The journeymen
Building a timber frame

The skills of green oak timber-frame building are rare, their use for constructing a new building rarer still. Barrie Evans describes a revival of a construction tradition.

The journeyman, a figure lost to industry, is much in the spirit of Timberwrights, the builders of a new green oak-framed building at South Harting in West Sussex. To be a journeyman was to have served an apprenticeship then to have travelled across the country working on different jobs to broaden experience on the way to becoming a master craftsman.

The journeyman was no itinerant. Institutions like the guilds provided direction. It is a learning method that lived on for timber framing in France, for example, in *compagnonnage* where the *maisons des compagnons* provided centres for finding work, for further instruction, and sometimes accommodation as well as teaching for local apprentices. Today, instruction is full time rather than fitted around daytime work but the *maisons* still exist, 1,2,3.

Timberwrights is a group of individual craftsmen who work together on large projects. The spirit of the journeyman remains: there is no sharp distinction between work and the rest of life and where building in local traditions and local materials keeps them on the move. At South Harting they lived on site in camper vans and a tepee five days a week. The cooking fire was always burning, though they found someone local to bring main meals to site so that they could concentrate on the work during summer daylight hours and relax together.

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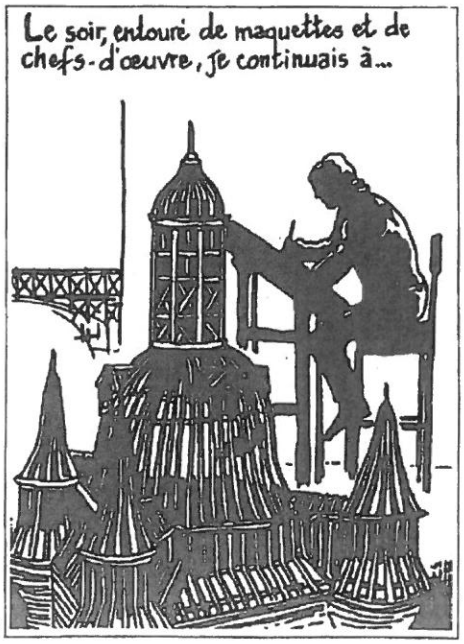
Timberwrights' craftsmen have honed their skills in recent years carrying out conservation and restoration work at the the Weald and Downland Open Air Museum at Singleton, West Sussex, mainly in the winter. Summer is the time for travel to repair and extend buildings. The South Harting project is their first wholly new timber-framed building, and seemingly the only one in the UK built using the centuries old plumb-line setting-out method. This is still taught in France but does not appear to be much used.



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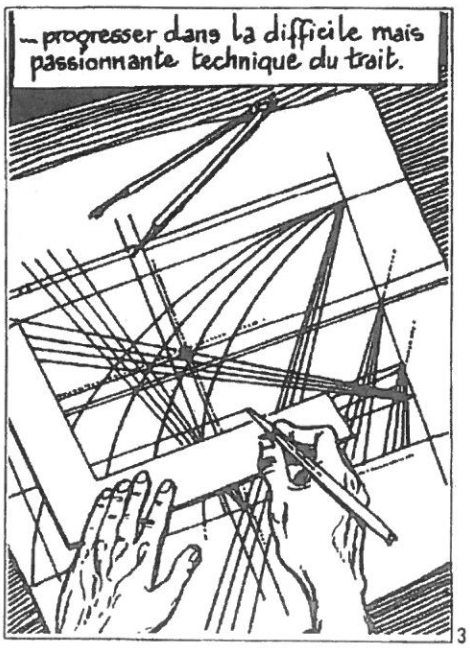

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1, 2, 3 Illustrations from a story of 'Le tour de France' of a journeyman charpentier in 1839-41. By this time, drawing techniques as well as making a maquette at about 1:20 scale had become part of their education.

Timberwrights regards building traditionally in green timber as ecological rather than historicist. The group sees long-life, timber-frame building as a viable method and a viable way of living today. The project comes alive and there is pleasure in the process of building. It is labour intensive but not plant or energy intensive. To date it has cost 2500 man hours but only £40 for on-site fuels for chainsaw and generator (plus materials transport). By knowing the timber, second-grade material can be used very efficiently, eyed up for its specific use in the frame and converted accordingly; swellings make jowel posts for example, and the best trunks go for floorboards. Such intimate knowledge of the timber allows timbers with knots and shakes to be used. The plumb-line method helps by allowing accurate marking up of irregular timbers (see later).

Agreement to build

Such a project needs a supportive client, one who welcomes the work camp in the field. Rupert Grey is a solicitor, one-time lumberjack and travel photographer, living in a small listed cottage hardly touched since it was first built in 1740s. It is overlooked from Harting Down, part of the South Downs Way, in an Area of Outstanding Natural Beauty. New building is strictly controlled by the planners. Also on site is a small thatched workroom that Grey himself built in 1968 and an existing timber-framed barn, thatched and clad in horizontal plain lap boarding. The new building is classed as a wagon store, to house Grey's collection of wagons. It is barn-like outside but hall-like inside with a part-panelled gallery at one end. So far the frame is built, external wall-boarding fitted and roofing ready for thatching; internal walling windows, doors and thatching are to come. Windows are to be inward-opening oak casements in the French manner, moulded to check draughts, and double glazed.

Grey met Timberwrights when it carried out some wind damage repairs to the existing barn in 1990. They got on well and agreed to build. As a solicitor Grey was well aware of the importance when setting up a congenial working relationship of avoiding contracts and the legal profession. A lump sum of £27,600 was agreed for the construction work — with timber, groundworks, etc, the final cost will be about £60,000. Not particularly cheap, but built to last several hundred years. Any significant variations were discussed as the job progressed. There were no specifications and no design professionals; Timberwrights provided a design and build service with just enough drawings to think through the design and to agree it with the planners, 4,5,6. Once convinced that the building would not be pastiche the county planners were very supportive.

