Bridging the gap

David Rigler draws on his fascination with industrial architecture to create his engineered desk

PHOTOGRAPHS BY DAVE RIGLER

Alongside my interest in furniture making I also have a passion for historical railway engineering and architecture. For some years I have wanted to take the engineered forms I find so attractive and reflect them in a piece of furniture. The forms I particularly wanted to strike a resonance with were the sweeping iron and steel arches of bridges and station canopies together with the cast, forged and machined shapes found on steam locomotives.

The need for a larger work desk presented the perfect opportunity. At the start I was not sure which materials I wanted to use but as the design progressed I decided I needed to have a strong contrast between the pins and the leg structure, which led to specifying oak *(Quercus spp.)* and American black walnut *(Juglans nigra)*.

Manufacturing considerations

This project is quite different from anything I had previously produced and more time was spent at the design phase thinking through how the various components would be made.

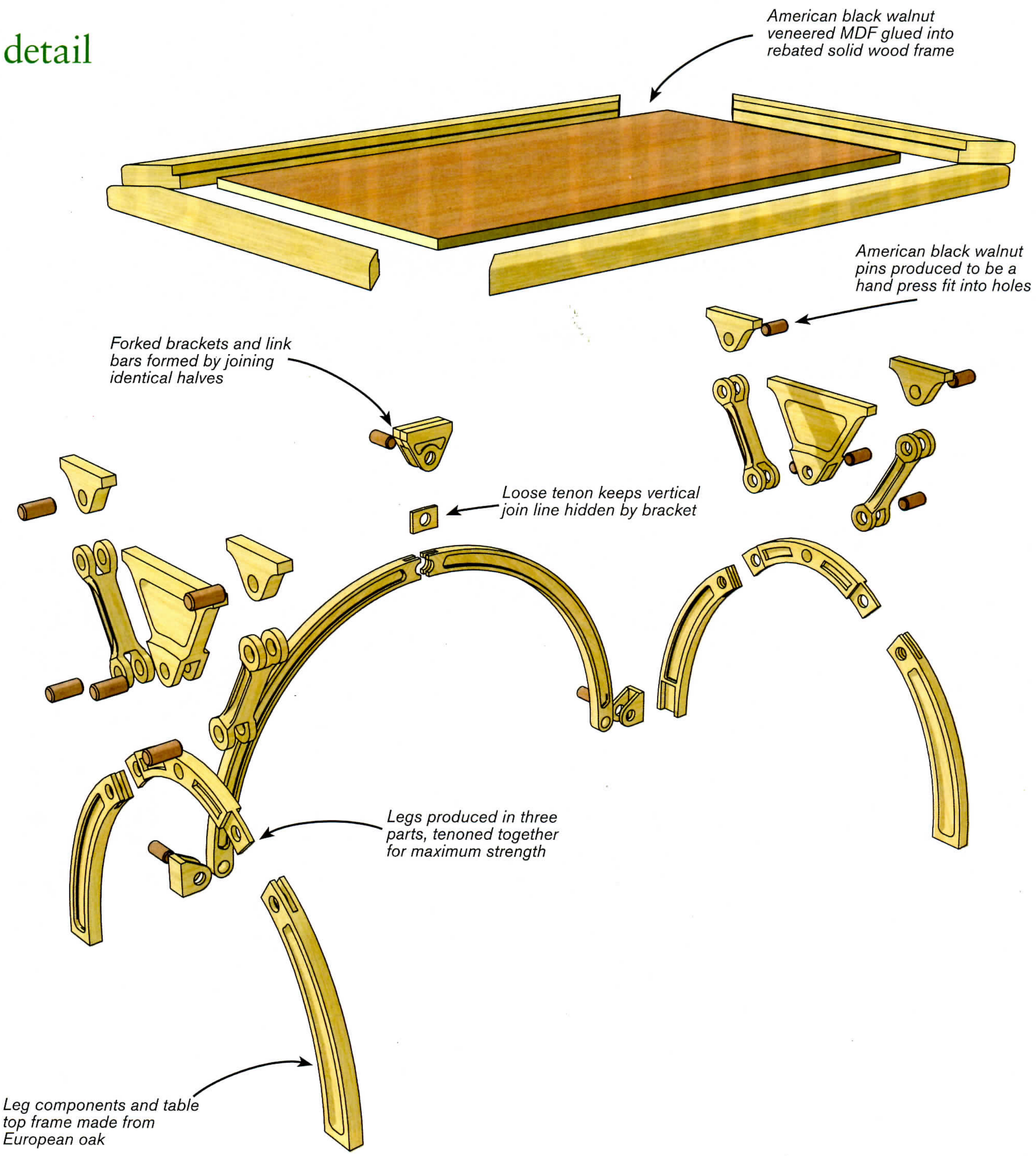
The relatively complex forms and the need for multiple identical components made a template approach the obvious choice. I had a set CNC cut from my CAD drawings but there is no reason why these could not be made by other means in the workshop. These master templates are then used directly for some jigs and operations and indirectly for the making up of other jigs.

