MISSION IMPOSSIBLE PART 4

In the final part of this series, **Shaun Newman** adds the fingerboard and frets, top nut and saddle bone, a finish, strings it up and sets the action, before making a bespoke flight case

In part 3 I described how the soundboard should be made, braced and fitted, as well as describing how to inlay the rosette. Next came the bindings and purflings for the soundboard, before working on, and fitting, the bridge.

Dry fitting the neck tenon into the soundbox

To ensure that when fitted the fingerboard is exactly flat, the top edge of the neck must be in exactly the same plane as the top of the soundboard and must not be set at a skewed angle as otherwise tuning and intonation will later become problematic. The easiest way of completing this task is to insert a shim of hardwood veneer into the sides of the mortise. In this case I chose ziricote. If the two surfaces are not exactly level, either a further shim can be added or a little can be taken off the sides of the tenon to ensure the correct fit (**photo 86**).

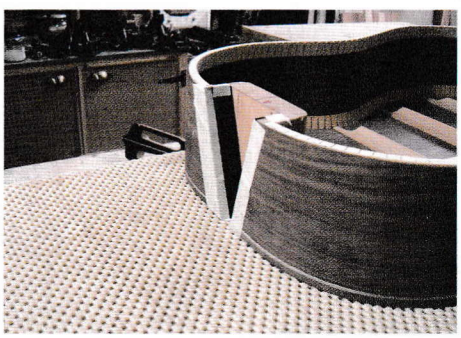
The fingerboard & frets

The fingerboard may be made from a variety of hardwoods such as ebony, rosewood, blackwood, ziricote, maple, etc. (**photo 87**). I chose to make this one from a billet of ebony measuring 55cm long × 75mm wide × 9mm thick. This would eventually match the bridge and headstock veneer. It was first planed on both sides to ensure flatness and brought to a thickness of 7mm. I had been wondering how to help the puny 5mm bolt of the Halsschraube out, as I had been worried that the neck might tilt forward under the tension of the strings or even twist, as the bass strings will exert slightly more pull than the treble ones. I then came up with the idea of fitting the fingerboard in two parts: first, a longer length would be fitted on the neck and would reach down as far as halfway between frets 13 and 14. The trick would be in cutting the lower end of the longer length into a wedge shape. This would then sit firmly in a reverse cut in the shorter length that would be fitted directly onto the top of the soundbox (**photo 88**).

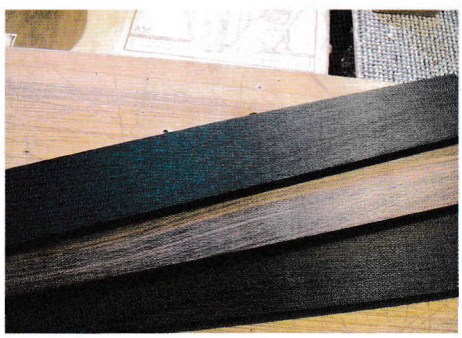
This idea did not only serve to help lock the neck and fingerboard into place, it also shortened the overall length of the neck, which later had to fit into the carrying case. If the whole fingerboard had been fitted to the neck reaching down as far as fret 20, it would have been almost impossible to get it into the box, even diagonally. So, two birds with one stone!

Having decided all of that it was now time to cut the fret slots. This job can be done with a fine dovetail saw and a small try square to ensure that each fret is parallel with every other, or a commercially available fret cutting jig can be used (**photo 89**). These are expensive and, as with the bending iron, if just one instrument is to be made it is probably not worth it. However, given that the same jig can be used for mandolins, dulcimers, banjos and all types of guitar, both classical and acoustic, it is a worthwhile tool.