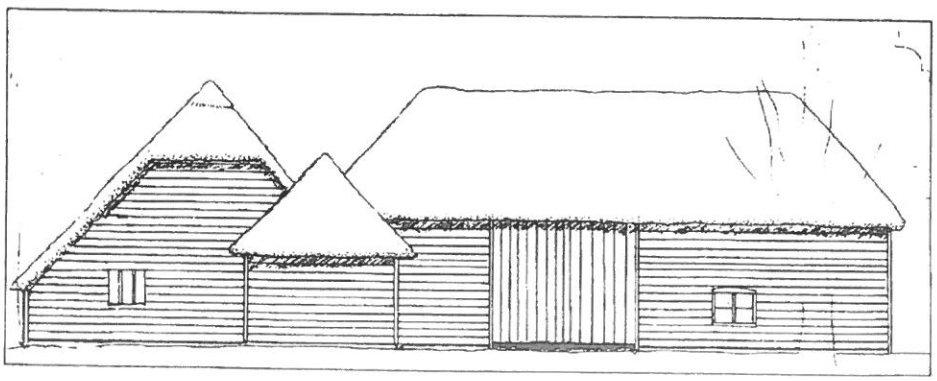
Design began with a discussion on adapting tradition, deciding on the overall dimensions (648sq ft footprint plus 108sq ft gallery), the cat-slide roof at the rear, and first thoughts on the walling. A planning condition was that the building was to be horizontally boarded and thatched, so the frame was made flush to the outer face rather than being jointed on the centre line.

The disposition of framing arose from tradition with members sized by eye, from Timberwrights construction methods and from the atmosphere it wished to create within the building. It is a barn outside, more spiritual within. Inside there will be lime plaster with the frame exposed. Crown posts are carved, one by Grey, and his wife Jan wants to carve the Latin inscription *Ad majorem dei gloriem* on one of the exposed beams, picked out in medieval colours. Grey also plans to have a fresco painted on the east wall plaster by Felix Delmer.

Grey purchased most of the timber by negotiating on the site of a new local by-pass where oaks were being cleared. They were not first class so would probably have gone for fence posts or shredding. Paul Russell of Timberwrights checked them over to look for shape, quality, wind twist, dead knots (die back of the ends of dead branches) and so on. Grey bought 33 butts of 17-25ft long, about 70 tonnes of timber for 50p a cubic foot. Elsewhere the market rate can be £20-25 per cubic foot, up to £120 for best dried timber in some conservation work. Converting the timber cost about another 50p per cubic foot and was more cheaply done in Bill Hackman's workshop a few miles away rather than on site.

The ideal timing of felling in winter was fortuitous. Later the sap is rising making the timber more vulnerable to disease and to drying out faster with more risk of defects developing.

Tapered rafters needed special conversion; reasons for tapering include making good use of a naturally tapering stem by quartering it, and putting more timber at the foot where the joint is more complex than at the head where opposing rafters are simply halved. Band saws make hard work of tapered cutting



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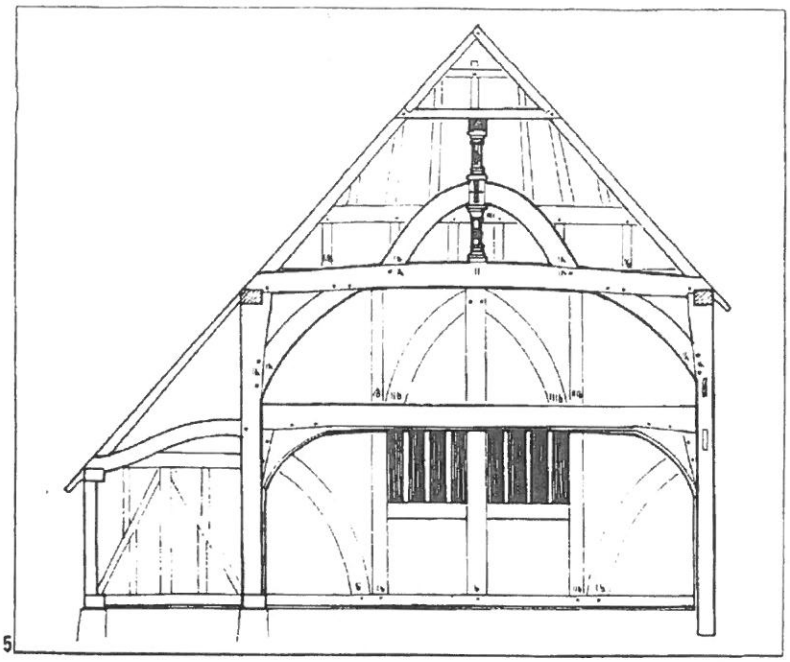
4 Planning application drawing showing west elevation of barn and adjacent buildings.
5, 6 Gallery cross-frame and side-frame elevations. Note the marking systems used. Ideally, every member should be marked in erection sequence but with such numbering systems there would be very large numbers. Typically the main frames are numbered first and then the subsidiary elements numbered in relation to them.