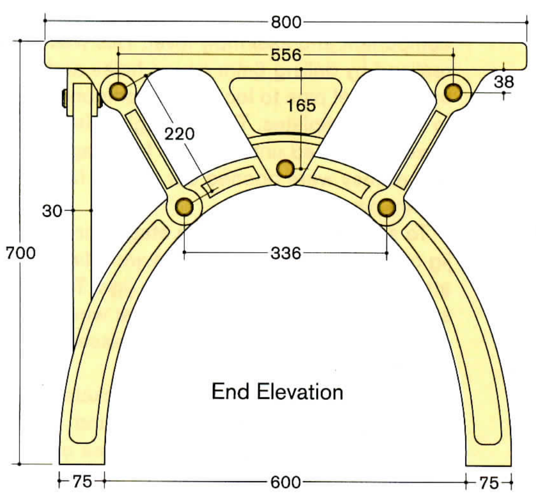
One of my main concerns was how to maintain precision. The pin joints have no adjustment potential and are critical for maintaining the alignment between components. Additionally the concentricity of the pin holes with the component profiles is visually very important. For these reasons the pin hole centres were chosen as primary gauge points for most operations at both component and assembly level. This was realised by drilling 6mm gauge holes and using dowel pins to locate the components to the jig/templates. These gauge holes were maintained until the very last stage before they were opened out to their final 30mm pin diameter.

To save repeating at each stage; for all jig operations the components were firmly attached by screws through the jigs. The screw locations were in areas that would either be hidden within a joint on assembly or removed by later operations.

The forked ends of the main brackets and link bars are 60mm in section and after some thought I rejected the idea of machining from solid in favour of forming ➤

In detail


American black walnut veneered MDF glued into rebated solid wood frame
American black walnut pins produced to be a hand press fit into holes
Forked brackets and link bars formed by joining identical halves
Loose tenon keeps vertical join line hidden by bracket
Legs produced in three parts, tenoned together for maximum strength
Leg components and table top frame made from European oak


