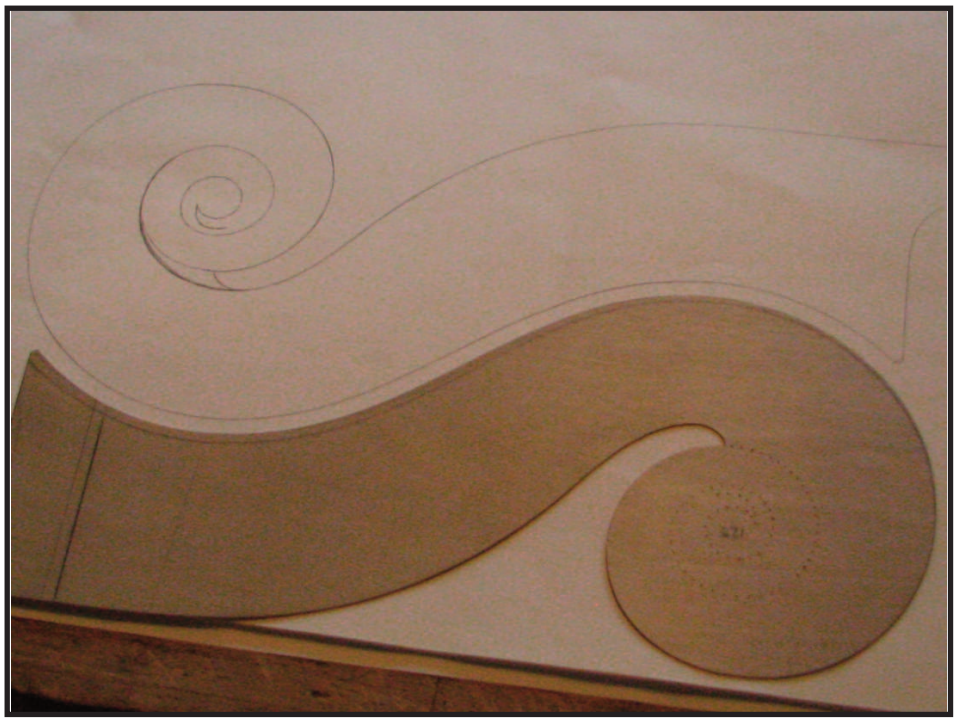
From the side drawing it is possible to note two or three further features that are often found on Amati heads. 21



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The first of these is a feature of almost all Cremonese scrolls. Viewed from the side, the peg-box flows smoothly into the first turn of the scroll. Such scrolls were inspired by classical Greco-Roman architecture and the mathematics of natural forms. The peg-box and scroll are not separate entities; they are integral parts of the same flowing form. As a result, the top line of the peg-box eventually merges with the line that runs along the back of the box gradually creating the side profile of the scroll itself. Essentially, the throat can be placed almost anywhere between these two converging lines.

From the photograph it can also be seen that the drawing and the template fit together almost perfectly

when set back to back; another distinguishing feature of many Amati scrolls.

A further feature is the comma form that is created when the chamfer on the final turn merges with the eye of the scroll. 22 This is a common feature of Amati scrolls, however, other than the rather heavy comma shape found on scrolls attributed to Omobono Stradivari, 23 this is not normally a characteristic of Antonio Stradivari. 24

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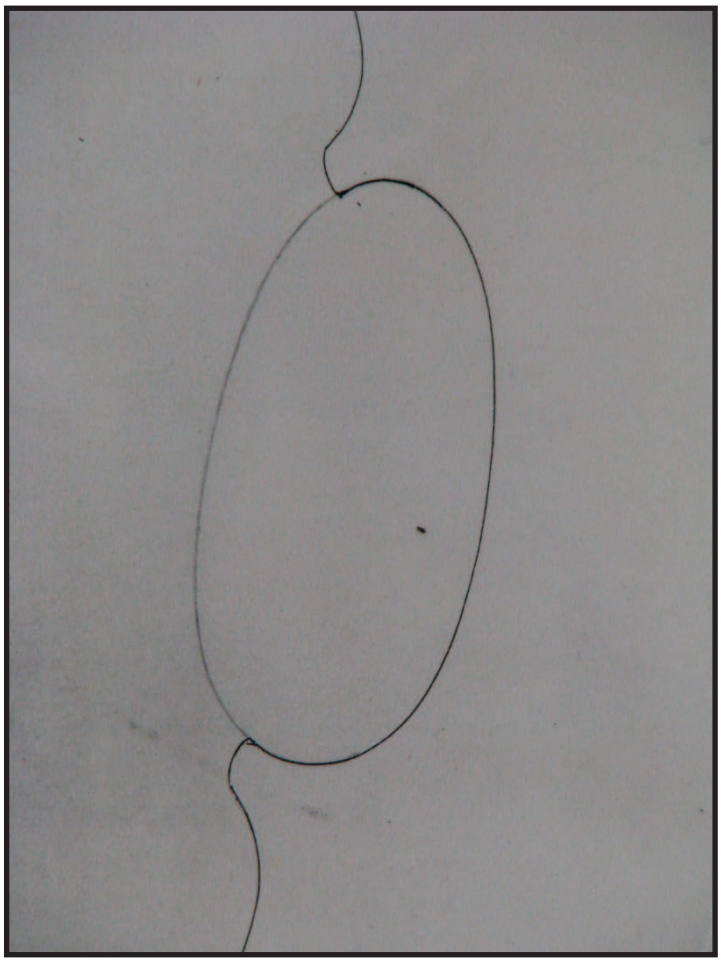
Amati instruments present many examples of such proportional harmony. For example, if the outlines of most Amati C bouts are reversed and superimposed, they will form a perfectly symmetrical ellipse. 25



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Indeed, although much of the edge-work and corners on this bass have been replaced, (a fact of life for most ancient basses), the centre bouts on this Amati certainly form a symmetrical ellipse. This will be a valuable reference when we begin reconstructing the heavily worn corners.

Establishing the side profile

Having drawn the scroll outline and made the templates, the neck block was squared and the side profile was inscribed and cut out. Working close to the line with the saw it only remained to finish to the outline with a course rasp. 26 27 28

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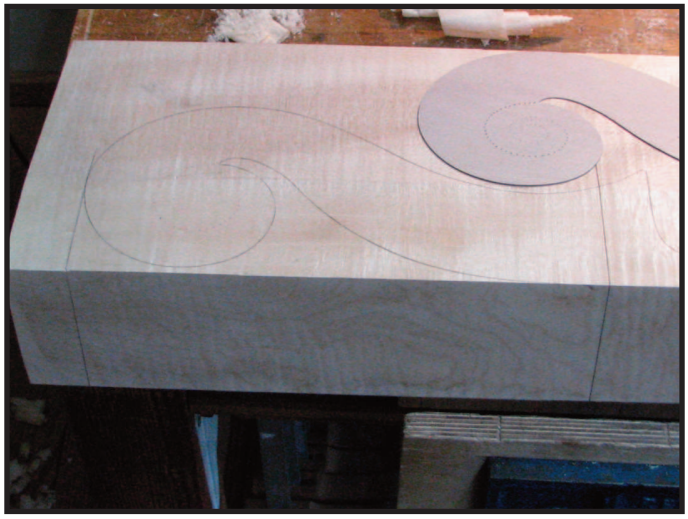

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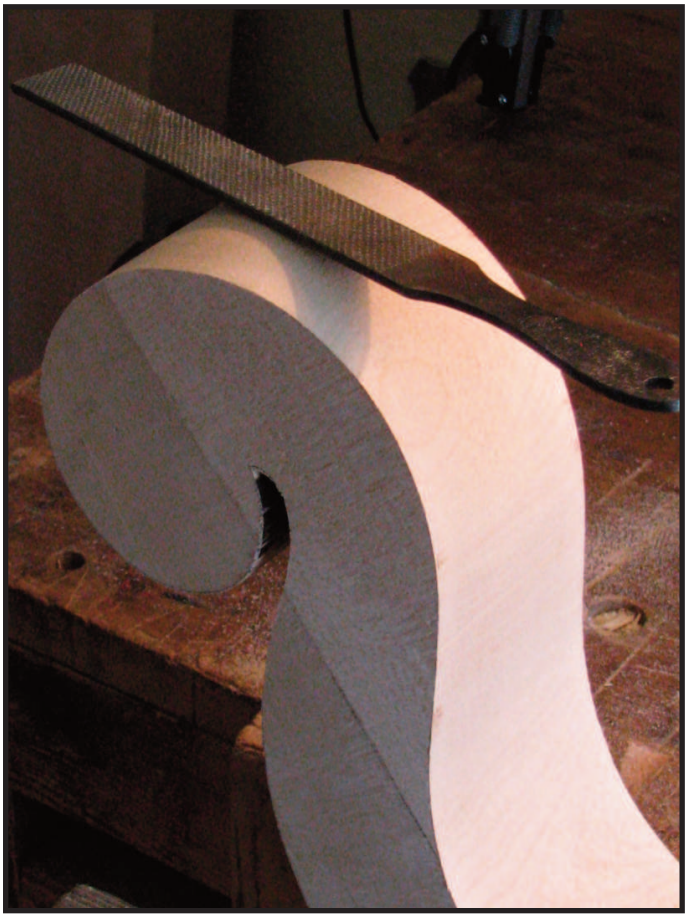

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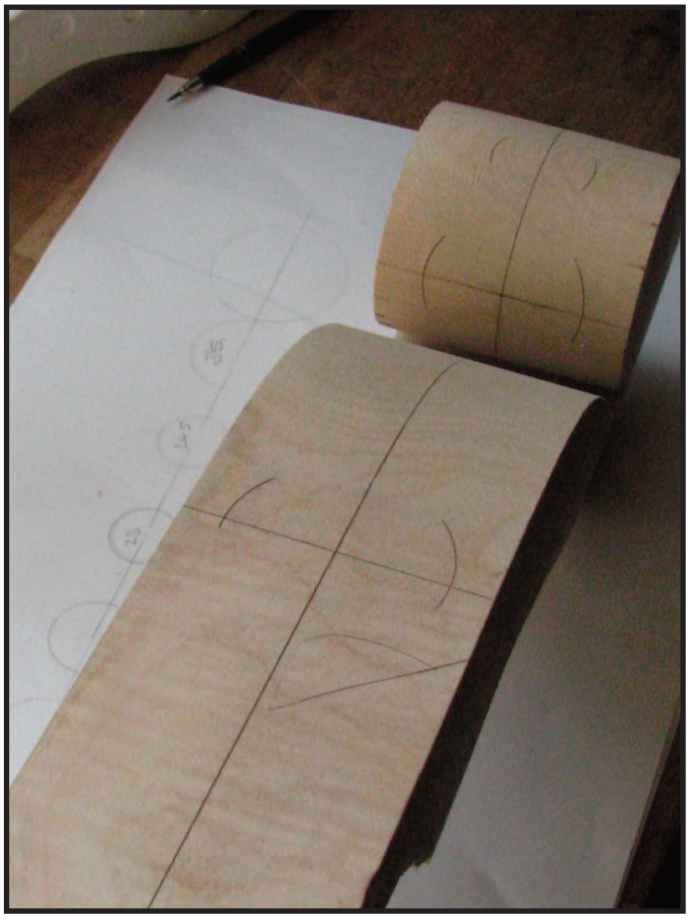

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I use this exact method when making violin heads. With the exception of the top of the peg-box walls, nothing of this profile surface remains once the scroll has been carved. Consequently, at this stage, no further cleaning up is required. On some rather hastily finished Cremonese instruments, especially those of Joseph Guarneri del Gesù, rasp marks can still be detected on the upper edge of the peg-box walls close to the throat.

Establishing the scroll widths and cutting away the sides of the peg-box

Once the side profile was established the various widths were marked out. In order to achieve this, I attempted to recreate the method employed by the great Cremonese makers.

Stradivari's method of marking out the peg-box and scroll widths is evident from the surviving drawings and templates, which in turn can be matched to the markings on many of his heads. This method was probably developed by the Amati family who's heads are marked in a similar way, albeit with fewer points of reference.

The first requirement was to scribe a centre line around the profile. On Cremonese heads, traces of these lines are often visible on the spine between the flutings. At various intervals on this centre line, pin pricks mark the point at which the dividers were placed in order to establish the various widths. Having made allowances for a slightly wider peg-box, I calculated the widths for this bass head with the help of my Amati plaster cast. (These markings have been enhanced with pencil lines to help illustrate the method.) The series of arcs thus created by the dividers were joined using a piece of flexible steel (a large clock spring) and a scriber (or pencil). This effectively mapped out the widths of the peg-box and the first turn of the scroll.
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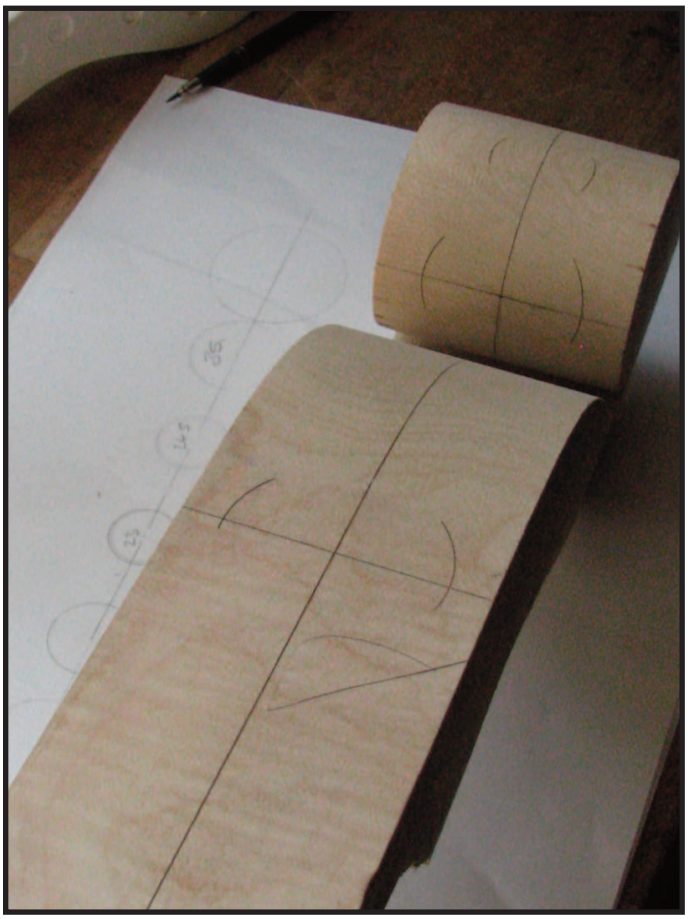

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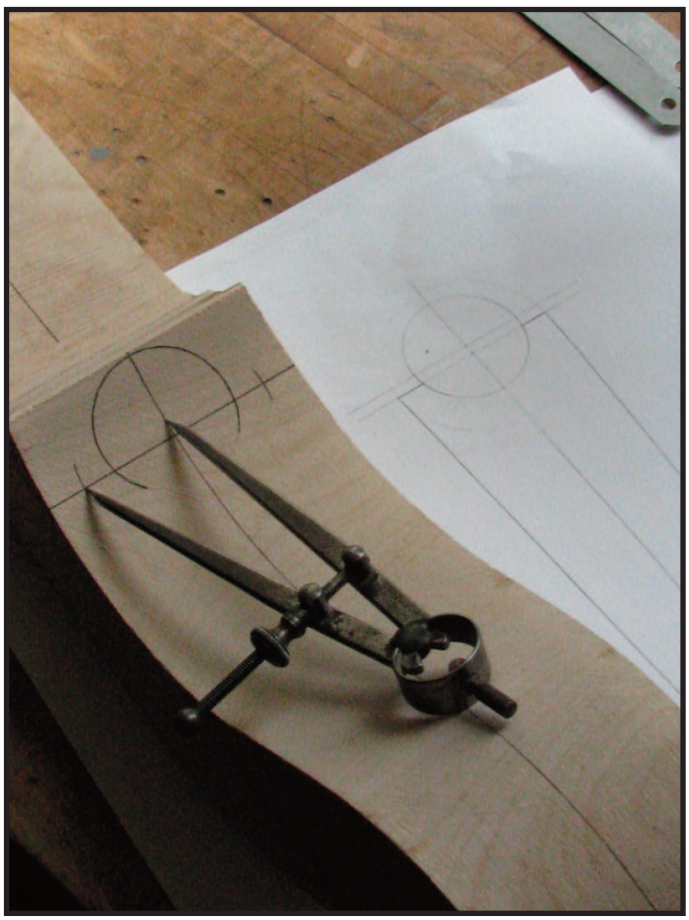

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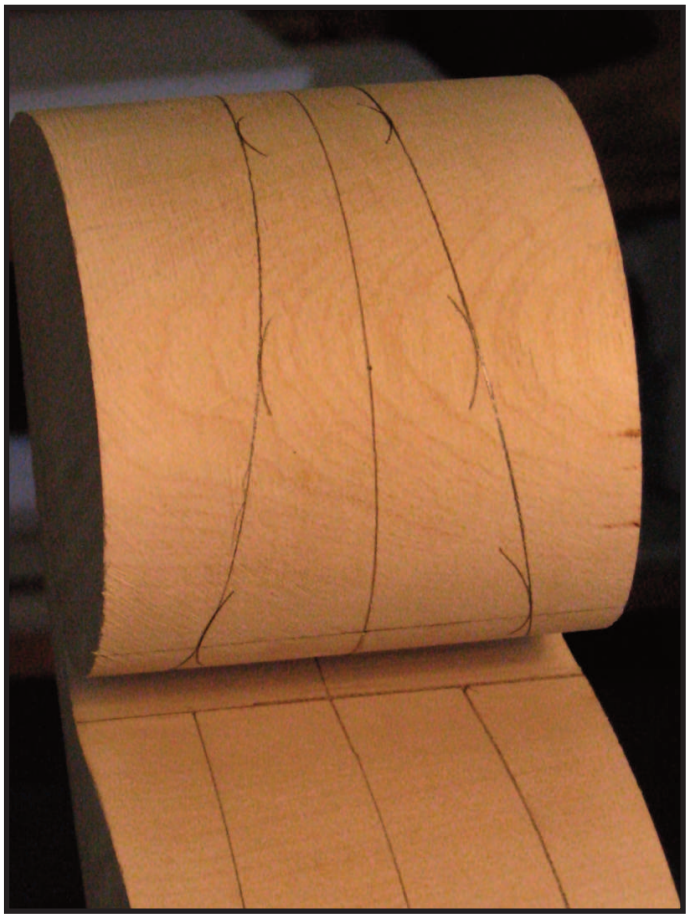

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Having established the heads widths, the sides of the peg-box were cut away, planed and rasped to the lines. Normally, for cellos, violas and violins, I would use my trusty 'Bishop' rip saw for this job [9]; 32 sawing down the sides of the neck root, along either side of the neck and the peg-box walls, right up to the first turns of the scroll. On heads with cello style shoulders two cuts are required for each side. The following photos show a viola head with small shoulders 33 34 35 and a baroque Stainer, 'birds' eye' maple violin head without shoulders. 36

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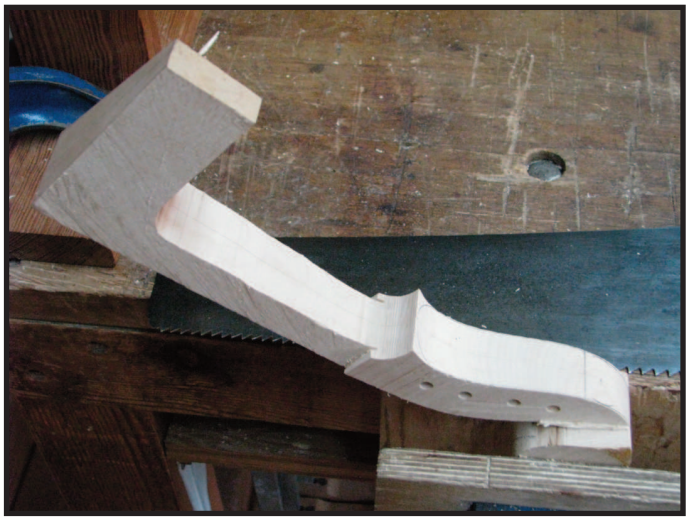

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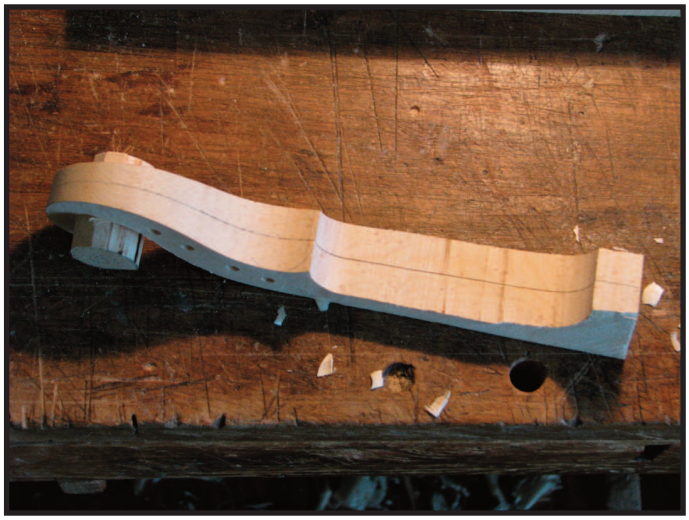

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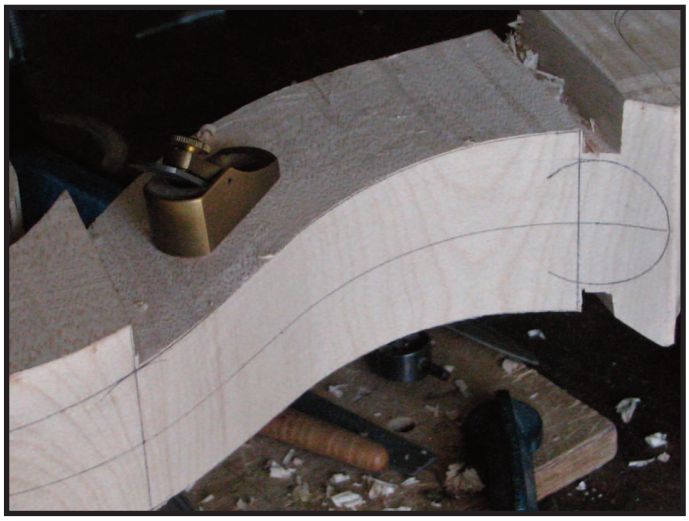
However, because René and I had not yet made our final decisions about the neck length and the neck root angle, such an operation was not possible at this stage. As a result, the bass peg-box walls were worked with chisel and plane rather than my large 'Bishop' rip saw. 37



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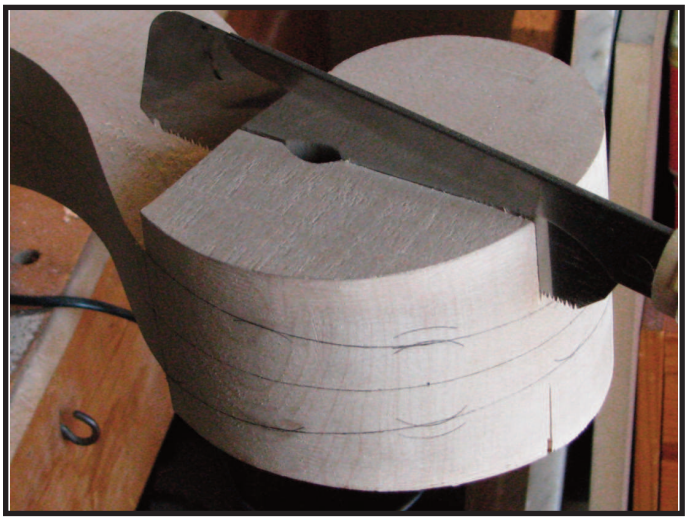
As a consequence saw cuts were mainly confined to the scroll. 38 39 40 41 42



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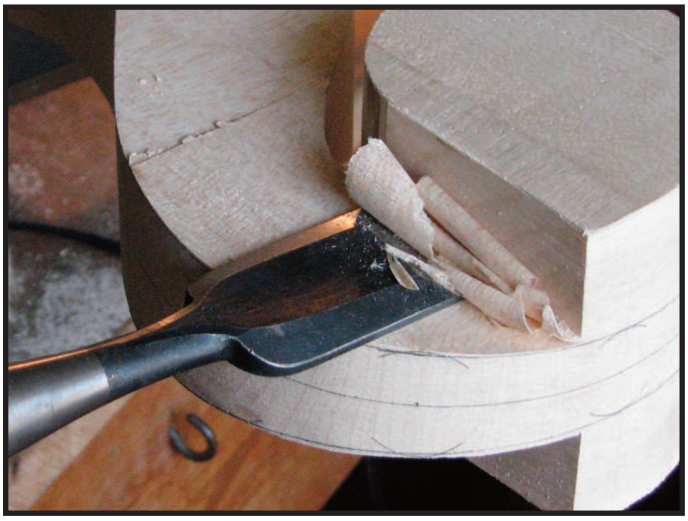

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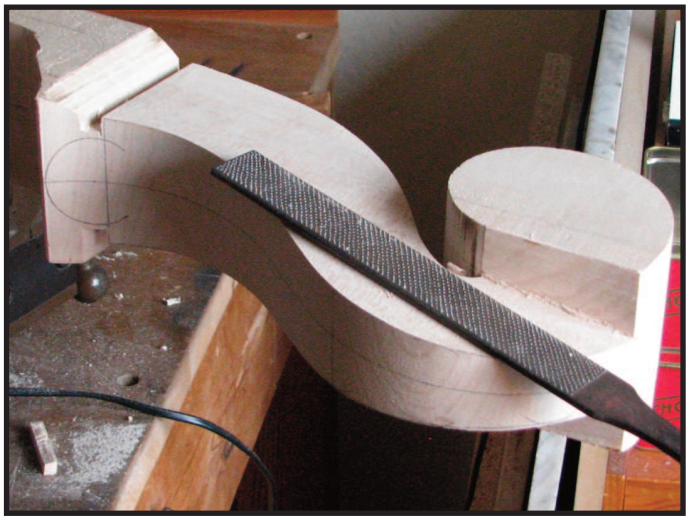

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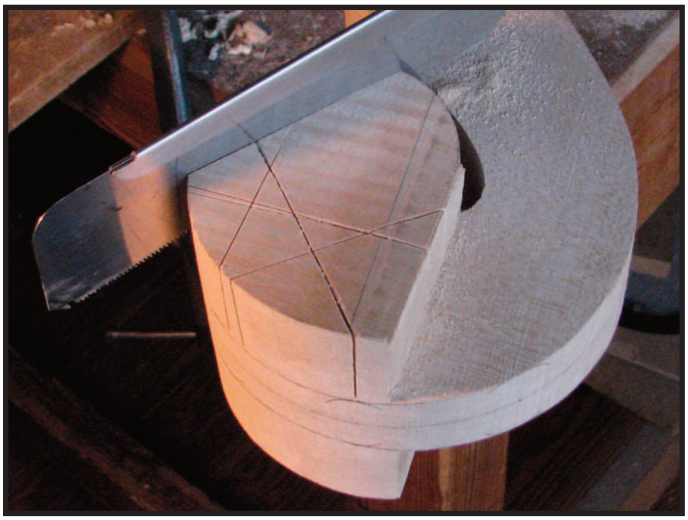

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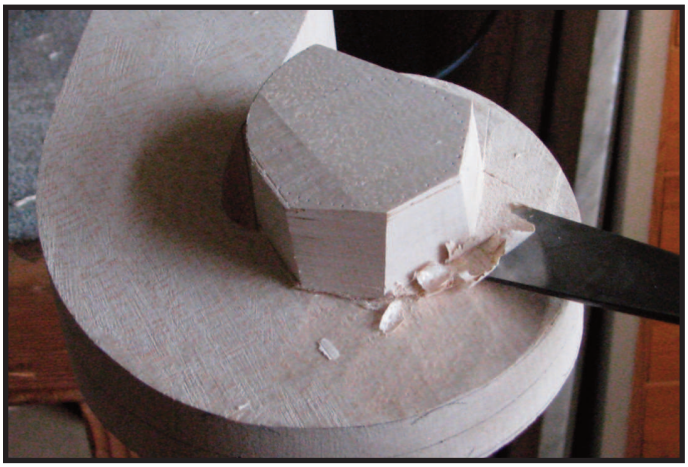
Finishing the turns of the scroll

The scroll turns were now finished in the normal way. 43 44 Because of the unusual width of this scroll, it was necessary to extend the eyes with two extra pieces, a fairly common occurrence on Cremonese cellos. 45 One of the nice things about carving this scroll, as opposed to that of a violin, was being able to use much larger tools. 46 47



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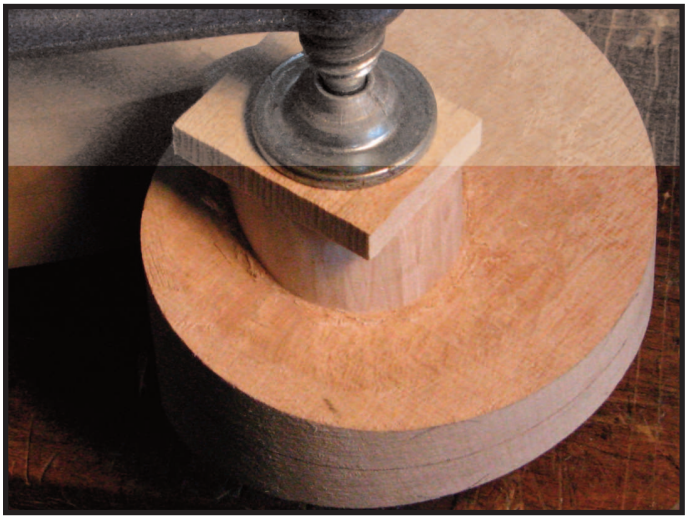

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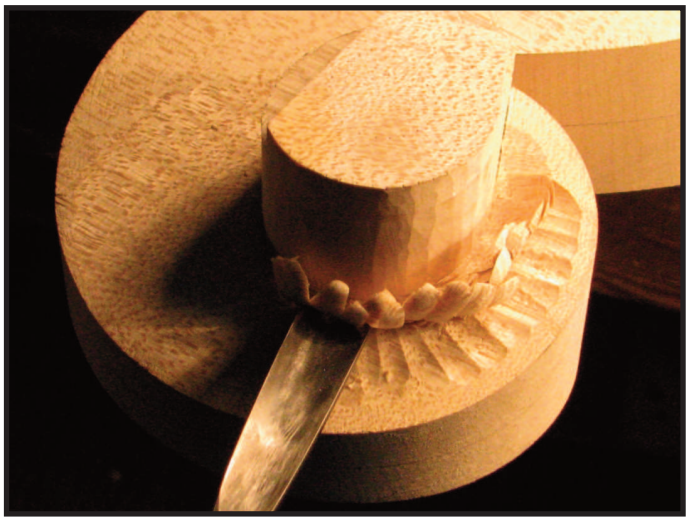

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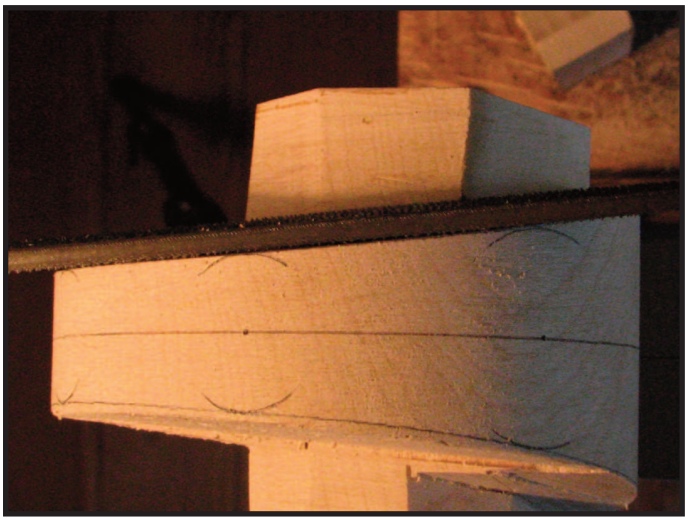
It is perhaps worth pointing out that on most Cremonese scrolls, but especially on Amati's, the outside curves of the volutes always appear strangely flat when a file or a straight edge is placed against them at any point. This makes it quite easy to create the correct flow, with a flat rasp or a file. This trick works equally well even on small violins. 48 With the flow thus established the volutes were cut to the required depth. 49 50



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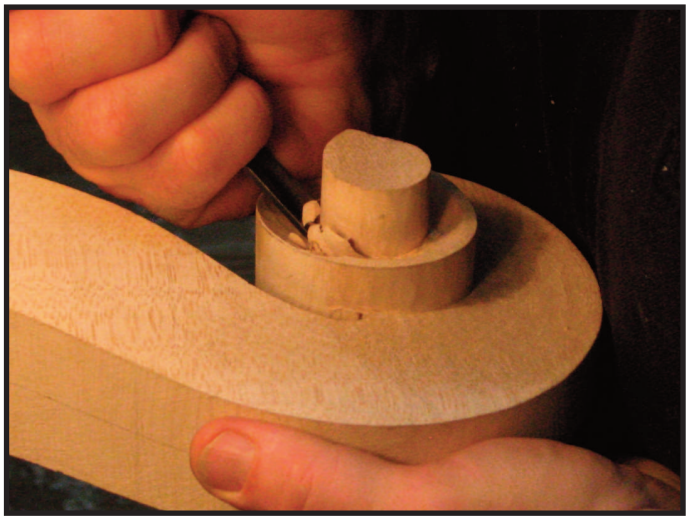

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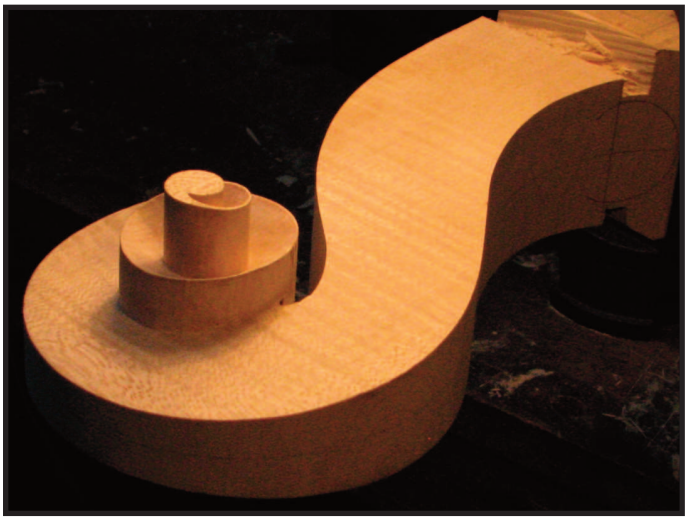

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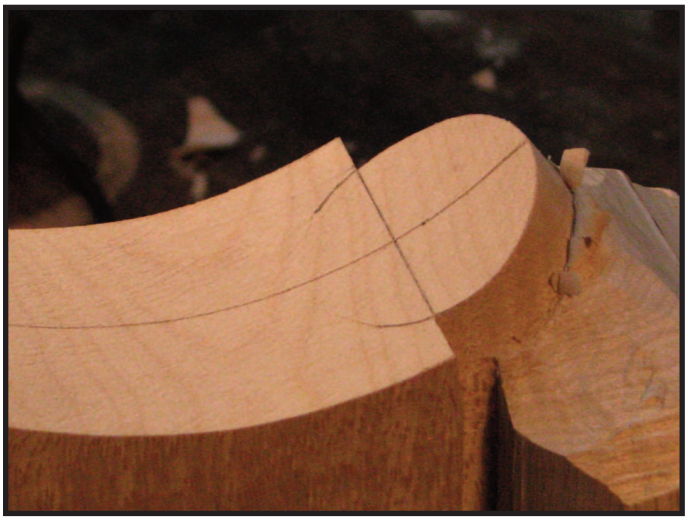
Chamfering and fluting

Next up were the chamfers. Amati chamfers are almost always very fine, (narrow). Like Stradivari chamfers, (which were considerably heavier), Amati chamfers were always applied before the flutings were cut. In contrast, Joseph Guarneri del Gesù, Guadagnini and numerous other makers cut their flutings first [10]. In such cases, the action of applying the chamfers lowered the outer edges, causing the central spine to become slightly higher. 51 52



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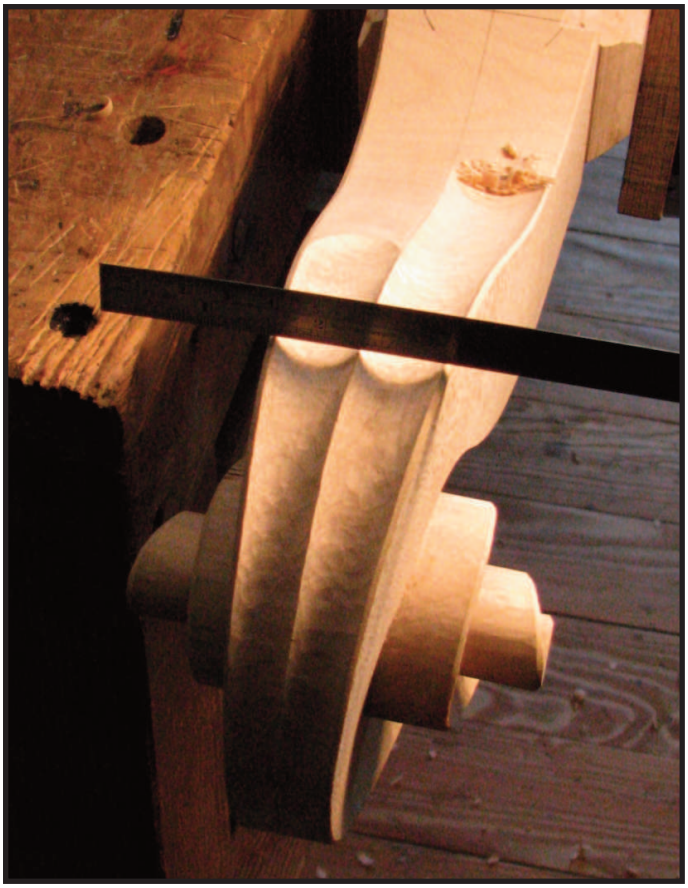
The flutings on Amati instruments were always deep, (even when worn) and unlike Stradivari's flat-bottomed flutings, they were rounder in section. 53 54 55 It can be seen from the darkened wood, that I have applied water to the end grain. Wetting the end grain helps when cutting flutings and other end grain areas. 56 57 As indicated, on early Amati heads, under the front of the scroll, the two flutes become one flute; a feature that I am particularly fond of. 58



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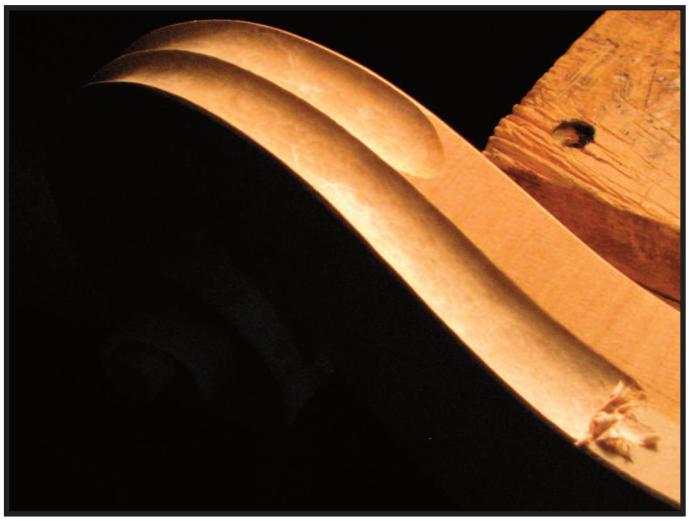

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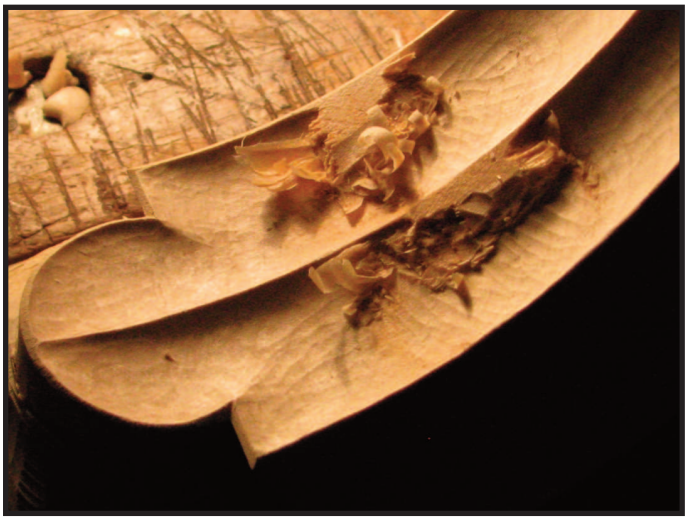

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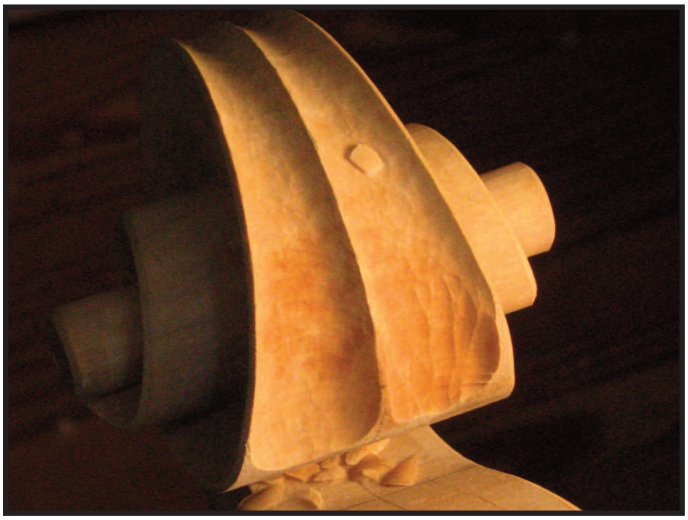

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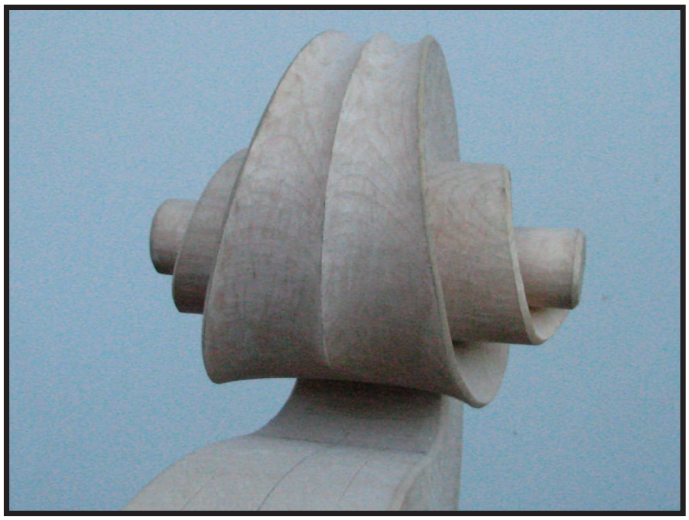

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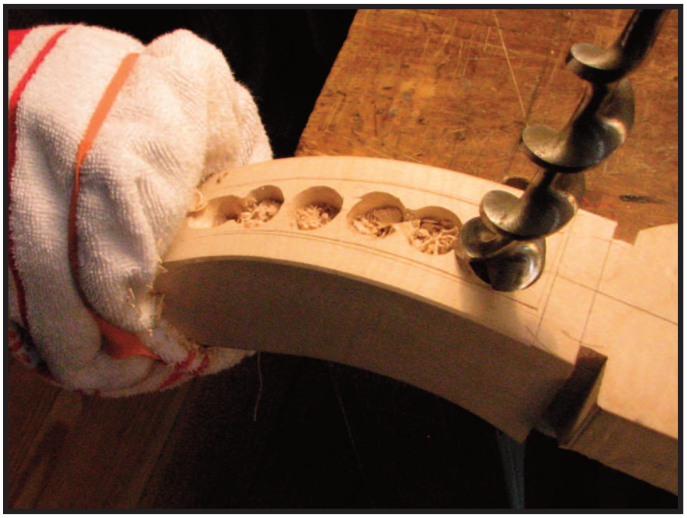
Hollowing the peg-box

Normally I would hollow out the peg-box before cutting the flutings and in most cases even before cutting away the peg-box sides. Clearly this procedure helps to avoid damaging the front of the scroll. However, the greater stability provided by this solid block also makes cutting the pegbox that much easier. Unfortunately, this time I was in too much of a rush to get on with the carving process. This was a mistake, but not a serious one.