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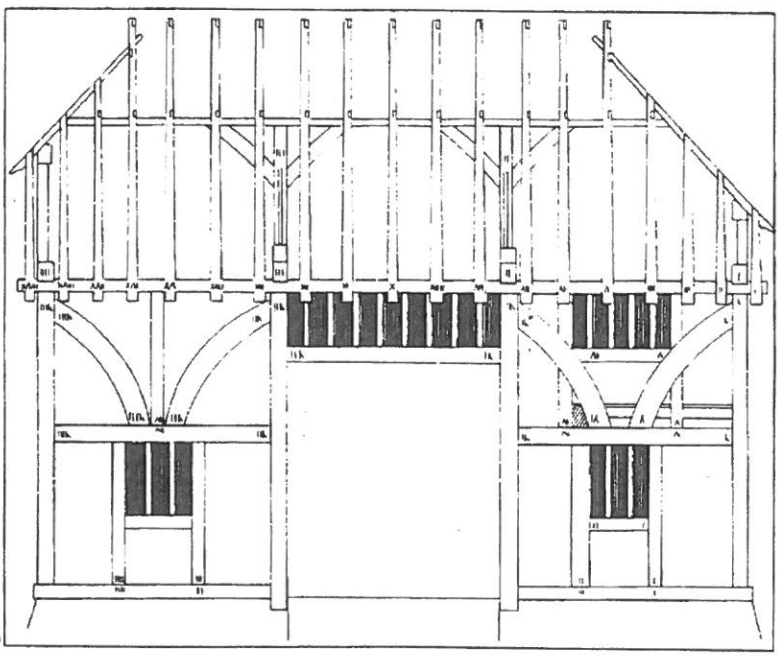

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which was offered at £3-6 extra per cubic foot. Instead, a chain saw was used following the grain. Band sawing, and particularly chain sawing, leave a ragged surface. Finishing on site with an adze, an accurate tool available in many sizes, increased durability by smoothing and closing the surface, removing less than a quarter of an inch in the process.

The more curved timber, which gives older timber-framed buildings some of their character, had mostly been burned. The curved diagonal braces could not be obtained from this source anyway because they need to be seasoned rather than green to limit their cross-grain shrinkage distorting the framing; green timber shrinks little in length on drying out. Braces need to be accurate, perhaps to a sixteenth of an inch. Grey found curved, five-year seasoned timber at Barchards in West Yorkshire for £9.50 per cubic foot in the round, costing about £1200 overall.

Construction sequence

We will look at framing and jointing in more detail below, but it is useful to have some overview. Handling is one of the hardest and most time-consuming aspects of timber-frame building, so much of the method is geared to controlling this. Handling at Harting was done by moving timbers on a two-wheel trolley; lifting was by block and tackle on shear legs.

Prepared timbers are used to lay out frames on the ground which are then marked out, joints cut, and fit checked while pegged with temporary steel pegs. Main elevations, cross-frames, and the whole of the roof structure are separately assembled on the ground as a check, then disassembled before assembly of the whole building starts.

Tenons and their shoulders are typically 1¼in across, with ⅛in allowed for cutting the mortice. Timbers are marked in sequence of erection and stacked in frame units so that they can be readily drawn out to the layout area when required. Erection is a piece at a time, the ring of sill beams first and then upwards. Cruck-framed (and Shaker) barns may have been reared a complete truss at a time, but there was no heavyweight pre-assembly and rearing here.

While timbers are being cut the foundations can be laid. This site is chalk and flint and thus difficult for foundations. Local builder Walter Bone used stone and lime mortar much as the eighteenth century cottage, but with concrete blockwork above ground up to sill beam level faced with hard clunch (chalk) with brick quoins.

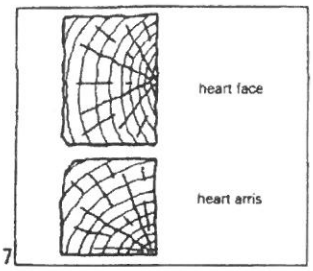
The overall construction sequence started with the drawings and finished in March 1991 after about a year's discussion. Timber was felled in February and converted in April. Timberwrights started on site in July. Foundations took from mid-August until the end of September. With two weeks lapse for the lime mortar to set, frame erection began. This took 10 days. The frame was topped out on 26 October to the accompaniment of spit-roasted lambs.

Framing

Since this is such an unusual event it is interesting to look in some detail at the framing and jointing of green oak.

The key principle of arranging a frame, or marking out a joint, is the use of imaginary horizontal and vertical reference planes. A predecessor of the modular grid, it has provided the layout logic for most of the current millennium. The point of imaginary planes is to provide absolute reference points for measurement; measuring from one uneven timber to the other is a recipe for cumulative errors. However, how far the logic of imaginary planes was understood back in the fifteenth and sixteenth centuries and how far the techniques were learned by rote is difficult to say. Bear in mind when looking at the following examples that the techniques were originally learned without drawings or our education in abstract geometry.

To begin framing the heart face is selected (if the timber is halved) or the heart arris (if quartered), 7, and the timber ends are sawn to produce a clean face. Sill beams are installed



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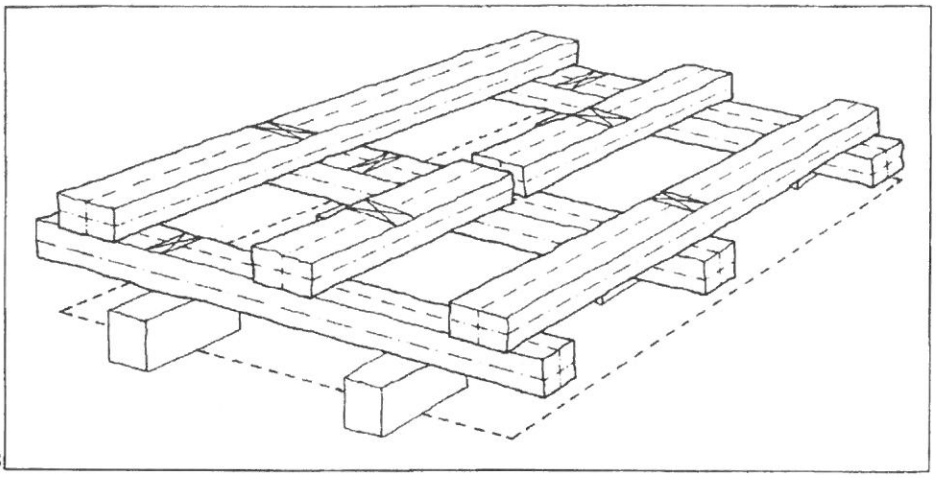

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with the heart face down or heart arris to the lower outside edge of the frame, wall plates with the heart face uppermost or heart arris to the topside edge of the frame. All other timbers are assembled with the heart to the outside face of the frame or panel. A strip is cut perfectly smooth across the heart face of main members for putting level marks. A datum line is scribed on an area cut smooth on each timber for reference during erection. Traditionally, measurement has been from 2ft down from the underside of the wall plate. It is not clear why, but may relate to another marking method, perhaps by rolling timbers.