800
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End Elevation
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600
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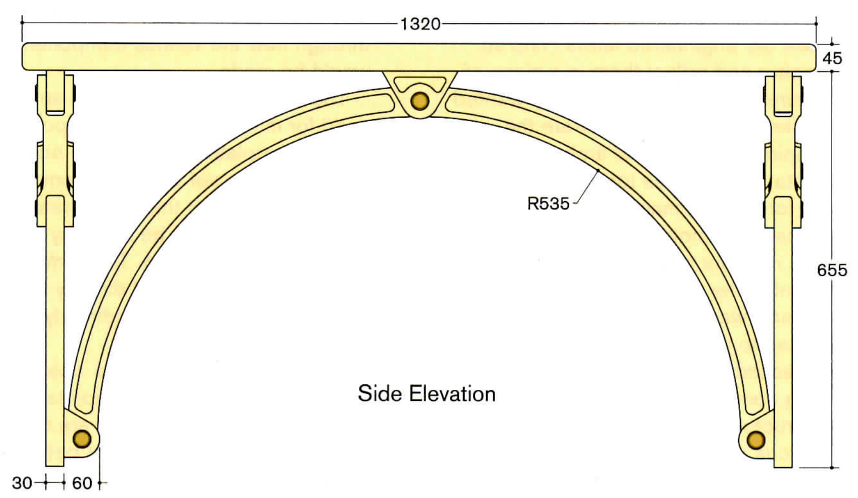
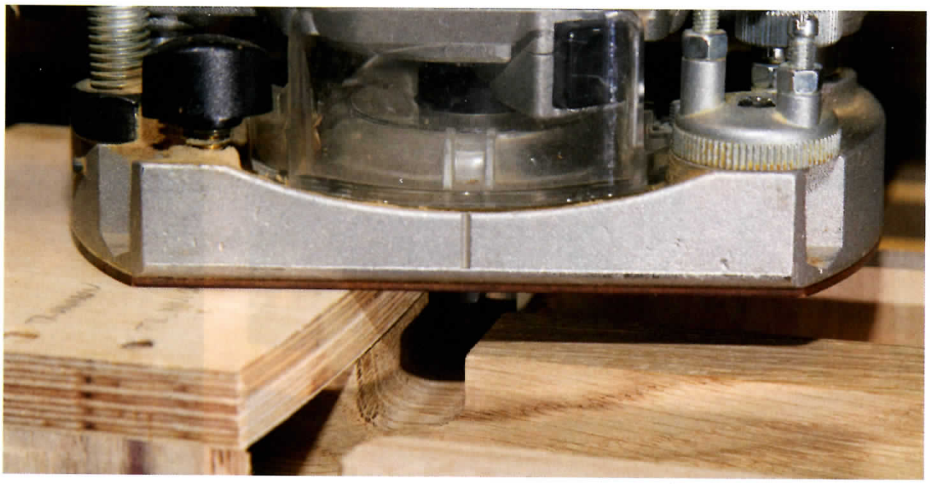
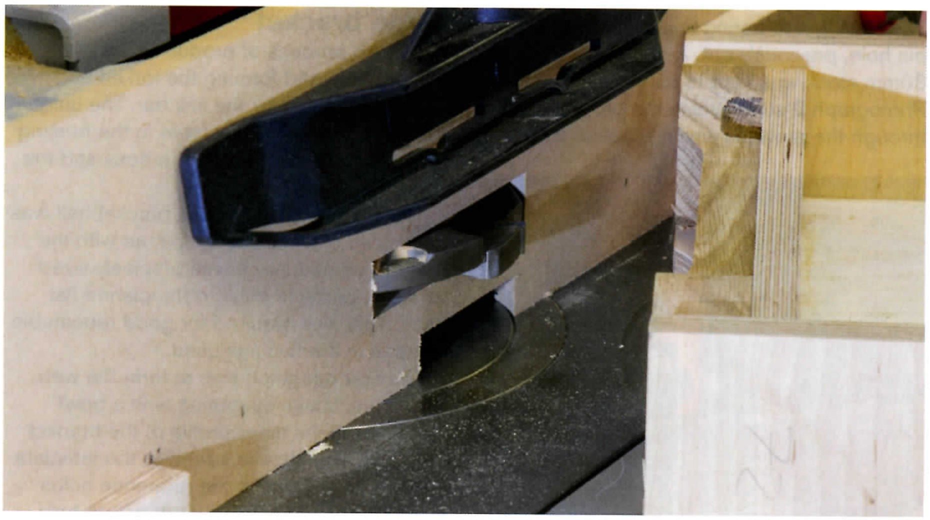

1320
45
R535
655
Side Elevation
30
60

1 The first step is profiling the link form using a spiral cutter and ring guide



2 Routing the root of the link fork with a bowl cutter

3 Forming the waist of the link shank



4 Stops on the straight fence control the length of the link flute

these components from two identical halves of 30mm thickness. The primary factor here was the importance of the fillet radii at the base of the fork and curvature of the fork base itself to match adjoining leg components. To produce this from solid would have required purchasing a new cutter head and tooling. This also matched the leg and rear brace thickness enabling the majority of components to be processed from 30mm planed stock, improving material utilisation through careful nesting, tracing round the templates.