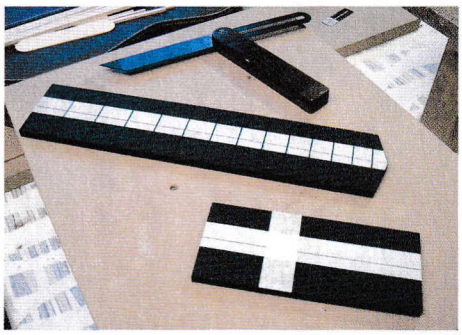
The frets must be carefully spaced according to the following formula for a standard 650mm string length. Remember that the string length is measured from the inside edge of the top nut and the inside edge of the bridge saddle. Note also that the 'V' join between the two different lengths of fingerboard must be cut before the lower fret slots are put in. This ensures that the frets from No.13 to 20 are not the thickness of a saw blade too close to the nut, which would mean they would play out of tune (**photo 90**). The scale is as follows: nut to fret 1 = 36.5; to fret 2 = 71; to fret 3 = 103.5; to fret 4 = 134; to fret 5 = 163; to fret 6 = 190.5; to fret 7 = 216.2; to fret 8 = 240.5; to fret 9 = 263.5; to fret 10 = 285.2; to fret 11 = 305.7; to fret 12 = 325; to fret 13 = 343.2; to fret 14 = 360.4; to fret 15 = 376.7; to fret 16 = 392; to fret 17 = 406.5; to fret 18 = 420.2; to fret 19 = 433; to fret 20 = 446 (**photo 91**).



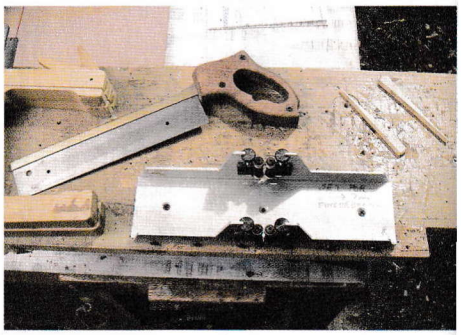
86 Hardwood shims in the neck mortise



87 Fingerboard blanks in ebony and rosewood

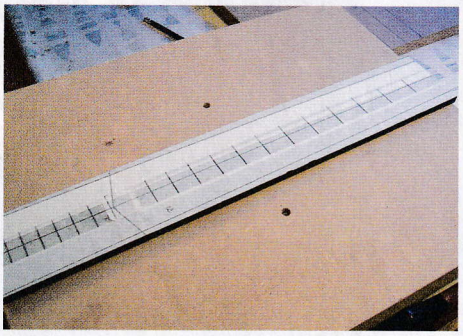


88 Fingerboard wedge to help lock the neck into place

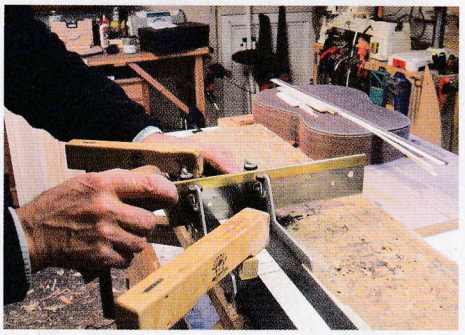


89 A commercially available fret cutting jig

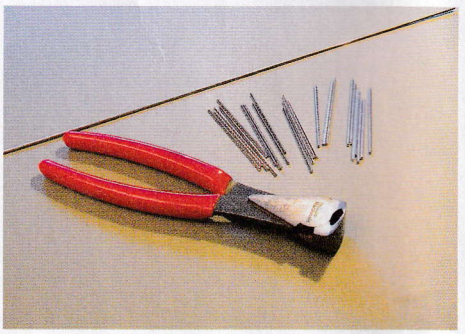

Shaun Newman
Crediton - Devon



90 Fret spacings marked on fingerboard



91 Cutting fret slots



92 Frets ready to fit

Each one is cut from a length of standard classical guitar fret wire and I usually cut them to around 6mm oversize. The overlap offers a part of the fret to hold between the finger and thumb while each one is tapped into place (**photo 92**).