The centre of each end of a timber is found by marking the diagonals. The timber is laid on flat ground and a plumb line or spirit level used to mark the vertical and horizontal through the centre of the end. Note that the timber may by twisted; it is the horizontal and vertical reference planes now defined from which layout measurements are made rather than the distorted surfaces of the timber. Chalk lines are run along the sides of the timber connecting where the scribe marks for the horizontal and vertical planes emerge from the ends, thus marking the imaginary planes down the full length of the timber.

With all the timbers necessary for a panel or frame marked in this way the layout, or piling, can begin. If there is a smooth level surface big enough the design is drawn full size on the floor. Timbers are positioned vertically above the drawn layout supported on suitable spacing blocks, 8. As each timber is positioned in relation to the ground plan by plumb-line, great care is taken to ensure that all reference planes — the imaginary planes defined earlier — are true to the horizontal. Each timber is carefully wedged to prevent movement. This is essential for success in subsequent operations.

Joint marking

Two examples of joint marking out are given below — for jointing a timber with a broken arris and for jointing twisted timbers — which illustrate the plumb-line method. The tools of the trade are the plumb-line, the dividers for transferring dimensions and a spike for making score marks. In both examples you will see that the plumb-line does more than make a vertical; it sets up imaginary reference planes parallel to the planes already marked on the timber, from which measurements can be taken.

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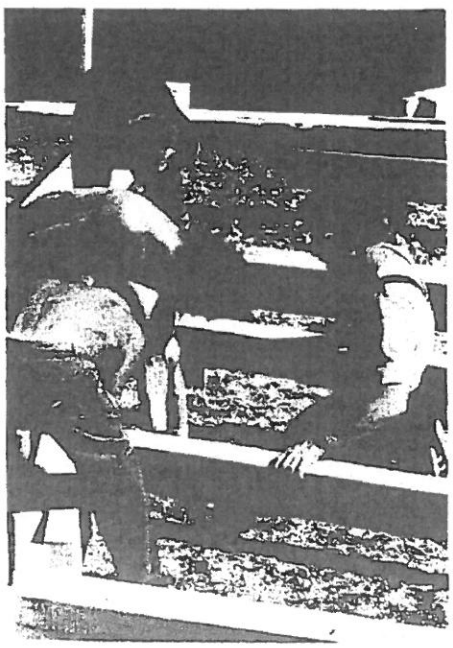

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7 Choice of face orientation improves durability of the frame.
8 Layout above the frame plan marked on the floor. The crosses on the timbers faces are the datum points for level measurement.
9 Trimming a joint face on a jowel post. Paul Russell of Timberwrights is using a 'bis aigue', a two-handed chisel he was given by a French carpenter.
10 A sense of the heaviness of the work when manipulating timbers precisely. In the background is the indented surface of a timber finished with an adze.

There were 1060 joints cut, though by no means all as complex as the examples. Some 380 pegs were hand-made, and a few cut nails were used for fixing the heads of the bonnet end rafters. Most pegs are round 'draw pegs'; the holes in the mortice timber and the tenon are cut offset so that driving in the peg draws the joint together. Halved joints such as at the top of rafters need a friction peg so these are cut more square than round, hence the expression about square pegs in round holes.

A 'oroken arris

Economising on materials involves marking out despite timber defects such as broken arrises. Most members in a timber frame are in compression so the accurate seating of the tenon's shoulders on the timber around the mortice is very important. If irregular timbers can be marked out accurately a good fit can be achieved, **11**. The example, **12a-h**, indicates a sequence of such accurate marking using plumb-line, dividers and spike.

Diagram **12a** shows the two timbers laid out on the ground, the imaginary horizontal and vertical reference planes marked, and the plumb-line hung at their intersection. The arris of the lower timber is broken away so the shoulder of the tenon will have to be shaped to fit round it.

Diagram **12b** shows transferring dimensions with dividers. The thickness of the upper timber above its horizontal plane is transferred to the lower timber.

In diagram **12c**, on the lower timber the depth of available flat area below the horizontal plane is transferred to the upper timber.

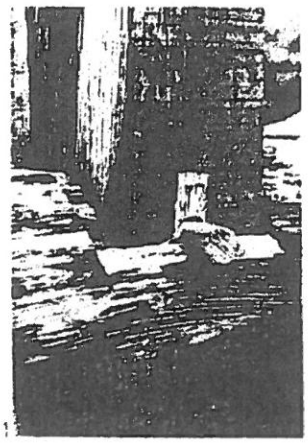
In diagram **12d** the imaginary reference plane (tint) set up by the plumb-line comes into use. The depth of the upper timber below its horizontal plane is transferred to the lower timber *measured down the plumb line*. Then the spike is used in the imaginary plane (tint) to transfer that height horizontally onto the timber.