The main components required multiple operations so it was important to carefully think through the process sequence. The link bars and large leg bracket are the most complex but also reflect the processes used on the other bracket components.

Link bar

The traced component blanks were rough cut from the boards and bandsawn to near net size. The master template was then screwed to the blank and 6mm gauge holes reproduced in the blank on the drill stand. I would note here that I found it was not safe to use the master template alone to profile to shape on the spindle moulder due to its small size. A larger jig was made using the master template to profile just over half the form. The blank was then profiled on one side and then flipped to repeat on the other side. The gauge hole dowel location proved very precise and the join between the two operations was barely detectable. The large blocks planted on the jig gave excellent control of the piece through the cutter and kept the hands well clear of danger.

The roots of the forks at the end of the link bar were formed using a router bowl cutter and jig. The top plate curved profile was produced using one of the leg templates. This jig was designed to also handle the rear brace brackets. The blanks were located using dowels in the pin gauge holes.

Waisting of the shank of the link was carried out next in another purpose-made jig. This was quite a deep cut of 10mm and I did find the cutter could tear out the material when climbing out against the grain. Although more time-consuming, cutting halfway and reversing the component in the jig resolved this and the overlap of the cuts was not visible. Marking and bandsawing to near net size might also have resolved this. The fluting was formed using the same jig against the straight fence with an adjustable height rebate cutter. The length of the fluting was controlled by stops clamped to the fence.

The component was then transferred to the drill press. A piece of waste plywood was clamped to the table and a 6mm hole drilled through. A dowel pressed into the hole then located the component gauge hole precisely on the drill centre line. A 30mm Forstner bit was then fitted and drilled partway through to form the pin diameter. Preserving some of the 6mm hole is important as this is used with dowels to align two half components together precisely when gluing to form the final component.

Before gluing, the flank of the fork was defined by scribing a line from the root cut around the end profile. After gluing together, the fork end was finished by bandsawing close to the scribed lines to remove the bulk of the waste before paring back to size.

5 A gauge pin in the ply base ensures the pin hole is concentric to the profile

6 Scribing from the root of the fork defines the fork flank

The sawing and paring revealed the 30mm pin hole, previously cut. A scrap piece of the 30mm stock was kept to hand to tune the fit. Photograph 9 summarises the progression through the previous seven process steps.

7 Waste material of the fork is removed on the bandsaw

Large bracket

The basic process of producing two half components and forming the forked end was the same as for the link bar. The unique elements of this bracket were in the forming of the waisted area above the boss and the web within it.

The blank material for the bracket half was bandsawn close to net shape, as with the link, but additionally it was precisely sized to width, perpendicular to the planed flat base. This was required for good repeatable location in the two jigs used.

The first operation was to form the web to final thickness by routing with a bowl cutter using the inner profile of the bracket template. The cheeks added to the template and the dowel pins in the reference holes provided the location. The pin gauge hole was also drilled on the drill press during this stage. The blank was then transferred to a second jig where a 12.5mm radius cutter was used to form the transition from the fork boss to the waisted area, very much like the forming of the fork base.

A line was scribed from the base of the cut around the profile to define the depth of the waisted area and the piece was returned to the jig. With the jig on its side, the waste was removed carefully on the bandsaw close to the scribed line.

The jig was then clamped horizontally to a work surface and the bracket planed down to the scribed line. The cheeks of the jig were set slightly below the finished height to help support the plane initially.

The piece was then returned to the template jig for finish profiling of the outer edge. Leaving the profiling until this stage removes any breakout from the earlier operations.

Like the link, the halves pin holes were part finished, drilled to 30mm and then joined in pairs with a dowel aligning the pin gauge holes.