In spite of removing wood with my brace and bit, using sharp tools and wetting the wood, I was shocked at the extra time I needed to complete this job. By comparison, violins violas and even cello peg-boxes are quickly finished. 59 60



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Cleaning up the scroll

For the final cleaning process I always use scrapers, rather than sandpaper. 61 62 63 64 65 Having said this I do use sandpapers to apply wear when I am making a copy; as can be seen in the photograph. 66 All told, the whole process was surprisingly like making a violin scroll, albeit on a vastly different scale. I realized this only two days later as I was carving a violin scroll; it was like working on a miniature.

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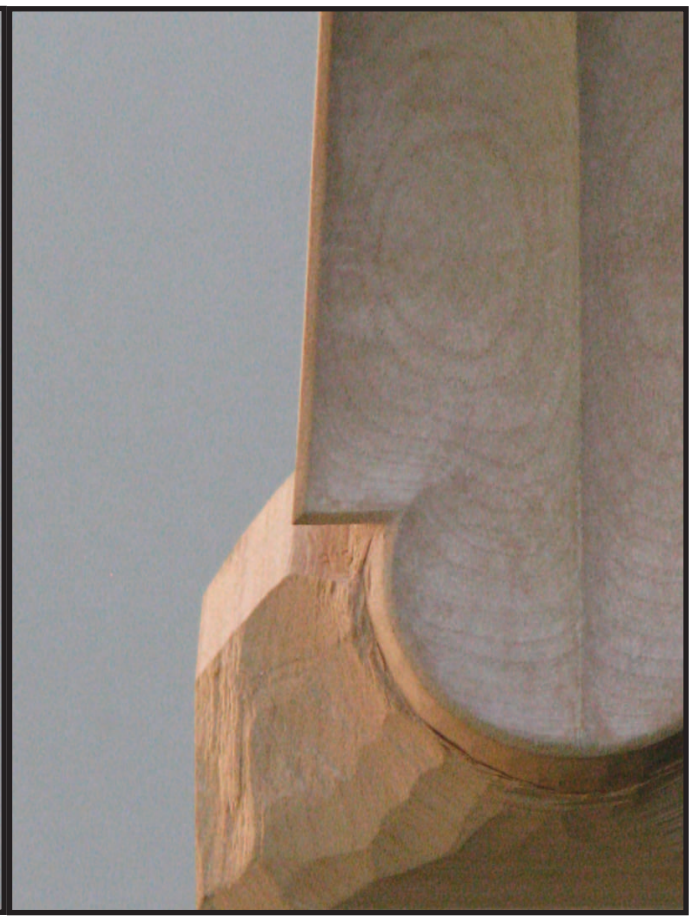

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Preparing the fingerboard

While I was designing and cutting the head, René was making the ribs and jointing the back and belly. René also had the unenviable task of preparing the fingerboard. Apart from being hard physical and dirty work, this process is entirely similar to making a high quality violin fingerboard.

Initially, the underside was flattened where it was to be attached to the neck. Before being glued, this surface was hollowed very slightly with a scraper. This slight hollow ensures a good joint along the sides should the neck and or the fingerboard wood swell when hot wet glue is being applied. Wood was also removed from beneath the protruding part of the board. René then glued the board to the flattened, but otherwise unfinished neck. 67 68 When the glue was cured he planed the upper profile, (fingerboard curve) leaving the final finishing and polishing to be done once the varnishing has been completed.

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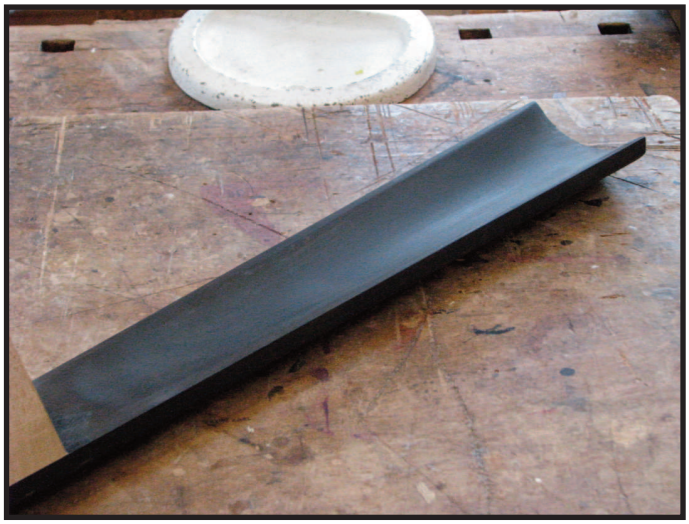

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Because of the length of the bass neck and board, distortion made photography rather difficult. For this reason I have also included several photographs of a viola fingerboard being prepared (and the neck being shaped). Just as with violins, violas and cellos, on a high quality bass, fingerboards and necks require careful calculation, the object being to remove excess weight, without compromising on strength. As can be seen from the photographs, the underside of the overhanging part has not only been hollowed, like the bass fingerboard, it has also been polished. (If a job is worth doing it is worth doing well.) In addition, the end of the board has been finished with a shallow chamfer to make the end curve appear more delicate that it actually is. The yellow china-graph (wax) pencil makes the scribe lines easier to see. Finally the top surface was planed and filed to a provisional profile, before being glued onto the neck with the help of two guide strips, held in place with several dots of superglue gel. 69 70 71 72 73 74 75 76 77

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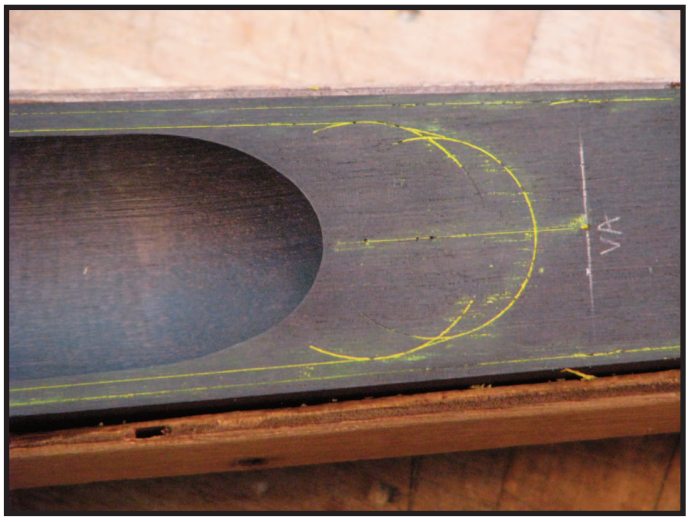

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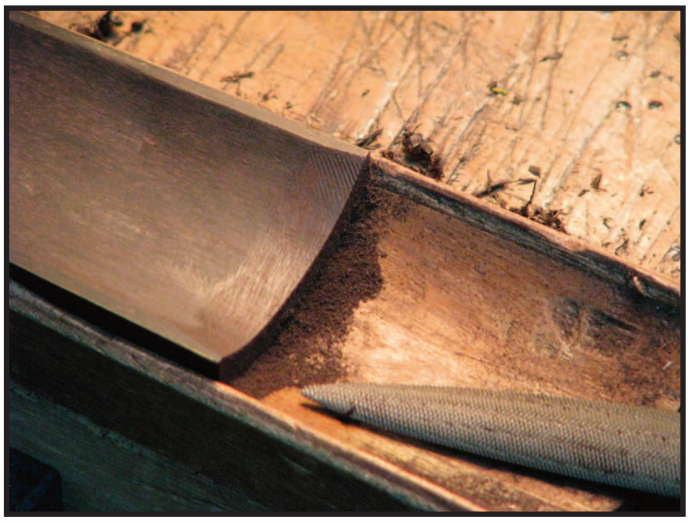

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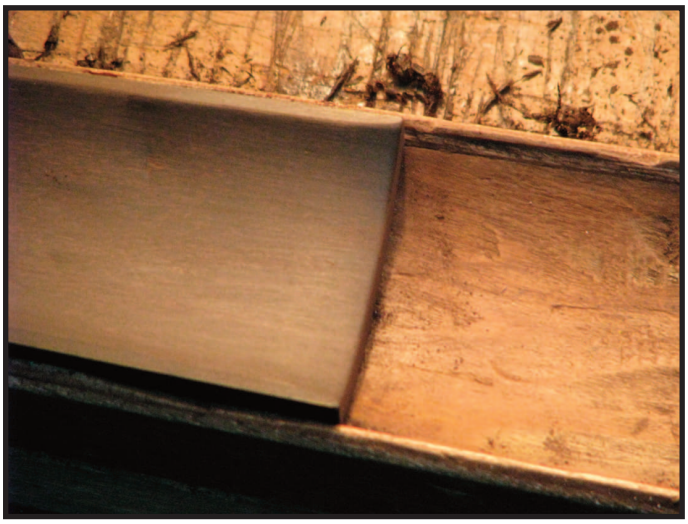

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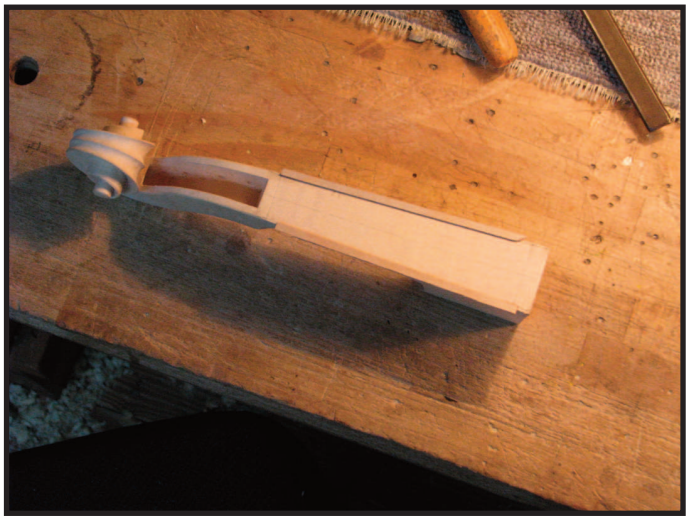

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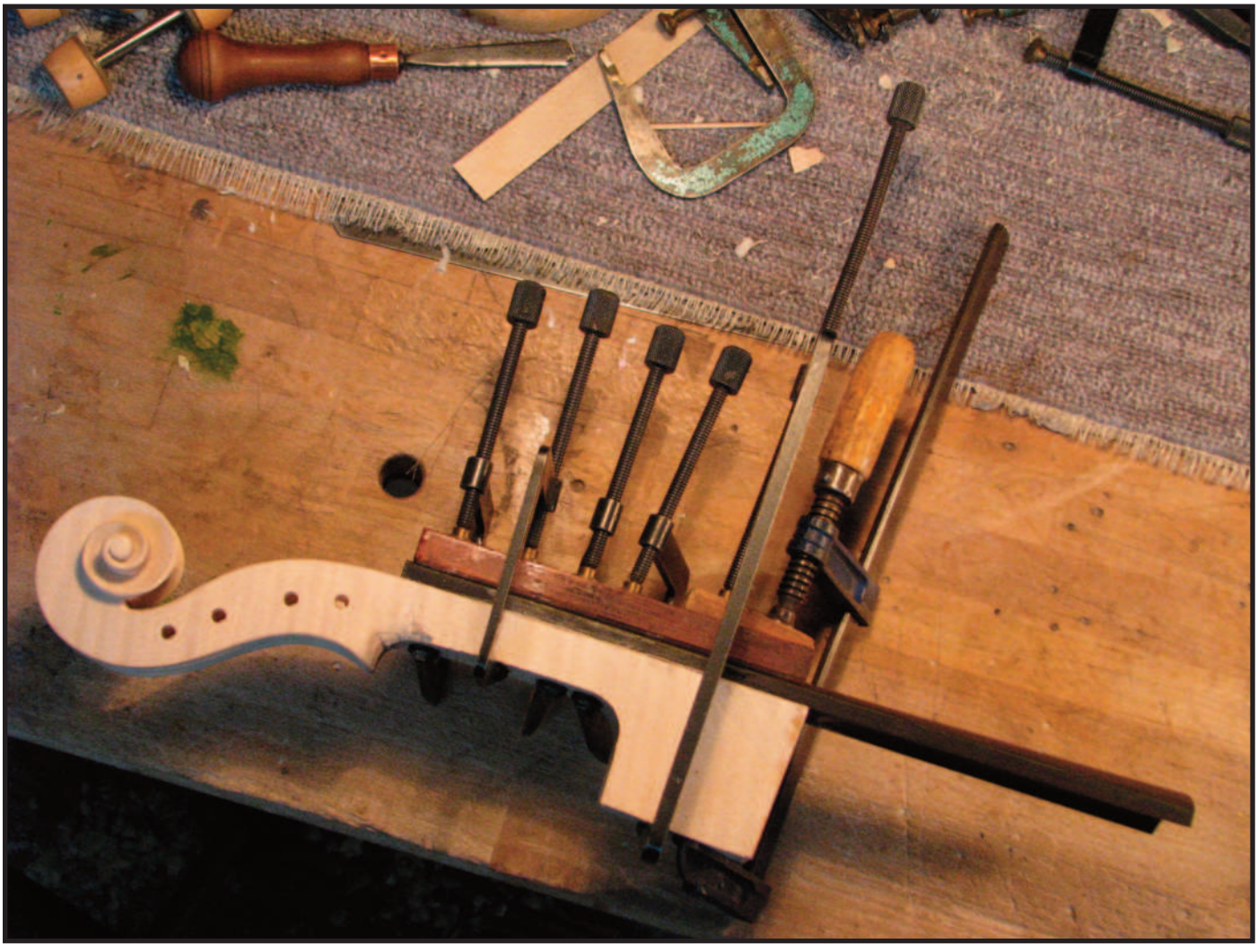

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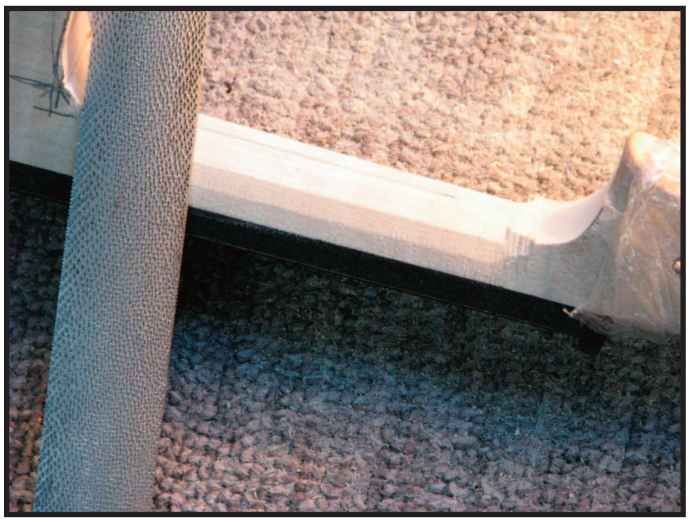
Shaping the neck

Having concluded this preparatory work, René and I met again in his workshop in Holland, where among other jobs we shaped the neck together. In our final year at the Newark School of Violin Making, John Dilworth, Joe Thrift and I, decided to make cellos. The school had only recently been established and these were some of the first cellos that had been attempted. Certainly, by the time we started our cellos; we had no personal experience and had never witnessed anyone making a cello.

John started his cello first and soon had his head carved and the body finished. Unfortunately, when making violins and violas, we had been taught to carve our heads first and to leave the neck and neck root only roughly finished. The final working was to be completed once the neck had been mortised and glued into the body. There may have been some sound pedagogical reason for this procedure, but I have not yet discovered it. Nevertheless, although this method did not pose any serious problems for violins and violas, for cellos it was a complete disaster.

Having finished the head and body, John dutifully fitted and glued the roughly finished neck into the mortise; and that is where his troubles began. It quickly became obvious that a cello is far more difficult to manoeuvre than either a violin or a viola. Observing John trying to shape the roughly finished neck and the chin of the head, while holding the cello body up in the air, prompted Joe, who was hot on John's heels, to finish both the chin and neck before gluing it into the body. However, Joe was a little too hot on John's heels, because he had not yet witnessed the problems that John then faced shaping the neck root. Fortunately, I was a long way behind them both. Being able to observe their struggles allowed me to fit the neck and then to finish the chin, the neck and the neck root completely, before finally gluing it in place. Today I do this with all my instruments, including this bass. The following three photographs show the neck of a viola being shaped before insertion. 78 79 80



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Like the viola the neck widths of the bass were also established using the fingerboard as a guide. This was quickly achieved with a course hand-made rasp. Both René and I use Herdim rasps. They are expensive, but they cut like blades and with care they can last a lifetime. Having established the widths, using a template we created the side profile of the neck, neck root and chin. Using a single cross section template, we then began to develop the neck shape. Again this was complete with Herdim rasps, (rather than files).

Working between the straight lines created by the width of the fingerboard and the long side profile, we gradually created a series of chamfers running along the length of the neck. Because of the necks taper, these chamfers gradually became narrower towards the head end. Each new chamfer was checked with a straight edge to ensure that they were neither too full nor too hollow. Gradually these chamfers were linked and rounded, until eventually the neck shape fit the template exactly. 81 If all of these chamfers are kept straight and even, a single template should be enough to check the whole length of the neck. I prefer to do this job in a darkened room, preferably at night, using a directional light. This helps to illuminate any bumps and hollows. In many ways violin (and bass) making is about the creative use of light.

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Finishing necks is one of my favourite jobs. For some reason I find it extremely therapeutic. It is also one of the most important components of the instrument making process. It is important, because if the neck does not immediately feel right to the player, it will no longer matter what the instrument sounds or looks like; the sale will already have been lost.

Having finishing the neck completely, I merged the chin with the neck. 82 From the photograph it can be seen that I have also completed some of the wear (or softening) on the head. I always like to apply wear several times before starting the final varnishing process. Applying wear in stages is easier than trying to accomplish everything at the end. It also allows me the opportunity to scrutinize the resulting shapes several times, and to match the various worn areas of the instrument with each other.

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Before the next stage the scroll and neck were covered with transparent bubble wrap and kitchen foil. This was done to protect its delicate edges and to stop ebony dust from spoiling the finished surface. 83

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The body and mould outlines

As indicated, much of the edgework on the original Amati bass has been replaced, especially on the belly, and like so many old basses this has not always been done well. Nevertheless, enough has remained intact; enabling us to take a usable outline from the flat back. 84 85

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The fact that so much edgework was still available, especially in the elliptical C bouts, made tracing the overall outline relatively easy. Not quite so easy, was trying to recreate a symmetrical outline from the somewhat asymmetrical outline of this Amati bass. Although the Amati family generally worked with great accuracy, no Cremonese instruments are ever totally symmetrical. Their method of making almost always created some form of asymmetry. [11] Moreover the larger the instrument the greater the asymmetry, and they don't get much bigger than a double bass.

Cremonese makers did not set out to make their instruments asymmetrical. In fact, they made every effort to ensure that the bass and treble sides were mathematical mirror images of each other. However, whenever discrepancies occurred, they were particularly adept at creating the illusion of symmetry with a few deft strokes of a knife.

Although Cremonese rib outlines are often asymmetrical, because the Cremonese inside mould was the starting point of the construction process, they were always highly symmetrical and accurately finished. [12] In fact, it was our need to make an accurate inside mould, which motivated us to create a symmetrical outline from this asymmetrical back. Eventually, by folding the outline and tracing a mean between the bass and

treble sides, to some extent we were able to correct deviation in the outline curves. Being used to viewing outlines from relatively close quarters, I was amused by the fact that the best way of assessing our progress, was to lay the outline flat on the floor, while standing on a table or a ladder.

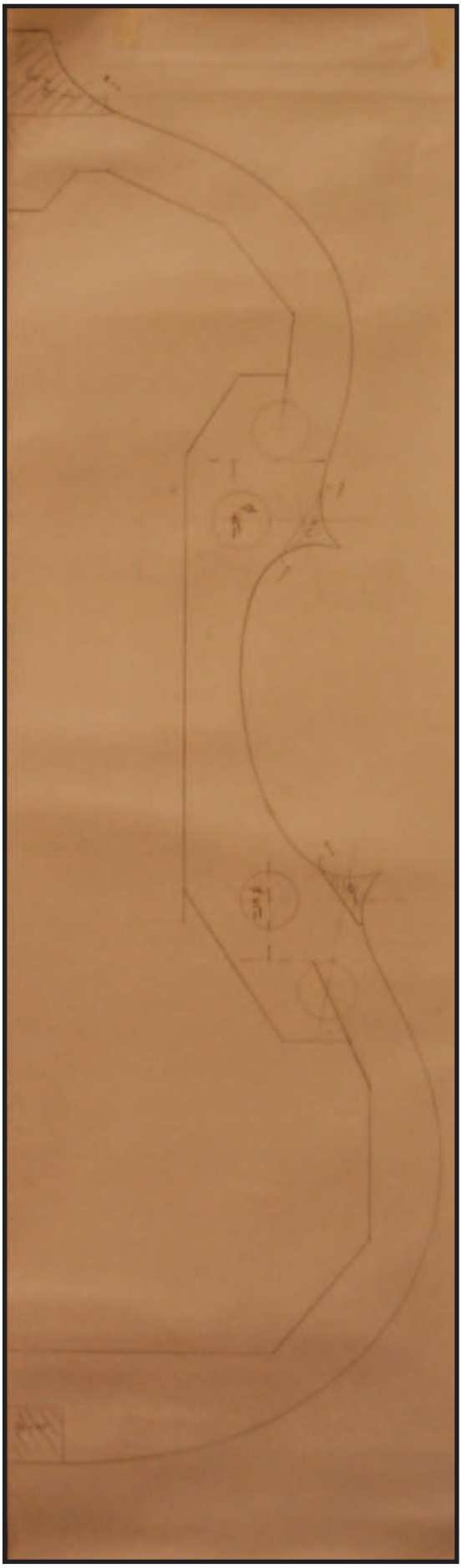
Essentially, this method of obtaining a symmetrical outline was the exact opposite of the Cremonese process. In effect we were attempting to make a symmetrical mould from an asymmetrical outline, rather than creating an outline with some 'natural' asymmetry, from a symmetrical mould. There are clearly several factors that make this process a little uncertain. For example we were working from the back outline only. However, from Cremonese violins, violas and cellos we know that the back outline is almost always closer to the original mould than the belly outline. Unfortunately, we cannot be sure that Cremonese basses were constructed in exactly the same way. In particular this bass has a bent flat back and pointed rather than rounded upper bouts, both features that link it to the Gamba family. Nevertheless, Cremonese makers appear to have been totally obsessed with the inside mould. Somewhat impractically, they even built their guitars around an inside mould. [13] For this reason an inside mould also became our method of choice.

Aside from any distortion, caused as the Cremonese makers aligning their necks, there is an additional factor to be taken into consideration. Especially on cellos and presumably more so on basses, because of the overall height of their ribs, it is difficult to assess how closely they followed the mould outline. It is quite possible that, at the time of construction, they were already loose and or twisted on the mould, deviations that were then further distorted by the neck aligning process. Because of such factors, in the end our corrections were essentially a matter of judgment based upon our collective experience.

In spite of the overall asymmetry of this Amati bass, the unusual symmetry of the individual 'C' bout curves was extremely helpful in recreating the corners, the outline and for developing the new mould. In itself this C bout symmetry is a further strong indication that this bass did indeed emanate from an Amati workshop.

Making the mould and constructing the rib garland

From our reconstructed outline, René created a mould outline. 86 He did this by reducing the outline by 7.5 mm, (representing the overhang and the rib thickness). Using this mould outline he constructed a mould from marine quality plywood. 87 Even with the large central area removed, this mould was surprisingly heavy; another shock for a humble violin maker. René eventually managed to reduce the weight further, by drilling numerous holes through the sides of the mould.



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Holding the corner blocks in place, René marked their profile with the mould and corner template, before removing them and cutting the (inside) central bout profiles. 88 89 He then glued the corner blocks to the mould. Like me René places a piece of paper between the blocks and the mould to help with separation. 90

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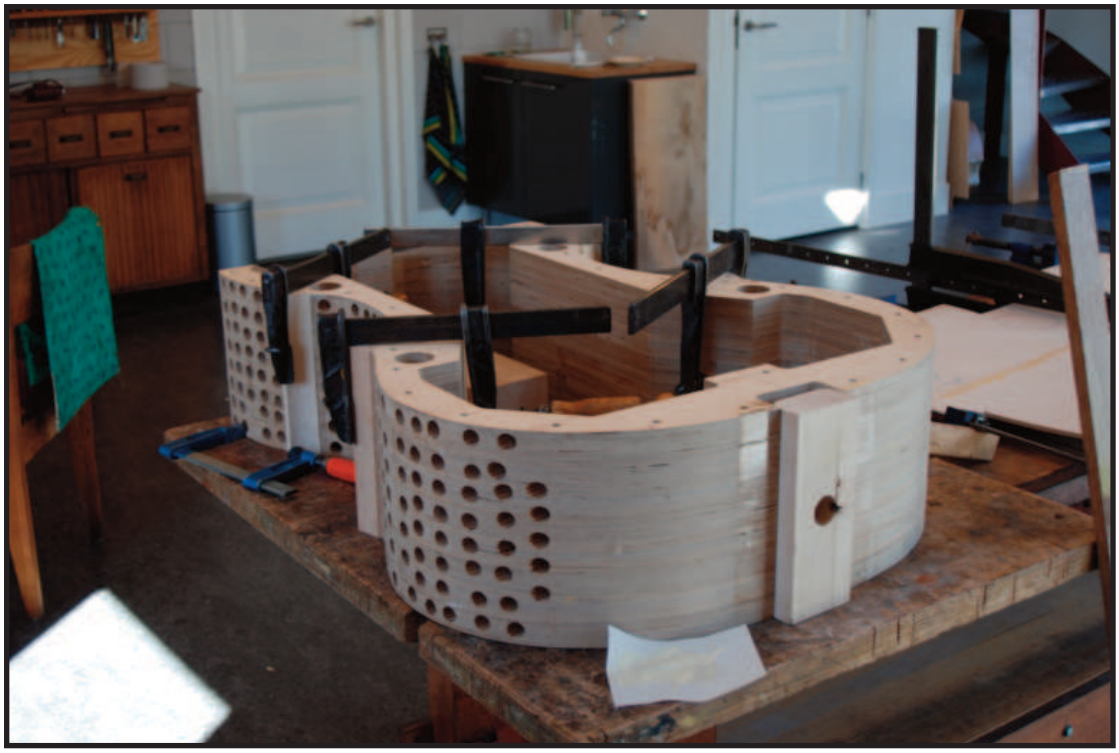

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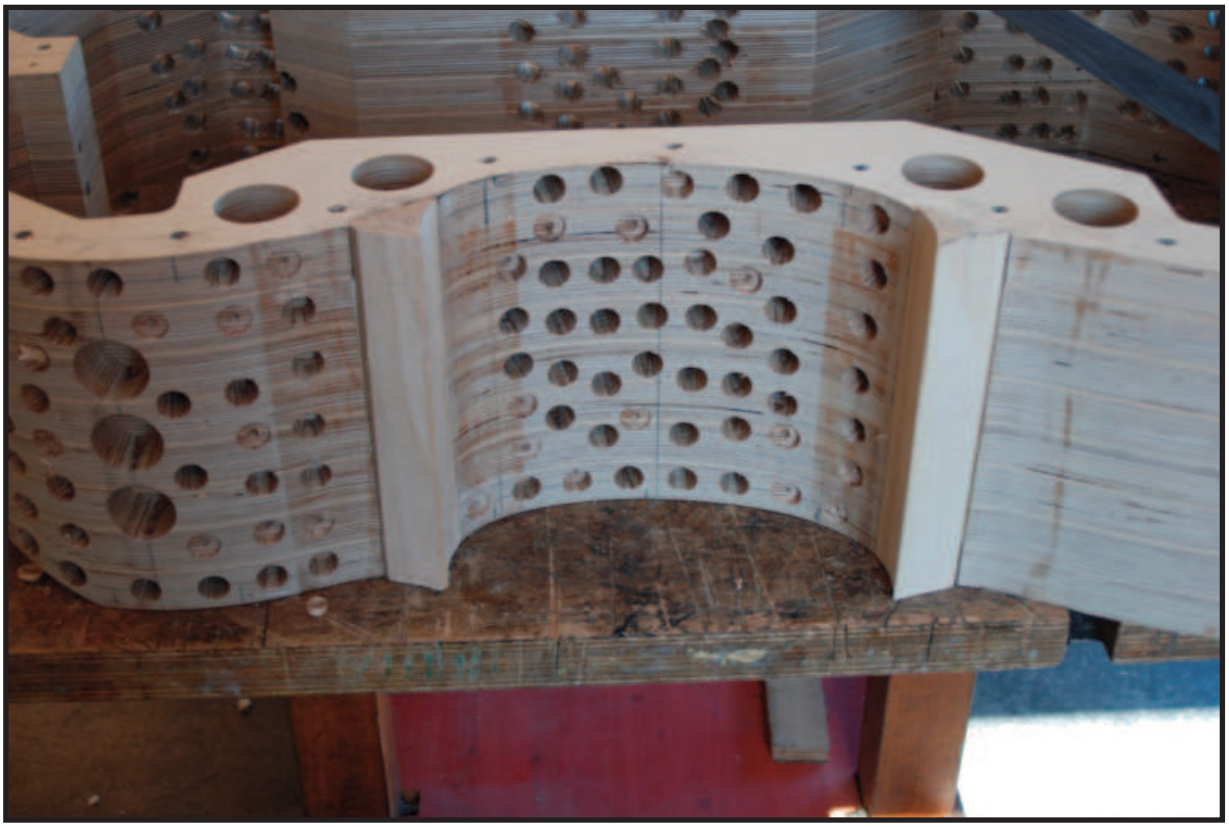

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With the partly shaped blocks glued in place René prepared the C bout ribs for bending. Having been cut from the same tree, the back, head and ribs were a perfect match. To save time René thicknessed the ribs with a thicknessing sander, after which I finished them with my scrapers. The problem with using sandpaper is that it always leaves traces of abrasive crystals and wood dust in the pores. These deposits will eventually kill the natural reflection of the wood under the varnish. In contrast scrapers are really cutting tools. If well sharpened, they should produce thin shavings. This creates a surface on the wood which is highly reflective. Although using a thickness sander in this way saved hours of time, the abrasive crystals embedded in the wood do not just kill its reflective qualities, they also blunt scrapers rapidly. Because we wanted to have the best possible reflective finish, sharpening and re-sharpening my scrapers and getting first-degree blisters on my fingers and thumbs was inevitable.

In addition to creating a reflective surface by scraping the ribs I also wanted to accentuate the flames (figure) in the wood. This ripple effect is a feature of most Cremonese instruments. Even with closed eyes it can usually be detected by running your fingertips over the surface of the back or ribs. This texture was probably the result of using freshly cut tone woods. [14] I usually achieved this by holding the scrapper at the same angle as the flames. Adding this extra dimension to the flame helps create a better profile when the varnish is being worn. Most of this final (profile) scraping was done once the ribs had been bent and glued. Doing this after completing the bending, had the added effect of cleaning the ribs. Eventually, this same thickness-sanding treatment, followed by scraping, was also applied to the back. Fortunately, the head, like the belly was done entirely by hand. 91 , 92

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As can be seen, for a violin maker this bending iron is gigantic. 93 The bending strap, also illustrated, is seen here covered with a cloth. 94 This cloth was wet before being applied to the rib and hot iron. Although in essence this entire process is exactly like making a set of violin ribs; I recommend a course of Commando fitness training before starting a bass. 95 96

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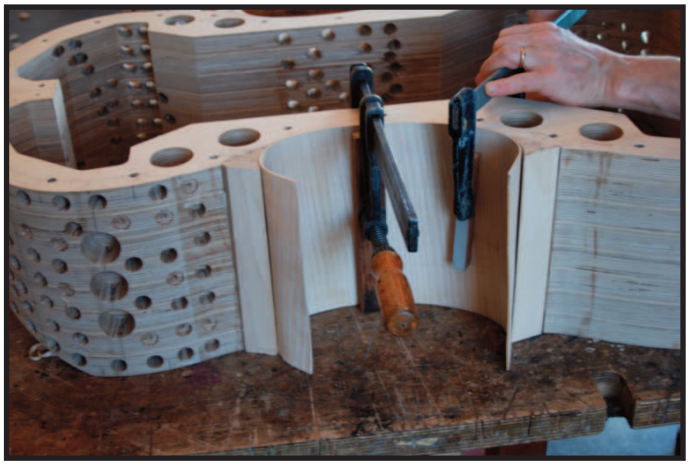

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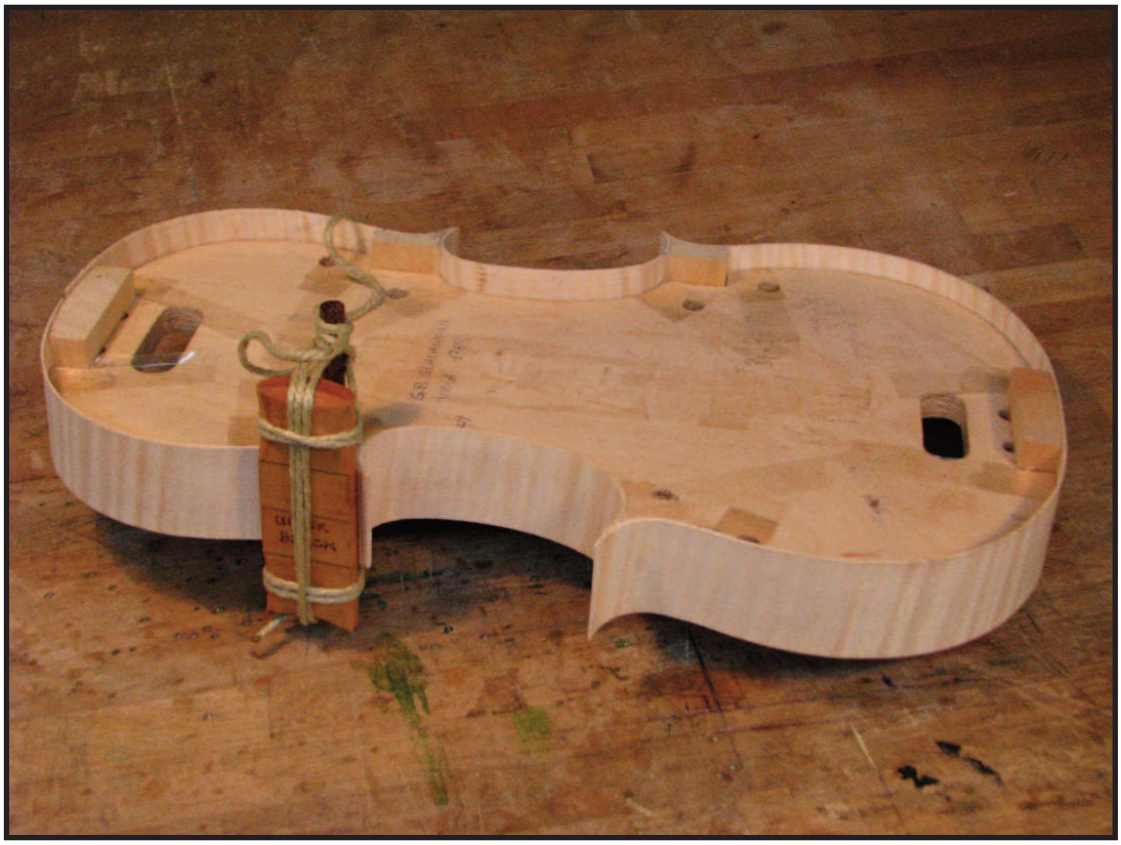
I normally construct my instruments using the string and block clamping system, as used by Stradivari and described by Sacconi. [15] The following two photographs show this system being used on my latest viola. 97 98



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However, I had the feeling that this bass would require the mooring hawsers from a battleship. In this respect I was more than happy to leave the rib bending and construction to René. Interestingly while I was recording the process on Maestronet, Trevor Davis sent me the following photographs of his bass ribs being assembled, using a Cremonese style inside mould, in conjunction with the Cremonese block and string clamping method. It would appear that no further proof is required. 99 100

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As can be seen on Trevor's bass, there is one glaring difference between bass ribs and those of violins, violas and cellos. On instruments of the violin family, Cremonese makers invariably used a one-piece top rib, which ran across the top block. This was done to counter the risk of the top block splitting as the neck was being nailed on. As already mentioned, like most basses, this Amati bass has upper bouts similar to those of a Gamba. This means that the ribs do not come together at the top. For this reason it is possible, as was the case in Milan, that they used a two-piece block to help prevent the block from splitting while the neck was been nailed and glued. In fact it seems likely that an entirely different method was used to attach the neck. This may have been similar to the wedge system used by Jacobus Stainer for his Gambas. It may even be the case, (although given Cremona's fixation with the inside mould, fairly unlikely), that a partial outside mould was used. Unfortunately as far as I can see, not enough evidence is currently available to make even a calculated guess.