The next task is to attach the fingerboard to the neck. To prevent the fingerboard from sliding out of line as the clamps are applied, four small holes (each 1.5mm in diameter and two per fret) are drilled through the first and the 12th fret slot. These will allow hardboard pins to be driven through the fingerboard and into the neck.

93 Attaching fingerboard – the pins prevent accidental movement

94 Levelling the fingerboard with a plate glass sander

They anchor everything in place as the Titebond cures and when the pins are removed the small holes will be covered by the frets when they are tapped in (**photo 93**). The fingerboard is then levelled. The best way I have found to do this is to take a piece of plate glass 60cm long and 8cm wide and cover it with 80 grit abrasive held in place with double-sided tape (**photo 94**).

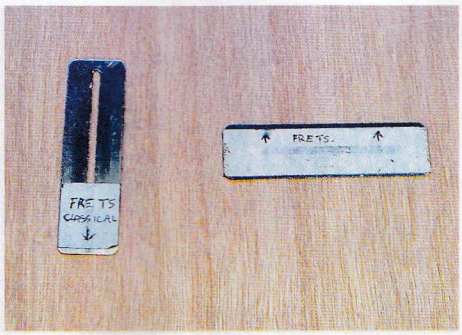
A hammer with a nylon face is best used to tap the frets in, as a metal face will damage the crowns. If you are lucky enough to own a 'dead blow' hammer, that is one with lead shot inside the head, with a nylon face, that is the perfect tool for the job (**photo 95**).

It is important to establish the correct depth for the frets as if the slot is too shallow the fret will stand too proud, but if too deep, the structure of the finger board will be compromised. An easy way to test the depth is to use homemade depth gauges. These are made from two pieces of thin metal and some masking tape. The masking tape is placed across the metal strips up from one edge at the depth of the fret tang. The narrow gauge can be used while the fingerboard is in the fret cutting jig, while the other can be used to examine the depth right across the fingerboard (**photo 96**).

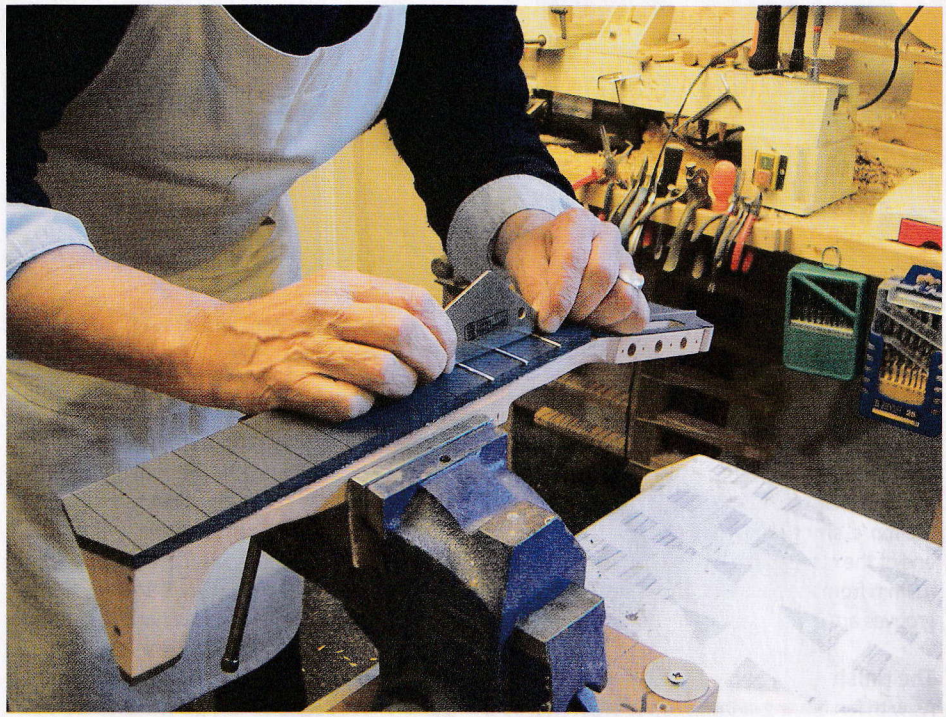
Once fitted and checked for level (**photo 97**) the fret ends are filed flush with the edges of the fingerboard and then the ends are sloped to 30° to take off any sharp edges. Two tools can be made to undertake these tasks: two old file blades are screwed to the underside of two hardwood blocks, one of which has the file edge sitting at 90° and the other at 30°. The blocks are gently run over the tops of the frets and the files do their job (**photo 98**).