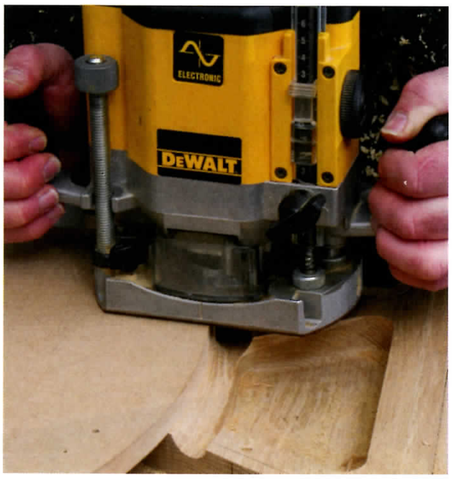
Legs and brace

The legs could be produced either in two or three sections. After some thought I produced the legs in three parts with break points at the two link pin locations. This was in part for better material utilisation but primarily because I felt the visual flow of the grain direction would be better. I used tenon joints, but am still pondering whether a loose tenon would have been better visually.

8 Final sizing of the fork is carried out by hand paring to ensure a good fit

9 Progression of link operations can be clearly seen here

10 **The main bracket web is formed using the bowl cutter**



11 **Transition from the boss to the upper part of the bracket is formed with a 12.5mm cutter**

12 **The bulk of the waste material of the bracket is removed on the bandsaw**

The rear brace, however, could only be made in two parts as the only reasonable break point was in the centre. This joint is a loose tenon. The process for these parts was to shape to near net size on the bandsaw and then, with the template screwed to the blank, drill the gauge holes. Note that the leg lower gauge hole is in the waste material below the finished length of the leg.

For these components, due to their irregular shape, it was important to create large jigs at the finished assembled size to enable accurate cutting of the joint interface ends, marking out of the joints and then assembly. The master templates were used to position the gauge holes, which again are the critical location feature. The joints were cut before profiling so that any marking scribes on the side surfaces would be removed.

Fluting of the legs and brace was produced with the router and bowl cutter using a large template capable of holding multiple parts. The advantage of this approach was that up to three parts could be cut in one setup and crucially there was zero risk of the router tipping due to the large bearing surface of the template. Location of parts was again done using the gauge holes and dowels, the resulting uniformity of wall thickness to outside profile was excellent.

Assembly gluing as stated earlier was carried out back on the large jig using the gauge holes to correctly align the parts. Finally, the 30mm pin holes were drilled fully through using the same process as described for the link bar.

Pins

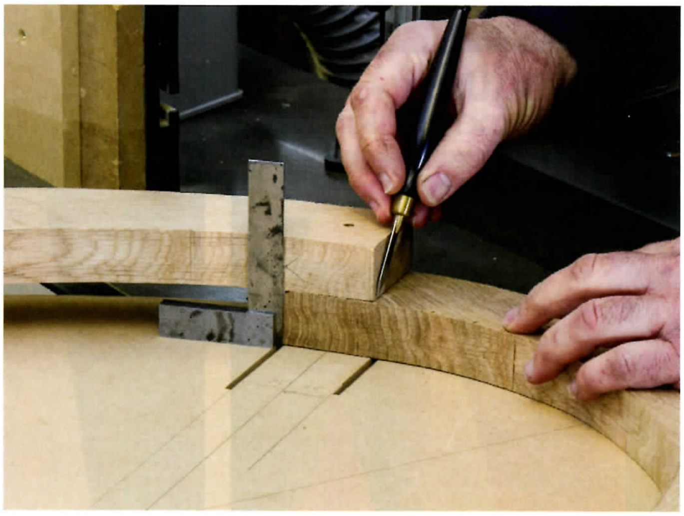
At the beginning of the project I thought I would have to outsource the pins as I did not have a lathe. However a chat with a local outfit revealed that they produce their round stock on a spindle moulder with half-round cutters. Why didn't I think of that?

Producing pins at precisely 30mm gives too tight a fit in the precise 30mm holes. To obtain a snug sliding fit I found that square section stock planed approximately 0.1mm undersized – 29.90mm – and passed through the spindle moulder four times at 90° rotations worked best. This produces near round stock with just four high points – at 30mm diameter – in line with the diagonals of the original square stock. This just needs a light sanding with a conforming block along the diagonal direction to achieve a nice fit.