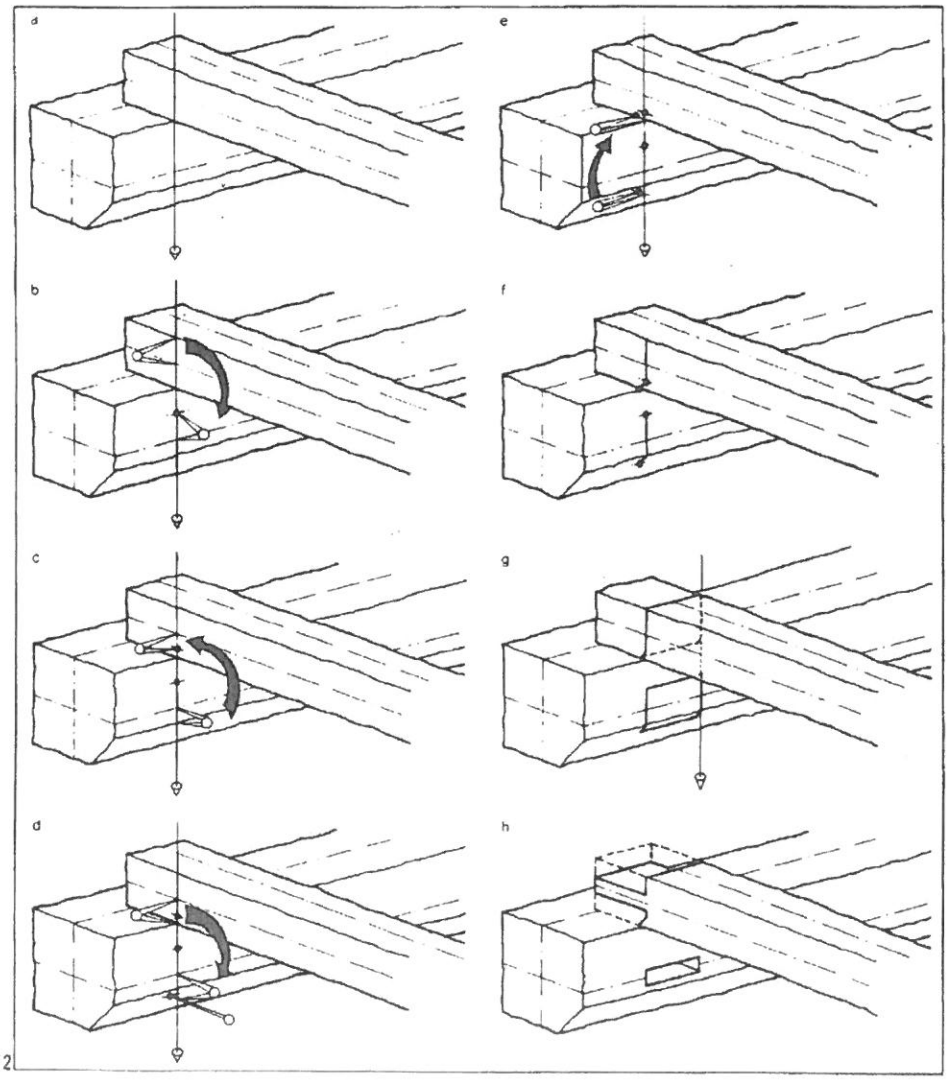
In diagram **12e** the offset of the point just marked from the plumb line, measured in the imaginary plane (tint), is transferred to the upper timber.

In diagram **12f** the transfer marks are joined up, marking the line of meeting of one edge of the tenon shoulder when cut.

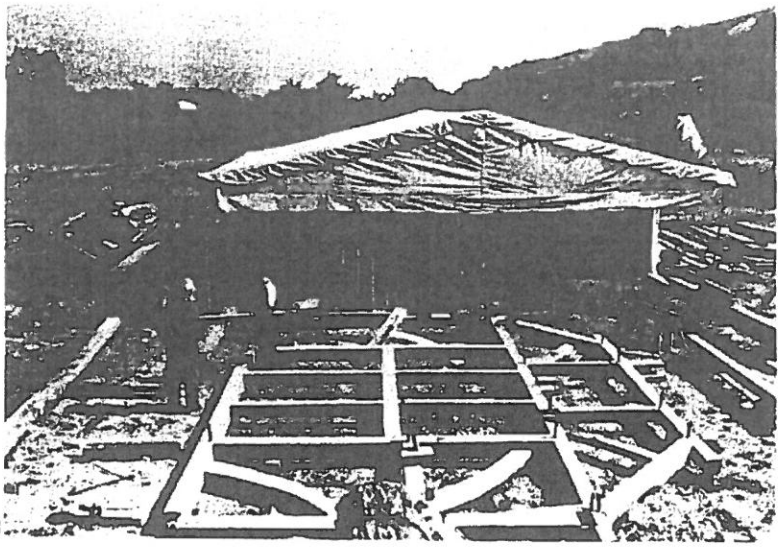
In diagram **12g** the dimension transfer process has been repeated on the other face of the upper timber, where the plumb-line is now located, and the dots are joined up to show where the shoulders of the tenon on the upper timber will meet the lower timber.

Diagram **12h** shows the timbers cut to fit.





11 Economical use of timber, dependent on a good fit of tenon shoulders to timber face.
12 Sequence described in text of marking out tenon shoulders to fit an irregular timber. It would be regularised to some extent to provide a sound surface. The imaginary reference planes are used here to explain the logic of the marking out; there is no evidence, for or against, that they were used in teaching the method in the past. The process looks elaborate but once practised is quicker to do than to explain.