At this stage just the longer length of the fingerboard will have been fretted, as this can be done immediately after it has been fitted to the neck; however, for the shorter piece it must first be fitted to the soundbox with extreme accuracy

95 Tapping frets in with a soft-faced hammer



96 Fret depth gauges



97 Checking the frets are level

and the slots cut and frets fitted afterwards. Next, a small ebony cap is attached to the heel (**photo 99**) and the whole neck can be reduced to its final shape and cleaned up ready for the first dry fit. A fine quality rasp helps to remove much of the waste wood around the neck (**photo 100**), and the final millimetre or so can be removed with a sanding stick. The profile of the neck beneath the fingerboard is usually 'D' or 'C' shaped: 22mm deep at fret 1; 24mm at fret 7; and 25.5mm at fret 9. The width of the neck at the nut is 52mm or 54mm, and at fret 12 it is 62mm or 64mm.

The top nut & saddle bone

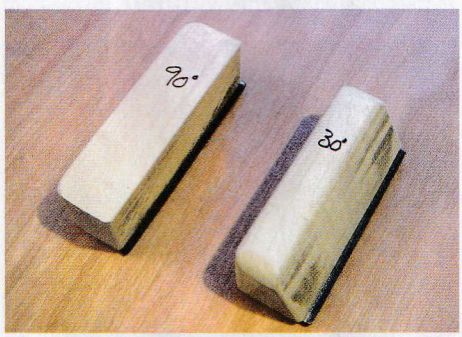
Each of these two parts are made from bone, though some makers have used very hard woods such as ebony. It is possible to go to a butcher and buy cattle bone, boil it for several hours (beware of the pong in the kitchen), then steep it in ley for a couple of days, and finally make up your own saddles and nuts. Yes, nuts! It is best to go to a luthiers' supplier and buy them in, however, as they are really not expensive (**photo 101**).

The saddle must first be made to fit tightly, but comfortably into the slot in the front of the bridge and should initially sit around 3mm above the slot on the treble side and 4mm above it on the bass side. The exact height of the saddle is determined later when the action is set (i.e. the string height above the frets).

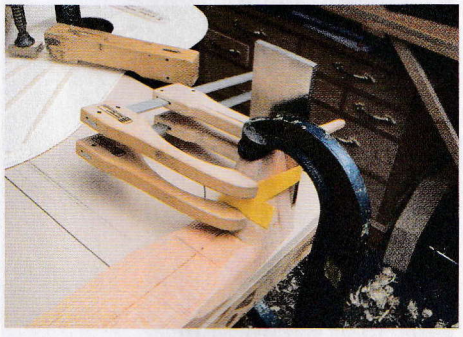
The top edge of the saddle is sloped down towards the tail end of the guitar to help the strings pass easily through the holes drilled in the tie block, and to prevent the strings from later buzzing as they are struck. For the third string (i.e. the 'g') the slope is reversed to help compensate for the extra thickness of the nylon, which can otherwise result in intonation problems (**photo 102**). When the saddle bone is fitted, the front edge will be rounded by just 0.5mm, which will help with intonation across the other strings caused by the increase in tension as they are depressed onto the fret. Note also that fret 12 is spaced at the halfway point between the nut and the saddle.