Although on a much larger scale, bending bass ribs to fit the mould is accomplished in much the same way as bending and fitting the ribs around a violin mould. The ribs having been thickness, as described earlier, were cut to the required lengths and bent to shape. 101 The only important difference being the S shaped bending required for the two top ribs.

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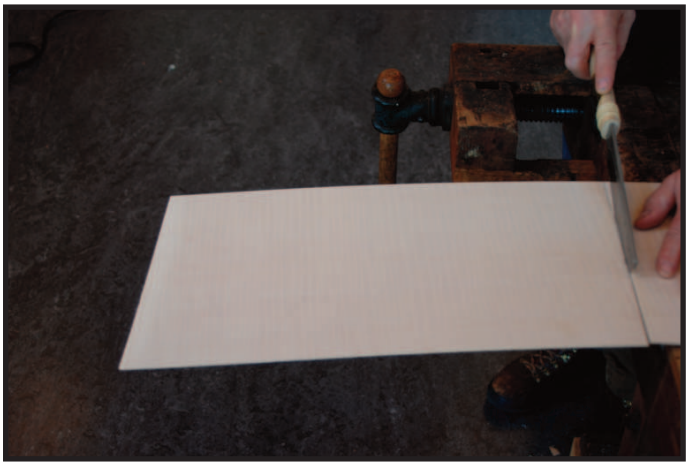

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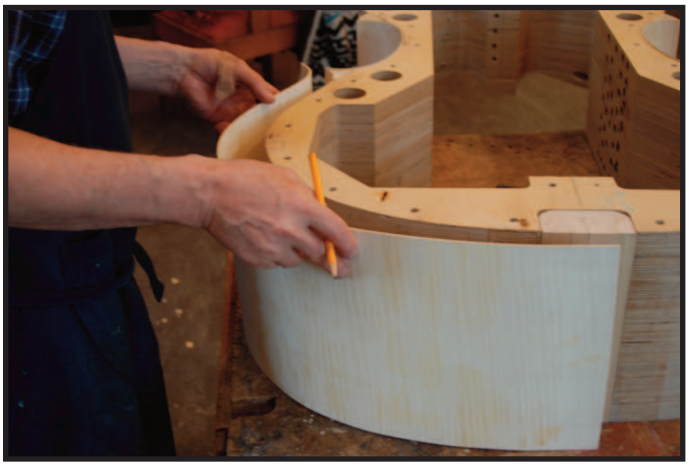

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René then bent and inserted the willow linings. René's mould is extremely cleaver. The top and bottom sections can be removed allowing the linings to be inserted. Linings are inserted to stiffen the top and bottom edges and provide a larger gluing surface for attaching the ribs to the back and belly. René then trimmed back the linings to lose weight. Finally he planed the ribs to their final height. This process included creating the angle to match the eventual bend of the back. 110 111 112 113

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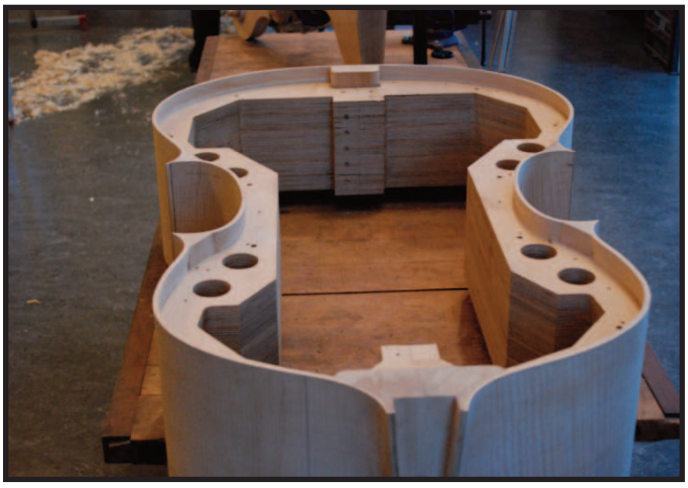

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The Back and Belly

While I was busy in Germany, preparing purfling and cutting the head, over in Holland, as well as making the mould and ribs, René had sawn the two back panels. With the aid of a shooting board, these panels were jointed using a long Bailey jointing plane. 114 René initially thicknessed the back by machine and then with the back jointed, he finalized the thicknessing by hand. There is just one point to make here. When two flat pieces are being planed square for jointing, one of them should always be reversed before gluing. This cancels any slight angle differences between the shooting board and the plane blade. Furthermore, when jointing thin flat pieces in this way it is also necessary to keep them pressed down on a flat even surface while the joint is being clamped. 115

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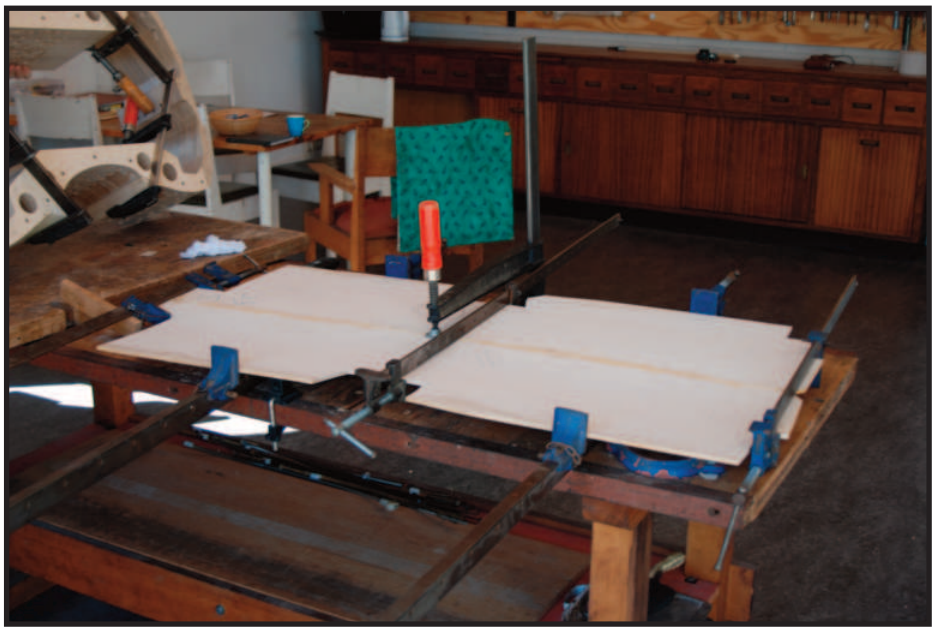

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Having jointed the back, René provisionally flattened and planed right angles on the two belly wedges with a planing machine. From the planer he then finished the joints by hand in the normal way; again using his Bailey jointing plane. The wedges were then glued and clamped with sash cramps. 116

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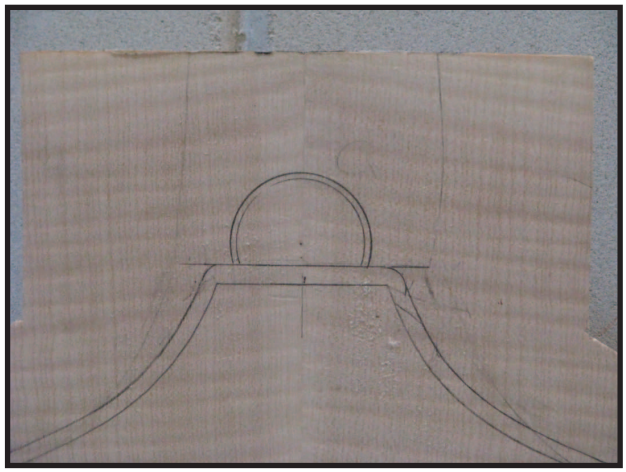
Like me, René uses a waterproof Tight-Bond type adhesive for such joints. Unlike animal glues, these adhesives are unlikely to come apart when wet. The alcohol that I use during the final varnishing process can also attack animal glue. Until it became too difficult to get hold of, I used casein glue for jointing backs and bellies.

Establishing the outline

The first stage in making the flat back and the arched belly, involves marking the outline from the ribs (sides). In this case the final outlines of both the back and the belly were taken from the finished ribs while the mould was still in place. [17] This differs somewhat from the original Cremonese method, whereby only provisional outlines were taken while the ribs were still attached to the mould.

Here, the flat back was simply clamped to the ribs and the outlines of both the rib and the overhang were taken, using a scriber and a ring of the required thickness. 117



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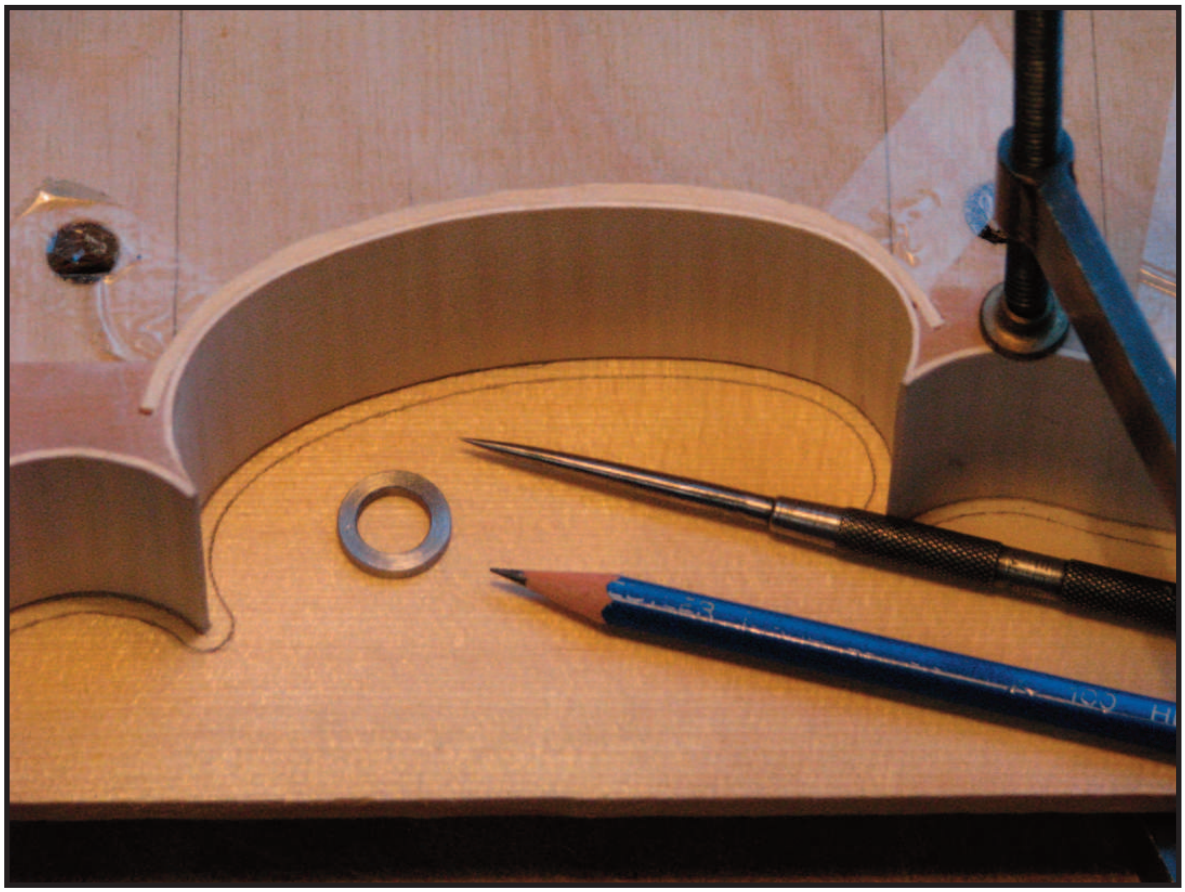
Unfortunately, I forgot to photograph this process, so I have also included, photographs of the ring being used on one of my violas. The pencil lines have been added over the scribe lines to help with the photography. 118



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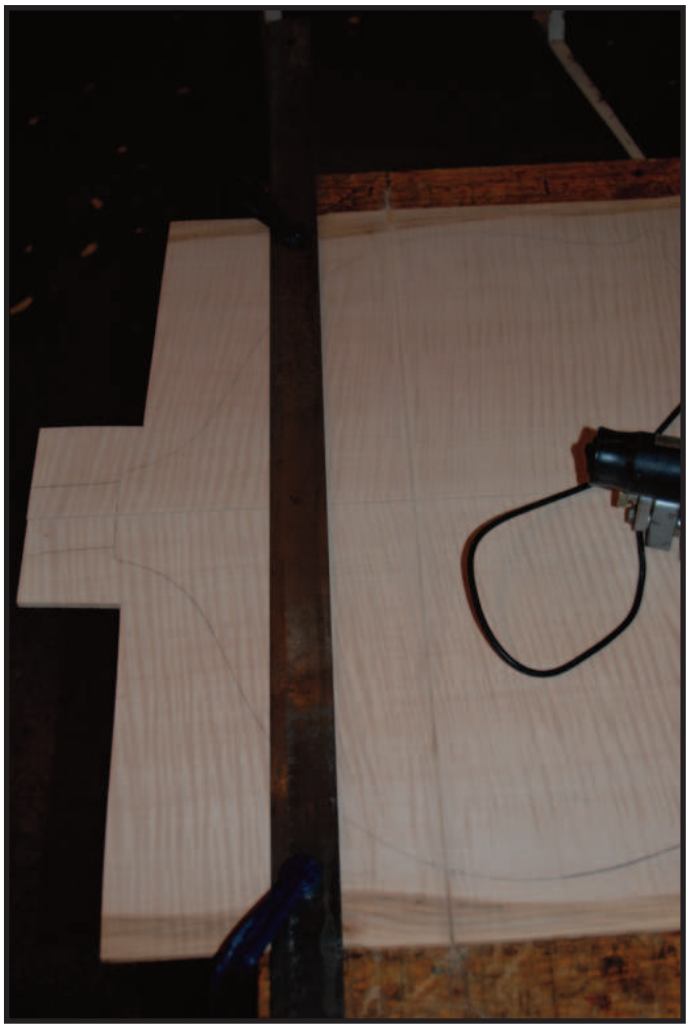
Almost forty years ago I made a set of 10 rings, but his was the first time that I had ever been called upon to use the (two) largest sizes. The overhangs were 5.5 mm in the centre bouts and 5 mm in the upper and lower bouts. Apparently, Stradivari (and presumably the Amati and all the other Cremonese makers) used a small square block with a pin for this job. [18] The form of this tool may be the reason why the overhangs increase slightly in both the corners and the C bouts. When Stradivari was scribing around an outer (convex) curve, this square block allowed the pin to remain close to the rib. But against an inner (concave) curve, the square block bridged the line of the rib moving the pin further away.

Establishing the back angle

At this stage René also marked on the back the point at which the back would be bent. 119 The flat back on the original bass has a Gamba style bend in the upper bouts. Once the lower portion of our bass back outline was complete, this bend had to be created. The angle of the back bend is critical for both the sound and for the player. The player must be able to access the instrument, (especially the higher registers) and this bend, whether on a flat or carved backed instrument, helps to provide that access.



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Now if there is one thing that I have learned over years of talking to bass enthusiasts, including my friends, Duane Rosenguard [19] and René Zaal (my partner in this enterprise), it is that where basses are concerned, there are no hard and fast rules. Apparently, the answer to bass making is to find the best model that you can and copy them with as much experience, intelligence, and intuition as you can muster.

The Amati bass that René and I are copying is a stunner. And as such, it is incumbent upon us to copy all its salient details as well as we possibly can. For this reason the angle of the back was finished as close as possible to the angle of the original Amati. This job is one of the biggest nerve ticklers that I have ever experienced as an instrument maker. I was told several times that it could be a real heartbreaker. [20] And so, like the coward that I am, I was pleased to delegate this job to René.

In effect you are required to bend a 5 mm thick, heavily flamed back, which is about 60 cm wide, to a sharp edged angle of about 20 degrees. And this must be done without cracking the wood or even creating a fine split.

Before René could build the mould, he needed to calculate the exact angle of this bend. Having done this he routed a line across the back with a tiny V shaped cutter. This was cut to within 1 mm of the outside. (Better him than me!) The back was then turned over and clamped onto a flat board, with the upper portion suspended over the edge. Steam was then applied to the routed cut with wet cloths and a hot iron, until René felt that it wanted to go. Actually, by this point I also wanted to go. Downward pressure was gradually applied until the required angle was reached. Once the angle was reached, it was clamped in position and left overnight. 120 121

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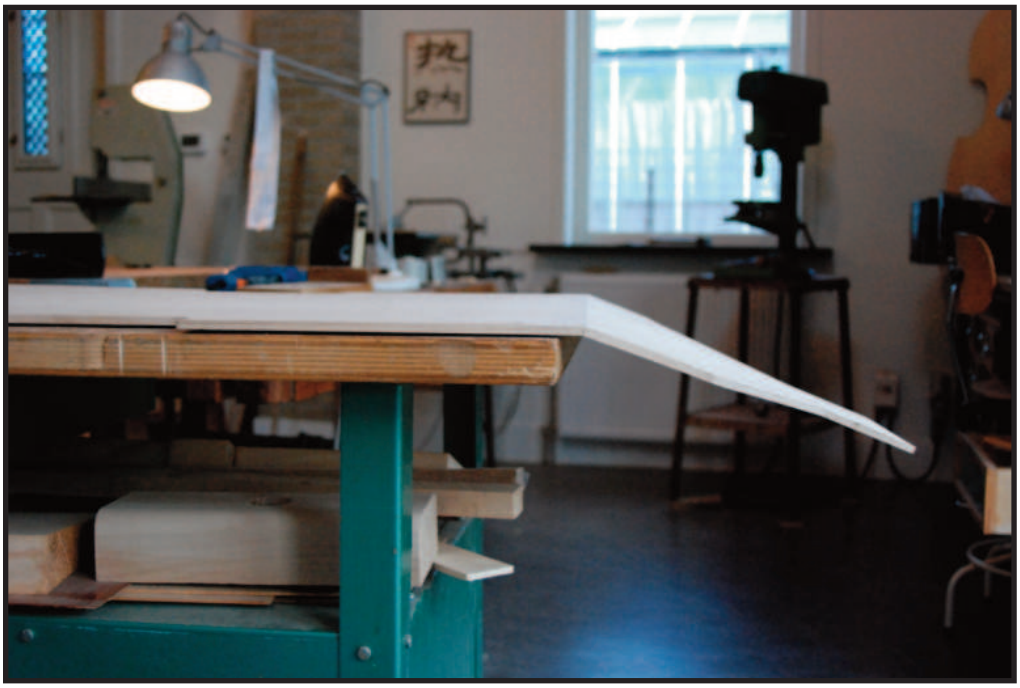

121

The following day seven studs were fitted to hold the bend in place. And not a crack in sight; that man René is a genius. 122 123

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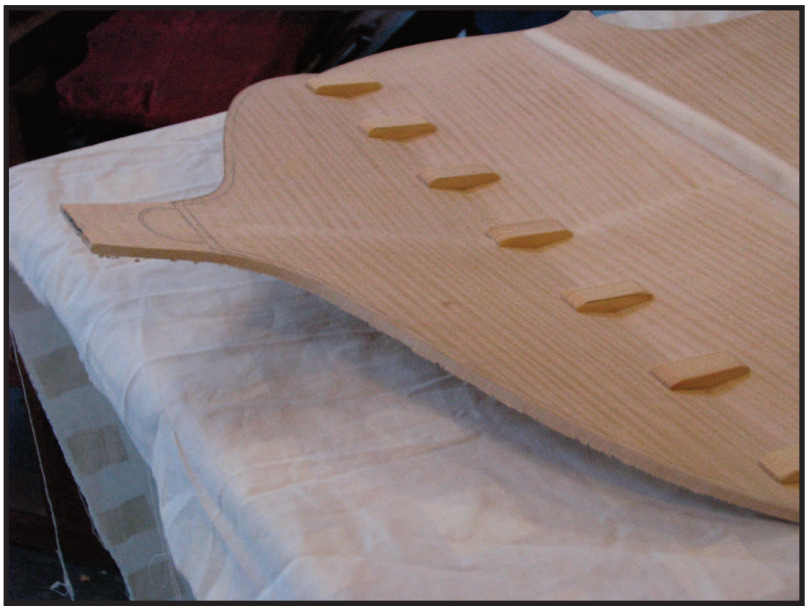

123

After marking the back and belly outlines with a scriber (and pencil for the photographs), I cut them out and finalized them with the same hand-made rasps that I always use for violins and cellos. With violins and violas I simply clamp a substantial plywood board to the underside of my bench. This board sticks out about 12 inches. I then sit on a high stool and using my knee; I jam the flat side of the back or belly plate against the underside of the board. In this way I can move the plate easily while rasping the edge. 124 To help eliminate chatter I keep the plate closer to the board's edge than the photograph indicates. 125

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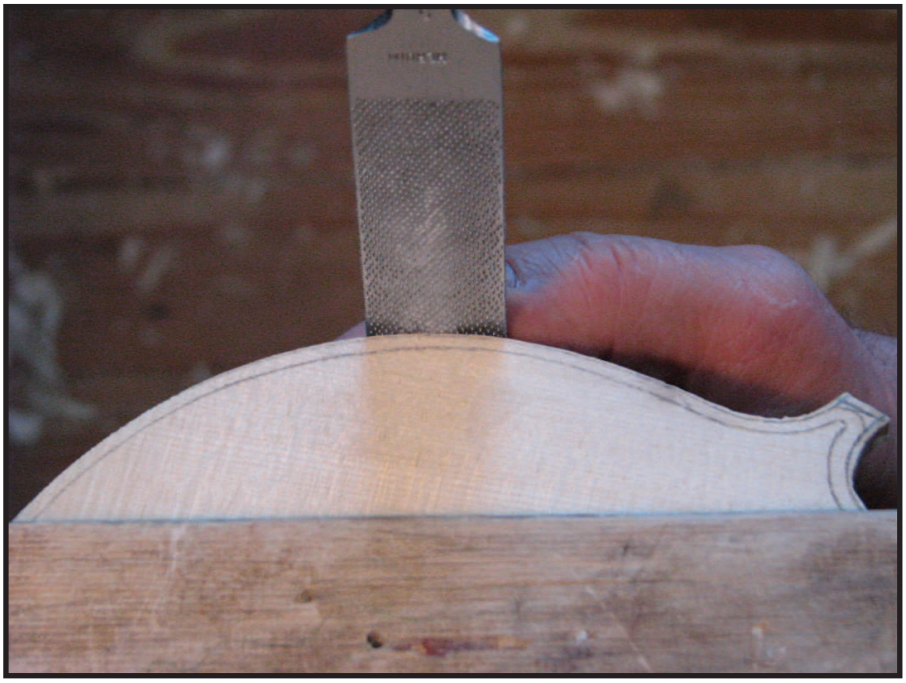

125

In spite of the bend in the back the major part of the outline is flat, consequently holding and rasping the outline at right angles did not present a problem. I simply hung it over the edge of a table. However, the belly is arched and for this reason I clamped it to the underside of the table. Although a little unwieldy, this technique worked reasonably well.

Fitting the cross braces

With the lower area of the back outline completed, René fitted the various cross braces, about which I also know very little. According to René it's a bit like fitting bass bars. However, I strongly suspect that like bass bars, no one really knows how they work. Which means that we mainly really on tradition and make every effort to hide our inability to produce a rational explanation, by introducing a strong mystical element. 126 127 128

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Applying wings to back and belly plates

As can be seen from the photographs, like the scroll eyes, the belly wedges were not quite wide enough. So, in the age-old Cremonese tradition, after roughly sawing the belly outline, René fitted wings. 129 130

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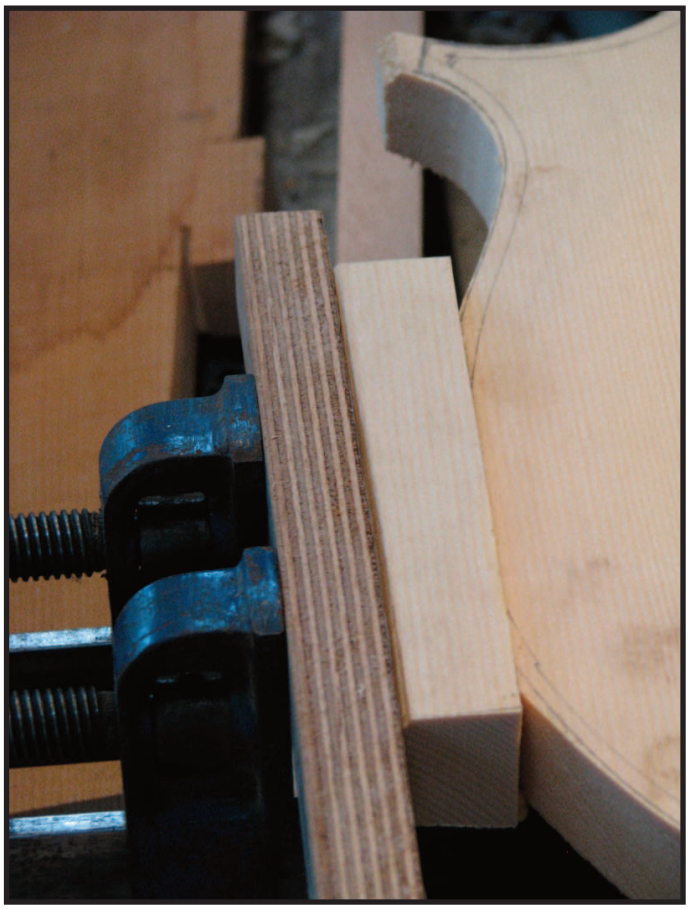


130

Arching and edgework sequencing

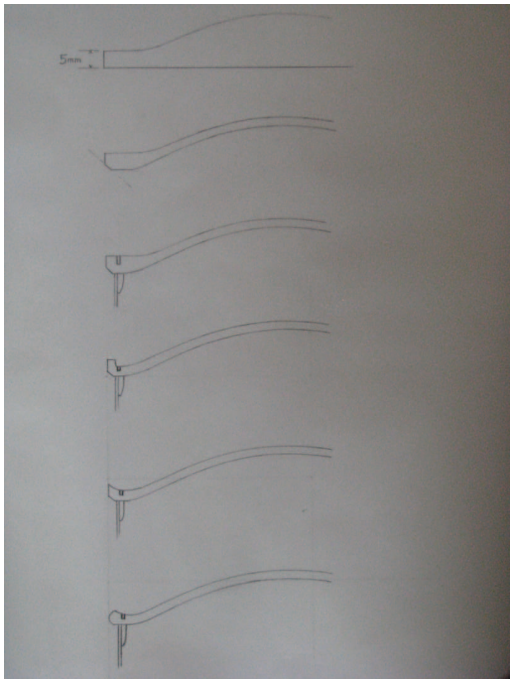
Several people have asked about the sequence of my arching edgework and purfling. The answer is not as simple as it might seem. Whenever I am making an instrument, the exact sequence I employ, depends upon the kind of instrument I am making. This might be a baroque instrument, a normal modern instrument, an accurate 'bench copy' or something that incorporates two or more of these variations. Although ostensibly a copy inspired by the beautiful Hieronymus II Amati bass, this bass is certainly a hybrid. Moreover for much of the time I have been working in René's workshop, using René's tools and much of his methodology. As such, during the making process I have often been called upon to include sequences that I would not normally have followed; but this is how we learn.

Those who know me, or have read my articles, are aware that I am something of a fanatic about Cremona and especially the Amati family. These ancient makers were bound by very strict rules and regulations and for more than 200 years they hardly changed their working practices. This ridged adherence to the 'Cremonese method', created a series of feature that are always present on well preserved examples of their work. [21] Consequently, whenever I am making a Cremonese inspired instrument, I always try to reproduce the essential elements of their methodology, even on instruments with a modern set-up; (modern rather than baroque). I do this because it is these elements that give the instrument something of that illusive Cremonese flavour.

A brief reconstruction of the Cremonese method of assembling the body and finishing the edgework

Having established the back and belly outlines the next phase was to complete the belly arch, the hollowing and the edgework. However, before I describe this process, I will attempt to summarise how I believe the Cremonese makers achieved this. I think that it is important to understand their methods if we wish to replicate both the appearance and the sound of their works.

The following series of diagrams show the various stages of the Cremonese arching and edgework process. 131



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The top illustration shows a (stylized) section of a violin plate. Once the outline had been finalized from the ribs, as Sacconi stated, [22] the arching was completed up to a flat platform that ran all around the edge. Although Cremonese bellies were finished in much the same way as the backs, they were finished and attached at a later stage.

The second picture shows the same section with the hollowing completed. The plate edge is clearly still flat. It was kept flat, because the available closing clamps were relatively crude and would have damaged any finished edgework. (See also the following diagrams and photos describing the edge finishing process.) Once the belly had been hollowed and furnished with sound-holes and a bass bar, a small chamfer was applied to the underside of the edge. This chamfer would eventually become the first stage of the edge rounding process.

At this point the plate was permanently glued to the neck and rib structure. With the back and belly thus permanently attached to the neck and rib structure, the purfling was inserted the edge fluting was hollowed and the edge was rounded off. This process is illustrated in greater detail in the diagrams that follow.

The first photograph shows the kind of clamps that were available to classical makers. These clamps belonged to Stradivari; they are now housed in the Museum in Cremona. They have square rather than round clamping units. 132 The second photograph shows a chamfer being applied to the underside of a viola plate. 133

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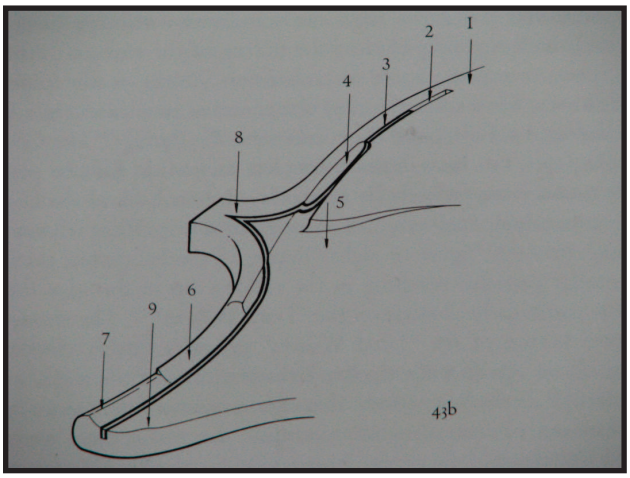
The following two diagrams show how, in the corner and button areas, the arching and edgework were finished from the initial flat platform. 134 135 The photographs are of this system being used on a Guadagnini viola copy.



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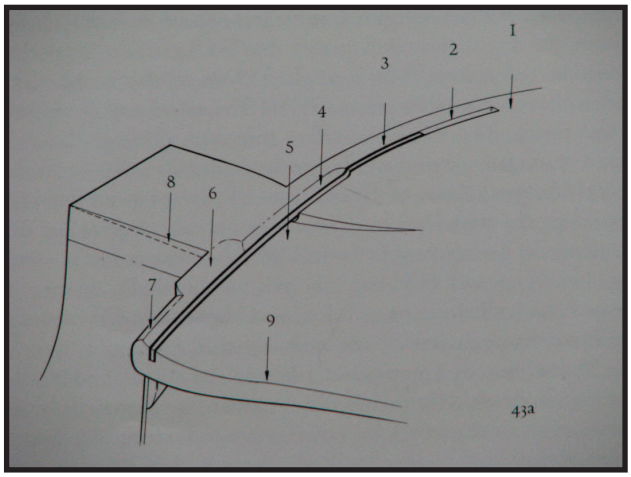
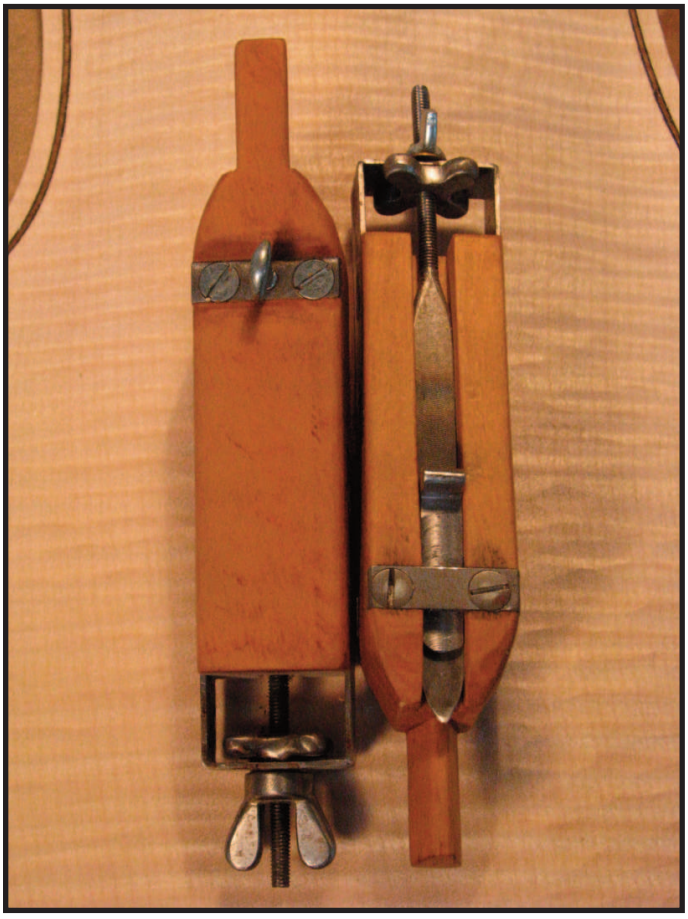


135

1. On a violin this platform would have been as much as 5 mm thick and in fact several Cremonese violins have worn corners that are still almost 5mm thick. (The 1742 'Lord Wilton' del Gesù being a fine example).
2. The purfling channels were cut probably using something similar to these two single bladed cutters, which are copies of the cutters in the Stradivari museum collection. Having only a single blade helped the cutter to cope with the extra depth, which was required because at this stage the edge was still fairly thick. 136 137 138 These cutters also had a depth stop, which prevented the channel from be coming too deep.