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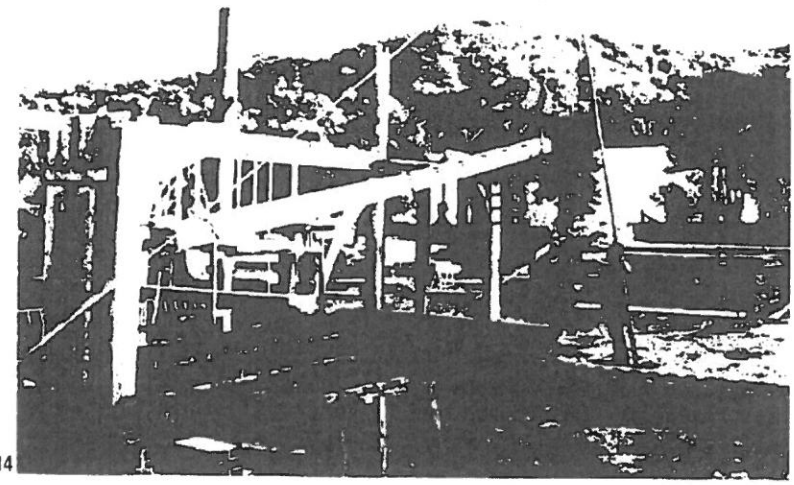

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13 Laying out a frame on the ground to check the accuracy of jointing and overall flatness, pegged temporarily with steel pegs. It is then broken down and erected piecemeal, as shown in 14. Note the marquee Timberwrights hired to improve working conditions and the tepee in the background.
14 Working from the end on the left, the galley framing is being built up. Lifting is by manpower. Steel pegs are used temporarily.
15 Head of a jowel post; one of the most complex sets of joints to make.

Joining twisted timbers

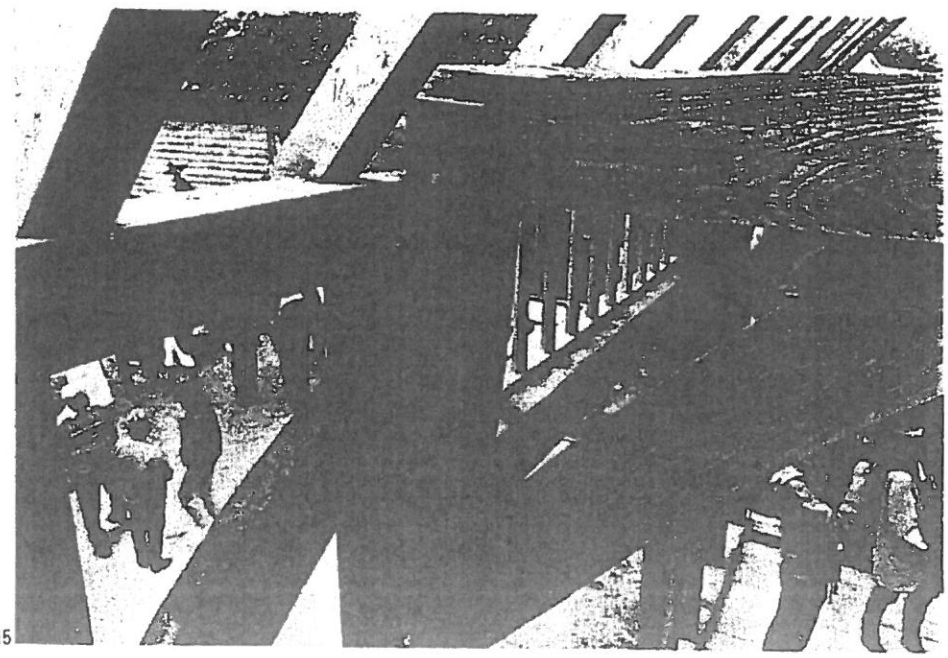
That was straightforward enough. The imaginary reference plane (tint), **12d**, was shown to be in line with the timber face above, so it was easily imaginable. More subtle is the twisted timbers method.

On diagram **18a** we see two timbers laid out meeting at an angle, say the corner of a truss, with the joint cut indicated. Marking out such a joint for cutting is straightforward if we have already got to the point shown in diagram **18b** where we know where the shoulders of the upper timber will meet the lower one. This is like the situation in diagrams **12g,h**. In this case we could mark it out simply by using a ruler since everything is orthogonal.

Let us now look at a real situation where the timbers are twisted, as in diagram **18c**. Here the timbers are laid out on the ground and wedged so that the reference planes already marked on the timbers are horizontal and vertical, even though the timbers' surfaces are not. The plumb-line touches the timbers at only two points (which will be different depending which way the timbers are twisted). But the principle is the same, as in the previous set of diagrams **12a-h**, of transferring dimensions from one timber to the other. In this case, **18c**, the plumb-line sets up two imaginary planes (tint) parallel to the vertical planes through the centres of the timbers. The upper imaginary plane (tint) is parallel to the vertical plane through the centre of the lower timber; the lower imaginary plane (tint) is parallel to the vertical plane through the centre of the upper timber.

In diagram **18d** we want to transfer the height and offset of the top edge of the upper timber down to the lower, making all upper measurements in the imaginary plane (tint).

In diagram **18e** we want to know how far down the bottom timber the upper timber will come. Again we must make use of the upper imaginary plane (tint), transfer the dimension down the plumb-line and project it horizontally forward in the lower imaginary plane (tint) using a spike.



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In diagram **18f** we measure the offset of the point just marked, measured on the lower imaginary plane (tint) and transfer it to the upper timber.

Diagram **18g** shows the process of transferring marks repeated on the other side of the timbers (as shown by where the plumb line is now located) and then their joining up to define where the shoulders of the tenon on the upper timber will fit against the lower timber. Having defined this, the actual mortice and tenon can be worked out with a ruler, diagram **18h**.