The top nut is stouter than the saddle at around 5.5-6mm thick. It spans exactly the width of the fingerboard at the top end. As with the saddle the edge is rounded, this time towards the headstock end, and grooves are cut into the nut to allow the strings to sit neatly in place. The grooves are put in place with fine round-edged files and should each be half as deep as the diameter of the string it will receive. This sounds complicated, but a set of fret files can be purchased from a supplier, or a fine set of needle files used carefully can fit the bill (**photo 103**).

Getting the string grooves in the right place

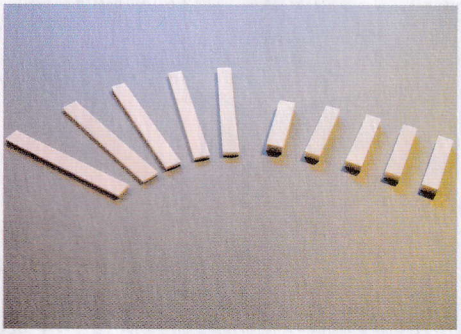


98 Fret trimming tools

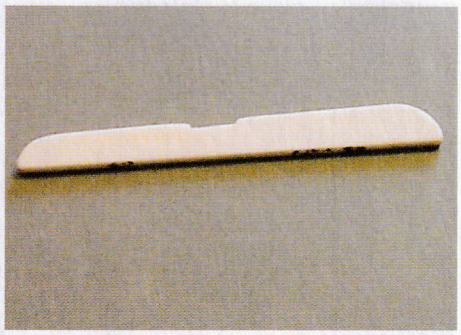


99 Ebony heel cap fitted

100 Neck cleaned up



101 Bone nut and saddle blanks



102 Finished bone saddle

103 Filing top nut string grooves

is important, as, for example, if the groove is too close to the end of the nut, then the string can roll over the edge of the fingerboard when it is pushed down by the fingertip. It is usual to place the top 'e' string groove at 5mm from the treble end of the nut, and the lower 'E' string groove 4.5mm from the bass end. The remaining four grooves are equally spaced in the remaining gap.

The finish

As with fan bracing, adhesives and timbers, there are many types of finish to choose from. The most popular nowadays are nitrocellulose lacquer, some oil-based finishes and a variety of polyurethanes. Some makers use urea formaldehyde resin plasticised in alkyd, while others still swear by French polish, despite the attendant difficulties of the latter. Over around a quarter of a century of instrument building, I have settled on the American product made by General Finishes, which is an acrylic resin and carries the name 'High Performance Water Based Top Coat – Satin' (**photo 104**). It has low VOCs and is environmentally friendly. It can be cleaned up with water and dries either to a satin finish or can be buffed to a gloss (note also it is available in gloss). It can be sprayed or brushed on. All in all, it works well with most types of musical instrument. Once the finish has been applied and buffed to a satisfactory sheen, the Halsschraube can be employed to put the whole instrument together (**photo 105**), then strings can be put on (**photo 106**).