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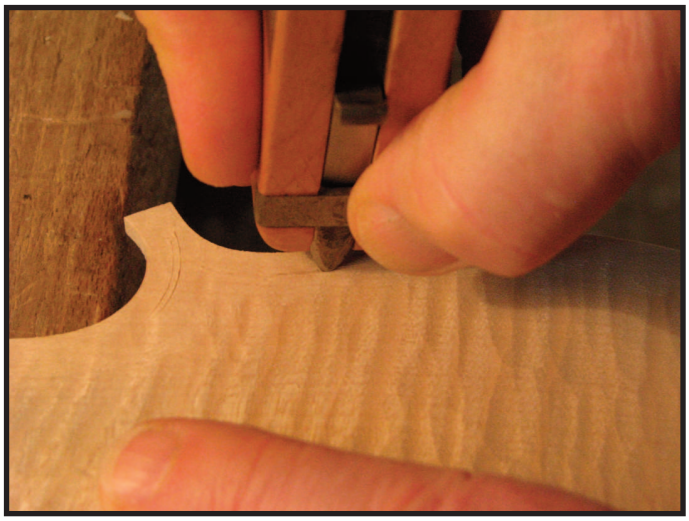

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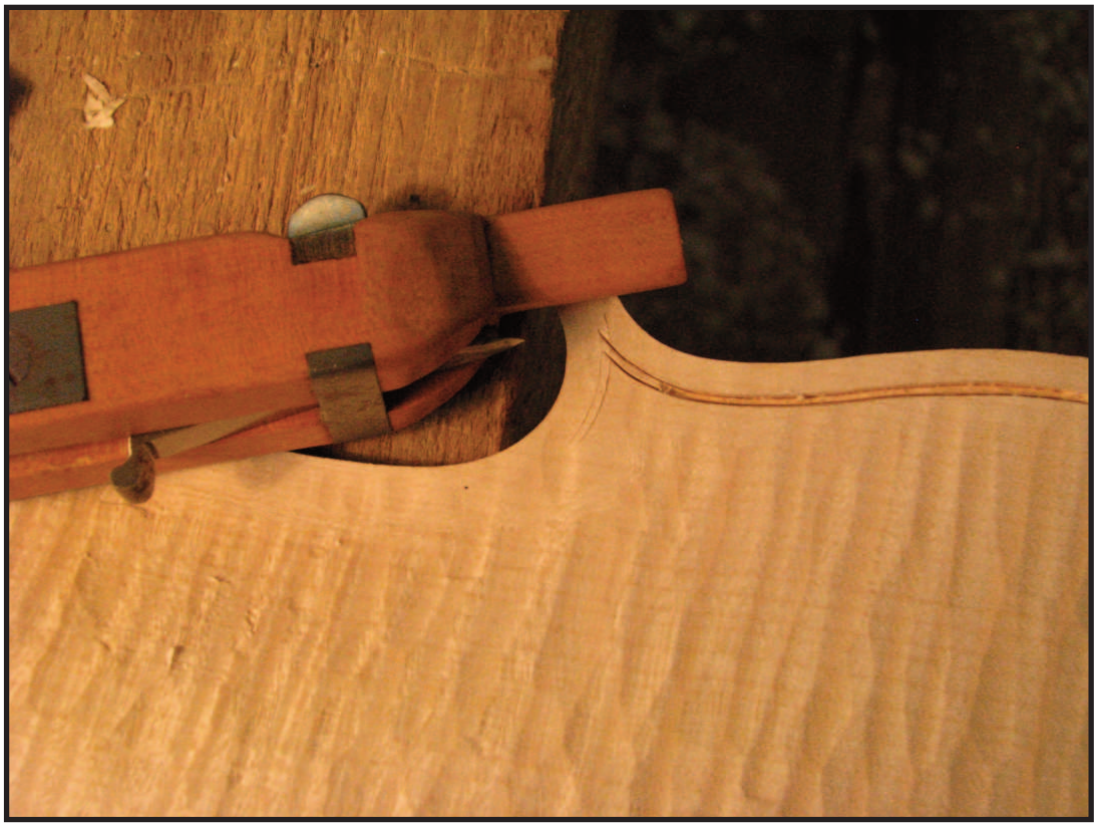

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3. The purfling was inserted and glued in place. 139

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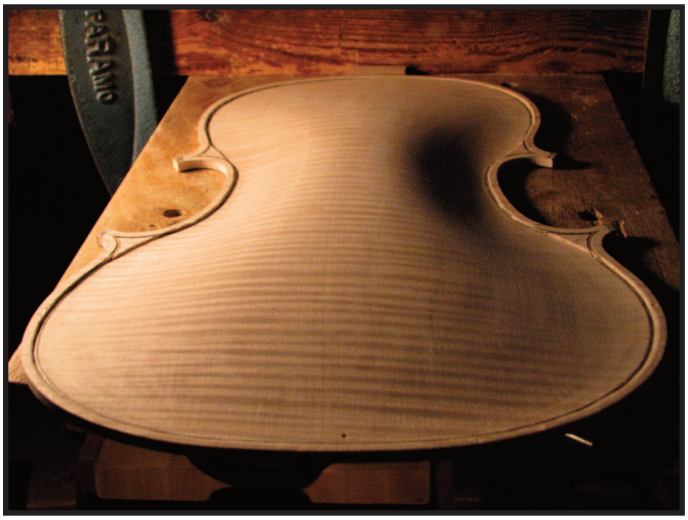
4. A narrow U shaped gouge was then used to cut along the line of the purfling to the depth of the fluting. 140 This little trick was pure genius. Once this had been done the two sides of the purfling channel effectively became separate entities. This meant that Cremonese makers were never required to work against the grain. Traces of this U shaped gouge are occasionally visible at the corners of Joseph Guarneri del Gesù's violins. Very occasionally they are also found at the bottom of the fluting channel on the line of the purfling. However, usually most of these traces were removed by the larger gouges and scrapers that were used to shape and finish the flutings. At this stage, because the corners and the button could be damaged by later clamping, they were left flat and unexcavated. (Position 8) Instead the narrow U shaped skirted the corner area. This action eventually led to the typical figure of eight fluting that runs around Cremonese arching.

140

5. The arching, which was complete to the flat platform, was now completed up to the tight U shaped channel. 141 142 On some Cremonese instruments, including late instruments by the Stradivari family, there is a distinct bump on the archings where this blending process was not quite what it should have been. [23] (Position 9)



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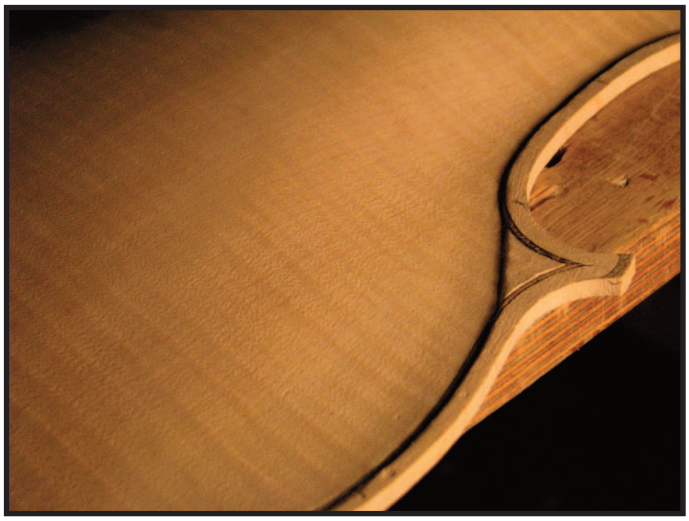

142

6. With the arching completed up to the purfling, the outside of the U shaped channel (outside the purfling) was cut with a curved gouge. 143 This is most obvious on Guarneri del Gesù's instruments, where the arching is scraped clean to the purfling, while the outer curve of the fluting is clearly formed by a series of gouge strokes. The Stradivari and Amati families worked with greater care; cleaning this outer curve of the fluting with scrapers.

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7. The edges were then rounded off as can be seen on this Guadagnini viola copy. 144 Amati and Stradivari families then scribed a fine line around the edge, marking the point to which the edge should be rounded back. This line is often visible on the high point of the edge. This line must have been applied on this outer curve because with the exception of the corners; the edges were lowered by the rounding process. Had these scribe lines been applied when the edge was at its full thickness, they would have been removed as the edges were being rounded back. Position 7 also shows how the edges (away from the corners) were lowered by the rounding process.

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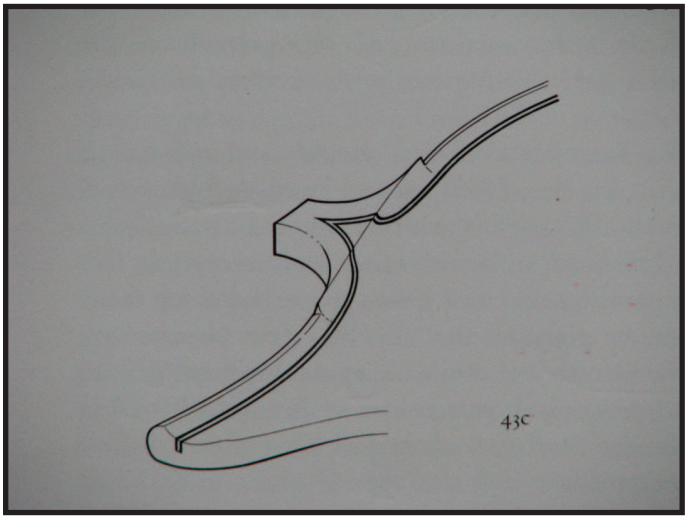
8. Shows how the corners and the button were initially left full and flat [24].

   The button was simply tapered towards the edge as shown. The final three diagrams show how the corners were completed. 145 146 147



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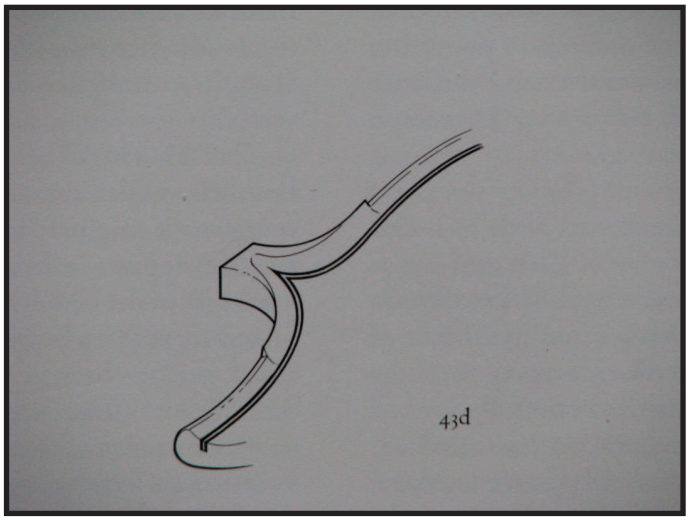

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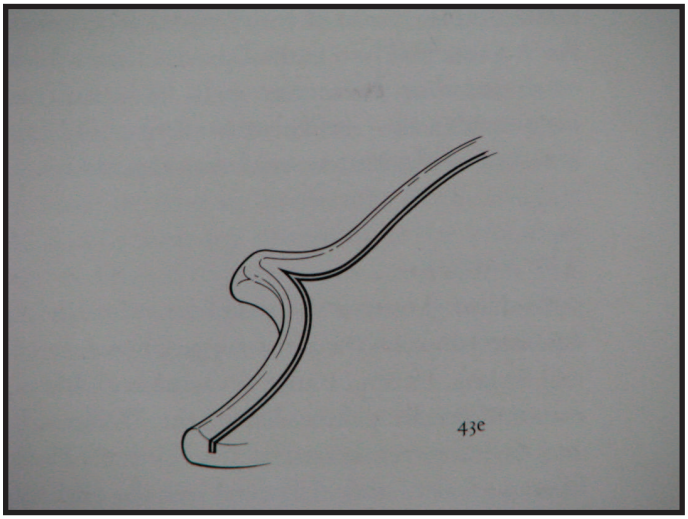
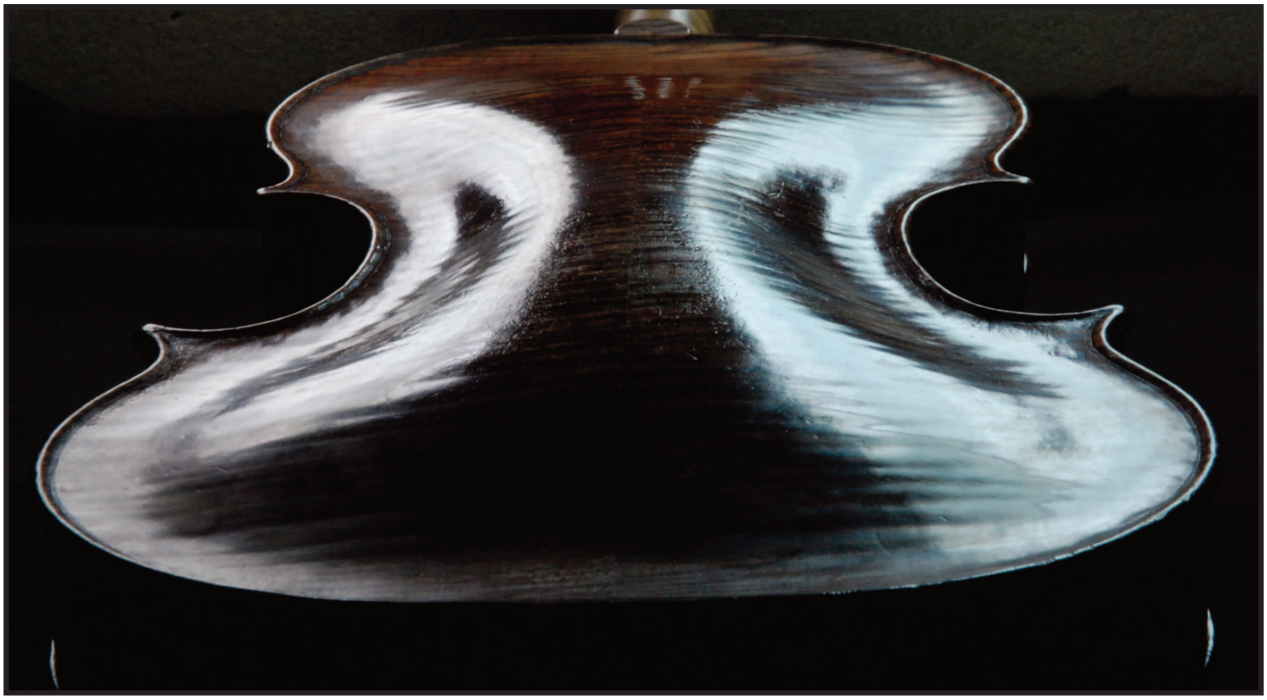


147

As can be seen from the rather extreme example of the 1649 Nicola Amati known as the 'Alard', on both the back and the front arching of all Cremonese instruments, this purfling channel runs across the corner area. When it catches the light, this figure of eight shaped flute can be seen running around the edge. It is almost as if this channel could be filled with water, to make a narrow figure of eight shaped lake [25.26]. 148 149

148 ©John Milne's website ashwww.moleaninstruments.com [26]



149 ©John Milne's website ashwww.moleaninstruments.com [26]

The following photograph, taken during the varnishing stage shows how, on this bass copy, the philosophy of emulating the important aspects of the Cremonese method have helped to create the figure of eight edge fluting. Although not normally as extreme as the Alard, this is a feature which is both quintessentially Amatese and typical of all Cremonese archings in general. 150

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In spite of my attempts to recreate the Cremonese method; when making a modern violin, slavishly following the Cremonese methods is not always practical or desirable. For example, if I am not making a baroque instrument, I do not need to finish the purfling and edgework with the instrument body and neck glued together; as the Cremonese makers invariably did. Instead, I can finish the purfling and the edges before the plates have been hollowed out. This has certain advantages, including the fact that the plates are more stable, allowing more pressure to be exerted on the purfling cutting tools. In fact this is the way in which I will be making this bass. The belly plate will not be hollowed until after the purfling has been inserted. In spite of this, the edgework will still be completed more or less in the Cremonese manner as described.

Rough arching the bass belly

With the back and belly outlines more or less complete, we began working on the belly arching. 151 152

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During this process the edge was cut down with a large gouge, almost to the final thickness. At this stage, as can be seen in the photographs, on cellos and violins I normally mark the final edge thickness with a cutting gauge before lowering the edge down to the incised line. 153 154 The final stage of this lowering process is done with a flat gouge and finished with a flat rasp. In order to save time on our bass, René used a router to thickness the edge. Routers scare the pants off me, so I was quite willing to watch him do this job from a safe distance. Apparently, the early Cremonese makers also used routers; in the old Cremonese dialect the name for a router is 'apprentisimo'.

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From this narrow platform René and I then completed the rough arching of the belly. This term ‘rough arching’ can be a little deceiving. Normally, on all my instruments, I like to begin forming the arching with the first stroke of the gouge. I do not like to see platforms and steps on archings even during these initial stages. I like to see the archings develop naturally throughout the entire working process. I also like to finish each stage as close as possible before moving on to a finer tool. As a general rule I always use the biggest possible tool for any job.

As a consequence of this approach, I never expect to make many serious changes to the arching with either my thumb planes or my scrapers. Thumb planes should simply be used to remove gouge marks and scrappers to remove the (usually toothed-iron) marks of the thumb plane. I find that the more experienced I become, the closer I am able to work each stage. I was pleasantly surprised to see how well this technique works on basses as well as violins, violas and cellos. Here I can be seen using my trusty (highly modified) Japanese form copier, sadly no longer available. This tool is a great help with balancing the arching’s symmetry. 155 156

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As with looking at the outlines of basses, there is also a problem with seeing the overall form of their arching. Working on smaller instruments in my own workshop, I simply black-out the room and use angled lights. René’s ultra large modern workshop has enormous windows that are ideal most of the time, but if you need to create a blackout, you have to wait until nightfall.

Method for making purfling

I have always preferred making my own purfling. Somehow it just seems more natural. Generally factory made inlays are too uniform; too perfect. I usually prepare shavings about 3cm wide and 50cm long. Here again, I use my Lie-Nielsen low angle (Nr. 62) plane, which makes excellent shavings, although it does limit their width to about 3 cm. However, although some makers favour wider shavings, I prefer these narrower strips. This is because I like to use freshly made purfling sandwiches. Purfling that has been glued together for a long time can become brittle and consequently difficult to bend and cut. Having said this, occasionally I still use single shavings that were prepared more than 30 years ago. Normally every three or four years I prepare a large batch of shavings of various thickness and materials. These might include strips of pear, beech, poplar, willow, maple and walnut, to suit the various models I might be asked to copy.

It is easier to plane these strips from a block that has been soaked for an hour or two in warm water. Soaking for such a short time does not allow the water to penetrate very far. However, it is not good to leave them

soaking too long, because they may warp or twist, making them difficult to plane. To overcome the problem of shorter soaking times it's a good idea to rotate these blocks. Since I use several different varieties of woods, at any one time I might have up to ten blocks in my bath. I hold them under water with a couple of house bricks.

In order to make good savings, the plane blade needs regular sharpening; it also needs careful adjustment to create strips of different thicknesses. Sharpening and adjusting also provides a little extra time for soaking. In this way I can take a few shavings off a block, (both sides); before returning it to the water to soak, while I take shavings of another block or work on setting up the plane.

Those shavings that I intend to stain I leave curled up as they leave the plane. If necessary I roll them a little tighter and hold them with a loose fitting elastic band. This prevents them from unravelling in the dying process. It also helps me to keep track of the various thicknesses. However, if the rolls are wound too tight, the black staining will be uneven. Sometimes, as with a Cappa copy, I want the individual black strips to be grey in the middle. In such cases I weaken the dye and shorten the cooking times. In contrast the Amati family is known for the intensity of their black strips.

For this bass I used willow for the whites (0.6 mm) and pear (0.5 mm) for the blacks. Although Sacconi [27] advocates pear wood blacks, in Cremona, the purfling blacks are often not only the same thickness as the whites; I believe that they are also made from the same wood. For this reason, pear wood may or may not be what the Amati family used, but it does stain exceptionally well and strongly resembles Amati blacks.

My usual recipe for staining blacks is the one I was given as a student at the Newark School of Violin Making in England. So far I have not found anything better. The trick is to wash the strips thoroughly after each stage and especially at the end. If this is not done there is a chance that the colour might bleed into the instrument when either hot glue or hot water is applied.

Recipe for dying the blacks strips of purfling

The following is a good recipe for dying the black strips. I stand the rolls upright in a deep pan. It helps if they cannot move around too much. If they break loose it can be a problem unravelling them at the end. Do not use a pan that you will later want to use in the kitchen. This process may or may not be poisonous, but the staining will certainly be difficult to remove, even from a stainless steel pan.

1. To one litre of water add 6 grams of potassium hydroxide (KOH). Boil the shavings in this solution for at least one hour, after which they should be washed thoroughly.
2. To one litre of water add 20 grams of Logwood chips. Boil the shaving in this solution for at least one hour and leave them to soak for 24 hours. Again wash the shavings carefully before the next stage.
3. To one litre of water add 12 grams of ferrous sulphate. Boil the shavings in this solution for one hour and leave them to soak for 24 hours.
4. Finally wash the shavings thoroughly and dry the strips. If they are not to be used immediately clamp the strips lightly together between two flat boards.

Two days before I travelled to René's workshop in Holland, I glued the shavings together; black-white-black. I then cover both sides of each strip liberally with hot gelatine glue [28] and clamped them to the edge of my bench between two boards covered with plastic tape. Effectively, in addition to gluing these strips together, this process creates a purfling sandwich that has a layer of gelatine glue on the outside. This sandwich is left clamped for at least 8 hours. The plastic surface on the clamping blocks should prevent the whole structure from drying out. Once the clamps and the blocks have been removed, (they usually slide off quite easily), the moist but not sticky purfling sandwich is then wrapped in kitchen foil. 157 158 159 160

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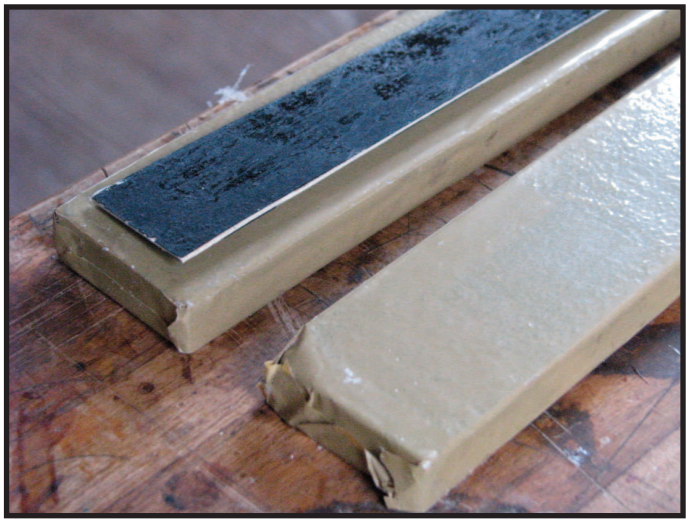

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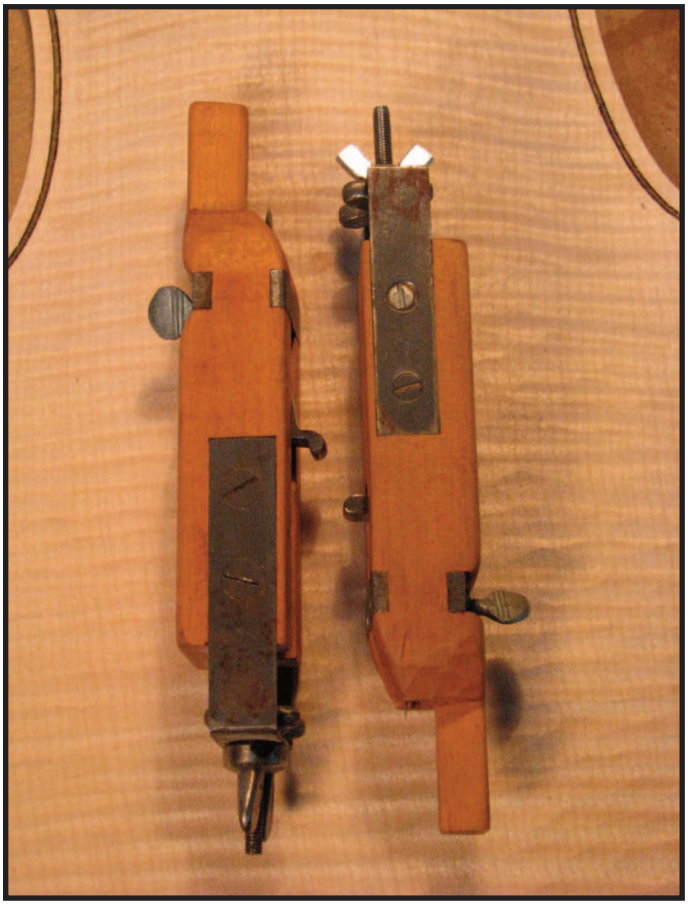
Kept this way the strips remain very flexible and usually they bend around tight corners with comparative ease. From these sandwiches it is a simple process to cut strips as and when required. Another advantage of making my own purfling in this way is that I can cut these strips to whatever depth I might require. For the bass this was considerably more than for a violin or even a cello. Had I used commercially produced purfling it would simply not have been deep enough for my version of the 'Cremonese' system [29].

Purfling the bass

It is always important to cut purfling channels to a specific depth. For this reason, Stradivari appears to have used two single bladed cutters with a depth stop. Normally, as previously shown, for violins violas and cellos I use the highly accurate copies of the Stradivari museum cutters that were made for me by Mark Jackson. [30] 161 162



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The fact that Stradivari's cutters had a depth stop strongly suggests that the plate edges were still flat as the purfling channel was being cut. Had the fluting been partially sculptured this depth stop would not have worked, or would have seriously damaged (especially the belly) edge.

Mark Jackson makes many fine tools including superb spiral reamers. Just as they probably did for Stradivari, these purfling cutters ensure that I don't cut my channel, either too shallow or too deep. If the channel is too shallow the purfling may fall out when the fluting is being cut. It will certainly not provide the protection that it is designed to give. Conversely, if the channel is too deep, the edge may become weak or even break off. However, as a concession to bass makers everywhere, I used a fine router for the main channel, only finishing the corners and tricky bits by hand, with the help of Marks tools. I also used an old double bladed purfling marker/cutter to open, (compress) rather than cut, the entire channel. This cutter creates a compressed V shaped channel that makes the process of inserting the purfling much easier. 163 164

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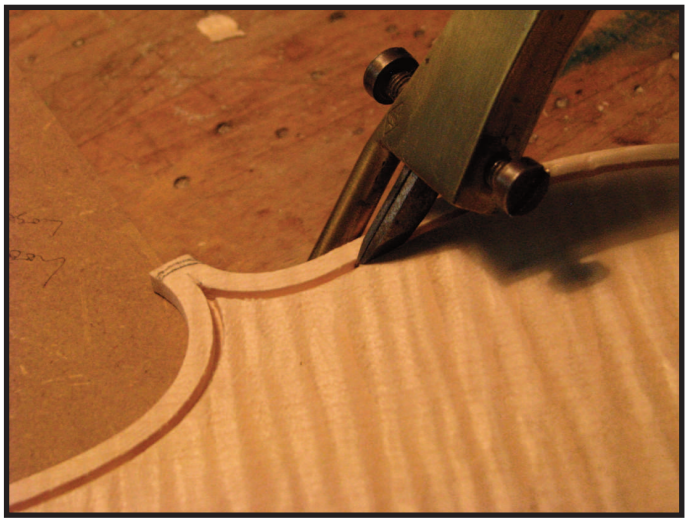

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This marker/cutter is one of several that I have pre-set for various models. I have also used them for scratching the purfling lines on Testore copies, (see section on pore filling before varnishing in part 2). In days gone by, I used these double bladed cutters all the time for marking out the purfling channel, in preparation for deepening them with my knife. The only difficulty with this system is controlling the overall depth. Having thus cut the channel, I prepared the mitres and inserted the purfling into the channel dry, making sure that the strips fit right to the bottom.

With the purfling thus inserted, using a brush, I simply (but carefully) run boiling water over the channel in order to reactivate the glue on the outer surface of the purfling sandwich. On cold days it is advisable to pre-warm the edges with a hair dryer or a heat gun. Applying boiling water works rather like licking a postage stamp. (Does anyone still do that?) The boiling water also rapidly swells the compressed V shaped channel causing it to close, clamping and gluing everything together. This process also avoids the usual excess glue from penetrating the fluting and the end-grain of the edge work.

I allow any left over purfling to dry out before clamping it between two plastic covered boards for storage. If purfling is kept moist in foil for too long it will eventually go mouldy. When they are required (even years later) it is relatively simple to rejuvenate them, by wetting the sandwich and then quickly wiping them dry before wrapping them in foil overnight. Usually they become flexible enough to bend even around tight corner curves. If not, you can steam them for a few of seconds under the lid of a small pan. 165 Be sure to wipe them dry with a paper towel immediately after they are withdrawn. You should be able to feel their increased flexibility. Remarkably, in spite of this treatment, they do not come apart and are usually both flexible enough to bend and dry enough to insert. Meanwhile, enough glue remains on the outsides, to hold them once the boiling water is applied.

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Although the bass belly was finished in much the same way that I would approach the purfling, edge-work and arching on a modern violin; purfling the flat back required a slightly different approach. Usually, whenever the edge fluting is cut down after the purfling has been inserted; the channel swells around the purfling creating an altogether better fit. In addition, any chipping to the purfling channel edges will usually be cut away when the fluting is finalized. On a flat back there is no fluting. This means that the channel must be cut perfectly. Fortunately, because of the nature of the materials, it is much easier to cut a clean channel in maple than in spruce. I should point out, that at this stage, the upper portion of the back outline and consequently its purfling channel was still incomplete. This is because, before these details can be finalized, we still needed to bend the back and fit the neck,

Cutting a good channel for the purfling mitres is not easy, especially to the extra depth required for a bass. It requires a razor sharp, non-flexible blade. As a student, many years ago, I tried using disposable medical scalpel blades for this job, but they proved far too flexible. The blade tip was prone to bend off line resulting in distorted mitres. A useful tip for belly mitres is to use a little dry soap on the blade in the immediate area of the mitre. This is not recommended elsewhere in the channel since it can cause problems with the gluing process, especially if the method of gluing that I have described here is being used. Dry soap helps the blade to slice the wood rather than to press through the fibres. If, in spite of your careful efforts the mitres are not good when the purfling and fluting are cut back, this is not necessarily a disaster. This frequently happened to the Stradivari family even in the golden period. When it happened he simply reshaped the mitre with a fine knife and filled the area with what Sacconi called black mastic filler. However, I strongly suspect that this was simply a pore filler mixed with varnish. Varnish mixed with filler always looks black in depth. 166

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It might surprise some makers to know that although the width of Cremonese purfling varied from time to time, they do not appear to have used wider purfling for larger instruments. For this reason, the purfling that I have used here is identical to that which I would use for an Amati violin copy.

With the main part of the purfling inserted the back edge, (below the bend), was rounded. Even with the cross braces and studs in place the back remained extremely fragile. It required very careful handling. This was a totally new experience for me. I don't recall ever having worked on anything quite so large and so fragile. It really required continuous concentration. Finding ways to hold and turn the back while rounding the edge was genuinely nerve wracking. As can be seen, apart from rounding the edges, the corner has also been worn slightly, in anticipation of the final copy work. 167 168 169 170

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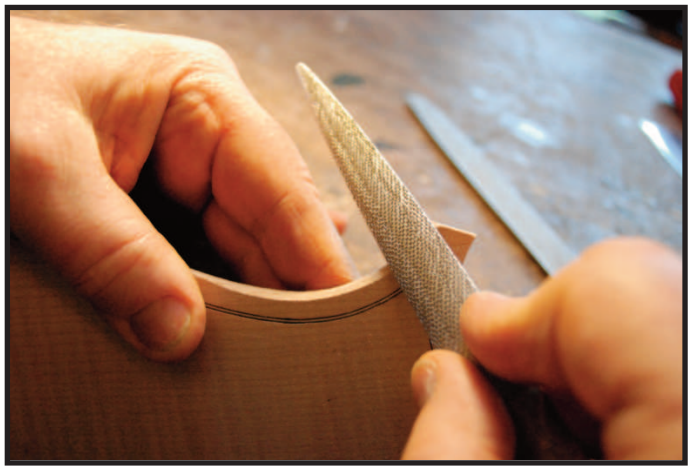

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Removing the ribs from the mould

The outline, purfling and edge-work are now complete up to the point where the back has been bent. The ribs can now be removed from the mould [31], so that the back can be fixed permanently to the rib structure. Once this has been done, the upper portion of the back (outline edge and purfling) can also be completed. Some minor adjustments will need to be made to the rib angle with a block plane, until the back and rib angles also fit together perfectly.

The mould that René made for this bass is almost a work of art. It is collapsible, and albeit in a slightly different way, like the Cremonese method, it allows the top and bottom linings to be glued in place on both sides. Because it is collapsible, this system also allows the ribs to be removed from the mould, without the need to spring the ribs apart [32]. René and I always glue a strip of paper between the blocks and the mould to make releasing them a little easier. A wide but thin steel blade and a syringe filled with alcohol, (Bols Jenever I believe), helped loosen the blocks. 171 172 173 174 175

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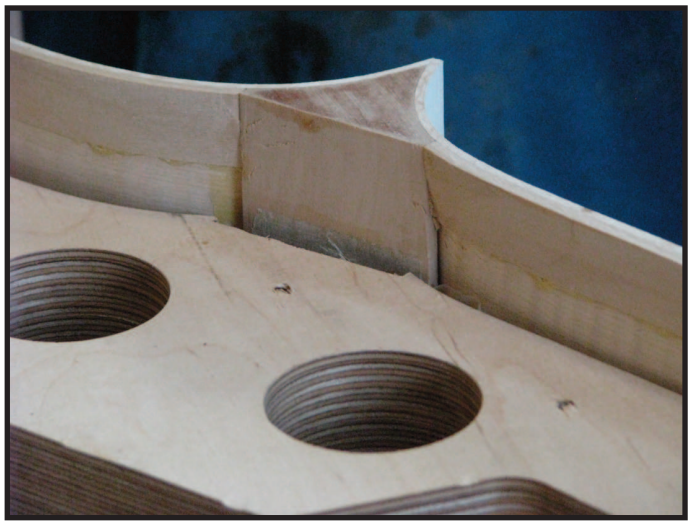

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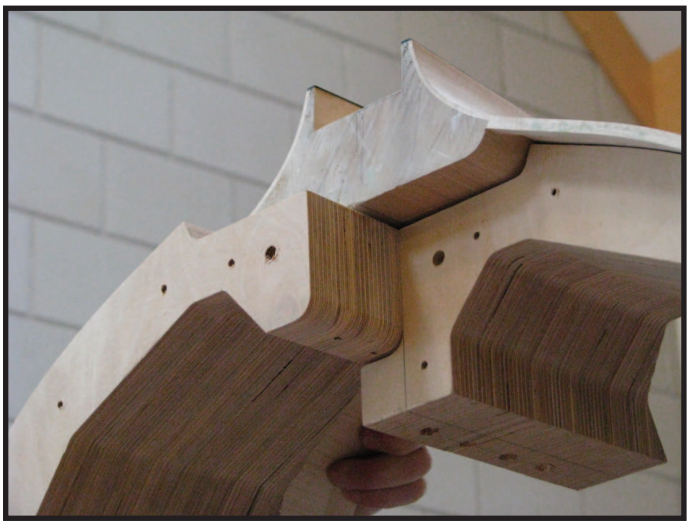

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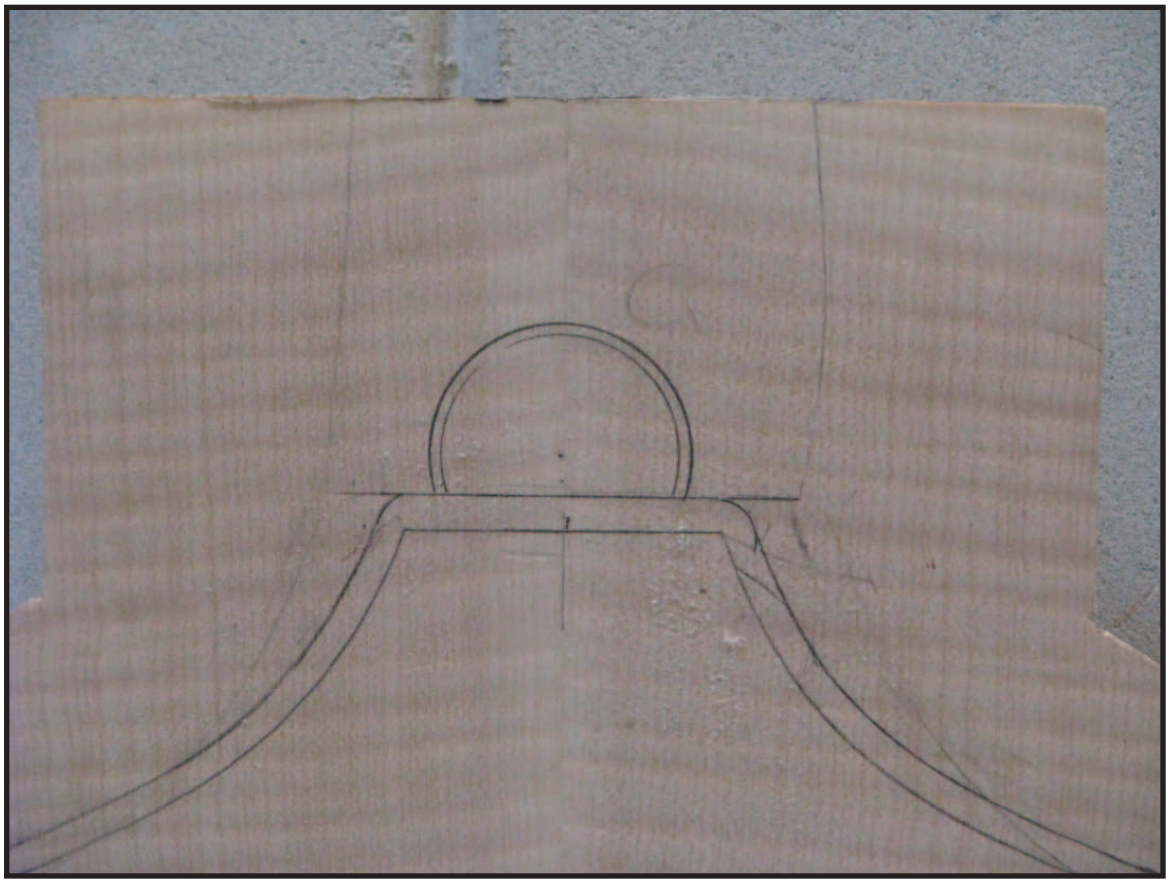
With the blocks loose, the ribs were free to open and expand. The screws that were holding the mould together were removed and one half was eased over the linings and out of the rib structure.

