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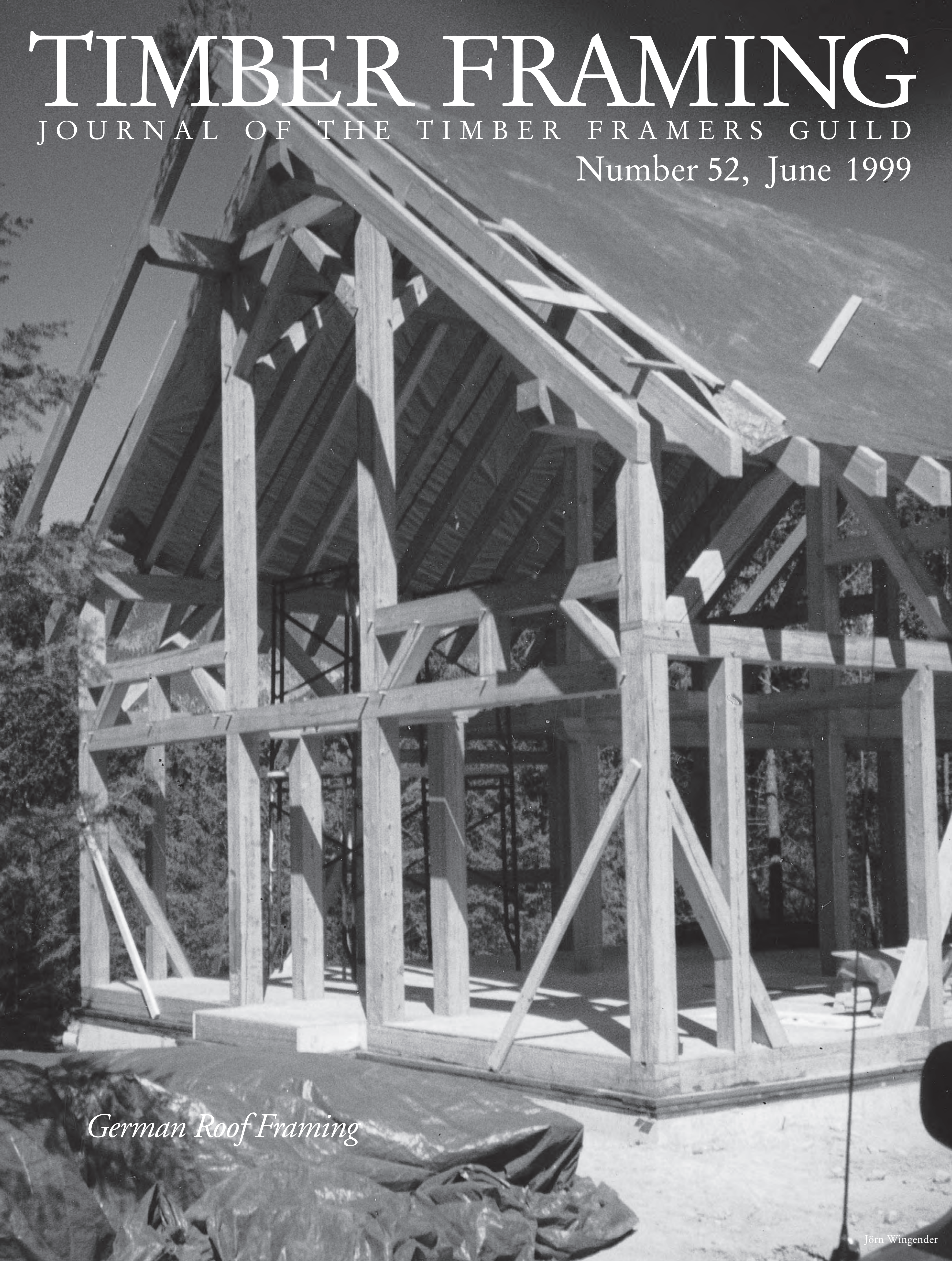

German Roof Framing

Jörn Wingender

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PO Box 60
Becket, MA 01223
www.tfguild.org
joel@tfguild.org will@tfguild.org
888-453-0879

Editorial Correspondence
PO Box 275, Newbury, VT 05051
802-866-5684 rowerk@together.net

Editor: Kenneth Rower

Contributing Editors
History: Jack Sobon
Timber Frame Design: Ed Levin

Correspondents
England: Paul Price

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TOPICS

More on Handwork

"It is possible, then, to believe that there is a kind of work that does not require abuse or misuse, that does not use anything as a substitute for anything else. We are working well when we use ourselves as the fellow creatures of the plants, animals, materials, and other people we are working with. Such work is unifying, healing. It brings us home from pride and from despair, and places us responsibly within the human estate. It defines us as we are: not too good to work with our bodies, but too good to work poorly or joylessly or selfishly or alone.
—Wendell Berry, *The Unsettling of America: Culture & Agriculture*

I WOULD like to report my experiences in two different timber frame companies where I worked the past year. One was a power-tool-driven company, which also assembled and raised frames cut elsewhere on automated joinery machines. The other company was a traditional timber frame company using hand tools and traditional techniques. These experiences led me to question the different methods used by timber framers today and their respective effects on the worker, on shelter, guild, community and culture at large.