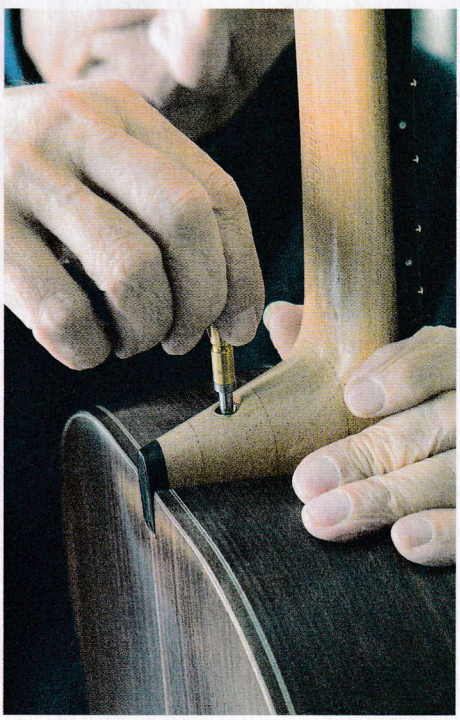
Stringing up & setting the action

The choice of strings for a classical guitar is vast, and more often than not relies on the players' own taste. Some will go for low or normal tension nylon, which may give a mellow sound; others will go for so-called carbon strings at higher tensions offering more volume and often a sharper sound. Due to the potential for movement at the neck join, however miniscule, I would recommend normal tension strings. As a starter I usually recommend D'Addario EJ45 Normal Tension, though lately have been attracted to the Savarez 'New Cristal Cantiga Premium' and 'La Bella 2001' strings (**photo 107**). The Savarez strings are available from the London Guitar Studio in Duke Street and the other brands are normally available in music shops. Whatever strings are chosen, steel ones should never be fitted to a classical guitar. I have seen so many good instruments damaged because the owner has inadvertently fitted acoustic or even electric guitar strings. Having said that, the famous Paraguayan guitarist, Augustin Barrios, always liked to fit a steel string for his top 'e'; however, his recurrent return trips to his repairer are almost as legendary as his playing! Beware.

One of the most hotly contested issues in the world of guitar playing is action. Some players, particularly of flamenco, and steel string instruments, like a relatively low action. Classical players often like a higher one. Normally the action is first measured at the nut end and is the distance between the top of fret 1 and the underside of the string. This height is normally set at around 0.7mm for all six strings, or the thickness of a standard credit card. The next part of setting the action takes us to fret 12, where again the action is determined by the distance from the underside of the string and the top of fret 12. For most classical players the action can be set here at 2.7-3mm for the top 'e' string, and 3.4mm to 4mm for the lower 'E', with the remaining strings having a graded action dependent on the flatness of the slope on the top of the saddle. Some players like the top of the saddle to be flat from end to end and others like a slight upward curve. Either way, the back edge of the saddle must still be rounded over towards the tie block.

At the bridge end, the underside of the 'e' string should sit at 11mm above the soundboard, and the 'E' at 12mm. Flamenco players will usually clip at least 1mm off these measurements and possibly 2. Tying the strings is an important part of getting things right. First, the string should be passed through the hole in the tie block and secured so that it will not slip. There are several YouTube tutorials available online, and a good guide in Rik Middleton's book *The Guitar Maker's Workshop*. The string is then extended up the fingerboard and over the top of the correct roller and the tuning button turned. Try to trap the loose end under the windings and this will help to ensure the string does not slip. I often tie a knot in the lower 'e' and the 'b', particularly at the bridge end, as they are rather thin.

104 General Finishes acrylic resin



105 Assembling the guitar with a Halsschraube

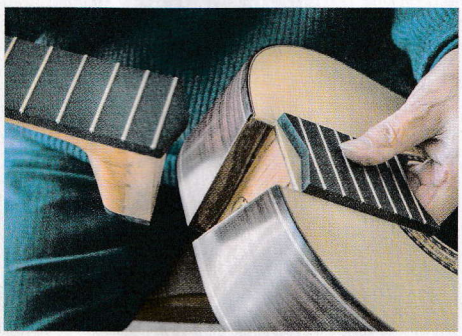
106 Putting strings on

107 Examples of strings by D'Addario, Savarez and La Bella

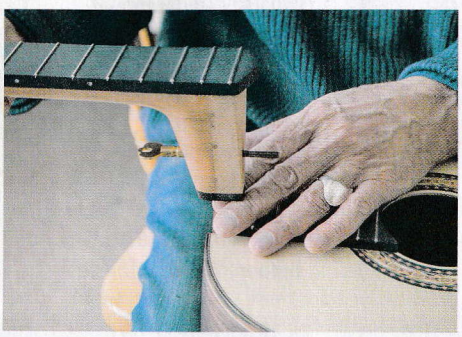
This helps to anchor them in place while the roller pulls it to the correct tension. The tuning regimen is E, A, D, g, b, e where when the 'b' is held down at fret 1 the note is middle 'c'.