Attaching the back to the ribs and finalizing the outline

Shortly before attaching the back to the ribs, the button shape was drawn onto the back to be finalized at a later stage. Now with all the cross braces in place, the back was glued permanently onto the ribs. In contrast to the original Amati bass, the accuracy of our mould and rib structure, meant that the back and belly outlines matched the ribs and each other, extraordinarily well. 176 177 178 179



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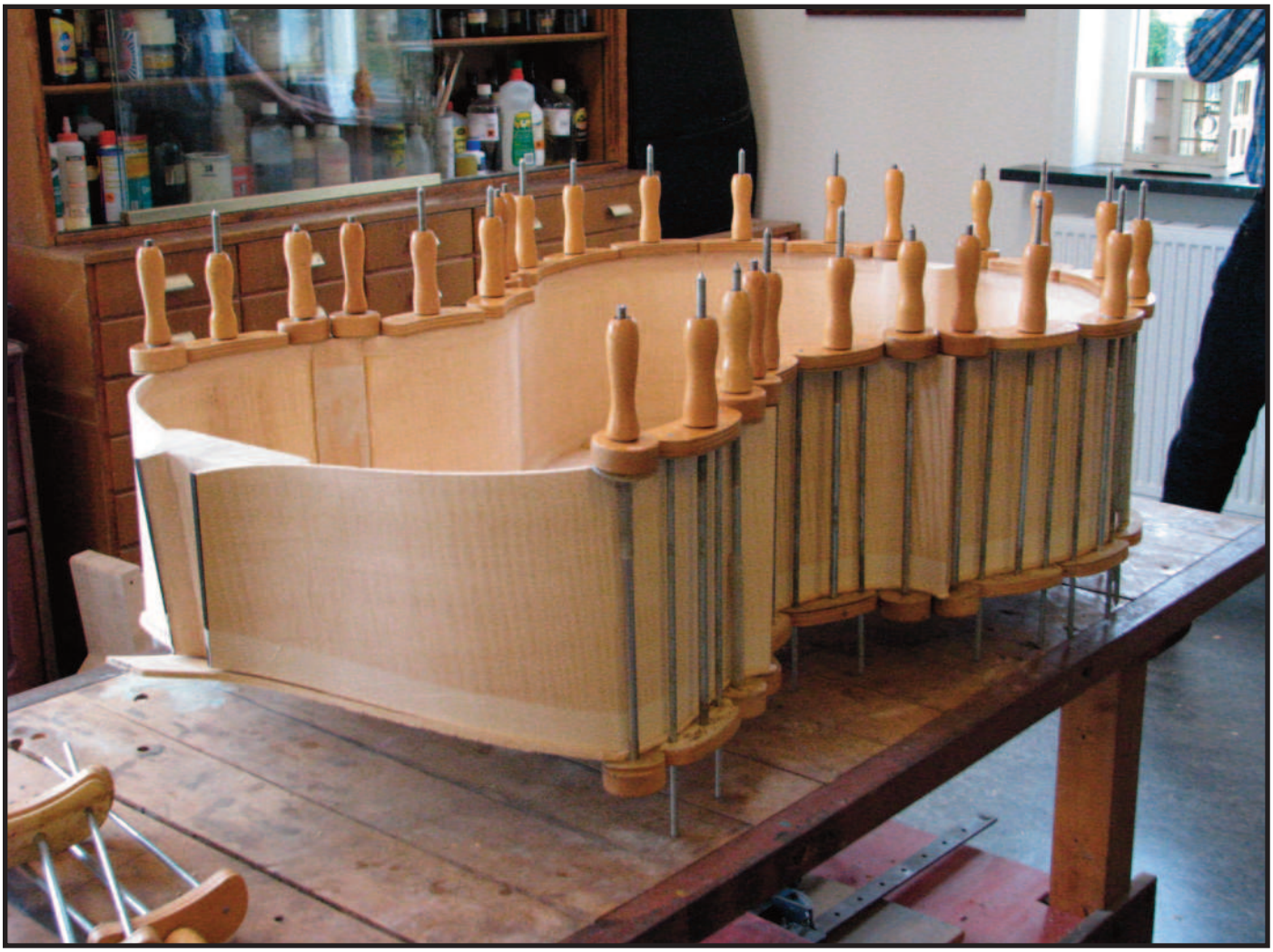

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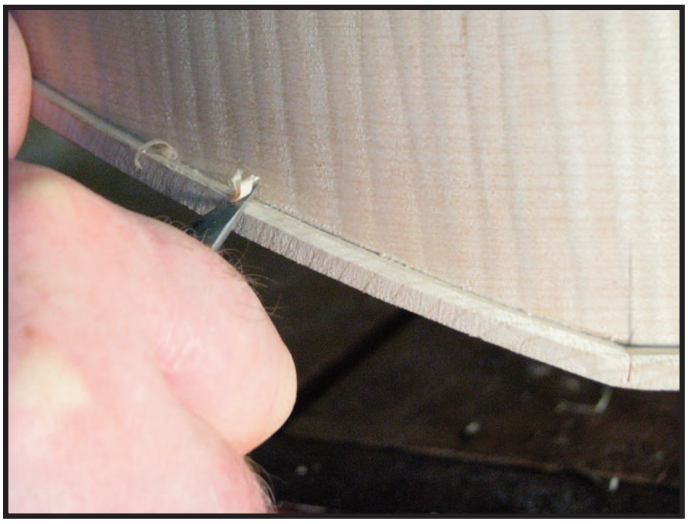
Unfortunately, we are still in the dark about exactly how the Cremonese constructed their bass ribs and in view of their rarity we are unlikely ever to know. Right now, the important thing for us is to finish the outline of the bent area; insert the remaining purfling and round off the edges. Effectively this will mean finalizing the final part of the outline and rolling the edge with the back glued to the ribs. (More or less as the Cremonese makers would have finished the entire instrument)

As indicated earlier, when I summarized the original Cremonese method, Cremonese makers cut a chamfer on the underside of their back and belly plates. This chamfer was always applied before the plates were finally attached to the ribs. Then, only after the plates had been permanently fixed in place, was the purfling inserted and the edge rounded. Obviously this chamfer was applied, so that it would be easier to round the edges without damaging the ribs. In this case however, on completing the outlines on this bass, (with the exception of the bent area of the back), I had cut a chamfer on the underside of the plates, inserted the purfling and rounded the edges, before they were permanently glued to the ribs.

Now, with the back attached to the ribs, it remained for the upper portion of the outline to be completed with a knife and a rasp. This was relatively easy done. However, the difficulty of cutting the underside chamfer with the ribs attached, made me realize why the Cremonese masters usually applied this chamfer before they attached their backs and bellies to the rib garland. 180 181



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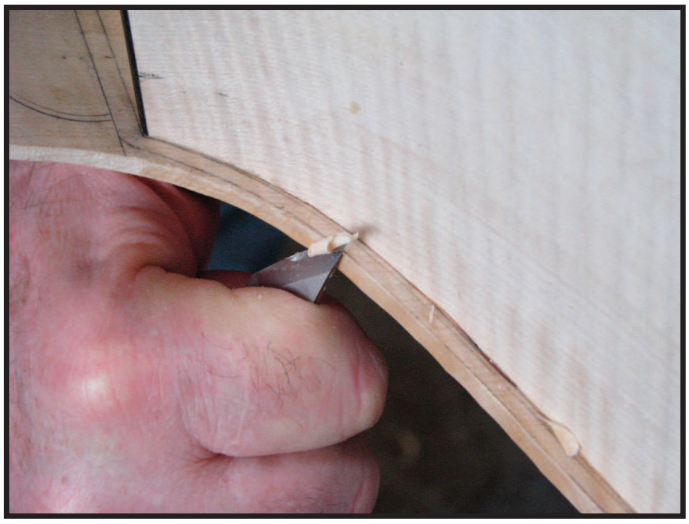

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Prior to rounding the back edge completely I finished cutting the purfling channel, this time entirely by hand. When I inlayed the remaining purfling, as can be seen from the photograph, I used a long scarf joint. 182 To explain how this works I have also included a photograph of a scarf joint in the 'C' bouts of a Guadagnini viola copy. 183 In addition, in order to provide a little more stability, the strip running across the button was not inserted quite as deep as the other pieces. Of course, this second attempt at purfling the back and rounding the edge would not have been necessary had we chosen to work entirely after the Cremonese method. 184 185

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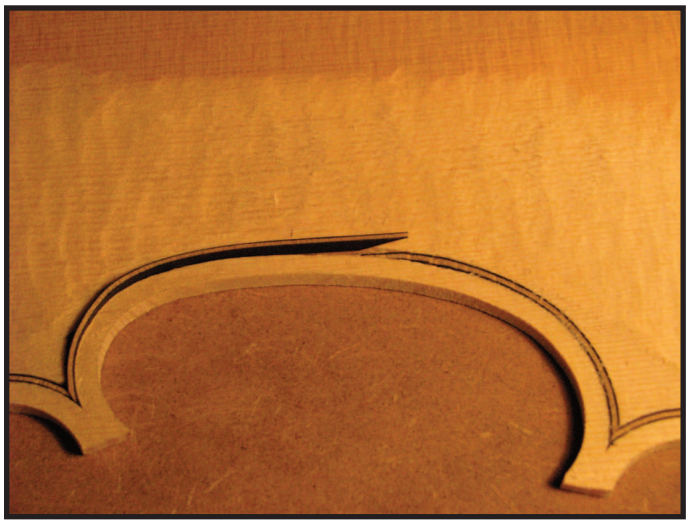

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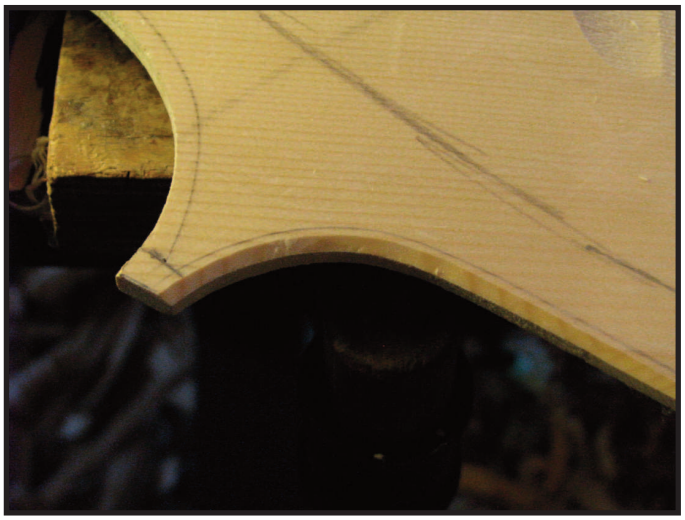
Finishing the belly edge

In contrast to the flat back, the belly is arched and the edge is fluted. The arching has a rather deep steep sided purfling channel, (flute), with the high spot of the edge more or less half way between the purfling and the outer edge. This is how most Amati family instruments appear to have been finished. The Stradivari family generally worked their flutings a little closer to the outer edge. With the purfling inserted the fluting was cut in the Cremonese manner. I offer one word of caution here. When attempting this method, some commercial purfling is not deep enough to be inserted into an edge with this much (extra) thickness. It is very easy to cut all the way through a shallow purfling when carving the fluting channel of this (extra) depth.

With the fluting channel cut to the outer edge, it just remained for the edges to be rounded back. As indicated, I began by cutting a Cremonese style chamfer on the underside. The rounding off was done with a file. For once my beloved rasps were too rough. When rounding the edges I always try to leave the corners a little long. This allows me to work the outlines without the risk of damaging or unintentionally rounding the corners. This extra length is particularly helpful when the rounding of the edge is being smoothed off; in this case with a piece of dogfish skin. Only when everything is finished do I finally round the corner ends. Here again I beginning with a knife cut chamfer on the underside. 186 187 188 189



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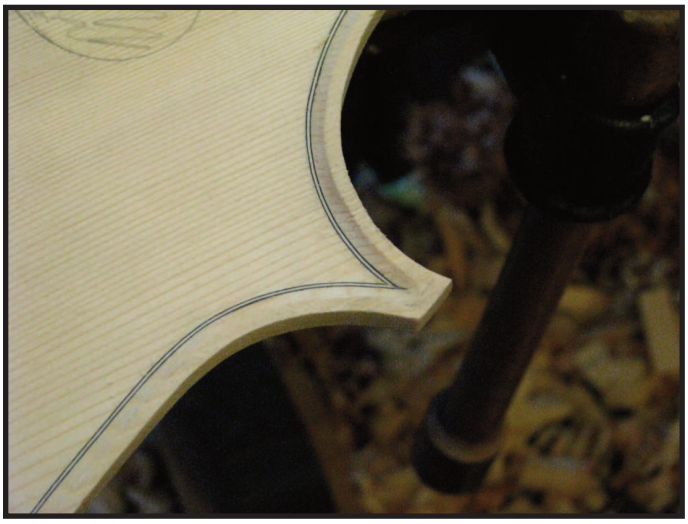

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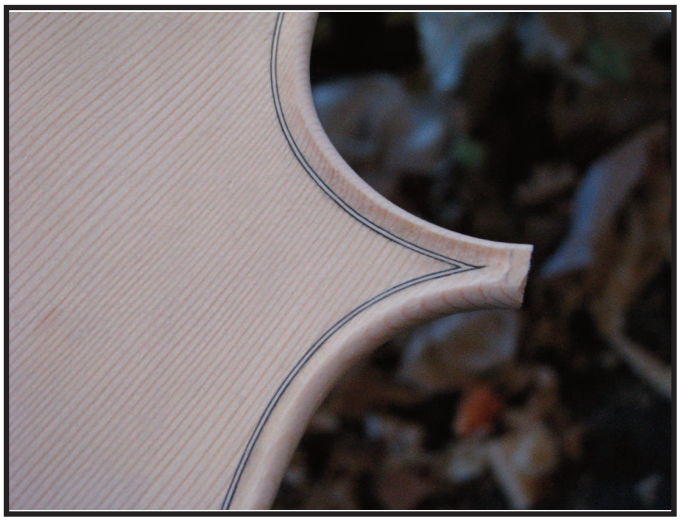

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From the above sequence of photographs it can be seen that I did not adhere to the Cremonese method of cutting the fluting right to the outside edge. The reason for this was because René had already lowered the edge to its final height; thus proving that there are many more ways of making instruments than there are instrument makers.

Again, I have worn the corners slightly. I have also drawn the sound holes on the belly and lowered the lower wings on both sides. As with wearing the corners, this was done to give the illusion of age. 190

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Thicknessing the belly

Thicknessing the belly was far more complicated than I had imagined. I simply thought that the belly would be of a more or less of even thickness, rather like a violin or cello belly. However, as René pointed out, the thicknessing of bass bellies is more akin to thicknessing a violin back. Of course I did not believe him. This was nothing personal; I never believe anyone. So I started asking around and everyone said much the same thing, until in the end I was beginning to suspect a bass makers conspiracy. The upshot was that René's system was laid out and as a punishment for my scepticism; I was forced to do the roughing out. I was told to within work to plus 2mm of his system, after which he would take over. I did this with my largest gouge. Although it was not particularly difficult work, it sure took a lot longer than hollowing a violin belly. In the end I was just grateful that we were not making an arched maple back. 191 192 193

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Having inspected my work, René then re-marked the belly for final thicknessing. In several articles I have mention Stradivari's graduation punch; my version can be seen here being used on a viola. I considered making something like this for the bass, but soon realized that such a punch would be about the size of the golden gate bridge. 194 195 196

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René used a drill press and a small-blunt drill to mark the required thicknesses. This is basically the same idea as Strads punch. He did not, as I had suspected he might, remove wood with a larger drill bit or a router head. After completing the marking it was back to the gouge, the planes and the scraper. René took final charge of this operation.

What I can say is that the thicknessing ranged from 9.5 mm in the centre to 4.5 mm towards the edges. The thicknessing of this belly was entirely dependent upon the reaction of the wood, which on both the back and the belly, is stiff and highly resonant. (Those with long memories will remember that at the beginning of this saga this was my main reason for buying this bass wood all those years ago.) Interestingly René did not scoop the hollowing at the edges or at the two end blocks. Instead, as it left the sides, the hollowing was convex and consequently the thicknessing around the edges remained strong. I was pleased about this, because this idea conforms exactly to what might be expected on any Cremonese instrument of the violin family.

On this bass there was also a slightly stronger band of thicknessing running along the centre of the belly. Presumably this was to counter the compression effect of the neck and tailpiece. Apparently this pressure is similar to that which is required to move a continent.

After several fine adjustments had been made, with the help of thumb planes, scrapers and callipers, the belly was ready for the sound holes to be cut.

Cutting the sound holes

With the arching finished and the belly thicknessed it was time for us to cut the sound-holes. As can be seen from the photographs the sound-hole templates were recreated using rubbings and measurements taken from the original Amati bass. 197 198

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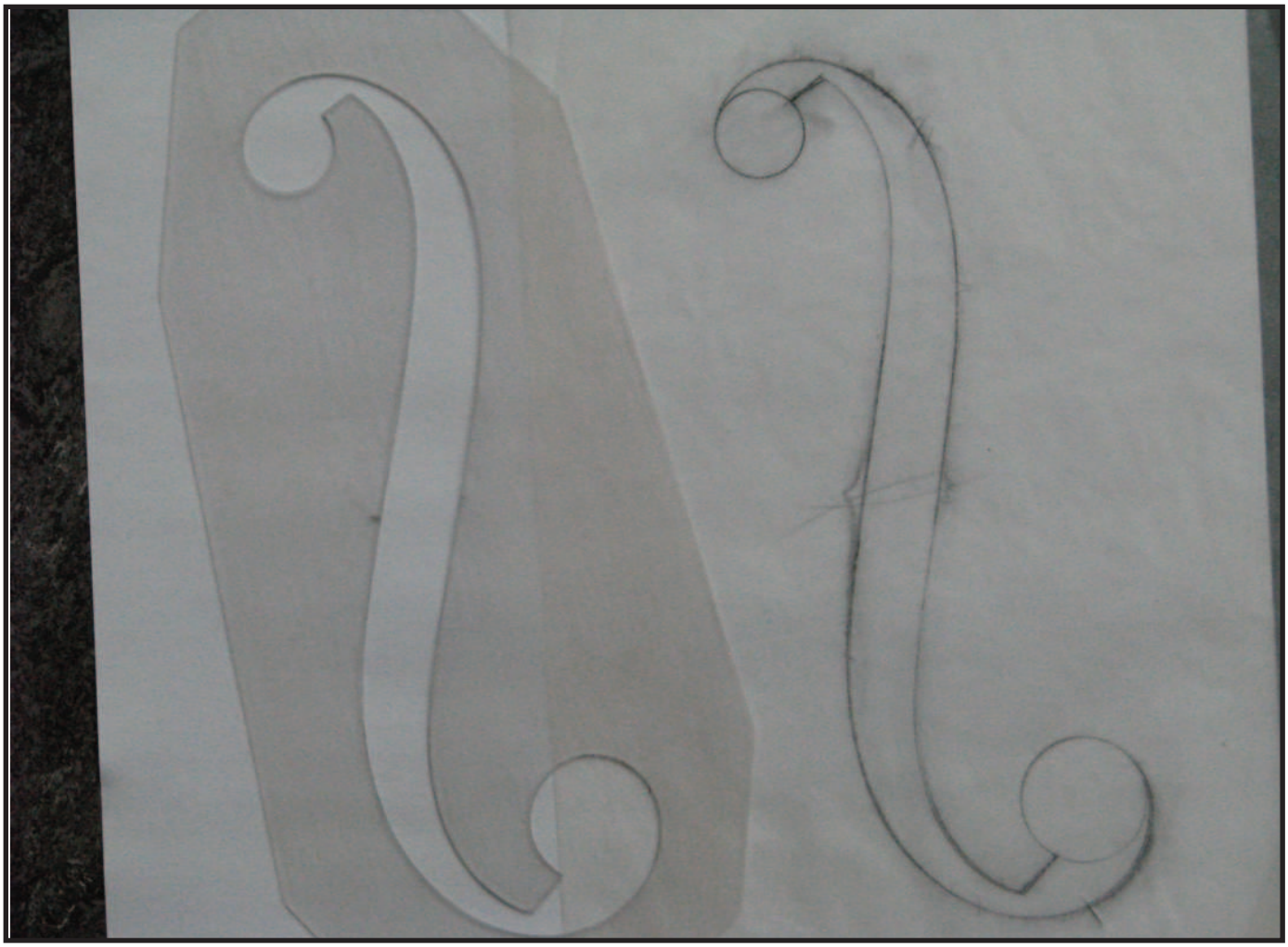

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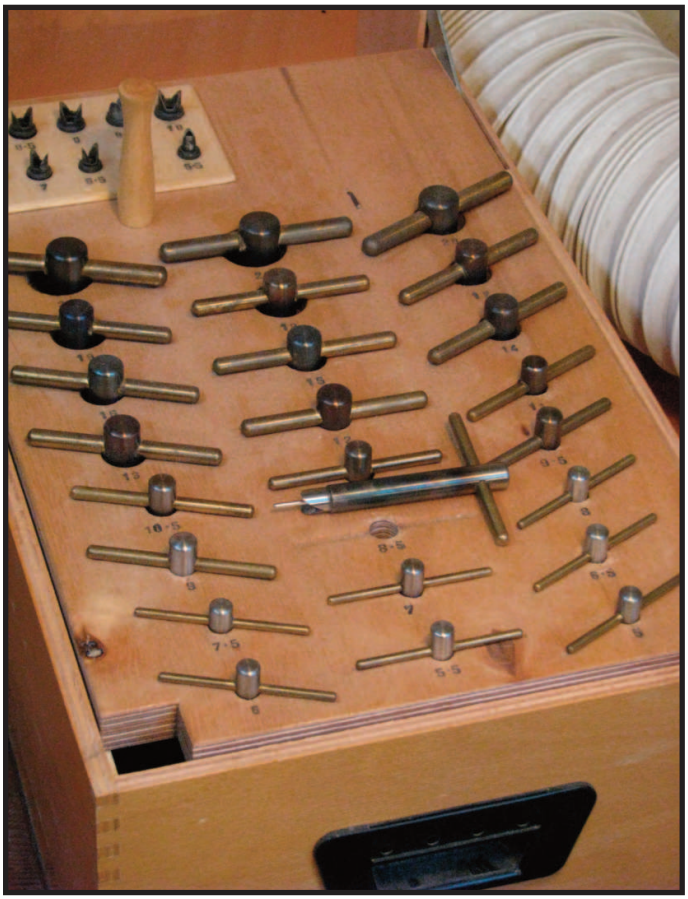
The first thing that became obvious was the nature of the top and bottom circles. Allowing for some distortion caused by a couple of cracks, all of these circles were originally perfectly round and had almost certainly been drilled. Although both sound-holes were slightly different in shape and position, three factors were important. The corresponding bass and treble circles were exactly the same size, (upper 21.5 mm and lower 32 mm). In addition, as far as can be ascertained, in spite of their different angles and overall positions on the arching, on both sound-holes the distance between the centres of the top and bottom circles was virtually identical, (approximately187.5mm). Finally the bodies of both sound-holes appear initially to have been cut at right angles to the belly arching. Again I would expect to see all of these details on any Cremonese instrument of the violin family.

Having drawn the sound-holes I made plastic templates. Normally I prefer to use an inside template similar to those used by Stradivari. Inside templates follow the flow of the arching whereas outside templates tend to open when laid over the arching. However, on this occasion we decided to employ outside templates. They are slightly easier to make and the template itself is generally more stable.

Next I placed the templates on the arching and drew the sound-holes. I began cutting the sound-holes by drilling the top and bottom circles. In classical Cremona, the top and bottom circles would have been drilled first and the sound-holes would have been marked out between these circles. The drills I use for cutting the top and bottom circles of all my sound-holes, were made for me by Brian Hart, a truly great toolmaker [33] . Brian made many wonderful tools for me including a two-way adjustable fret saw. The photographs show these tools being used to cut the sound-holes of a viola. 199 200 201 202 203



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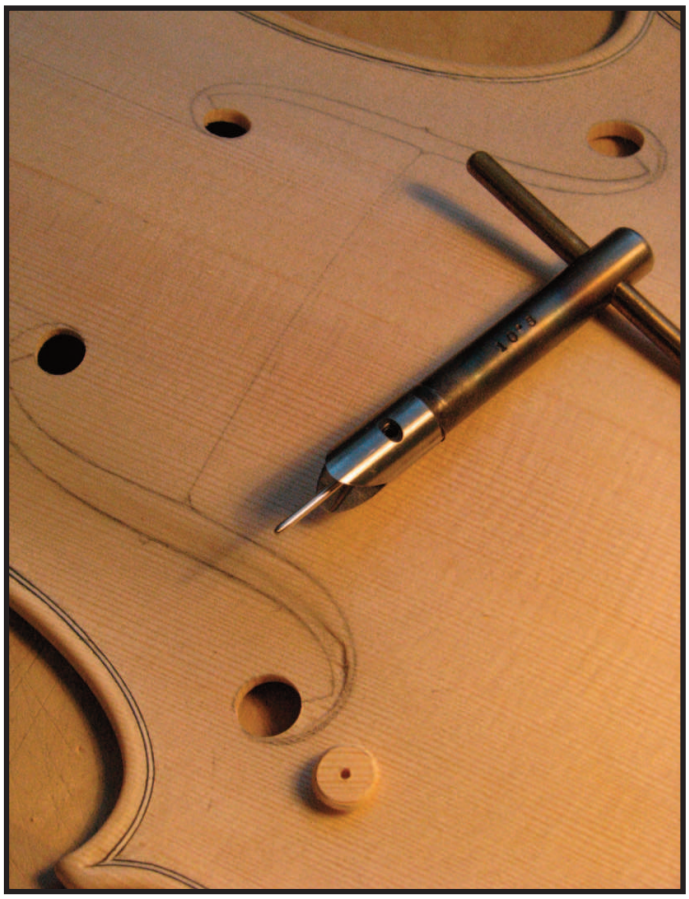

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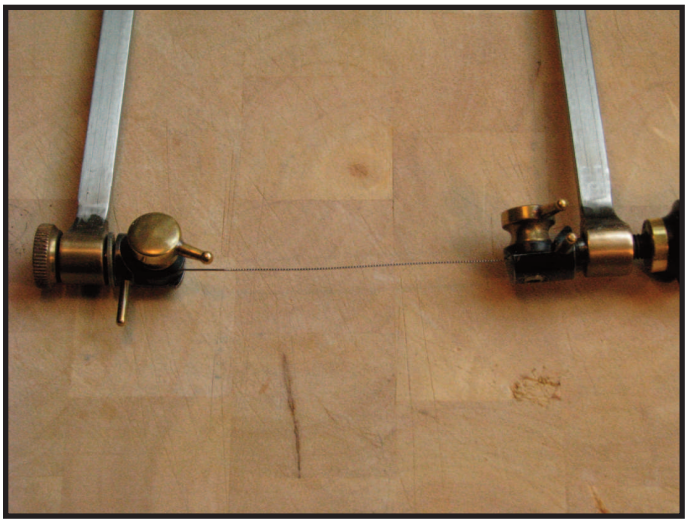

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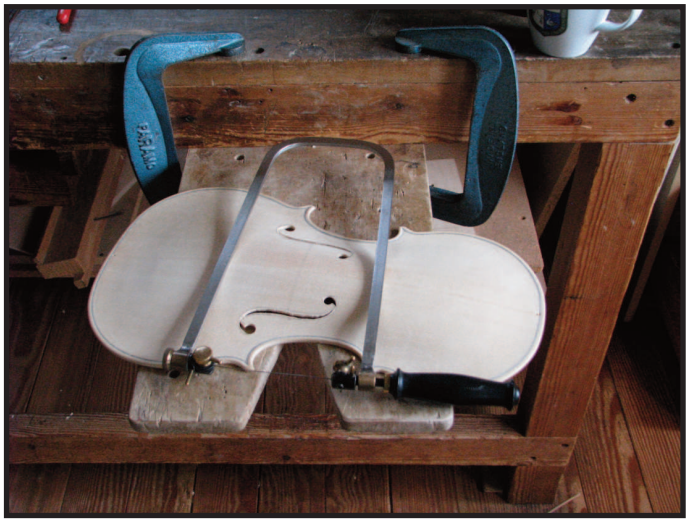

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Cremonese sound-hole circles were always drilled. If you examine Cremonese sound-hole circles, you can sometimes see the remains of a line where the cutter has come from both sides and met in the middle. I believe such lines indicate that these holes were cut from both sides. Also on this viola the sound-hole wings have been lowered slightly as I did on the bass. Unlike the bass, these viola sound-holes were marked from an inside template, which explains the 'free hand' appearance of the lines joining the body to the circles.

With the circles drilled, René then cut out one of the holes using a coping saw. He used a normal blade, but one that had been re-sharpened with a small triangular file. This is a trick that we learned from Wilf Saunders, (Jacobs Saunders father). René is left handed so I cut the other hole using my Brian Hart fret-saw. I asked Brian to make this saw for violins and cellos, but as I found out, it works on bass sound-holes equally well. Also visible is the V shaped board that featured in my rasping the outline explanation. I use this board for a number of jobs, including cutting sound-holes. Unfortunately it was too small for the bass. I finished both bass sound-holes with a knife, a job that can only be described as awkward. Working at arm's length it requires a very sharp knife, a strong arm and stronger nerves. 204 205 206

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From the beginning making this bass has involved a considerable amount of compromise. For example, we quickly realized that we would need to work in the Amati family ‘style’, rather than attempt a ‘warts-and-all’ copy. No-doubt it was this that caused our sound-holes to resemble each other, far more closely than the originals do. This was not planned. In spite of all my preaching, I guess that I cannot shake off my modern roots either. Nevertheless, René and I are both happy with the results.

As I pointed out previously, in order to give this instrument some appearance of age, (we are after all making a slightly worn copy), I lowered the bottom wings of both sound-holes slightly (2 to 3 millimetres). This is not an easy thing to do well, if the wings are to blend into the arching in a natural manner. In addition, this operation necessitated some adjustment to the belly thicknessing, which had been left slightly full in order to avoid the wings from becoming too thin as they were being lowered. I do not lower the sound-hole wings for acoustical reasons. I really don't think that this makes the slightest difference, except possibly if they become too thin. I do this purely for optical reasons. 207 208

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Fitting the bass bar

With the passing of the sound-holes it was time to fit this bass's bass-bar. The process turned out to be somewhat easier than I had imagined. Although it was fit in the normal way, using studs and chalk, the bar's 20 mm width provided a vertical stability that violin, and even cello bars do not have. As a result René had the bar fitted and ready to glue in about the time I normally need for a violin. René then covered the area that surrounded the bass-bar with masking tape and sized both the belly and the bar with hot glue. Once they were dry he briefly re-fitted the bar and glued it in place. I secretly checked the fit while he was at the toilet. It really was very good. 209 210 211

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Neither René nor I believe in springing bass bars. I consider it to be pretentious nonsense, originally developed as an excuse for lazy chalk fitting. At best it does nothing and at worst it can distort a fragile belly. Arguments against this statement should be directed to René Zaal, somewhere in Holland.

In shaping the bars profile, like me, René likes to keep the heaviest area directly under the bridge foot. The bar is then tapered and rounded on its upper edge. The masking tape being used here not only keeps excess glue off the belly, it also helps protect the belly while the bar is being tapered and profiled. 212

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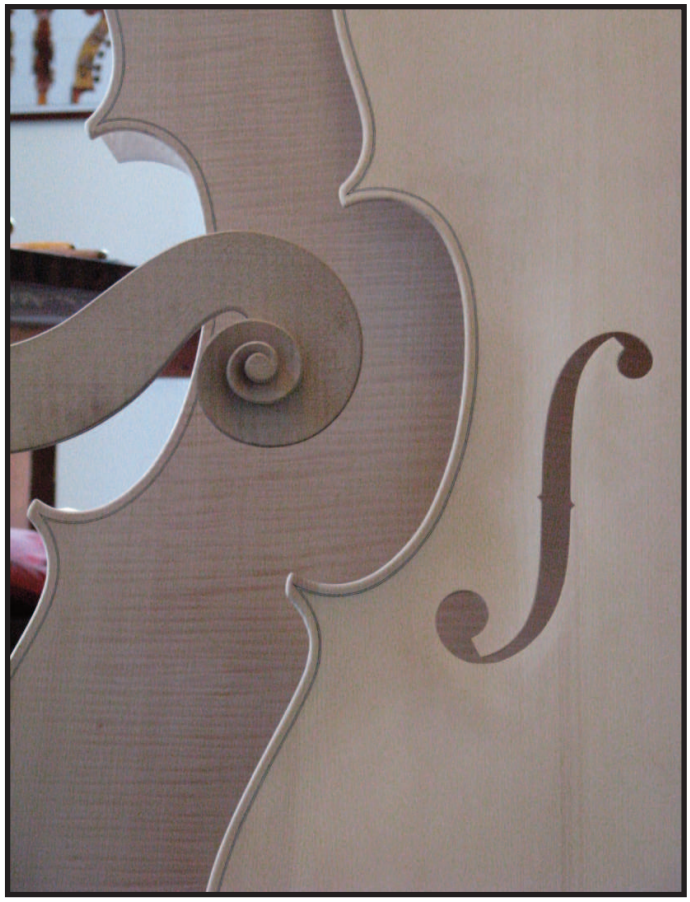
Closing the body

It was now time to close the body. 213 When I went to bed after the bar was finished, I began thinking about all the difficulties I have experienced fitting bellies onto back and rib structures. Consequently, the following morning I was astonished how easily it all went together.



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Having liberally glue-sized the blocks and linings and also the belly edges the previous day, we simply clamped everything together. Then, removing two or three clamps at a time, we slowly worked our way around the overhang with a hot wet knife. It is important to keep two or three thin pallet knives in water that is close to boiling point. These knives cool quickly enough in the air before reaching the belly/rib joint. These hot wet, (but not too wet), knives soften the glue just enough to reactivate it. This process helps prevent excess glue from spreading. In spite of this method we again placed masking tape around the ribs to prevent even the smallest drops from penetrating the rib wood. 214,215.

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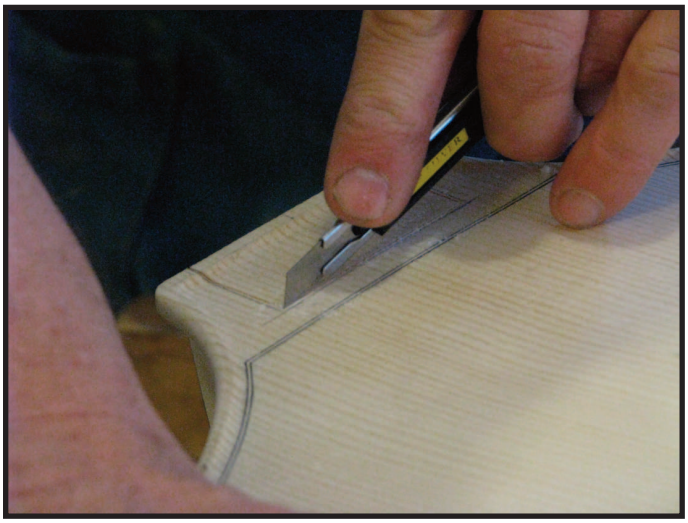
Finishing the neck root and fitting the neck

With the neck and chin already finished, René prepared the mortise and chalk fitted the neck root. René uses yellow chalk, which is easier to see. However because it is also slightly more difficult to remove, it should only be use in areas where it will not be visible. 216 217 218 219 220 221



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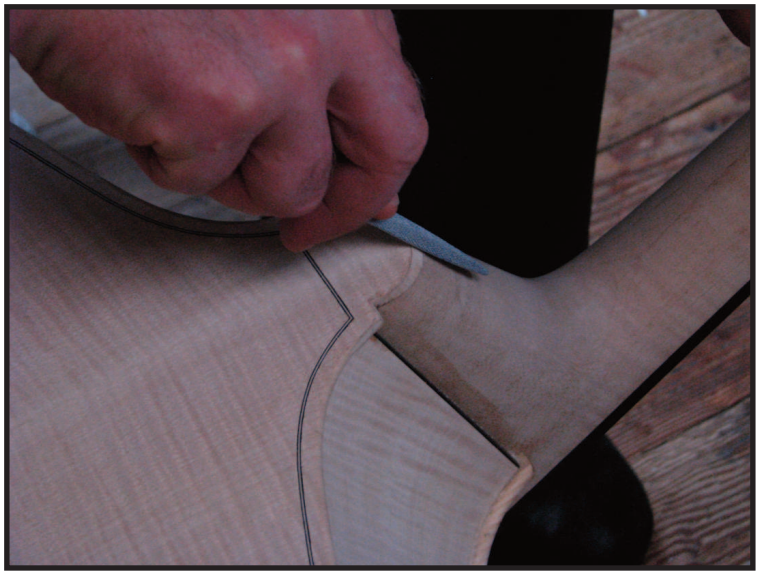
Gluing the neck and finishing the button

Once the neck was fitting snug, I established the button's width by rasping it level with the sides of the neck. I then marked the button's circular shape with a pair of callipers. (I only used pencil for the photograph.) This was a little tricky. Because of the extreme angle of the neck root, I needed to be sure that the button would end up being the correct height, when it was eventually blended into the neck. 222



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Although original Cremonese buttons are rare, they often have the remains of a central (compass) point. As in Cremona the centre of this button was set a little higher so that the curves comes back on themselves very slightly at the edge. In spite of this being a usual Cremonese feature, I used a small piece of tape to stop the compass point from penetrating too deep. At this juncture, I finished the neck root completely before the neck was glued into the body. As I pointed out earlier, even for violins this always saves a great deal of time and effort. 223

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It only remains now for the neck to be permanently glued in place, and for the button and root to be blended together. As demonstrated earlier, before gluing, we protected the surrounding area with masking tape. We also cover all the ribs edges and neck root areas not meant to be glued, with masking tape. This will help prevent excess glue from running onto surfaces where it might be difficult to clean off. 224

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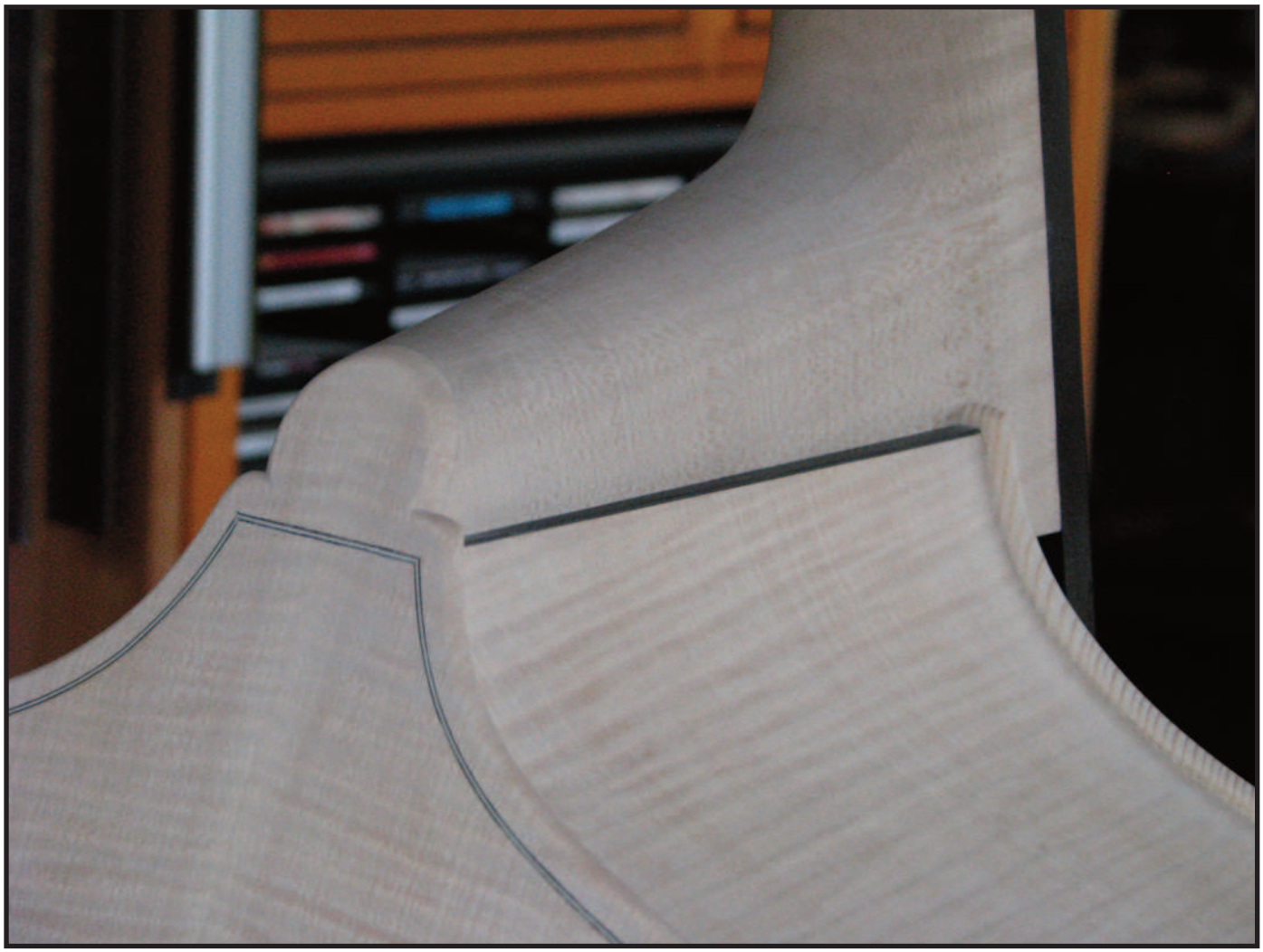
The bass was then transported back to my Meyenburg workshop from René's place in Bemmel, Holland. I am sure that the poor thing feels a little cramped in my comparatively small workshop. Indeed, after the luxury of René's noble establishment, I feel like a pauper myself.

Having already established the button's shape, I finished the remaining back edging and applied the button chamfer. In keeping with my wish to give this bass the look of an old instrument I again softened everything slightly. [34] 225



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PART II - VARNISHINGAND SETTING UP THE BASS

Varnishing Preamble

Whenever I'm varnishing, I find myself trying to reconcile two conflicting principles. The first is to produce an attractive varnish that also enhances the instruments sound. The second is to simply recreate a fine classical Cremonese varnish.