Stopping short of machining full length and leaving a short section square assists with indexing the stock round for each pass and then knowing where the diagonals are ➤

13 **Final finishing of the bracket is performed with hand planes, the jig providing good stability**

14 **Precise parting of the joint end of lower leg using the full-size template**



15 **Marking out of the tenon joint with all three leg components located with gauge pins to the template**

16 Two lower leg and one brace component located on the fluting template

for final sanding to fit. The chamfers were produced on a small router table with a 45° cutter, rotating the pin against the stop and vertical fence.

Desk top

The desk top is of conventional construction with frame sections mitred at the corners, aligned and reinforced with 10mm Festool Dominoes. The inner top edge is rebated to take a proprietary American black walnut-veneered MDF insert. The outer edges, upper and lower, are radiused. The underside has rectangular sockets to take the leg and brace brackets.

Assembly

As previously noted, the pin joints leave no latitude for adjustment for tolerances in manufacture. The two areas where tolerances can be taken up are in the depth of the brackets in their sockets and the final cutting of the leg heights to the underside of the top. For the leg brackets the smooth radiused transition into the top must be maintained so any adjustment must be out of the socket and then the bracket radii paired and sanded back to eliminate any step.

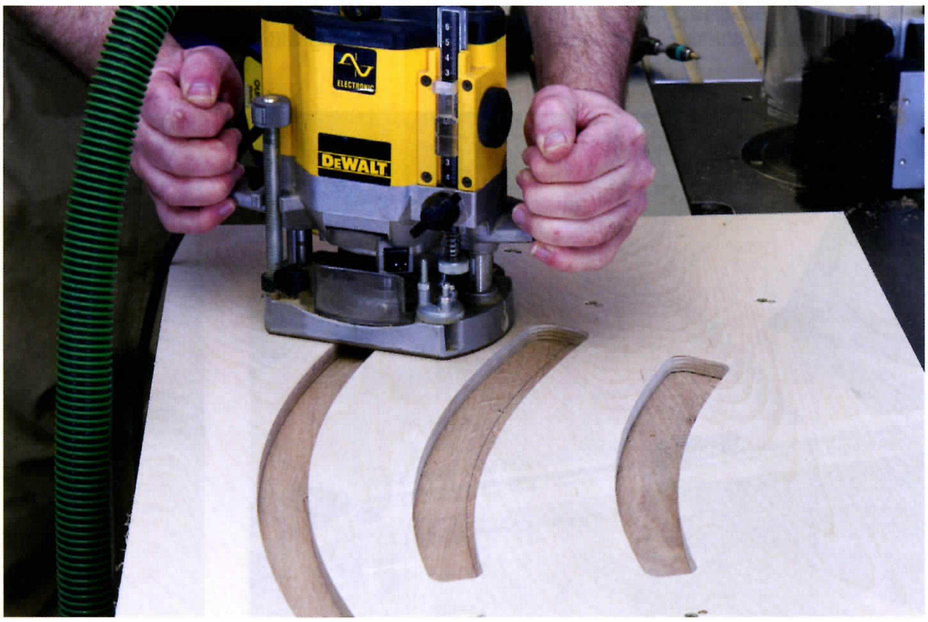
The process was to fully assemble the table inverted. I adjusted the brackets for each end and the brace so that any mismatch was above the socket. I scribed a line to pare down to and marked the leg height cutting lines to the same height above the underside of the table top.

The table was then dismantled, bracket adjustments made and the legs parted to correct height. The table was then reassembled with glue applied to the bracket sockets to finally set them in place.