Confused? You may well be. And if you are not, can you now imagine it for differently twisted timbers? 'Imagine' is the key word. If you have followed the process closely you will certainly have stopped to check if you have it right. But for centuries this was taught without drawings, and not necessarily by *proficient* teachers. The craftsman had to imagine the planes without diagrams, or learn them by rote. Trying it helps of course, but when the result is a few pits made by a spike or the point of the dividers which are scarcely distinguishable from the natural defects in the timber, learning can be painfully slow.

It is a tribute to the craftsman that timber frames have been built so accurately over the years (or maybe others fell apart). No wonder knowledge of such 'mysteries' was so highly prized and protected by the guilds.

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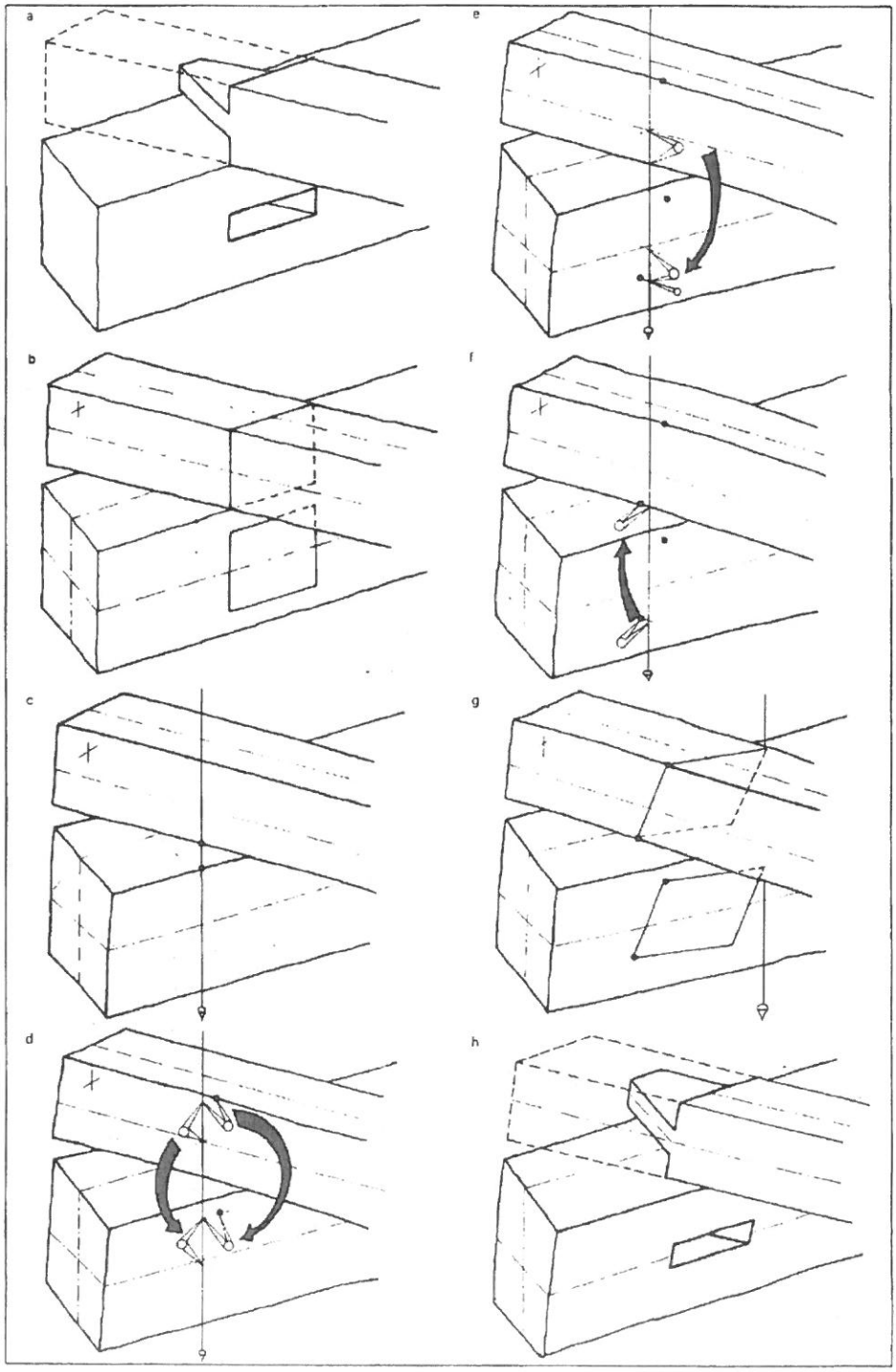
16 The plumb-line method used in anger.
17 From the same source as figures 1-3, an earlier use of a plumb-line method. Note too the frame layout drawn on the floor.
18 The efficient use of twisted timbers is where the plumb-line method really comes into its own, with the craftsman working from imaginary reference planes rather than the timber faces.



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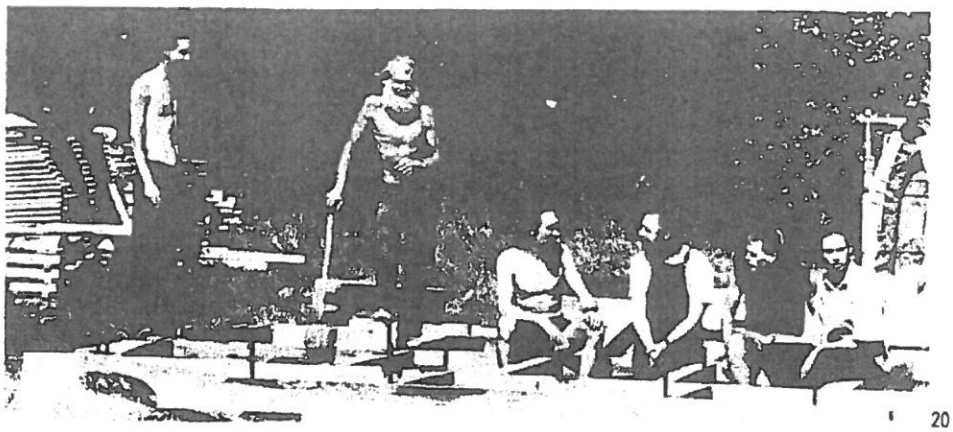
19 The frame was completed on 26 October last year after 10 days of erection, including working late by artificial light. Later that day some of the guests from the topping out remain. The raised gallery is on the right.
20 The Timberwrights.