Whatever the attractions of re-creating the classical Cremonese vanishes may be, my first priority is always to produce a fine looking varnish that enhances the instruments tone. If making a simple varnish were not difficult enough, I also want a varnish that is flexible enough to use for the many different models that I am asked to copy and one that wears well. Getting to the roots of the great (truly great) Cremonese varnishes is a slightly different, but not unrelated story.

I came to violin making from an art school background. For three years, from 1967, I studied 'Fine Arts'; with emphasis on portrait painting. What I learned at art school, had more to do with painting and decorating, than with the technical composition of artist mediums. Nevertheless, I was a good draftsman and I did learn how and where to look for the relevant information. As an amateur, I built a couple of guitars, but my real introduction to the music business came via my skill as a painter. I was asked if I could paint copies of Flemish harpsichord lids and soundboards. With the confidence of youth I remember saying something like, "Sure that should be no-problem!"

From there I progressed to building harpsichords and spinets and while doing this work, I was introduced to and fell in love with the world of Gamba's and Fiddles. By the mid 1970's I had started a three-year violin making course at the 'Newark School of Violin Making' where I began varnishing my first violins. We had considerable help from Wilf Saunders and Glen Collins. Wilf, who taught us one day each week, showed us how to make simple oil varnishes. Glen taught us how to varnish using shellac, an underrated skill that has proved its worth over the years. However in spite of their help, where varnish was concerned, we were largely left to our own devices.

The two years above my year in the violin school were very secretive and as a group we had to find our own way. It was not easy, but in the long run it was probably a good thing. Although at that time secrecy was still the rule in the violin business, it did not take us long to discover that the biggest secret that most makers had and many still have, is that they don't have any secrets.

Perhaps it was the times. Perhaps it was sheer desperation, but our year group bonded exceptionally well together, forming relationships that have lasted a lifetime. We also had an excellent relationship with the students that entered the school after us, René Zaal being one, Koen Padding [35] another. It was a lucky and very heady mixture of talent.

We began by making Michelman, Fry and Fulton varnishes. I devoured books that I should have read at art school [36] and already before leaving Newark, I had amassed a fine collection of rare books about varnish and pigment manufacture. Many of these came from libraries that had begun to downsize with the advance of Thatcherism. These included; Hurst's, 'Painters Colours Oils and Varnishes', of which there are only 3 known copies in the UK; Perkin and Everest's treaties on 'The Natural Organic Colouring Matters'; Livache and McIntosh's, 'Varnishes Oil Crushing, Refining and Boiling and Kindred Industries'; Heaton's, Outlines of Paint Technology' and of course the wonderful Series of Workshop Receipts for; Manufacturers Mechanics and Scientific Amateurs. Fortunately, some, like Eastlake, Mayer, Doerner, Merrifield, Laurie and the like, have since been reprinted, others are available on-line.

Surface preparation

As noted in the first part, the wood surface is mainly finished with scrapers and in many places like the scroll; my gouges are the final tools that touch the surface before the ground is applied. I never burnish my instruments before varnishing commences. I prefer the raw matt appearance of the ground. I know that my friend Koen Padding was keen on burnishing, but I never saw any advantage. Perhaps if you want a super clean finish, but that is not really what I am trying to achieve.

Colouring the wood

The first step in the varnishing process is to create a background colour for the wood. For the initial colouring process I used Koen Padding's 'Primer I' and 'Primer II' in a fifty-fifty mix. In order to stop the mix from penetrating the belly unevenly, I wet the belly liberally beforehand with lukewarm water. This is a trick that Brian Lisus taught me. Brian was also a member of my year group at Newark. Although it is important for the belly to remain damp during the application, it is essential to wipe off any surface moisture with paper towels or an absorbent cloth just before the mix is applied. It is not necessary to pre-wet the head back and ribs.

I have been using this fifty-fifty mix for many years. I initially worked with Koen on the idea, but when he began making it professionally I stopped making the primer myself. It was a messy job and, at least for me, a very hit-and-miss process. Koen's mixes had a shelf life, but they were reliable. The first photograph shows the bass immediately after a coat of Koen's Primer I and II in a fifty-fifty mix had been applied. The effect is rather garish but once it has been exposed to UV light it changes fairly quickly. 226

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With Koen's tragic passing, I find myself once again involved with the process of making a ground colour for myself. This involves working with animal urines and faeces (mainly rabbit and horse dung). With luck, the resulting substance will give the wood some colour, but most importantly it should react with ultraviolet light to create a warm golden brown hue. The mix should also accentuate the darker reed lines of the spruce. [37] Once the stain is completely dry, the instrument can be placed in the new UV light box, (shed) I am in the process of building. Over several days this strange tincture should slowly turn the wood a golden brown colour. Although it is not absolutely necessary to use UV at this stage, it does speed up the process.

Historical methods for treating wood

In the early 1980's I visited the Aubert works, with Anne Houssay and John Dilworth, both were in my year at Newark. We met old Monsieur Aubert, a tall robust looking man in his nineties. He was walking about in the works and we got talking to him. We had seen the workers dipping the bridges in liquid ammonia. It soon became clear that the old man did not approve. He proceeded to tell us how previously; the uncut blanks were laid down in layers. These layers consisted of; wet rabbit dung, followed by straw, followed by bridge blanks, followed by straw, followed by dung, followed by straw, followed by bridge blanks, until the stacks were up to three meters tall. The stacks were then left for two or three years, until apparently they gradually became much lower. He also told us that they were covered at the top, but were otherwise exposed to the air.

Now this was almost 40 years ago and Monsieur Aubert was extremely old, as I am now, so the reliability of this story may be questionable. Nevertheless, I also know that this kind of treatment was used to 'cure' oak house beams in Northern Germany. Before being used, these beams were laid for several years in dung. This treatment was said to help prevent worm attack and to harden or strengthen the timber. Monsieur Aubert complained bitterly, saying that simply dipping new (1982) bridges into ammonia filled tanks for a few hours was in his opinion worthless. He insisted that the old slow way was much better. I have no-idea how long these bridges were eventually left in the tanks or even if this system is still in use. At that time we purchased a fair number of bridges; they all smelled strongly of ammonia, but after a few weeks the smell dissipated.

Historically dung and urine were important resources. Urine was used for numerous things including whitening teeth and softening leather. It was also used extensively in the dying industry and for making soap. Across the world, the sale of urine was not only profitable, it was taxable. In particular urine was turned into saltpetre, also known as nitre, to become one of the crucial ingredients in gunpowder. In order to extract saltpetre from urine, gunpowder manufacturers set up "nitre beds" of straw. The urine was filtering through the straw, which would concentrate the salts for easy collection.

Until World War I, before people learned to produce nitre synthetically, urine, guano, and manure were all collected for the production of gunpowder. In most communities outhouses had trays under the toilet seat that could be pulled out. These were emptied by 'night-soil-men' who came with wagons to collect the contents. This collected waste was then dumped into tanks, where it was allowed to ferment. To recover the saltpetre the resulting liquid was run through ashes into shallow evaporating trays.

Initially, saltpetre had been scraped from the walls of stables; but this was inefficient, so the various authorities began collecting urine and dung. In many counties piss and shit were highly controlled substances. Amongst other authorities the French army stringently controlled the collection of night-soil and violations were severely punished. Koen did a lot of research on this subject, but for his families' sake, I cannot tell you what he was doing, even if I knew this exactly, which I don't. However, I will say that it is worth looking at other crafts for clues.

The 18th century French cabinetmaker André Roubo gives a recipe for staining wood derived from horse dung and urine in his landmark publication; l'art du Menuisier

"Before finishing the dyeing of wood, I believe I ought to give a least-costly method of dyeing white wood red, which is done in the following manner: You take some horse dung, which you put in a bucket of which the bottom is pierced with many holes, and you place it above another bucket, into which falls the water from the dung, as it gradually rots. When it does not rot fast enough, you water it from time to time with some horse urine, which helps a lot and at the same time gives a red water, which not only stains the surface of the wood, but penetrates the interior 3 to 4 lines deep. In staining the wood with this dye, one must take care that all the pieces be of the same species, and about equal in density if one wishes that they be of equal colour throughout. This observation is general for all water-based stains, which have no palpable thickness or even appearance [they leave no residue or any evident change in appearance], which requires the cabinetmaker to make a choice of wood of equal colour and a density as I mentioned before." [38]

Alternative methods for colouring wood

There are several alternatives to using a colouring agent made of animal urine and dung. One of the easiest ways is simply to use ultra violet light. Although the actual process of browning wood with ultra violet light is chemically and physically complex, achieving results is relatively straightforward, if a little time consuming. Over the years, all the best colouring agents that I have tried have basically oxidized the wood. Simple sunlight (UV) will do this and in my opinion it gives some of the best results. However, here in North Germany, artificial UV is more reliable. Depending on the strength of my tubes, I usually expose my instruments continually for about 10 days and nights, after which, nothing more seems to happen. I suspect that seriously prolonged exposure is detrimental, but that's just a guess.

I know that some people do not like exposing wood to UV, but I think this is a question of moderation. In any case, exposure to UV is almost unavoidable if you intend drying any linseed oil based varnishes. For those concerned with authenticity, it is worth noting that at the time of the classical violin makers, using sunlight to dry drying oils was standard practice. Consequently, sunlight (UV) may also have been the way in which violin makers coloured (browned) their instruments. The Hill book mentions that Strad had some kind of open roof area, but if, (and I assume that he did), Strad was using the sun to dry his varnishes, then even in those days he must have used some form of fly screens to protect the instruments from insects. Fortunately Cremona was a highly important centre for weaving, (including silk) so I can see no reason why this would not have been the case.

Another, modern alternative of darkening instruments is with ozone gas. The optical effects are undoubtedly good. Many years ago I experimented with ozone, but ozone is toxic even in relatively small doses. I am not sure of the long-term effects of ozone on wood, but it is certainly not good for the lungs. For this reason I am not recommending it.

The same applies to Nitric acid. Nitric Acid has a long history amongst violin makers. Several books and treaties have been written about Nitric acid varnishes. I have also experimented extensively with Nitric recipes. In conclusion, I can say that I have never been happy with the idea of either wood, or varnish ingredients, being treated with nitric acid. Nitric Acid is extremely aggressive and at some point these treated substances will come into contact with the musician's skin. Until quite recently nitric acid has been used to stain boxwood chinrest, tailpieces and pegs. I have often wondered if, at least in part, these might have been the cause of those unsightly marks on the necks of so many violinists. In fact since the 1980s, unless they were specifically requested, I have not used stained boxwood fittings on my instruments. The American peg maker Eric Meyer finetuning@aol.com makes exceptional fittings from mountain mahogany. Because the natural colour of this wood is similar in appearance to stained box they do not require staining.

Building the UV shed

Ideally, once Koen's primer had dried, I would have placed the bass in the UV light shed I have been building and left it in there until it became nice and brown. However, here in North Germany it has rained for several weeks, seriously delayed the completion of my new UV shed.

In spite of the weather, with the help of my daughter, my new UV shed was eventually finished, painted and waterproofed. The UV box I normally use for violins, violas and cellos, has lamps placed above and below the instrument. The inside of this box is also covered with aluminium foil. When constructing UV boxes, air circulation is very important; however it is not advisable to use an electric fan because fumes from the varnish might cause an explosion. Several large holes on opposite sides, one row up and one down should be enough to create circulation. A fine wire mesh will help prevent flies and moths from entering and spoiling the varnish. 227 228 229 230 231 232 233

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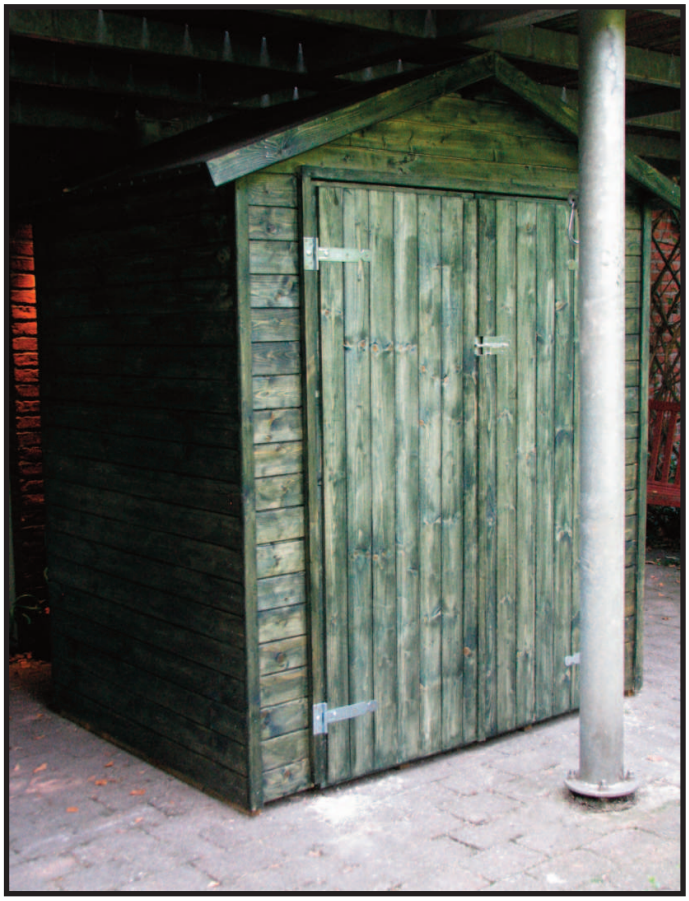

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It is mid July and finally we are experiencing some genuine ultra violet rays. As a result, most of this afternoon the bass has been lying in the first sun we have seen in weeks; I even set up my office outside to enjoy the warmth. In fact, this is where I wrote the original blog entry on Maestronet. The colour, as you can hopefully see in the photographs, is already beginning to look very nice. 234 235 236 237 238 239

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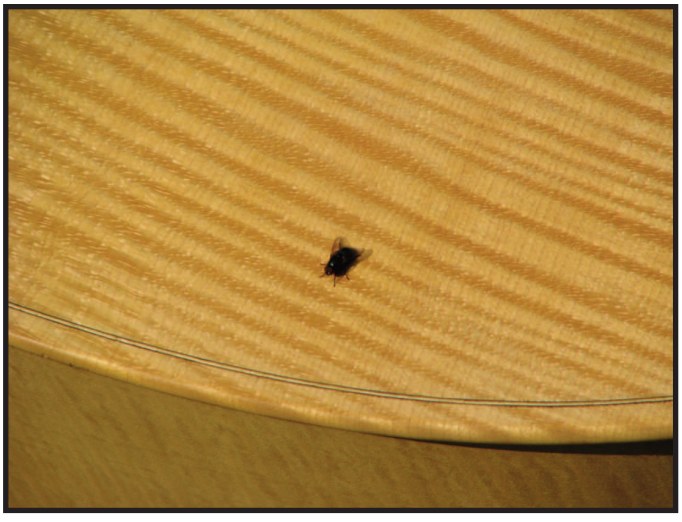

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Another deterioration in the weather meant that the final hours of exposure to UV light took place in the new shed.

Preparing and applying the pore-filling ground

This bass was varnished with an oil varnish. My varnish is usually touch-dry in about 6 to 8 hours with UV-A (normal sun bed strength lamps). Once my instruments have received their basic ground colouration I make sure that the pores of the wood are suitably sealed. I do this by applying a pore 'filler'. Basically these fillers block or fill the pores in the wood to stop the oil varnish from penetrating too deeply. [39] There are two main ways of doing this. The first is to apply the filler before the varnish and the second is to mix the filler with the varnish.

There are probably as many types of 'filler' as there are violin makers. These include; bolus (a kind of clay), powdered glass, chalk, marble dust, silicates of various types, mica, marine glass, and a whole bunch of natural and commercial 'fillers' and extenders with various commercial names. Most of these products are available from companies like Kremer and Hammerl. Neil Ertz and I even made a rather nice 'filler' from an Alum/Potash precipitate; the sort of thing that you fix lake colours on, but made without the colour.

Now it is important to say that these pore fillers are usually fine powders and some, possibly all, are dangerous if breathed in or ingested. Mica and Marine glass are particularly horrid. Silicosis and pneumoconiosis are not just diseases that affect miners. Allergic and respiratory problems can already be caused by wood dust; we don't need to aggravate the situation. Wear masks and if possible work outdoors when using any of these substances, because there is no point in wearing a mask, if the workshop is full of dust when you remove the mask. For the bass, I have chosen to make a pore filler from Plaster of Paris.

Method for preparing a 'Plaster of Paris' filler

The process starts with a 1-kilo bag of Plaster of Paris, which is still 'hot'; meaning that when you add water it will set. For our purposes it will need to have all the 'fire' taken out of it and here is how this is done. I believe that what we are making are fine crystals, of a fully hydrated form of calcium sulphate.

- Get up early in the morning and fill a bucket with ten litres of cold water. A plastic bucket is best. An old metal bucket might just transfer some iron into the mix.
- Next get yourself a smooth stick. Slowly pour the plaster into the water and stir the mix vigorously. Keep stirring continuously until your arms are falling off. Depending on your state of health this might take ten minutes or an hour. The longer you can keep going the better. When you need a rest let the plaster settle for a minute or two; not longer before you begin to stir it again. Do this as often as you can for at least an hour. If you let it settle for more than a minute or two it will start to set and the resulting particles will be too big.
- After an hour of continuous stirring, let everything settle again and as soon as it is possible, pour off the upper layer of water. Even if this water looks clear, DO NOT POUR IT INTO A SINK OR A TOILET OR ANY FORM OF CLOSED DRAINAGE. No matter how much water you follow it up with, it will eventually settle and set. If you have a compost heap, pour it on that. It will add lime to the mix.
- As soon as you have done this refill the bucket with fresh water and stir vigorously. Again, keep stirring for as long as you can. The more you stir the finer the particles will be. The time you need to stir depends upon the type of plaster and how fresh the plaster is. Usually you will need to stir vigorously for a minute or two every ten to fifteen minutes. Do this until lunch time (about 4 hours in total).

- After a short lunch break pour off the excess water again and refill the bucket with fresh water. Stir vigorously for a few minutes every half hour until tea time (4 more hours). In the evening leave the TV ever hour and give the bucket a stir. Last thing before going to bed... well you know by now.
- Next morning pour off the top water, fill the bucket again with fresh water and stir. For the next three or four days, change the water each morning as before and stir it vigorously every two hours or three hours. Doing this for a week will achieve the best results. After a week you can allow a small to amount dry to see if it sets. It should not, but it still might. If it stays soft and friable like slightly course talcum powder you are about right. This powder is fairly inert, but I always wear gloves because it can irritate sensitive skin and even cause dermatitis. Allow the powder to dry thoroughly and then store it in a dust and metal free container.

Filler application process explained

Before we begin the application process, a couple brief explanations are required. The first time I applied a 'Plaster of Paris' ground, I was shocked and horrified at what I had done. If you have done the work well, the instrument will look as if someone has rubbed it all over with talcum powder, (also a useful filler). It will quite literally be white. This is perfectly OK, but what you do need to avoid is too much powder building up on the surface. This can also occur if you do not wash the Plaster of Paris long enough.

The second explanation concerns why such a white ground is going to provide a good undercoat for our varnish. Well, this boils down to something called 'refractive index'. The easiest way to explain this is to imaging a thin sheet of transparent glass. If we then take a hammer and break this sheet into tiny pieces, and then grind those pieces into a fine powder in a pestle and mortar, the glass will no longer be transparent. However, if we then pour this opaque white glass powder into a glass of water it will again become transparent, (not entirely, but enough to work as an example). This is because powdered glass has a similar refractive index to the water. The closer the refractive index of the medium, (in this case the varnish), is to the 'filler', the more transparent the ground will eventually appear. This is where experimenting with various fillers is important, because the closer the refractive index of the filler is to your personal varnish, the more transparent the final product will be.

Method of applying the Plaster of Paris filler

It is essential to read through this section very carefully, before you begin working. You will need to have everything well planned and prepared. 240

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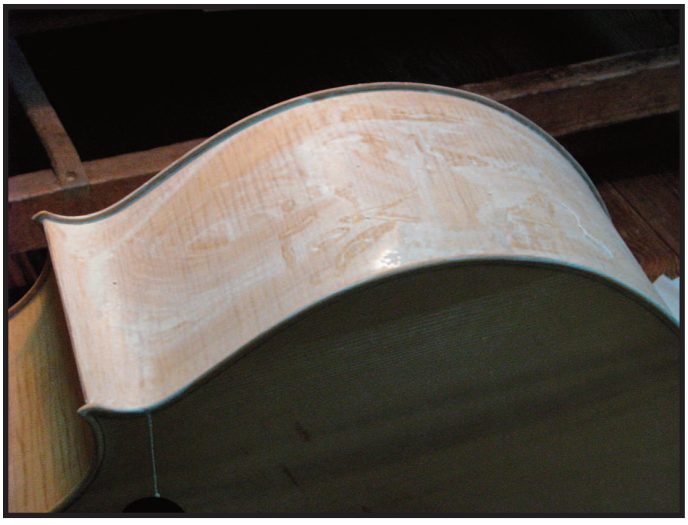
Because it may not always be practical to photograph the bass while I am working, in order to illustrate the whole varnishing process, I will occasionally refer to a violin and viola that I worked on while making the bass. Exactly the same system was used for each of these instruments.

The previously prepared Plaster of Paris filler powder was again mixed with a small amount of water, until it turned into a muddy paste; a kind of slurry. At this point it was applied liberally to the wood. 241 242 243 244 245 246



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Before this slurry has a chance to dry, the mix is rubbed well into and then off the wood with a lint free cloth. Removing the thicker surplus with a Perspex scraper helps to speed the process and prevent waste; the excess sludge can be taken from one area and used elsewhere. It is important to rub off every bit of surplus slurry, especially from all the nooks and crannies. This becomes more difficult as the surface begins to dry out. For this reason, even on violins, I tend to work on one section at a time, starting with the ribs. I then move to the back and belly before finishing the head and neck. 247 248

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I cannot emphasis enough how important it is to rub the slurry well into the wood and then to rub every bit of surplus off the surface. It is essential to ensure that all end grain, especially the back and belly edges are well sealed. If the slurry is not fine enough a stick of school chalk will help with this. I mainly use two brushes; a stiff dry one and a stiff wet one. I use the wet one to spread the slurry. The dry one is for getting the last bits out of corners and edges. You will need to be careful not to roughen or scuff the surface when doing this. On a violin the mix takes about 40 minutes to apply and rub off. The bass took about 4 to 5 hours.

Although it is not wise to let the slurry dry too quickly, (before it is rubbed in and then off), it is also important to avoid getting the whole instrument too wet; otherwise joints are going to start springing open. This should not be a serious problem if you work quickly and efficiently.

Having just mentioned that too much water can cause joints to pop open; unfortunately, the belly/rib joint did indeed pop open. (Sods law!) I had to re-glue this, which did not take very long, but it had to be done with great care, to avoid any excess glue touching the rib. 249 250

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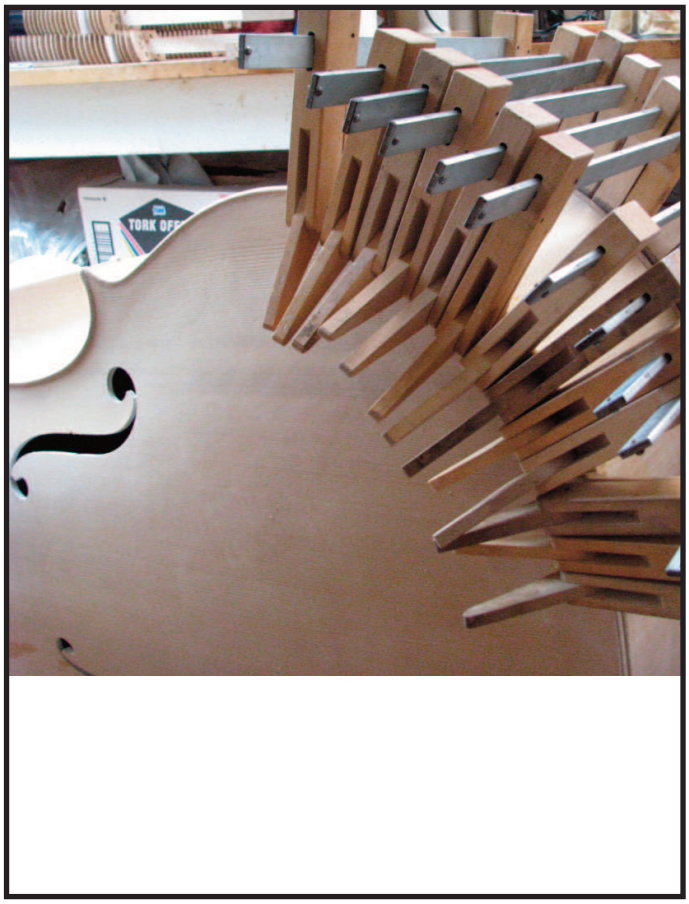

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Once the water-based filler has been rubbed in and off, it is left to dry out. As it dries the instrument will gradually turn white. 251 252 253 254

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Applying the Plaster of Paris filler directly onto the instrument with the varnish

There are a number of methods of applying the plaster of Paris pore filler. The one that I recommend, especially the first time, is the one described above. The second easiest method is to mix the filler with your normal varnish into a thick honey like paste and apply it directly onto the instrument. Whether you use a water-based filler, or an oil varnish based filler, there are two important points to be aware of.

The first is that during the making process, you must make every effort to avoid glue getting onto any surface that is about to be varnished. This was our main concern when René and I masked around those areas that were being glued. If the Cremonese makers were using casein glue, for the back and belly to rib joints and for fitting the neck; it is possible that they had fewer problems with spillage. Gluing with casein is a slower process and there is less need to apply larger amounts. Either way Sacconi suggests that Strad cut off the surplus glue around the rib to back/belly joints [40]. This makes perfect sense to me, because washing glue off only spreads it around, pushing it into the pores of the wood. If you choose to use either of the methods that I have described here, any glue left in or on the wood will leave a semi transparent or even opaque white area under the varnish. With good reason, this effect is known as 'ghosting'. Ghosting can occur with any kind of filler. A small amount of 'ghosting' occurred on the bass along the crease where the back was bent. Although there was no break or split, in places the wood was nevertheless thin enough to allow the glue to seep through. On a copy this is relatively easy to hide, but not so easy on a clean varnish job. 255

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The second important point is that any end grain areas need to be filled with extra care. If edges and corners are not well sealed, they will rapidly draw varnish in. If this occurs, the edges will be irreversibly stained black. Using the varnish filler mix, it is important to note that on all end grain areas the mix must be applied very dry. However, in order for the process to work well, (also with the water method), the molecules of var-

nish must eventually surround the molecules of the filler/extender. Any areas where this is not the case will remain white. The balance is not easy. If too much varnish is introduced to the mix the end grain areas will turn black; too little and there will be white patches from the filler. In spite of these requirements is always best to ire on the dry side. If white patches remain, a little vigorous rubbing with a varnish soaked cloth, will general cause the varnish to surround the filler.

With this second method the resulting ground should be even rather than patchy. Although it will of course appear matt, it should also be the colour of the final varnish,. With both methods the resulting ground should be identical in both appearance and in its physical properties.

Influence of fillers on sound

I believe that the use of fillers does something that fundamentally influences the instruments sound. This is probably because it seals the pores of the wood and stops over-deep penetration of the varnish, whatever that varnish might be. I certainly believe, but have no proof, that once I began using fillers, almost a lifetime ago, in both their tonal quality and their volume my instruments improved beyond measure.

I have been asked, if different fillers produce different sounding instruments. Well, I have changed my fillers my varnishes and my method of application almost as often as I change my socks. Optically there are some minor differences and in this respect, it is important for everyone to check which filler matches their particular varnish. (The refractive index again.)

Acoustically the question is more difficult to answer. Over the years, I have I conducted several tests with instruments that I made before I began using fillers, against those that I made since. What I can say is that the instruments where fillers were used, display one conspicuous characteristic; they all carry very well in large halls. Beyond this, trying to estimate which fillers best influence the sound is a none-starter for me. As you will have noticed from my other writings, I am extremely sceptical of people that claim to be able to identify instruments by their sound, and here we are talking about picking out minor nuances, as a result of applying very similar fillers to different instrument made of different materials. So as to which filler works best, the short answer is; I don't know!

If I might add a little anecdote; more than thirty-five years ago, I made a copy of a Testore violin. This violin completely fooled two top connoisseurs. (Both now sadly deceased.) I was over the moon; until I went to a concert being given by the man who owned the original. After the concert he played my violin for a few minutes. Close up it sounded good even against his Testore. I then asked him to play again, but this time I went to the far end of the hall. I was seriously shocked to hear the difference in carrying power between the two. I was then seriously depressed for many weeks. I just kept thinking how utterly useless it was to make a violin that can fool an expert visually, but who's sound production was an absolute disaster.

This was about the time that John Dilworth and I started looking at the possibility of analysing varnish samples. This eventually led to the works of Professor White, and Barlow and Woodhouse. I can clearly remember the influence that those first electron microscope pictures had upon my thinking. The conclusions I drew from their work may or may not have been correct, but from that moment I began reading about fillers and extenders and experimenting with their affect, both visually and acoustically. Shortly after, both the sound and appearance of my instruments improved dramatically.

Since those heady days I have been happy to put my violins up against any classical instrument. Indeed many soloists and concertmasters play very successfully on my instruments. I am not saying that my work is better than the great classical makers and if I had the money I would buy a classical Cremonese instrument immediately, but sound-wise I am no longer afraid. Although there many factors involved in making a great violin; personally the greatest step forwards that I made, was using fillers.

A short uninformed diatribe about historical varnishes

Some thirty years ago a member of the Hill family gave me several samples of classical varnish. These were pieces that had been removed from cellos in the 19th century. When Professor White analysed these samples and others that Beares provided, he handed us a rather complex set of results [41]. In fact over the intervening years many more analyses of various instrument coatings have been undertaken. Today the Internet is bristling with them. Probably the best place to find a comprehensive introduction is the compilation by Bruce H Tai, which was published by the VSA in the summers of 2007 & 2009. These papers have the advantage of being both comprehensive and lucid. Otherwise, almost without exception, the findings of most analyses are both complex and difficult to interpret.

However misguided they may be, my efforts were mainly inspired by the combined works of White, Barlow and Woodhouse. According to White, the varnishes that he examined largely consisted of a drying oil, colophony and a small, almost insignificant (his words) amount of mastic resin. Although this analysis may appear relatively simple, if we examine the first ingredient, a drying oil, we notice that there are already numerous possibilities. Drying oils are many and varied. Amongst others, they might include poppy and walnut oils, or the more conventional linseed oils. Walnut oils were used by many Venetian painters, whereas linseed oils were preferred by Cremonese painters. Such preferences were largely due to the general availability of these oils. For example, Cremona was an important centre for the production of linen and linen is made from the flax plant, the seeds of which (linseed), are the source of linseed oil. Not only do these various basic oils have different characteristics of drying, transparency and aging. They also react in different ways when combined with other ingredients such as resins and pigments.

Even if we confine ourselves to linseed oil, there are numerous possibilities that require consideration. First we need to consider how the oil was extracted from the seed? Was it cold pressed or extracted by various heat and chemical procedures? Then there are the various possibilities for treating the oil after extraction. Amongst other treatments, these oils may have been washed, boiled, or thickened in the sun. In addition various dryers may have been added. Consequently, even the selection and treatment of the first of our three ingredients is beset with difficulty.

For the sake of our sanity, I will gloss over the various possibilities for the other two ingredients. The problems of obtaining the correct type of resin, in an unadulterated form, are legendary in the business. Even assuming that a good source can be found, variations will occur depending upon when, where and how these resins were collected, refined, stored and marketed.

Even after successfully selecting three ingredients, our problems are not over. We must still decide how much of each ingredient should be added to the mix, after which, we must decide if and how these items are to be cooked, and, at what stage and temperature they are to be combined.

I could go on forever outlining the infinite permutations that even three relatively simple ingredients can create. And even this is not the end. If we wish to add colours or pigments, apart from knowing how to make and add such colours, we must also know something of the effect that time and the environment will have on any colouring agents. Even the finest, most detailed analysis, can only offer us a tiny insight.

Recreating historical varnishes

Back in the 1970's and 80's we were desperate. Accordingly, after several long distance telephone conversations with Professor White, (an expensive business in those days) I finally persuaded him to give me a simple breakdown of his results. And, very reluctantly he also discussed possible recipes with me. From our conversations and from various ancient recipes, I came up with the following fairly simple varnish formula. I doubt that White, Barlow and Woodhouse would support my speculative conclusions; they are after all scientist. However, at that time I had little choice but to use the available information to the best of my ability.

According to White, the varnishes that he examined consisted of a drying oil, colophony and a small, almost insignificant, amount of mastic resin. Eventually I made a varnish that, by weight, consists of 55% colophony cooked together with 40% cold pressed and washed linseed oil. To this I added about 5% of mastic tears. All told these amounts were a guesstimate, based upon his gas chromatography results, several known antique recipes and the scientific information that was available at the time.

The method(s) I used for combining these ingredients was based on two or three further snippets of information. The first of these concerned the length of the colophony molecules. These were found not to have been significantly altered. Accordingly, White had concluded that the colophony had not been cooked at a high temperature. He suggested that it had probably been heated just hot enough and long enough to blend it with the oil and mastic. His conclusion about the mastic was that it had probably been added as plasticizer, last of all.

In addition to this important observation about the cooking temperature, at a later date Professor White was asked to examine a violin by Sanctus Seraphin sporting a typical red Venetian varnish. White was specifically asked to identify the colouring agent. His reply was illuminating. Having examined the instrument he concluded that the redness in the varnish was simply the result of oxidisation, rather that any additional colouring agent. For me personally this was a revelation.

In view of White's conclusions a further characteristic of linseed oils should be considered. After several centuries, drying oils, (especially linseed), become increasingly dark; they also become more transparent. Oddly, while artists might consider both these traits detrimental, most violin makers would consider them an advantage.

Replicating this natural, centuries long process of oxidisation, over a relatively short time scale is extremely difficult, if not altogether impossible. Indeed, over the intervening centuries, emulating the effect of age and oxidization has probably been the major problem for violin varnish makers. As a consequence, makers have developed numerous artificial methods of emulating this aging process. Some are more successful than others, but they all involve compromise.

These limitations are further frustrated by the fact that pigments were undoubtedly added to some, if not all varnishes. Clearly, these pigments will have varied considerably in both quality and type. They may have changed or faded and/or the medium in which they were locked may have altered their properties markedly. In fact, added colouring matter may have altered the configuration of the varnish itself. For example, lake colours, especially Madder lakes, seem to promote Craquelure.

Varnish preparation

All of these considerations are worthy of investigation, but what I would like to offer here is a simple varnish that not only works well, but is flexible enough to allow several variations to be developed.

Colophony varnish recipe

- 500 grams colophony (resin)
- 50 grams mastic tears
- 450 grams cold pressed linseed oil
- Heat the linseed oil to 200C
- Slowly add the colophony (resin) and stirred for at least 2 hours
- Allow the oil/resin mix to cool a little. Add the powdered mastic tears last of all and stir for 1 hour more
- It is extremely important NOT to remove the cooking pot from the stove and place it on a cold surface. This can cause a violent reaction.
- The still warm, but NOT HOT varnish can then be filtered.

Preparing linseed the oil

I always use artists' quality cold pressed linseed oil. NEVER use oils that were not prepared for artist use. These may have been pressed in presses used for olive oils or some similar non drying oil. Even a small amount of contamination will spoil the oils drying properties. This problem was known in antiquity.

I wash my oils twice. Although it takes time, the process is relatively easy. It is best to use glass containers because you can see what is happening. You need about three measures of water to one of oil. Neither do you need to add sand or anything else. You just need clean water and oil together in a jar. Shake it up every day for a week and leave it for a week to settle; sometimes it goes quicker. Do not be tempted (as I was) to use an automatic mixer; it may cause emulsification. Once it has settled, Siphon off the good stuff leaving the crap in the water. If you are really keen, you can wash it several times, but this is not usually necessary. As I indicated, the process is relatively easy. In fact it's one of the easiest things about varnish making. The process is also described many times on the Internet. 256 In a dark cupboard this washed oil and/or finished varnish, can be stored for many years. However, unlike the jars in this photograph, it is important to have as little air as possible in the storage jar. 257

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I mainly wash the oil because it increases its transparency. I also filter my finished varnishes to further increase transparency.

Cooking the linseed oil and colophony together

Gradually combine the colophony/resin and later the mastic, with the linseed oil. The colophony (or similar resin) can be powdered and gradually added to hot linseed oil until they blend. However, this is not always as easy as it sounds; if the oil is not hot enough the various ingredients will separate on cooling. Moreover, if you wish to add mastic, you should allow the colophony oil mix to cool considerably. This is because mastic should not be allowed to become too hot. For this reason I always add my mastic last of all.

In spite of such difficulties this method should eventually give you a good varnish. It will also be a varnish in which the molecules of the colophony have not been markedly altered. Unfortunately, when applied to a violin, this varnish will be almost as clear and colourless as the cold pressed and washed linseed oil. In other words it will be boring. Even with a fine ground colour underneath, it will be boring. In three centuries it may look magnificent, (like the Seraphin), but for the first few decades it will be boring.

Colouring varnish

When faced with a boring varnish, we are mainly left with two possible methods for creating that illusive appearance of an ancient 'oxidized' varnish [42]. We can either colour the varnish, by adding a colouring agent. Or we can attempt to 'oxidize' the varnish using various artificial methods. These choices are further

complicated by the fact that we also have the option of employing both methods; 'oxidizing' and introducing colouring agents.

There are many ways of to approach 'oxidization'. For many years nitric acid has been employed by modern makers, in spite of the fact that it was not available to the classical Cremonese makers. Creating violin varnishes with the help of nitric acid has taken many forms. It has also been used in various ways to colour the wood before the varnish was applied. Amongst the most famous formulas are those described by Fry in his 1904 book "Italian Violin Varnishes". In the dim and distant passed I have had some success with this book. However, I would add one massive caveat; nitric acid is extremely dangerous and can create explosive substances with a great many organic materials. For example it can create nitro/colophony a highly unstable explosive.

When 'oxidising' by cooking, the method that I use brings me into conflict with the Classical Italian method of cooking colophony as interpreted by White. In order to darken the colophony sufficiently I cook it for a very long time and I am fairly sure that the time and heat required to darken the colophony almost certainly alters its molecular structure. The cooking time required depends upon many factors including the outside temperature, the relative humidity, the quality of the raw materials, the method of cooking, and the amounts being cooked. I have cooked in temperatures of plus 30˚C to minus 8˚ C. In cold conditions the time required for cooking was six times longer than for warm weather cooking.

Preparing colophony and notes on safety

Although there are several alternatives, I mostly use colophony as my main resin and this is the basis of the varnish that I used for the bass [43]. Colophony has a similar refractive index to Venetian and Strasburg turpentine's, but it is probably the easiest usable resin to find and to work with [44].

A stainless steel asparagus pan with a heavy bass is perfect for cooking resins. It stands about 18 inches high and has a 6 inches diameter [45]. Having decided how much varnish I wish to make, I cook the resin low and slow. After quickly loosing various volatiles, it is gradually reduce in volume; up to and possibly more than 80%. I cook outdoors, well away from anything inflammable. I have a small temporary shelter to keep the cooker out of the rain. I bought myself a small plastic and aluminium green house from a garden centre. This protects the stove and pot from inclement weather. It cost about 25 Euros. It is only about three feet high so I set it up on bricks, making sure that it was very stable. You don't want anything falling over. This house needs to be high enough for the stove, the stainless steel asparagus cooking pot and some clearance. My house opens at the top allowing me to check the temperature, stir the mix and allow the fumes to escape. Especially in the early stages this cooking process will give off a lot of highly inflammable stinky sulphurous yellow gases. These will not please the neighbours and or the authorities, especially if you live in a town. I suggest you find a friendly lab or move to the country for a while. Your electricity bill will be extremely high, especially if like me you occasionally cook in the winter. However, cooking outside in summer poses an added fire risk.