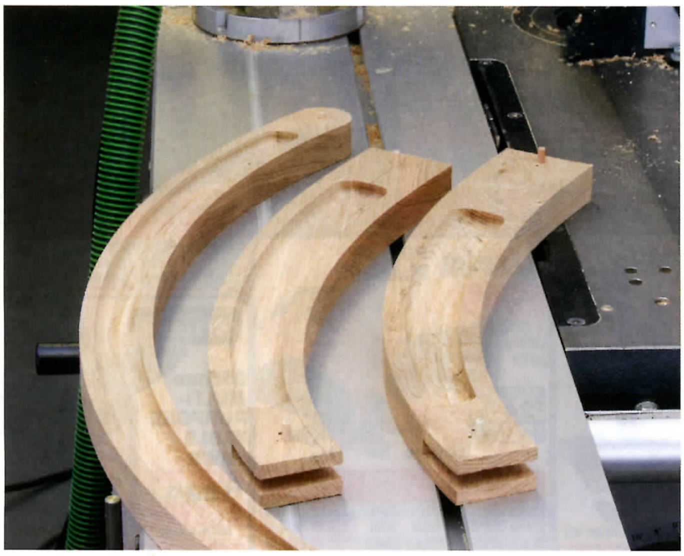
The leg components were then dismantled again, all parts sanded smooth and finishing oil applied to achieve the desired sheen. Before final assembly the pin holes were waxed with a candle to aid insertion.

Conclusion

Overall I am pleased with the end result and feel it meets my own design brief well enough to develop further designs off this theme. F&C



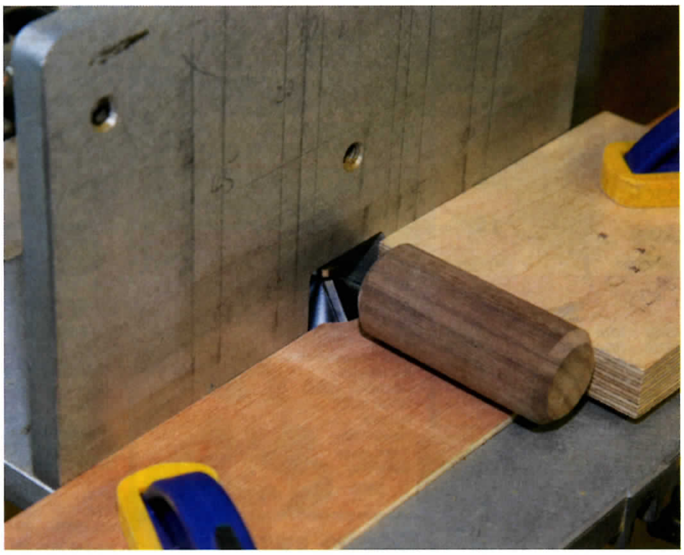
17 Machining the flutes with the bowl cutter



18 Finished fluting showing good uniformity of wall thickness to outer profile

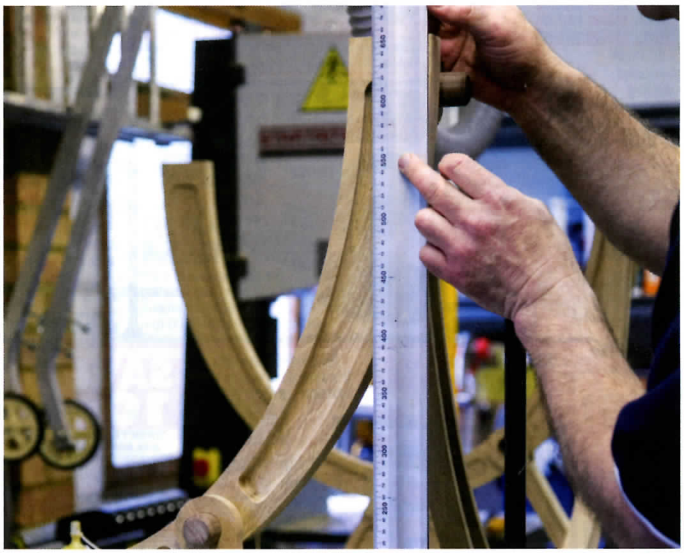
19 Two halves of the rear brace located with dowels to the assembly template and glued together with a loose tenon

20 30mm pin blank after four passes through a half-round cutter. Shop-made push stick keeps fingers intact



21 The 3mm pin chamfer is formed by rotating the pin against the horizontal stop

22 Leg components dry assembled and brackets scribed where necessary for adjustment



23 Leg height setting