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Credits
location South Harting, near Petersfield, West Sussex
client Rupert Grey
timber frame Timberwrights: Paul Russell, John Winterbottom, Andrew Holloway, James Russell, Ben Wansbury, (tea — Amsden Russell)
substructure Walter Bone
timber conversion Bill Hackman

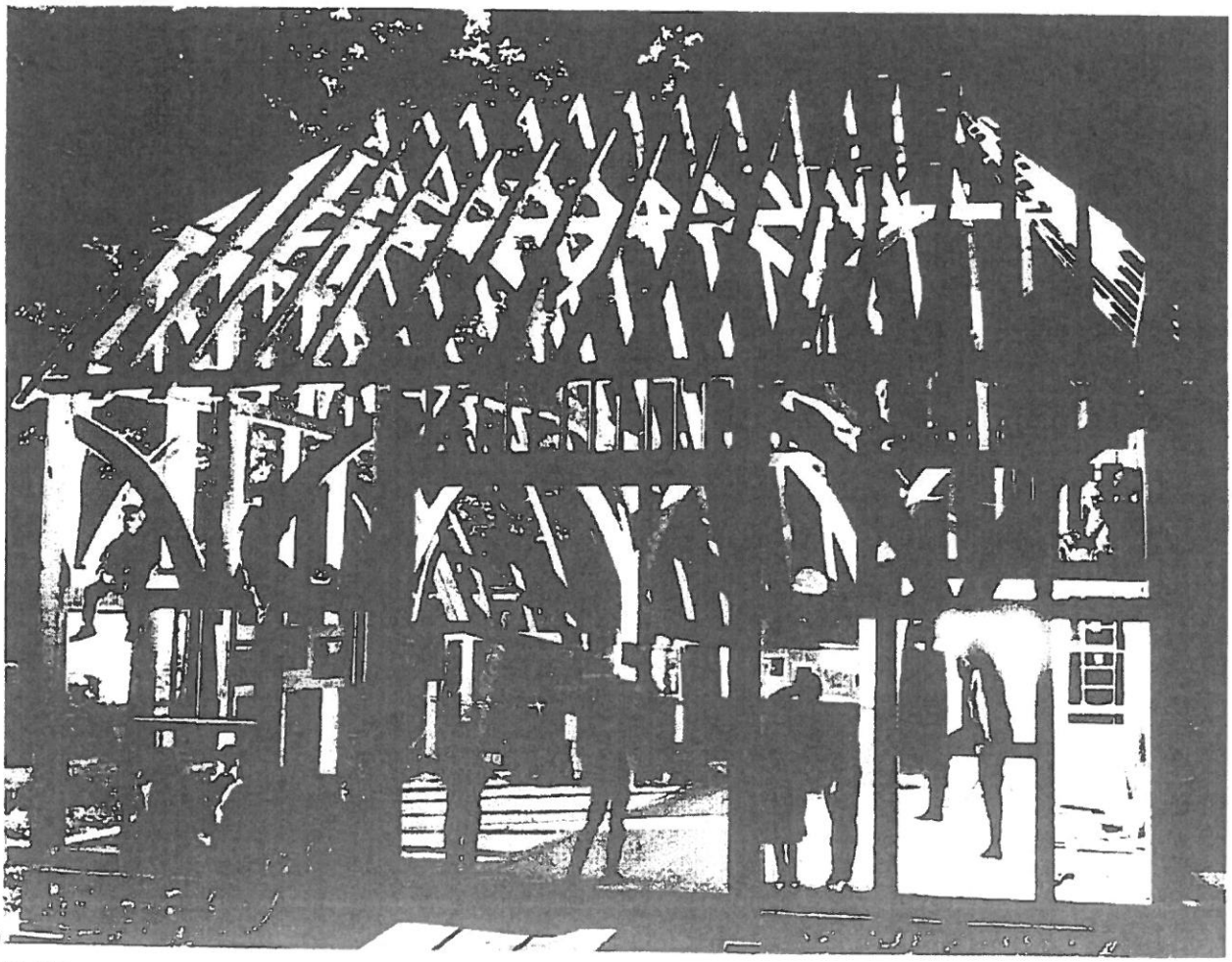
Photo credits
Photographs by Rupert Grey, except 15 by Brian Shuel.

A family extension

Timberwrights continues its exploration of the essence of the timber-frame tradition and its renewal as well as building. Timberwrights is trying to unpick which aspects of recent understanding derive from mechanisation rather than hand craft. It detects in old frames a more sculptural approach, both to the timber surfaces and the jointing, than one shaped by linear geometry. And now it has refined its own use of the plumb-line method examples of its earlier use are being sought. The most evident sign is the characteristic hole made by spike or divider end then a scratch mark dragging away from it to help find it again.

One building does not make a new building industry. This may remain a one-off. But Timberwrights is keen to explore the potential of the technology as part of spec housing to see what cost targets might be met. It hopes to start a school to spread its work. And it also argues that you have to pay for quality. This is a long-life building and one where the marks of man and the irregularities of line and texture of natural materials add to the spirit of the place.

The building process on site attracted the children and their friends, neighbours and local schools. The building in progress and the people it gathered became part of family life. Few clients will say that they are pleased not just with the finished building but enjoyed the building process too.□



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