If you do decide to cook varnish, even in winter you need to be very aware of the possibility of fire or even an explosion. Oils and resins can quickly become exothermic and if you are cooking for several days and nights, you cannot be there all the time. Clothing especially wool and cotton garments can absorb fumes and become highly flammable. You should always have a fire extinguisher close, but not too close. This should be capable of putting out an oil-based fire. Never cook varnishes on an open flame.

There are several historical reports of people being killed while cooking varnishes. In most towns and cities cooking varnish was only allowed outside the city walls. I personally know several people that have received severe burns; one required skin grafts. Best of all is gaining access to a lab, where extractors and proper temperature controls are possible. If you do not have access to a laboratory extractor this needs to be done in the great outdoors.

DO NOT BE TEMPTED TO COOK TOO HOT OR TOO QUICKLY, if you allow the colophony to get too hot it will burn and turn an ugly black/brown/green colour. I check the temperature constantly with a thermometer that reaches 400˚ C. As the amount decreases you will need to reduce the temperature accordingly.

Initially, to save time, I cooked large quantities of varnish. This turned out to be a mistake. Without the appropriate equipment large quantities are difficult to regulate. The main problem is keeping an even temperature throughout. It is very easy to burn the bottom of the batch, while the top is being cooled by the surrounding air, (especially in winter). Because even a small amount of burning will spoil the entire batch, it is best to cook smaller amounts. Once cool the resulting red resins can be mixed together with oil at a later stage. Any burned batches can be discarded. As I pointed out earlier, whichever resin you chose a considerable amount will evaporate. Because the overall amount is often quite drastically reduced, instead of simply adding this red resin to the oil, I add it to oil that has already been blended with some colophony in the simple way that I described earlier. I cannot tell you exactly how much; because this will depend upon the colour of the resin and how much of it has boiled away. In the final analysis I try to keep to the ratios that I mentioned earlier.

I have never found this job easy and especially at the beginning I burned quite a few batches. Moreover, I have shown many people how I make my varnishes, but in the end they all create their own variations.

Thoughts on the historical significance of colours

As indicated there are a several possible sources of the colour that we 'see' in classical varnishes. It may simply be that some classical instruments were initially coated with a fairly transparent, clear varnish and that they have become darker and more attractive with the passage of time. In truth, long before Andrea Amati in the 16th c. musical instrument making in Europe was already an ancient craft. A wide variety of varnishes were being cooked before violins arrived on the scene. Moreover the so-called classical period of violin making was itself more than 200 years old by the time these varnishes began to disappear. This 200-year tradition might also mean that Cremona's later makers were already seeing 'oxidized' red/brown instruments, and like us they wished to emulate them.

I have made some mention of the different drying oils that were available. For example, it may be that Venetian violin makers were using walnut oil based varnishes. Walnut oil was certainly used by Venetian painters. Walnut oils not only turn red with age, but they also have a greater tendency to develop Craquelure in the way we often associate with Venetian varnish.

Some of the early decorated (painted) instruments of Andrea Amati may have had an extremely thin transparent red layer applied over them, to enhance their various motifs. This process, known as 'glazing', was standard practice for many painters. There is a lot of information about glazes and glazing on the net. The objective was to 'lift' the whole work and make all the colours appear richer and warmer. However, glazes of this nature were highly transparent and not particularly intense; otherwise they would have hidden the paintwork.

Having raised the subject of Andrea's decorated instruments, I should also add that Cremonese decorated instruments appear to have been coated with a fairly 'standard' varnish, similar to that used by all the early Cremonese makers. Of course time may also have changed these coating. However, many of the motifs on these decorated Amati instruments show no sign of their colours having faded significantly, even after 500 years. The reds in particular almost certainly include lake colours of some kind; a fact which must interest those makers who use, or wish to include lake colours in their varnish. Consequently had a red pigmented varnish been applied over the top it would be surprising not to find some vestiges.

Quite a lot is known about colour fade. For more than a century, most of the colours that were available to the classical makers have been tried and tested. The truth is that in violin varnish most of the top end colours, such as the ever-popular lakes and various earth colours are quite stable; presupposing that they

were well made. Although many of these colours, especially the lakes, are officially classified as fugitive, these classifications relate to extreme exposure to UV light. It would be unusual for violins to receive such exposure.

Nevertheless, the possibility that colours were added to varnish and have since faded cannot be ruled out. Colour fading is not uncommon even with modern artists' pigments. Organic colours are particularly vulnerable; 'Dragons Blood' and Saffron, being two of the most notorious examples. Apart from the colour itself, to some extent the rate of fade depends upon the kind of medium that was used to carry the colour and ultimately how much exposure to UV light and similar destructive elements these colours have had.

Use of colouring agents

There is considerable evidence that some classical Cremonese varnishes were coloured. However, if we assume that some form of (red) colouring agent was occasionally added to violin varnishes perhaps it is important to ask ourselves why. The simple answer is that any addition of red colouration may have had as much to do with the importance of red as a status symbol, as it did with the desire to make beautiful instrument. Red colours were precious and difficult to make. Red clothing was worn and displayed along with gold, ermine and pearls. It may be significant that many, especially Milanese instruments of lesser quality, do not appear to have been coated with red varnishes. This does not exclude the possibility that they were originally red. The reason they appear comparatively pale today may simply be down to their makers having used cheaper pigmentation.

Today, probably because of their known tendency to be naturally transparent, the most commonly used violin varnish colouring agents are lakes. Theoretically the process of lake making is relatively simple, but in reality it is extraordinarily complex. Historically these red lakes were always some of the most difficult colours to produce. Amongst violin makers the most explored lakes have always been madders. Today we are lucky to find one or two suppliers of madder root in the entire world. However in the 16th century there were more than forty varieties in Holland alone. And herein lays the first problem of creating high quality lake pigments. Many of the raw materials are simply no longer available. Apart from the madders, seed-lac (or stick-lac) [46], kermes, cochineal and now even pernambuco, are becoming increasingly difficult, if not impossible to obtain. Even in my working life many of these raw materials have disappeared and along with them, the knowledge and experience of how to grow, collect and use them has also gone. Those recipes that have survived are often either extremely complex or far too simple. It is not without reason that highly trained colour masters often specialized in creating only one type of colour.

Mineral colours are also a possibility, but many that originally came from ancient natural deposits are also no longer available. Although usually exceptionally stable, most of these 'earth' colours are at best only semi transparent.

I should point out that I am not a great advocate of adding colour to varnishes. This especially applies to colour mixing; that is mixing reds with yellows to make oranges and possibly even adding black or blue to make browns. Generally speaking this is a total disaster. 'Mixing' always turn colours muddy and opaque. A better option is 'blending'. Blending involves taking different batches of the 'same' colour to create a specific shade of that colour. Colour blending is a highly skilled profession. Moreover, it presupposes that you already have, or can make something approaching the colour that you require.

Unfortunately, since the colours that most of us are chasing, have almost certainly been altered in some way, our chances of finding suitable replacements are limited.

Madder and other lake pigments

Since my student days I have always enjoyed making lake colours and over the years I have made hundreds of batches of both natural and synthetic lakes. I have used a great many combinations and variations of base materials, salts, liquids and temperatures. However, I more or less stopped using them in varnish about fifteen years ago. Quite honestly I have never really had much success with them. They just do not do what I want them to do. Admittedly, this may be because, for whatever reason I simply cannot make the kind of lakes that were available in classical times.

Making lake colours is a lot of fun and I have no wish to discourage anyone, but I really think that you should think twice about even bothering. You can easily waste a whole lot of time and money. I have certainly spent a small fortune on ancient books and thousands of hours of experimentation. I have no idea what, if anything, Cremonese violin makers added to their varnishes. But when I am judging competitions, modern makers are often amazed when I identify the colours they have used.

"How did you know that it is an alizarin red, black and Indian yellow mix?"

“How did you know that it is a madder/cochineal/Pernambuco/alizarin lakecolour?”

“How did you know that it is dragon’s blood?”

“How did you know that it is an earth colour, an aniline stain, a tincture etc?"

Well I know, because I have done it all myself. Now I am not saying that there are no varnishes out there that contain such things and still look great. There may well be. Nor am I saying that the only nice varnishes are Cremonese. Perhaps what I am saying is that most of what I see just does not come close to great Cremonese varnishes. This is largely because in order to reach some depth of colour, most modern varnishes contain so much pigment that the pigment itself becomes the prominent feature of the varnish. Varnish should enhance the wood, not the colouration. On great varnishes the colour is the varnish; not an obvious component part of the varnish.

Before I leave this theme, I should say that some people have been adding madder and other tinctures directly into the varnish. The problem is that, if not fixed in some, way tinctures can be quite fugitive. In addition tinctures are also prone to colour change. This is because, rather like litmus paper, they react to the presence of acids and alkalis. Consequently, unless they are fixed they can be change by outside agents such as cleaning fluids or sweat.

Merrifield cites shellac was introduced as an artist’s pigment in Spain in the year1220. The first photograph is of Montagnana copy cello that was varnished with a colophony/oil varnish containing my own lake colour made from seed lac (also known as stick lack, the raw ingredient of shellac). The second is a Stradivari copy cello coated with the same basic vanish coloured with a cochineal lake. The third, a Galliano copy viola is coloured with madder lake and it has a pinkish hue. These instruments were all made in the 1980 and early 90’s. You may love them and they do look nice, but for me they are not right. The final instrument is again varnished with a colophony oil varnish, but the colouring was derived from Dragons blood. It is a Testore copy. I wanted the varnish to fade in order to give the violin a slightly washed out yellowish look. I painted some of the original varnish onto the back to show how much the original colour had faded. 258 259 260 261

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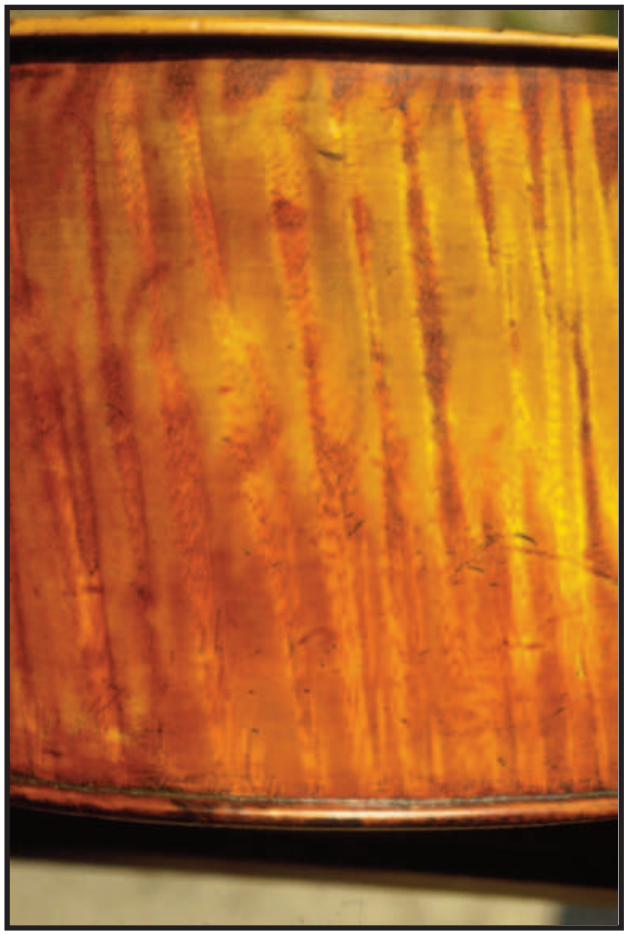

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Applying the varnish to the ground

After applying the initial colour primer, doing the sunning, (UV) and applying the Plaster of Paris filler/sealer; I applied the first varnish coat. Although this varnish has no added colour, it has had colour cooked into it (also described earlier). This is exactly the same varnish that I will be using for the final coat(s), which will also have no added colour.

As with rubbing the Plaster of Paris pore filler onto the bass, applying this first coat of varnish over the pore filler took about five hours to complete. The process was fairly simple, and although it obviously took longer and was physically hard work, in some ways it was easier than working on a fiddle. The biggest problem was simply holding the bass and turning it over. My workshop is not tiny, but it is not big either.

The most exhausting task was rubbing the varnish in and off. As I pointed out earlier, during this process it is important to make sure that the edges are very well sealed, and that any places that appear to be soaking up excessive amounts of varnish are very quickly re-sealed with additional chalk or powder. I always keep a little of the dry plaster powder at my side to rub into any offending areas. I do this with a piece of lint free cloth. Again it is important to rub this first coat of varnish vigorously into the ground. And then it is essential to remove every spot of varnish and pore filler from the surface. This process is not difficult, but it is fairly easy to mess it up. I am sorry to have to say that you can only really get the hang of this with a little experience, so don't be tempted to start with a bass.

Unlike a violin, doing the bass was really a case of doing a bit at a time. Because no varnish is left on the surface, once a coat has been rubbed in and off a particular area, moving the instrument around did not present a problem. This meant that I could have my lunch or take the dog out between areas. It will not be quite so easy when I come to do the final varnishing.

I started with the head and neck, after which I had a cup of tea before moving on to the ribs. 262 263 As can be seen from the photograph, there is quite a lot of varnish on the rib. I try to spread this as far as possible with a brush. If you are not careful this can be a very wasteful process. As with the plaster of Paris pore filler, I use several small strips of Perspex to remove, (scrape off), any surplus. 264 This surplus can then be reapplied elsewhere. Here again are several pictures showing how I use the same technique on violins and violas. 265 266 267 268 269

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Having finished the ribs I started on the back. It is essential with a bass, to make sure that you have enough varnish to finish this job. I guessed quite well, but I had some extra ready just in case. The reason why this is so important is because I used dryers with this first coat. Just a normal artist dryer for adding to oil paints will do. I use half the recommended dose. I add a dryer because I really do want it to dry thoroughly before I apply the final coat or coats. For the top coat or coats I do not use any dryers. The scratches that can be seen in the photographs were not deliberately applied, but as can be seen from other photographs, some areas of this bass have already been partially worn. Had this been an 'unworn' instrument these scratches would have been a minor disaster. 270 271

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As indicated earlier, a similar ground can be achieved by mixing the dry 'Plaster of Paris' powder, directly with the varnish. (Again with a little added dryer.) The resulting mixture should look and feel like thick honey. This mix can be either brushed or rubbed on and into the wood. Rather like applying the water based pore filler, this mix must be thoroughly rubbed in and rubbed off using a lint free cloth. Although this 'Plaster of Paris' powder mixes well with water, some fillers don't. These fillers are better mixed directly with the oil varnish. Whichever system you use for applying the pore filler, the final result should look much the same. Again the resulting ground should be the colour of the final varnish, but it will appear matt.

Here it is important to repeat that the varnish-pore-filler mix needs to be applied very dry on all end grain areas. For this process to work well, (also with the water method), the molecules of varnish must eventually surround the molecules of filler. Any areas that are not surrounded will remain white. Especially on end grain areas this balance is not always easy. If too much varnish is in the mix the end grain areas will turn black; too little and you will have white patches.

In the final analysis, whether I apply my varnishes over or mixed with the Plaster of Paris ground varies with the type of varnish and or filler I am using. Generally, the thicker my varnish is, the less I will waste and the less it will sink in. However, if it is too thick then it becomes difficult to spread and more difficult to rub off. If the varnish is too thin it can sink in too rapidly and you may have to stop this very quickly with an extra application of the Plaster of Paris powder.

It is obviously better if the instrument is well sealed in advance. In my opinion the easiest method of achieving this, is to apply the pore filer with water, which is why I chose to do this on the bass. However, whichever pore filler you choose and whichever method you employ for its application, in the end this will only get easier as you gain experience.

As my earlier (liberal) use of masking tape suggests, I am meticulous about not allowing surplus glue penetrate the surface to be varnished. However as could be seen on photograph 255, where even a small amount of glue squeezed through the bend, the resulting white spots, (of animal glue), can clearly be seen. If you imagine this on a larger scale and you will have some idea of what can happen. With the ground coat applied the instruments were initially placed in the UV drying shed and then when the sun finally appeared they were left outside. One big advantage of the UV shed is that insects do not crawl over the instrument dragging their varnish soaked wings across the surface. The ventilation holes on my shed are covered with insect mesh. Good for the insects and good for the varnish. 272

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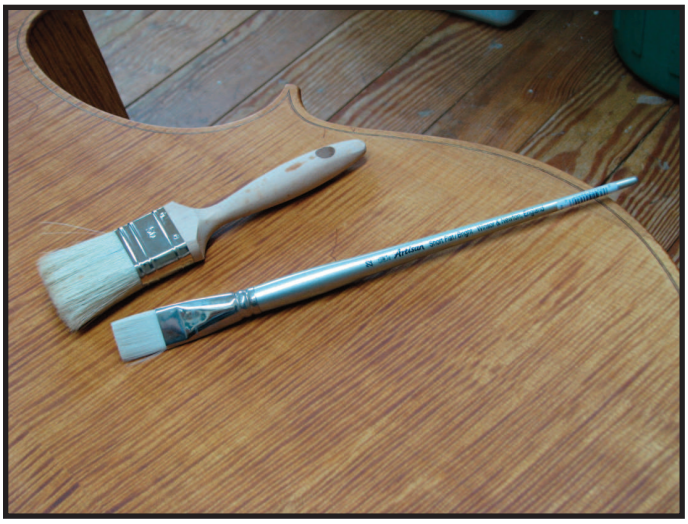
Varnishing the Bass – First coat

After a lot of thought I decided to varnish the ribs and back first and to start the belly and head only after these areas are completely dry and the initial wear has been applied. There are two reasons for this. First, I have a tight staircase leading to my workshop and a long walk through my overgrown garden to the new drying shed. Second, I am going to try antiquing this bass and I don't want too much work at any one time. Actually I am quite terrified of the prospect. I have antiqued many cellos, but this is my first bass and the first time I have varnished on line.

Having pored a little of the varnish into a pot, I selected a 1 inch synthetic artist brush. 273 The wider brush in the photograph is for removing any lose bits of dust etc. I always use good quality brushes, because they keep their shape and don't lose hairs. Since my varnish is quite thick I also use a fairly stiff brush. (I do use cheaper throw away brushes for sloshing on the plaster mix.) Within reason, the thicker the varnish is, the less likely it is to run when drying and the fewer coats you will need. If you are brushing it out well, varnish tends to find its own natural thickness. 274 275 276 277 278 279



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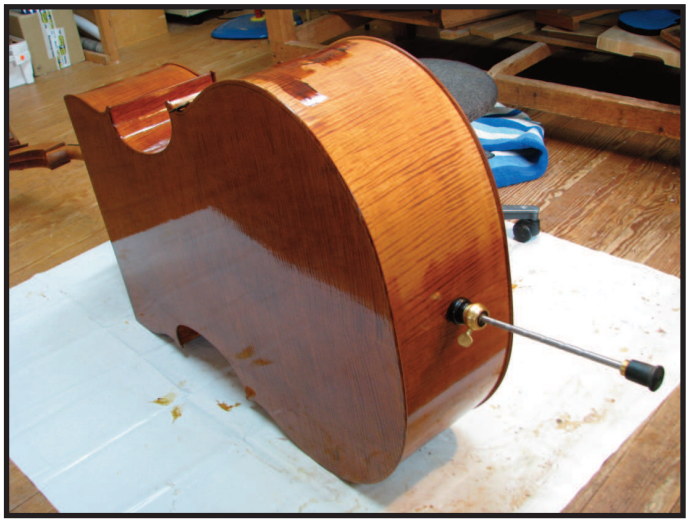

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For those of you that cannot believe that this colour is simply from cooking I suggest you look at the jar in the picture. This is a Strasburg Turpentine varnish. The varnish that I have used on the bass was made from colophony. The recipes method and final appearance are more or less the same. Although they may age differently, for the moment I am still not sure which of the two I prefer. 280

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I applied two coats of varnish to the bass. When I am antiquing I want the ground coat to be hard and very dry. This is why I added a little dryer and also why the ground coat was dried for about 100 hours. In contrast, because of the wearing process that will follow, I don't want the top coats to become too hard. The problem with several coats is that the upper coats will always be softer while the lower coats will continue to become progressively harder. For this reason I apply the next coat of varnish as soon as the first coat is hard enough for a new coat to be applied without it pulling. Of course, if you are varnishing a clean instrument, this is not desirable. In that case you do need to let each coat dry well before applying the next one.

Second coat of varnish on the Bass

I went down to the UV shed and checked the varnish at midnight, about 12 hours after applying the first coat. It was touch-dry, but obviously still a little soft. If the time had been right I would have put the second coat on immediately, but it was very late and it was also raining a little. So I switched off the lights and went to bed. Even with the lights off, varnish that has been exposed to UV will continue drying, although fortunately much slower. Altogether it had taken about 12 hours to reach touch dry. This is a little longer than normal, so I guess that my new lights are not quite as potent, as the ones in my smaller UV box, or perhaps they are just a little further away. Normally this varnish needs about 8 hours to reach touch dry.

The next morning I got up bright and early and made a start on the second coat. 281 282 283 I added a few drops of washed linseed oil to the varnish. This will help prevent cracking. I always use the classical painter's technique of working from lean to fat. Rather like my body in fact. This additional oil also makes the varnish a fraction easier to spread. Nevertheless, you only need a few drops of to make a difference. Too much and the varnish layers will have a slightly different hue. Moreover, they will dry at different rates and for my antique work both of these factors might end up causing difficulties. This is not a good time to start using thinners like turpentine or even lamp oil. You might want to start with them, (I try to avoid it), but you don't ever want to finish with them.

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It took me about an hour and a half to varnish only the back and ribs. I put the bass back in the UV shed at 9:30 and varnished a violin. This took me 15 minutes.

After cleaning up the workshop and washing the brushes, I looked at pictures of old basses to get some wear ideas into my head. The thing about applying wear is that you should always try to mimics what has happened to genuinely worn instruments. Anything else will simply look artificial. 284

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The antiquing process - Applying alcohol

The bass now has two coats of varnish on the back and ribs; it is dry, but not hard. I always try to work outside whenever I am working with alcohol. For normal work I use only top quality alcohol, but for this work I use quite a lot of industrial alcohol. The room can quickly fill up with fumes and this can have three bad effects. Firstly it can attack the mucus layer in the lungs eventually even causing permanent damage. (Please don't underestimate this danger.) Secondly, I believe that it can even make you slightly drunk. It can certainly go to your head and make you woozy. I did two cellos together some time back. By the time I was finished I felt very dizzy and the following day I had a hangover type headache. I could never have driven a car or operated a machine; really stupid! Thirdly, there is a real chance of explosion or fire; any spark, even a static spark could set it off. So, for me the rule is always outside and always wearing a mask that actually filters alcohol out. Again you have been warned!

So the first items in my box of tricks are a mask, a new filter and alcohol. 285 I forgot to include the gloves [47], which I remembered after taking the photo. Also on the table are old cloths, paper kitchen towels, pumice powder, some small stones, a bone burnisher and two agate burnishers [48]. There is a roll of packing tape, a jar of thickly mixed walnut stain, (Hammerl walnut stain crystals mixed with water) and several pieces of natural sponge. The sponges are for applying and removing the walnut stain. Finally there is a box of "oxygen powered stain remover for clothes". Also missing from the table is my hot air gun. Previously I used a hair dryer, but I recently purchased a hot air gun with several heat levels. These guns are used for paint stripping. In most ways it is better, but its potential heat and power makes it far more dangerous. If you lose concentration even for a second you will be in deep trouble.

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Because of the heavy rain, I set up in my usual place under my sun, (in north Germany it is mostly a rain), umbrella. This is dedication! Aren't you guys that live in hot climates jealous? 286

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Having spent the last evening studying the photographs of old basses that René had given me and my copy of Duane's book, this morning I had one final look and placed them opened, just inside the back door. I really do like to work from photographs. Not to copy them slavishly, but to get inspiration from them. So by now I more or less know what I want to achieve, it's just a case of doing it. Doing this kind of work well is not easy. Admittedly most people will not appreciate the difference between a well-made copy and a cheap factory job. But then surely we are all working for our own personal satisfaction. My best piece of advice is to work towards your goal gradually and above all to keep it subtle. When you see some of the following photographs, you might be forgiven for thinking that I have not been very subtle, but I assure you, I have.

The first thing I do is soften the varnish with alcohol. 287 Normally with a violin I would cover the back with a piece of kitchen roll, (paper towel), and run alcohol onto it. The paper will hold the alcohol in place while it does its work. If you wish to soften only a specific area, then just apply the alcohol to the paper in that area. Here a word of warning. If you leave it on for even a few seconds too long it will not be soft, it will be gone. I also have several blank dry papers to quickly soak up any puddles or surplus alcohol left on the surface after the alcohol soaked paper has been removed. In this respect you really need to watch out for any alcohol running elsewhere. If it runs anywhere without you noticing, you will have lines across your varnish that will be extremely difficult to disguise. How long the alcohol needs to soften the varnish will depend upon the varnish and how hard it has become. Often the varnish is still soft enough so that simply running over it quickly with a damp alcohol cloth will be enough to soften it. In the photograph this is what I am doing on the back. On the ribs the varnish was already harder and so I had to use the paper towel soaked in alcohol method. 288 If this sounds drastic, be under no illusions, it is drastic. I have been doing this for many years and I have developed a routine, but not without making some bad mistakes.

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Scratching denting and removing layers

Once the alcohol is soft I begin the complex process of scratching denting and removing varnish in several stages. I begin by removing varnish from those areas where soft rubbing rather than scratching would have removed varnish. On the violin this is usually where sweat and the action of the chin or hands have gradually scoured the varnish away. I also remove varnish from prominent edges and corners on the head and body. These two initial stages quickly begin to create a basic profile. It is important that this basic profile runs from the back to the ribs to the belly and even to the head. When I am judging competitions, I often see instruments where the wear patterns are quite good, but unfortunately, on the various parts of the instrument they don't match one another.

Always be looking at photographs and thinking about what you are doing while you are doing this kind of work. If I am copying a specific instrument I try and take good pictures of details. For example varnish does not simply wear of edges evenly. In some places it stays and in others it is totally gone. I cannot really help anyone with this, any more than to say, look and think. And this also applies to how wear has occurred on original works. If a clamp has made a mark, then the best way to emulate this is to use a similar clamp. Of course, it is not always possible to use the exact thing that has caused a particular mark. Consequently, we must compromise, but always try to create something that at least looks authentic. The worst thing that you can do is to use the same tool over and over. If it is at all possible examine genuine instruments and make notes.

I use stones to apply most of the scratches, but I also use bits of old bows and closing cramps and whatever fits the bill. 289 290 291 292 It may not seem so, but the stones I use are very carefully selected. I am always picking up stones and other items when I am out walking. Even with the right object it is very easy to rub them the wrong way. You do not want to end up with a lot of circles or parallel lines. The rule, as always, is be subtle. At some point you will gradually need to begin the process of combining and blending the soft and harder areas of ware.

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As I have shown, I covered the entire instrument with my ground varnish, but because I wanted to atique this bass and because of its size, I varnished and wore the bass in two halves. The ribs and back were finished, up to and including the first stages of the antiquing process. So far this has included the main wearing process and also the application of any varnish craqueleur. In most cases copyists apply too much craqueleur. Cremonese craqueleur is usually fine and delicate. Andrea Guarneri's instruments and those of Hieronymus II, sometimes have a little more, but nothing in the manner of some Montagnana cellos. So once again subtlety is the rule. However, it is important to point out that for whatever reason basses, like cellos, tend to have thicker varnishes and as a result they also tend to have slightly heavier craqueleur.

I used a thick walnut stain for the craqueleur on this instrument. 293 This is a strong stain, so great care must be taken that it does not touch any areas of bare wood. This stain is supplied in crystal powder form by Hammerl in Germany, but I purchased mine more than 25 years ago, so I am not sure if it is still available. I make the mixture very thick; it looks rather like Marmite. However, there are many mixtures that you can buy or make to create craqueleur and I often use different methods depending upon what kind of craqueleur I am attempting to copy [49]. The type of varnish that is being crackled is also an important factor. Today there is a lot of information about this process on the Internet.

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I always use natural sponges to apply my craqueleur mix. I use natural sponges because they are not as uniformly structured as plastic sponges. I have a large selection and I try to choose a sponge with pores that match the size of the craqueleur I wish to make. You need to dab or spray craqueleur mixtures or varnishes onto the surface. If you use a brush, the craqueleur will follow the lines of the brush strokes.

This is the point where the hot air gun comes into its own. I apply only a little craqueleur mix at a time, so that I can control the rate and size of the craqueleur as it dries. The thickness of the mix and the thickness of application both affect the finished craqueleur, so you will probably need to experiment. As soon as the required state is reached, I remove the excess mix immediately. I do this with a larger sponge and clear water, after which I quickly dry the surface with paper towels. For the back and ribs of the bass alone, this entire process took me five and a half hours. At this stage it looks very mat and rough, but eventually it will be fantastic. At least I bloody well hope so.

I took the bass back into the workshop and applied the first top coat of varnish to the head and the belly. 294 295 The photograph shows the belly with two coats, contrasting with the ribs which have already received the first stage of the antiquing process. The back and ribs have also had chance to harden a little more while the second belly coat was drying in the UV shed.

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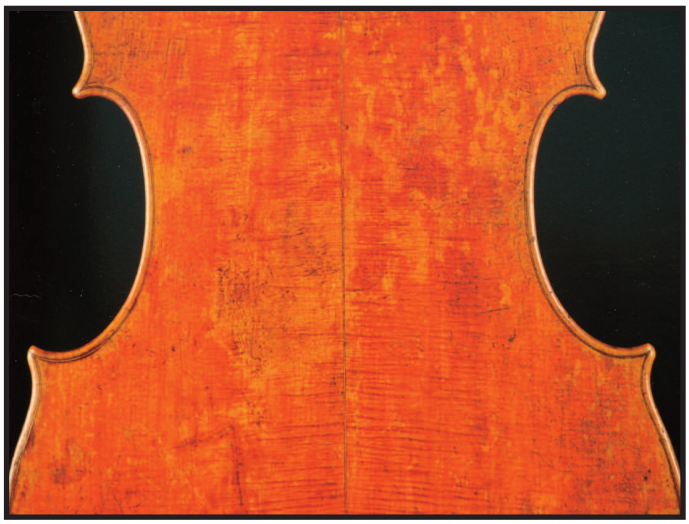
Old basses are often very heavily damaged however I don't want to apply too much damage. I would like it to end up looking something like that wonderful Strad cello with the flat back; said he nonchalantly [50]. 296 297

296 © Mr Shinichi Yokoyama [50]



297 © Mr Shinichi Yokoyama [50]

Two coats of varnish and it have now been applied to this second half of the bass and it has been in the UV shed for about six hours. I switched the UV lights off at about midnight and now I expect it to continue drying more slowly.

I included the following picture of the bass belly, because the light reflections show the figure of eight purfling channel that runs across the corners. 298 As mentioned in Part I this is a typical feature of all Cremonese instruments. There are several photographs in the Ashmolean museum catalogue which illustrate this feature beautifully. Here are two of the 'Alard' Nicola Amati of 1649. [51] In this case the purfling channel is particularly pronounced. 299 300

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299 © John Milnes [26]

300 © John Milnes [26]

Once again I am wearing a mask because of the alcohol. 301 302 This time the varnish was still soft enough so that rubbing it on with a cloth was enough to prepare it for the wearing process. Again I started by treating the "soft" worn areas and the edges. I usually do with a little pumice and alcohol. The pumice makes the alcohol a little more aggressive. Here again you do need to be very careful, otherwise you will cut right through the varnish layers way too quickly.

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Once the varnish has been softened, I began applying the scratches and dents. Initially these scratches always look worse than they do on the finished article. (At least that's what we hope.) Nevertheless I would always urge caution. It is very easy to do too much. After the initial scratching and denting I again craqueleur the varnish as previously described.

Ineglected to say that I sometimes create fine blisters in the varnish with my hot air gun. This is extremely dangerous and must be done with caution. The heat must be applied gently until tiny (minute) bubbles (blisters) begin to appear. On figured maple these usually emerge along the lines of the flames, where the end grain is most prominent. In this way that I imitate the feature known as 'pinning'; tiny pin like holes in the varnish. There are several reasons 'pinning' occurs and although seldom extremely so, it is quite common on Cremonese instruments. After 'pinning' the varnish, once it has re-hardened, it is necessary to rub the tops off with a fine abrasive paper. This creates the tiny holes, which like the crackled areas will be filled with patina.

I have also included photographs of my viola and violin, which are now more or less at this same stage of development. 303 304 305 306 307

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These days, like craqueleur varnish, you can also purchase patina in bottles, some are water based, some oil based. I make several types, but the main one I make is a mixture of many transparent colours. 308 309

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These include a tiny amount of lamp black, yellow, green, red, and any other bits that I have lying about from my oil painting sessions. This patina needs to be a sort of dirty brownish grey colour. But I like to vary this and between stages I will often make up something different. Like the plaster and cracking mixes, I apply the patina thickly. I rub it well in and then I rub it all off. Some will always stay in the hollows and scratches, but most of it must be removed. Too much patina is always a disaster. 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328

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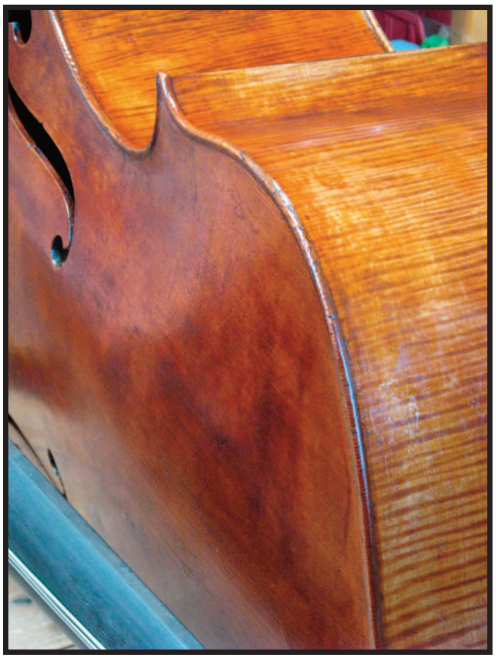

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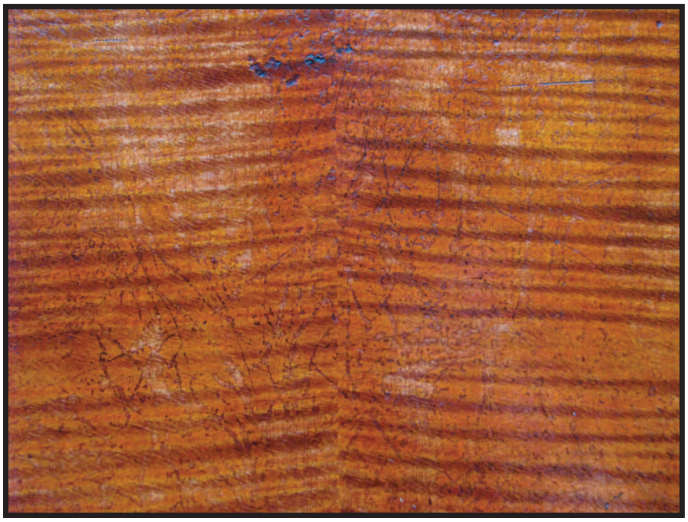

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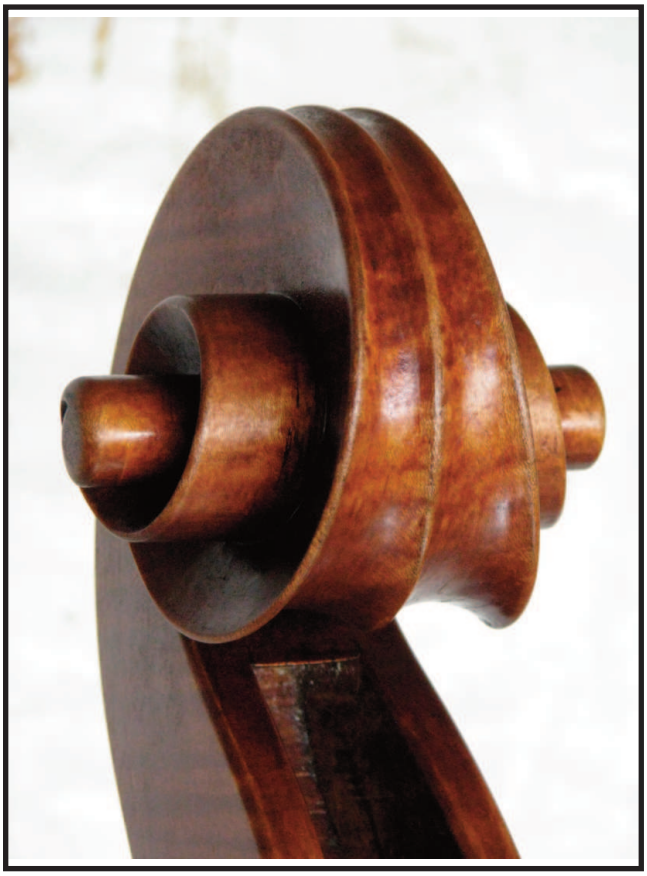

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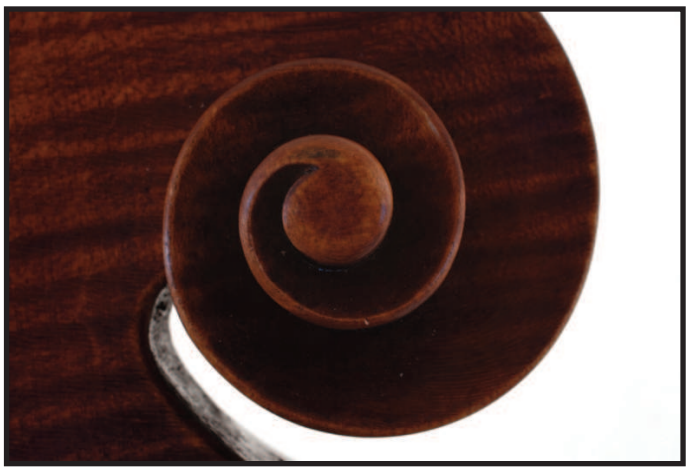

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To recap, I always try to work through several stages; initially softening, followed by the initial wear, followed by cracking the varnish, and blistering with hot air. After the blistering I give the varnish a light rub with a fine abrasive paper or cloth such as Micromesh. This is followed by an application of patina, (dirt) after which I again rub the varnish (very lightly) with a fine abrasive paper. This last rub with fine abrasive paper (2400 grit), is not to flatten the surface or to prepare it for the next coat. By exposing the various layers and levels of the woods figure, the bare ground, the varnish, the craqueleur, the pinning, and the patina, this rubbing process helps create a three dimensional picture.

Getting this combination right is difficult. I often repeat this entire process three times. And, especially on the second and third sessions, I like to concentrate on creating a balance between the various worn areas of the instrument. Here it is important to keep turning the instrument to check these interconnected wear patterns.