The flight case

Having spent so much time making this guitar, it would be a real shame to get the case wrong! It must, as has often been mentioned before, comply with the requirements of an overhead locker in an aircraft, so 55 × 40 × 20cm. To begin with, a box is made up in the usual way, and the top cut off with a fine floorboard saw to ensure the lid and rest of the box fit together properly. The lining is made as mentioned earlier from 1cm thick rubber foam covered in crushed velvet. Each panel is held in place with a thin bead of epoxy running along the uppermost inside edge with double-sided carpet fitter's tape holding the lining to the rest of the box sides. It is clear that when the neck goes into the box it cannot simply sit on the back of the soundbox as the tuners could do serious damage to the rosewood. I therefore put two blocks into opposite corners of the box, each of which hold the neck just off the back of the soundbox. The headstock end is supported by a block, which has a 'V' shaped mortise cut into the top and lined with soft leather



111 How the fingerboard locks into the soundbox



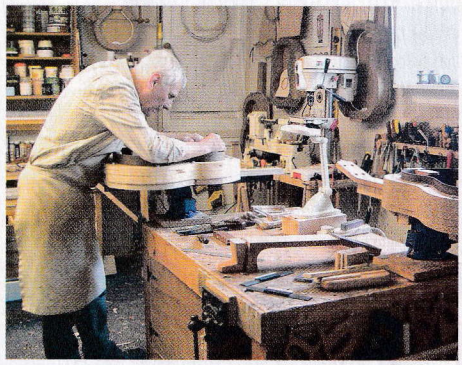
112 The bolt and clock key

108 Inside view of carrying case showing supporting blocks

to hold that end of the neck. The heel end of the neck also has a block with a mortise lined with leather but also with a hook-and-loop strap, which could be pulled tight holding the heel firmly down on the block (**photo 108**). Simply for 'belt and braces', I also made up a pad of foam covered in crushed velvet to lie between the neck and soundbox, just in case (pardon the unintended pun) (**photo 109**).

So, now it is time to fly off into the sunset, accompanied by your lovely classical 'air guitar' above your seat and safely stowed while I work on the next commission in the workshop (**photo 110**).

109 Foam pad to insure against accidental damage



110 Hard at work in the workshop

SUPPLIERS OF MATERIALS, TOOLS & ACCESSORIES

- **www.stewmac.com** – for all materials, tools, plans, drawings and accessories
- **www.touchstonetowoods.co.uk** – for timber and tools, rosettes and bindings/purflings
- **www.tonetechluthierssupplies.co.uk** – for timber and a wide range of tools
- **www.luthierssupplies.co.uk** – for timber, tools, rosettes and tuners
- **www.madinter.com** – for exotic timber, tuners, rosettes and tools
- **www.tonewoods4luthiers.co.uk** – for beautiful, exotic timber
- **www.dictum.com** – for fine quality tools
- **www.londonguitarstudio.com** – for strings, sheet music and many accessories
- **www.magic-guitar-parts.com** – for good quality tuners
- **www.smallwonder-music.co.uk** – for inlay materials, purflings, etc.

READING LIST

- *The Guitar Maker's Workshop* – Rik Middleton – ISBN 1-86126-040-7
- *The Classical Guitar, Design and Construction* – Donald McLeod and Robert Welford – ISBN 0852190778
- *Guitar Making Tradition and Technology* – William Cumpiano and Jonathan Natelson – ISBN 0811806405
- *Making a Spanish Guitar* – Jose Luis Romanillos – ISBN 13008619001
- *Classical Guitar Making* – John Bogdanovich – ISBN 9781402720604
- *Making Master Guitars* – Roy Courtnall – ISBN 0709048092
- *Make Your Own Classical Guitar* – Stanley Doubtfire – ISBN 0805238336
- *Classical Guitar Construction* – Irving Sloane – ISBN 0860012328