I almost always polish in between each complete cycle. This is not the kind of French polishing with shellac that many restorers apply. Too much of that will eventually cause the wrong kind of crackeleur to appear. I do use the French polishing technique, but I polish with linseed oil and alcohol only. Do not be tempted to use a mineral oil at this stage, in case you wish to apply more varnish or patina later on. Any mineral oil will prevent them from drying. It may also impede the slow hardening process of the varnish, which will otherwise continue for many months [52].

Polishing in this way also helps to fix the dirt layers and it also raises the refractive index. After I have finished I wipe off any surplus oil with an absorbent soft cloth or paper towel. Then it is back in the shed for another blast of UV.

This more or less completes the first stage. It is important for the varnish to harden a little between stages I also like to have time away from the instrument. This gives me fresh eyes when I come to work on it again. The next job is to begin fitting up the bass ready for playing. Once this is done I will complete the final touching up, rubbing down and whatever else needs to be done.

Removing some dents

Before meeting up with René, I removed a few of the heavier unsightly dents. There are always one or two. I do this with balls of wet cotton wool and a battery powered soldering iron. Having completed that task, I gave the bass another quick rub down, using an alcohol oil mix on a hard, flat, fine weave cloth.

An amusing encounter with René

The following day I drove towards Holland where I met up with René at a motorway service station. Kind of like a drug deal or something. René fondly summarised the encounter in a short blog post:

“Today I met Roger at an autobahn truck stop, halfway between his workshop and mine. After coffee and a conversation with his new puppy, he opened the back of his car and handed over the bass. Although I had seen it in the white after the initial making process, and also later on Maestronet, it was exciting to see it for real; varnished and antiqued. I must say that it looked even more beautiful and convincing than I had imagined from the photographs; Roger has done a great job. (I won't tell him though; otherwise his ego will get even bigger than it already is...) The reason why I now have the bass is so that it can be fitted up. The varnishing still needs to be finished off and polished, but for now it’s back with me.”

Setting up the bass

In the next few sections René continues the story by describing the initial setup process for the bass

Correcting a warped fingerboard

I started by checking the fingerboard that had warped quite markedly in the drying cabinet. Fortunately we had allowed for this by leaving enough thickness. Nevertheless I had to shoot it again. I usually leave about 2.5 mm of clearance under the E-string and around 1.5 mm under the G. However this is only a guide because in the end it will depend on the tension of the strings, the final elevation and the player’s preference. Some players like to bow really hard; in such cases I will tend to scoop the board a little more. For the bass to work really well I like to make the clearance slightly deeper towards the nut end and slightly less towards the bridge. This is because towards the bridge the stings leave the board at a steeper angle and consequently they require less clearance. Essentially this process is no different from preparing a violin board.

The nut and saddle

The nut itself caused no problems and the saddle likewise. Nevertheless once I am finished I always realize what a lot of work these ‘small’ jobs can be. These days I "half-edge" the saddle rather than cutting through the whole thickness of the belly. This helps to prevent the kind of belly cracks that I have seen on so many basses at either side of the saddle. Such cracks are usually caused by the belly shrinking at different rates to the nut. For a while the Hill family had a problem with this on their new instruments. This was caused by a workshop foreman insisting on tight fitting lower saddles

Nuts and saddles are mini sculptures and with care they should not only work perfectly, they should also look beautiful. How far I insert the saddle beyond the purfling, is partly a matter of taste and partly a matter of stability. This distance can be quite critical if a saddle goes right through the belly and/or if the bellies overhang is quite large. 329 330 331

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In September I took the bass to the annual meeting of the Dutch Violin Makers Association. Because I wanted to show the bass to the group, I left the machines until later, and continued with the sound-post and bridge. It was quite an experience showing the bass and hearing the comments. I expected some colleagues to show no interest, (after all it is a bass). Some colleagues professed to be "disgusted" by the antiquing. As far as they were concerned, a new instrument should look new. Most colleagues really liked the instrument and the way it has been varnished. The copy techniques drew quite a lot of attention.

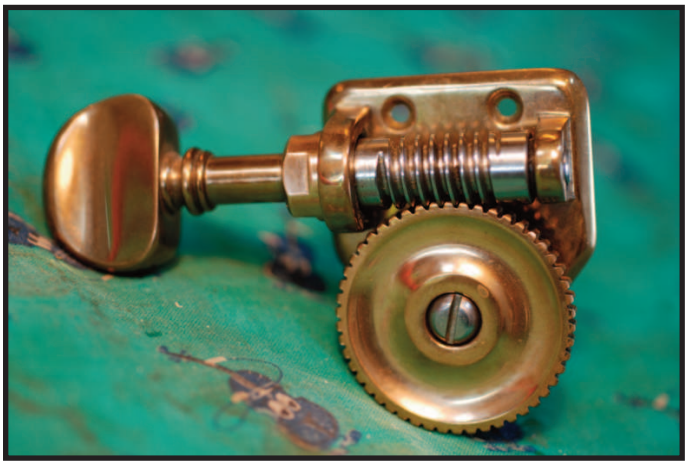
The Sound post

I measure the length of the sound-post, using several older posts as a kind of dry run. Sometimes it takes a long time to fit a post, but this one fit remarkably quickly; upright, in the right position and with just the right amount of tension. Am I a genius? I would love to think so, but it was probably just luck.

Fitting the machines and the bridge

With the sound-post in place I fitted the bridge feet. However, before I could finalize the bridges height I needed to fit the machines. Fitting the machines is one of those jobs where any number of things can go wrong and I knew that Roger would kill me if they did. The peg-box itself is fairly short, so the machines

needed to be placed close together, but with enough spacing for the tuning heads to turn. I use Irving Sloane machines. They look good and they work superbly well. They are slightly more complicated to fit, as the ends do not protrude through the opposite peg-box wall. Also because they are not tapered, (the shaft is 15 mm throughout), the drilling needs to be done with great precision. The Irving Sloane endpin also matches the machines. 332 333 334 335 336 337 338



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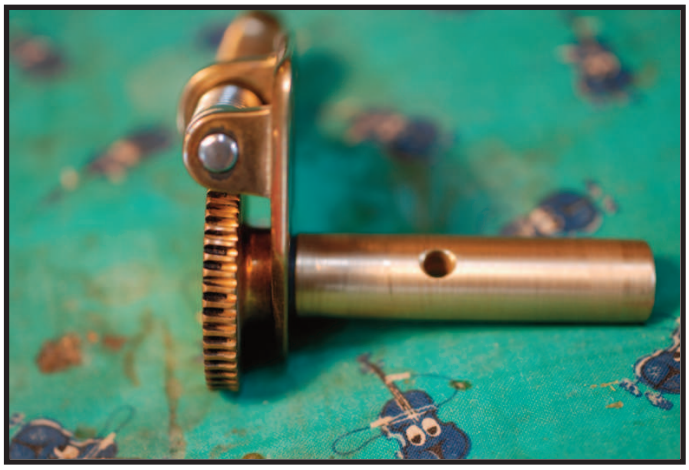

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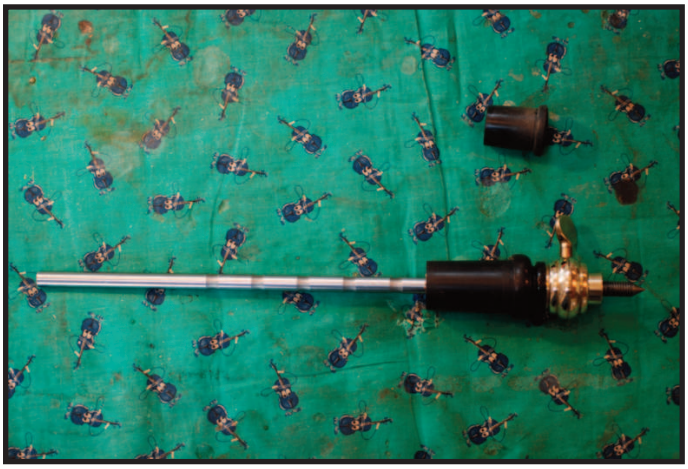

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Tailpiece

Picking up from where René left off, I will now describe the how the tailpiece was made. This tailpiece was designed and made by René. We wanted this bass to be a real handmade bass from start to finish, which is why René chose to do this himself. We both have enough good quality ebony, (all now nicely registered), but this tailpiece is made from a kind of ebony which although it is not very dark, is nevertheless strong and above all it is very light weight. It will eventually be stained to match the fingerboard . The inlayed strip is made of brass to match the machines and the endpin. The first photograph is of the card template. This was cut from a folded card to create a symmetrical template. 339 340 341 342

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Polishing the Bass

In preparation for final polishing, I applied an almost invisible layer of fine scratches to every surface and the rubbed the varnish down a little more to once again raise the three-dimensional appearance. After this, I added a little more dirt. 343 344 345 346 347 348 349

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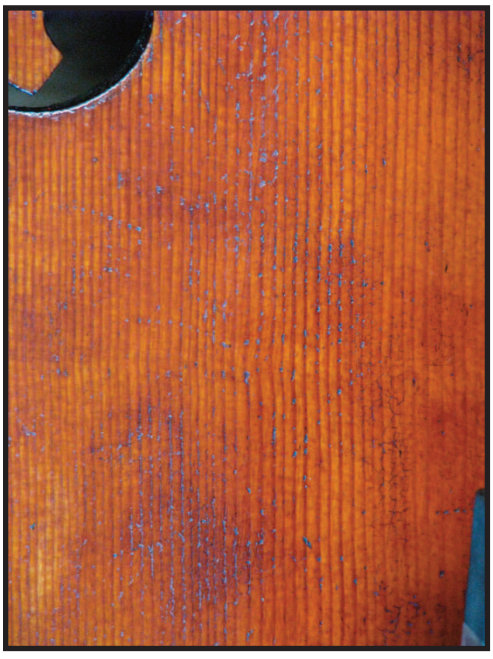

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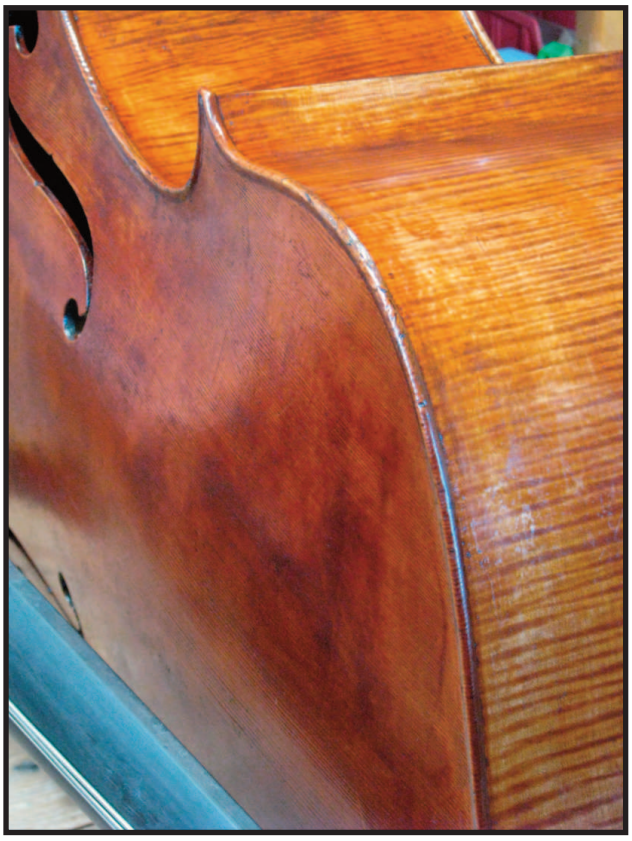

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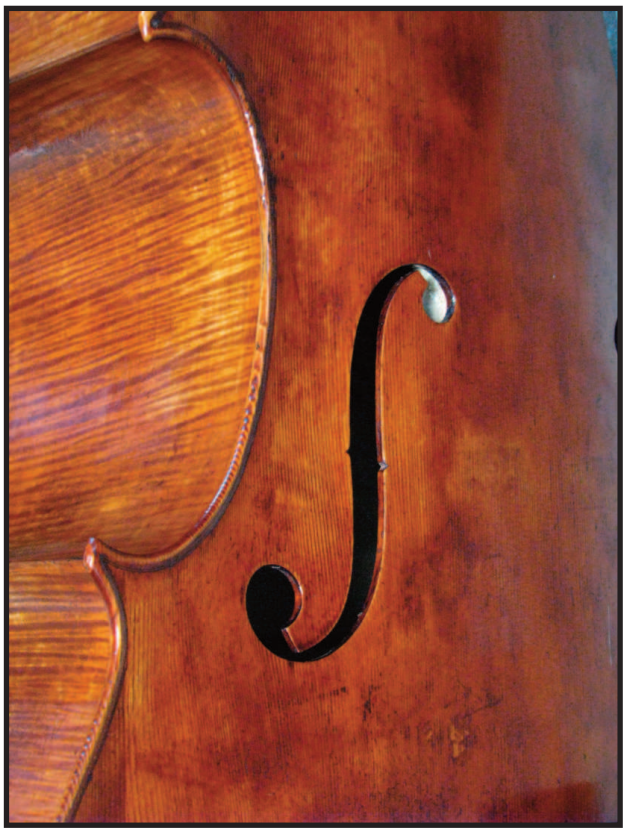

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The polishing process took over two days. This was a demanding, very physical process. Depending on the quality of the varnish (and ground), polishing an instrument will help to raise the refractive index of the varnish. This improves the transparency of the varnish and helps to reveal the woods natural structure and beauty. Instruments can easily be ruined by polishing. Along with cleaning, polishing is a procedure that can go seriously wrong. Over the centuries, but particularly during the last fifty years, polishing has inflicted serious damage to many once pristine historical instruments. The purest varnishes we see today have been preserved simply because they have not been polished.

Probably more than any other aspect of our craft this entire process depends on good training and eperience. Everyone needs to develop the correct feeling for the process and developing this feeling takes time. Unfortunately this is not a procedure that can be easily described in words.

The main problem with polishing fine instruments is everyone believes that the little bit of polishing they do is not going to do any harm. The problem with believing this is that you are never the only person thinking this way.

What drives this urge to polish is the idea that a polished instrument will sell better, or that after a repair a well-polished instrument will impress the customer. However, for reasons that I hope will become apparent I do not recommend polishing any instrument, other than one of your own make.

So why do I want to polish the bass? Well basically this is part of the procedure that goes with creating a copy. I am trying to emulate what might have happened to an original instrument over the centuries. The very process of wearing, scratching, rubbing and scrubbing varnish off any instrument, (but particularly a bass), is going to damage the upper surface. This is especially true with the process that I use to copy heavily worn sweat areas. This is because I generally use water and pumice powder. For various other reasons I also use pumice to help build up thicker areas of varnish - the kind of places into which varnish would have been pushed or have collected naturally. I also use this treatment if I just wish to thin an area of varnish without either damaging it or removing it altogether.

When your neighbour doesn't want you to see him or her undressing in the bathroom, they get the glassier to fit a piece of frosted glass. Frosted glass can be made in many ways, but the easiest method is to sand blast the outer surface. This creates thousands of tiny scratches that cause the light to disperse in many directions, destroying the glass's natural transparency. If for some reason we should wish to restore this transparency, there are two basic methods of doing this. With a piece of frosted glass you can gradually raise the transparency by rubbing it with a series of increasingly fine abrasives, until all the scratches have been removed. However, this process will also remove a considerable amount of the original glass. Another alternative is to apply a transparent layer of transparent lacquer to the frosted area, in effect creating a new surface. And when violin makers polish with shellac, they are basically creating a new transparent surface.

Essentially with this bass I was faced with several large areas of varnish that had been 'frosted' by the various processes that I have outlined. Consequently, I needed to raise the transparency, either by using increasingly fine abrasive papers, or by applying an entirely new surface. There is however, a further possibility for raising the transparency of a freshly varnished instrument. In my younger days this process was known as 'cultivating'. As with most of my instruments, on this bass I employed all three methods. There are a few areas where the varnished surface has been heavily broken up. In these areas there are places where thicker layers of varnish are protruding. These also needed to be levelled. To do this I used a series of Micromesh papers beginning with 2400 grit and gradually working towards finer grades. To assist with the cutting effect I used water, something that must always be done with care. If water is left on a varnish for too long it will cause it to bloom (become milky white).

Areas that have been scrubbed clean of varnish and certainly areas where the ground coat has been removed altogether will require a new protective coat of varnish. In most cases I use the same varnish that I used for the original ground coat. However, sometimes I use shellac, simply because this is what has usually been painted on similar areas on historical instruments. The problem with applying shellac is that if it comes into contact with any of the (still softer) varnish that is already on the instrument, it will cause that varnish to crackeleur. Now although sometimes this might be a deliberate process, if it happens where it is not wanted it can be a pain in the proverbial...

My paternal grandmother worked as a professional French polisher between the first and second world wars. When I was a kid she would occasionally earn a little extra money polishing for a furniture dealer in Leeds. As a child I watched her French polishing cabinets and tables and before I could read I could make a passable polishing pad. I have polished a few tables myself over the years and I can confirm that as well as being a skilled job, it is physically hard work.

So far I have never been called upon to use a polishing pad on an instrument; not even a bass. I was taught how to polish by Glen Collins and later by colleagues at Hills and Beares. We simply used a finely woven, lint free, strip of linen cloth. This cloth was wrapped tightly around the fingers in the manner shown; the middle finger being used to apply tension to the surface of the cloth.

These cloths only become good after having been used several times. In order to prepare them for working on an instrument it is essential to use them on a smooth board first. I find that an off-cut of MDF works just fine. Essentially this process polishes the surface of the cloth; removing any excess lint that might otherwise rub into the varnish.

Method for holding the polishing cloth

I tear a strip of cloth to a size that will fit my fingers when folded into three. 350 Folding the cloth gives it some body. It must also be long enough to wrap around the fingers. 351 352 353 354 355 356 Begin by holding the back of the hand facing upwards. Pass one end of the cloth under the third finger and over the index finger while the middle finger is held back. Wrap the cloth tightly around the front of the fingers pulling the index and third finger together. Next, use the middle finger to place tension on the cloth. If this has been done

correctly you will have created a firm flat area of cloth above the palm of your hand.

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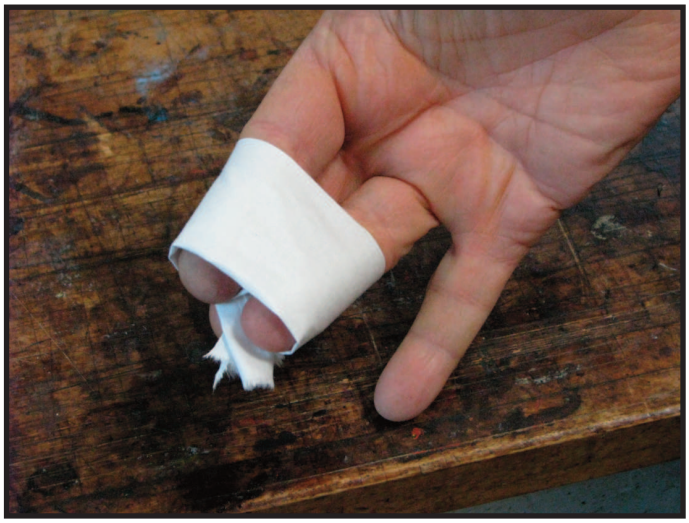

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When I worked as a restorer, these cloths were always kept in sealed glass jars. 357 After use they were moistened with a squirt of alcohol before the lid was closed. When I worked in London, other than the owner of these cloths, no one was ever allowed to touch them. We always kept several spare cloths in the jar, with the favourite folded on top. Eventually this one would wear out and the next cloth would take its place.

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I have spent some time explaining this process, because it is essential to get it right. If the cloth is not held correctly, it will eventually stick to the varnish and that is a disaster that must never be allowed to happen. I recommend that you practice this many times on a piece of MDF, before going anywhere near an instrument and please remember that instruments are not easy flat surfaces. As well as having complex curved surfaces, the instruments themselves are difficult to hold while the work is being carried out. And don't forget; only polish your own instruments with this method.

Use of oils in polishing

Now we come to the question of oils. I am going to assume that you are either polishing a freshly varnished unworn new violin, or a freshly varnished worn new violin. Either way the same points will apply. If you wish to cultivate or polish an oil varnish you must first decide whether or not you have completely finished the varnishing process. The reason why this is so important is because the best kind of oil to use for

the cultivation process is a non-drying mineral oil, such as Vaseline oil. However, as I have already indicated, if you still wish to treat a bare area with patina, a varnish or a drying oil, then Vaseline oil will prevent them from drying.

The next stage is the most dangerous and I do not use this word lightly. This is the main reason why I am reluctant to recommend polishing or rubbing down any freshly varnished work. In fact, unless they are copies I never polish my own instruments; neither do I rub down with fine abrasives, not even between coats. In my opinion this technique should not be necessary if the varnish has been correctly applied. On copies I only rub down to achieve the three-dimensional effect I described earlier.

Having wound the cloth around my fingers, I used the technique of feeling the surface of the cloth on the inside of my other wrist. This helps to show if the cloth has too much alcohol. Too much alcohol might remove varnish rather than reconstituting it.

Some of my old cloths (in the jar) have holes worn in them (see picture 126), but I still prefer to use the unworn areas, rather than begin with a new piece. When I am French polishing the blank areas on a copy, I am often dealing with applied dirt; rubbing it in or off. So I thought that you might like to see my French polishing board circa 1979, which gives some idea of the circular motion that I have used for some thirty years. It also gives you some idea of what can happen to an instrument that is regularly French polished. Also for your delight; my French (dirt) polishing apron MK 2, circa 1997. MK 1 stood up in the corner on its own, but it eventually wore through in the middle. 358 359 360

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As well as shellac some commercial polish preparations also create a ‘new’ coating, often to the long term detriment of the original varnish. The Hill varnish reviver that was used when I worked there contained linseed oil. Others contain worse. The old guard at Hills called it 'feeding the varnish'. In a rather macabre way that is what it did; some penetrated where the ground and wood was worn away and some remained on the surface and dried. Long term, these polishes can combine with colophony and dirt creating a thick grimy film that kills the original varnish in much the same way that an old varnish on an old master painting can kill the colour of the paints, making them appear muddy.

Because of the risk of creating crackle, any method that deposits shellac on the surface of an instrument, should not be used over an oil varnish. However, if the ground is thoroughly dry shellac can be used over an oil-based ground. This is how I eventually finished the bare areas on the bass. However, rather than a mineral oil, I used linseed oil and alcohol in combination with the shellac. I might also add that had I had more time with the bass, I would probably have opted for a final thin glaze of my own varnish. I normally apply this with my index finger in a tightly fitting plastic glove. (Don’t ever use rubber gloves, they tend to absorb and hold solvents against the skin.) This technique leaves an extremely thin layer of varnish that covers everything including the dirt and any scratches that have been applied. I cannot emphasis enough that this final varnish (glaze) layer must be oil rich (if necessary add a bit) and it must also be extremely thin.

Epilogue

The following photographs show the finished polished surface. With the bridge and strings back on, I had two good players give it a whirl before flying off with the bass to New York, just in time for the ‘Contemporary Violin Makers Exhibition’ hosted by Reed Yeboah Fine Violins 361 362 363 364 365 366 367

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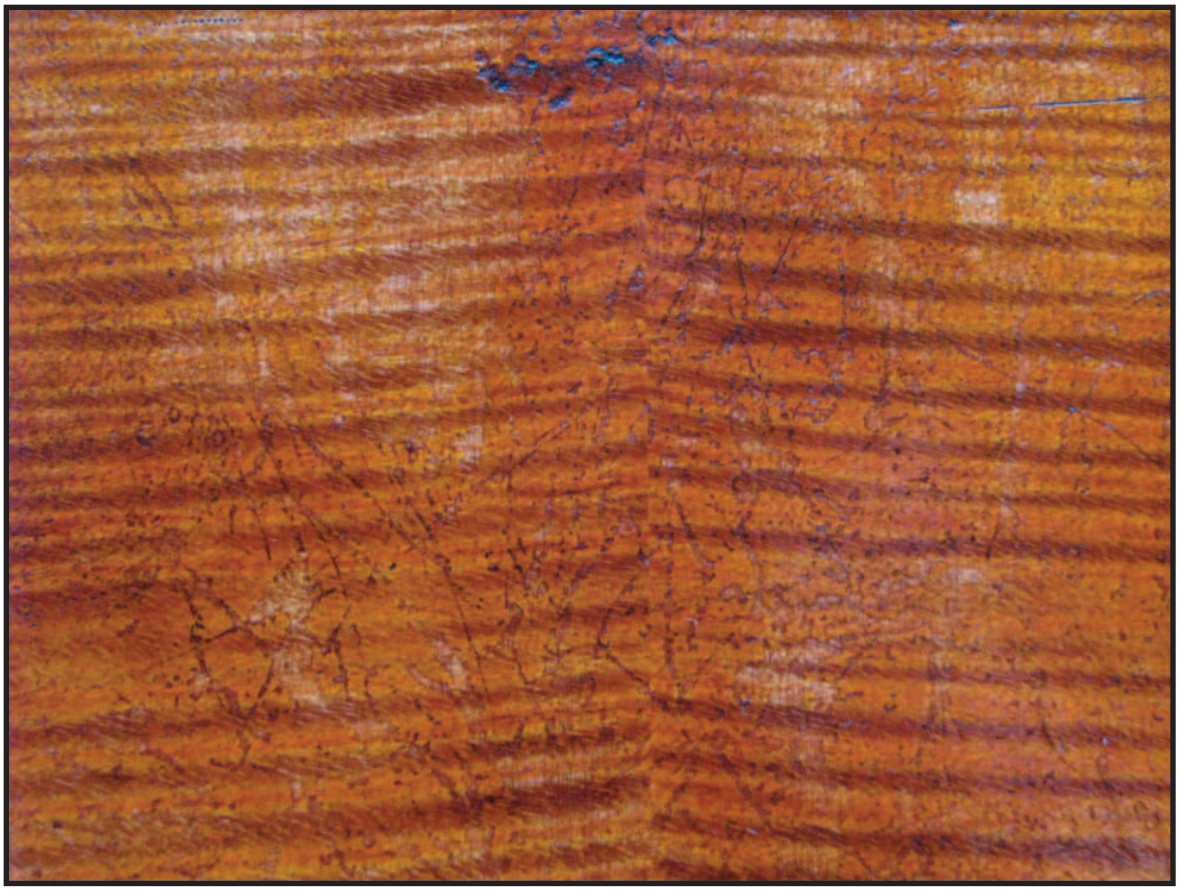

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Oh yes of course the bridge and the label. 368 369

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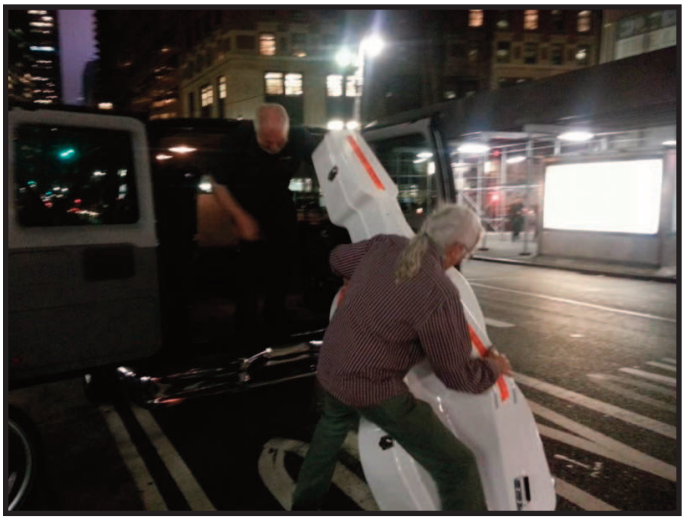
I cannot believe how much a bass weighs in its flight cases. Everything is getting a bit hectic now and I still need to iron my underpants. I believe the US border agency checks them.

It was a relief to say the least, to have the bass finally fitted up and sounding really fine. Don't you just love that moment when the first tones come from one of your instruments? I am dreading the trip to New York; the case is so big and heavy. Quite clearly the case does not fit in my car.

In the end because it is a new model the case did not even fit in René's truck. We had to break out a rear window to get it in!

After an absolute nightmare trip that taught me to have enormous respect for bass players everywhere and considerably less for airlines, here is the bass arriving in New York, being welcomed by all my friends; Joe Thrift, Yi-Ping, Julie Reed, George Yeboah and finally being played by Jason Sypher; an amazingly talented player. 370 371 372 373 374 375 376



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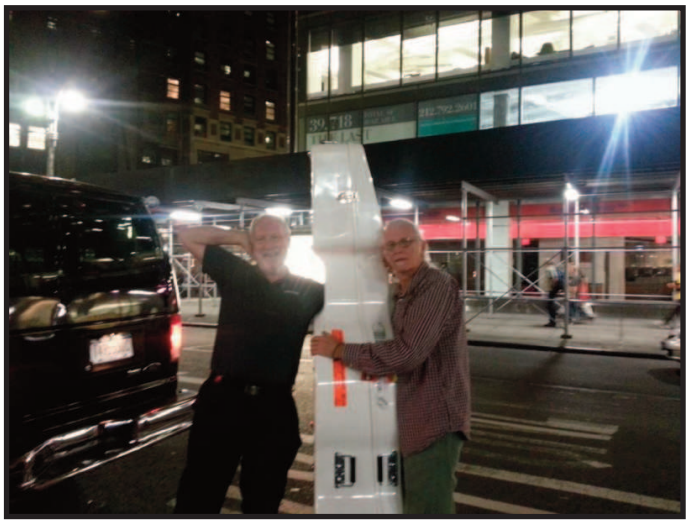

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I am getting old and forgetful, so as our journey comes to a close, René and I would like to thank everyone who helped us on this project: all those people on Maestronet who supported me when I wanted to give up on documenting the story. Then there is Julie, Yi-Ping and the team at Reed Yeboah Rare Violins, Chris Ruffo who has helped me to organize edit and this work, Ewen MacLaine on the computer, and finally my long suffering wife Claudia. If I have left anyone out I am very sorry.

Footnotes

1 Antonio Stradivari in Japan. Pub. Gakken and Co, Ltd. Tokyo 1984. P.135 Detail taken with the kind permission of the violin photographer Mr Shinichi Yokoyama.

2 Giuseppe Guarneri del Gesù. C. Chiesa, J. Dilworth, R. Hargrave, P. Klein, S. Pollens, D. Rosenguard, E. Wen, Peter Biddulph London 1998. The article entitled The Working Methods of Guarneri del Gesù and their Influence upon his stylistic Development from this book has been posted to the author's website. Visit www.roger-hargrave.de for more information.

3 To learn more about René's work, visit http://www.renezaal.nl/

4 Hieronymus Amati II, b. 26 February 1649, d. 21 February 1740. Known as Hieronymus II or Girolamo II

5 Harry Danks: Born May 18 1912; died April 26 2001. A pupil of the great viola virtuoso Lionel Tertis, Danks had a multi-faceted career - as orchestral principal, viola soloist, chamber musician, leader of a viol consort and authority on the viola d'amore. For many years he owned a Brothers Amati Viola of 1615, which he purchased from W E Hill and Sons, London.

6 It is very likely that this problem was not as acute in Amati's time. Since the original bass would almost certainly have had only three strings. It is also possible that the very early Cremonese cellos and even violas and violins had only three strings.

7 Antonio Amati, possibly born before 1540, died Cremona 4th March 1607, and Hieronymus Amati, probably born 1561, died Cremona 2nd November 1630. Together they were known as the 'Brothers Amati', or 'A. and H. Amati'. Individually Hieronymus is often referred to as 'Girolamo' or 'Hieronymus I'.

8 A bench copy is generally considered to be a highly accurate copy of a specific violin. Such copies are usually made from instruments sitting on the makers' bench while they are being restored.

9 I also use this saw to cut ribs off one-piece backs. I was shown this trick by Wilf Saunders, one of my mentors and instructors when I was a Student at the Newark school of violin making.

10 For a detailed description of this process and the features that it produced see; P. 139. Vol II, 'Giuseppe Guarneri Del Gesù'. Published by Peter Biddulph, London 1998.

11 The reasons for this asymmetry are analyzed on my web site at: http://www.roger-hargrave.de (The Working Methods of Guarneri del Gesú and their Influence upon his stylistic Development)

12 Stuart Pollens; The Violin Forms of Antonio Stradivari, Peter Biddulph, London, 1992.

13 Using an inside mould caused problems with the inside curve of the waist; their solution was to pin the sides to the mould. On Strad guitars this tiny pin is still visible.

14 Dendrochronology indicates that most Cremonese instruments were constructed from trees that were cut only a few years earlier.

15 "The Secrets of Stradivari" by Simone F. Sacconi, pub. Libreria del Convegno, Cremona 1979.

16 In the 1970's I saw a Guarneri violin that had been in a flood. It had more or less fallen completely apart. All the new edges and the bass bar had dropped off; even a large belly patch had fallen out. Nevertheless, although the belly centre joint was barely 1 mm thick where the patch had been, it was still intact. The back joint, the rib to corner block joints and the rib to endpin block joint were also intact. As my 1980's Strad article suggested, See my website; www.roger-hargrave.de 'The Case for Casein'. I believe that the Classical Italian makers, including the Cremonese, used casein glue for most if not all of these jobs. Probably, as far as they were concerned, it was not necessary for these joints to be made reversible. I also believe that Cremonese makers used casein for fixing the neck to the ribs. When made with quick lime, Casein is reasonably (not totally) waterproof. Furthermore, it can be used cold and for an hour or

so it allows joints to be adjusted. In contrast gelatine based animal glues have several disadvantages. They have a comparatively short working time and even in a Cremonese summer, some form of fire would have been necessary for their preparation. In winter however, larger fires would have been required to prevent the glue from gelling in their cold workshops. Casein also has one added advantage over most modern glues; it is possible to use animal glue to repair an open casein joint.Melvin Goldsmith recently found a supplier in the USA. The web address is www.nationalcasein.com

17 Since we were not attaching the neck, using the traditional Cremonese method, the back and belly outlines were established and finished before the ribs were removed from the mould.

18 A block of this nature block is preserved in the Stradivari Museum in Cremona.

19 Duane Rosenguard, frequently published author and bass player in the Philadelphia Philharmonic Orchestra.

20 Breaking the bend can mean ruining the back altogether.

21 See my web site: The Working Methods of Guarneri del Gesù and their Influence upon his stylistic Development

22 Sacconi, pp 61-65

23 Sacconi, p. 117 illustrates the unfinished contour of the 'Canto del Cigno' Stradivari of 1737

24 See p. 153 "Giuseppe Guarneri Del Gesu". Published by Peter Biddulph, London 1998

25 Initially this process also left the corner area flat. This was necessary, so that the corners could be clamped without damage, when the fingerboard was being attached.

26 These photographs of the Alard Amati were kindly provided by John Milnes ©John Milne's website ashwww.moleaninstruments.com they were originally published in 'Musical Instruments in the Ashmolean Museum', pub. Oxford Musical Instrument Publishing 2011. (Photo Number 148,149).

27 Sacconi p. 109

28 Gelatine glue is a general term for any form of animal or fish glue. For this job I used simple freeze dried animal glue from Kremer. You don't need anything special for preparing purfling.

29 There are generally three strips of purfling. This is because three provide a better barrier against cracks. Cracks usually start at the edges, especially where the end grain is. Any crack might break through a single layer and continue into the plate. Although a single strip might be the same thickness (or more) than three thin strips, rather like (although not quite the same) plywood, three strips are always much stronger.

30 Mark Jackson mark@cmjackson.plus.com

31 Whether or not Cremonese makers used an inside mould for their basses is debatable. Nevertheless this was the method that Rene and I chose, albeit employing a somewhat more 'modern' approach. There was for example no need to remove the ribs from the mould and attach the neck before finalizing the outline. Also the outlines of both the back and the belly were finalized together, while the ribs were still on the mould. Inevitably this had the effect of producing an instrument that is considerably more symmetrical than the genuine Cremonese bass that are were copying.

32 Hargrave, 'The Working Methods of Guarneri del Gesù and their Influence upon his stylistic Development', www.roger-hargrave.de

33 Sadly Brian passed away in 2013.

34 Although in many cases these pinpricks were removed when the buttons thickness was tapered to match the edge thickness, on original Cremonese buttons they are often plainly visible. See also my web site: www.roger-hargrave.de 'The Working Methods of Guarneri del Gesù and their Influence upon his stylistic Development'.

35 Koen Padding sadly passed away in Augusts 2012. He was a hugely influential figure in the world of violin making. Through his company Magister, he specialized in the research and the production of historically accurate violin varnishes. A collaborative project is under way to collect Koen's articles, talks and advice on the practice and theory of violin varnishing. Visit www.violinvarnishbook.net

36 Insert references.

37 So far no recipe has been found amongst Koen's papers. Although I only know the basics of the method, because this was a major source of income for Koen's family, I always promised not to say exactly how it was made. Perhaps something will turn up and the family can earn a little from Koen's research.

38 An English translation of the marquetry sections of l'art du Menuisier published by Lost Art Press. You can read more about urine/dung stains at the lost art press blog and follow' Woodworker Jonas Jensen of Mors, blog where he is documenting the process.

39 I think that I should also repeat here what I have said several times already. There are two approaches to varnishing. We can try and find out how and what they (whoever they were) used and try to make and do the same. Or we simply try to make something similar that works. This latter option is the option that you see here. I have spent many hours discussing this with Brigitte Brandmair. I have also bought and read her book. So I know that she did not find minerals in the ground layers like Barlow did. But Barlow was in the 1980's and she was mainly working with a Montagnana sample. (Don't panic! They won't crackle like that; it was probably the oil that he used.) I started using this system back then; I have gradually refined it and it works and it looks good. I hesitate to say that it has even fooled several experts. And just to alleviate any last fears. This system does not create the kind of mineral thickness that Barlow found and photographed. It is very much thinner than that.

40 "The Secrets of Stradivari" by Simone F. Sacconi, pub. Libreria del Convegno, Cremona 1979. Sacconi cites places on the rib to back and belly joints where this is apparent.

41 See White and Dilworth, The Strad Oct 1984, pp.437-438

42 Oxidization is a generic term that refers to the changes that occur in oil and oil varnish films over a longer period of time.

43 I purchased my Colophony from Kremer in Germany

44 Although inadvertently I showed the Strasburg Turpentine bottle, the varnish that I used on the bass was a colophony varnish.

45 Several colleagues have pointed out that if the pot needs to be removed from the heat quickly; a long handled pot might be better. Personally good fireproof gloves work well for me.

46 Stick lac is the source of shellac, which was initially imported into Europe as a red dye, the varnish parts

were thrown away. Today the story is the other way around. The difficulty again is getting the raw stick lac. I understand that the Indian government do not allow its sale because they want to extract the shellac themselves. Last time I bought any I had to get it from India directly. This might have changed. If you are interested in lakes it is easier to use and is certainly light fast enough.

47 I always use a plastic based glove. Rubber gloves not only absorb alcohols and solvents, they can also hold them against the skin, making the problem worse that wearing no gloves at all. Always check specifications before you buy them. Size is also important. You cannot work in gloves that are too big or to small.

48 These were originally used by my father to apply gold leaf.

49 Most artist suppliers make and sell crackle varnishes.

50 Antonio Stradivari in Japan. Pub. Gakken and Co, Ltd. Tokyo 1984. P.135 Detail taken with the kind permission of the violin photographer Mr Shinichi Yokoyama.

51 These photographs are reproduced with the kind permission of John Milnes. They are illustrated on page 140 of 'Musical instruments in the Ashmolean Museum', pub. Oxford Musical instrument Publishing, UK.

52 With linseed oils this drying process can continue for many decades

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