In the predominantly power-tool shop, I found not only a different set of tools and techniques from the traditional worker's, but also a separate set of standards and values for the craft of timber framing. With the extremely loud noise and the high volume of dust, the worker must wear earmuffs, safety goggles and respiratory masks, thereby hindering many of his or her natural senses. I must say that after a 40-hour week of all this, I was beat, but on my weekend I would use traditional tools, and, to my amazement, it took only a day to recover and bring back my love of this craft. Whereas the experience of working with large (if hand-held) power tools was one of debilitation, use of the traditional tools healed and strengthened not only my body but, most important, my spirit and love of the work.

The two technologies oppose each other at every level. Whereas the power tools are bulky and work against the body, the hand tools are refined and designed for one's natural movements. For example, compare a Mafell chain mortiser, 14-in. saw and 12-in. planer with a Millers Falls boring machine, hand saw, axe and adze. Go ahead and try them some time. I don't mean for an hour or day, but weeks on end. I think you will get the picture. Using the hand tools, you'll breathe freely and hear your thoughts, the birds and the wind, instead of popping aspirin, sneezing sawdust and tripping over cords.

The proposed use of automated joinery machines was, I believe, the most controversial topic of discussion at the power-tool company, for it struck at the heart of the matter. It is plain to see that such machines' purpose is the removal of human labor from timber framing, and I think this fact alone produces resistance to the technology. The discussion began with talk of purchasing an automated joinery machine and led to a series of frames the company subcontracted out and that we handled, *repaired* and raised.

The first bundle of timbers arrived shrink-wrapped and sterilized. We went to work spreading the material out and laying out the pockets, mortises and so on, to check the machine's joinery. We quickly found out that the layout was not to a thousandth of an inch (as proposed in this journal), but truly all over the place. Routs were crooked, pockets were off, and it took a good deal of work to get them usable. This inaccuracy may be remediable in the machine, but what affected me most was the demoralization of the timber framer whose hands are in physical contact with the wood. This is the principal effect that leading lights in the Guild have not questioned. Cleaning up for a Hundegger does not take a skilled craftsman. I would compare the task to pulling nails out of boards. If you doubt my sincerity, I recommend that you square up mortises and chisel 45-degree brace pocket angles in the timbers from one of these machines, and then ask yourself if this is what you would like to spend your days doing, and if this work is beneficial to the craft and your family and community. I can attest that it provides no very bright future for those who love to work with their hands. Yet to the business owner, whose voice is often heard above the worker's, it is a lucrative opportunity for fast frames.

The first machined frame I helped raise was also the first frame I walked away from in embarrassment, not only for its lack of quality but also because the homeowner was given a lifeless frame human hands did not care for or take pride in. I know this is what the homeowner sought—to be assured that someone, a craftsman, cared about the construction of his home. This assurance was absent from that timber frame and will be absent from every future frame the machine cuts.

TIMBER FRAMING, Journal of the Timber Framers Guild of North America, reports on the work of the Guild and its members, and appears quarterly, in March, June, September and December. TIMBER FRAMING is written by its readers and welcomes interesting articles by experienced and novice writers alike. Contributions are paid for upon publication at the rate of $125 per published page. ♻

This frame was the first of a series cut by the machine, and it was the same story with each one of them. Lack of quality joinery in the frame, lack of quality work for the timber framer. The automated machine's speed is undeniable, yet I believe when its negative effects on the environment, craft and worker are considered, speed is not a sufficient justification for its use.

In traditional timber framing, satisfaction lies not only in the end result, but in the process by which the result is achieved. The worker has a personal stake in the enjoyment of his or her work. On the contrary, the automated joinery machine owner or timber frame employer has forsaken his role in the process of constructing the timber frame, thereby relinquishing his involvement and intimacy with the craft.

I propose that with traditional timber framing we interconnect with others who desire right living and a sustainable future for both man and earth. The methods are consistent with sustainable forestry practices, for both proceed at a pace conducive to a long-term relationship with your local region. I would say that the machine mentality and the machine itself are hungry for timbers, and have insatiable appetites. Hand tools eliminate the need for electricity, a need which sustains nuclear factories, dams and other life-threatening devices. Traditional methods lead us to be farsighted, whereas machine culture seeks immediate gratification and puts off apprehending the long-term damage to natural resources and future timber framers. The traditional timber framer deals immediately with his energy requirements and places the burden upon the self. This truly is an ecological way to act. For these actions have more far-reaching consequences than empty slogans of "earth-friendly timber frames."

I believe that interest in automated joinery machines is solely financial, and I agree that these machines can and will meet that interest—but that's where it should end. Let us not redefine craftsmanship for personal financial interests. Let's state clearly what the machine is for—reduction of human labor, leading to faster production and increase in profit. I do not believe financial interest brought the revival of timber framing. Yet we are at a turning point, for the revival could meet its demise at the hands of those with a willingness to sacrifice integrity for profit.

I was repeatedly told at the power-tool company that traditionally constructed timber frames were uneconomic to the buyer, and furthermore that the buyer should not have to "subsidize" someone who wanted to work with hand tools. These comments led me to a financial comparison between the traditional timber frame company and the predominantly power-tool company. I asked what the power-tool company would charge for a timber frame that we had produced at the traditional timber frame company. The structure was in the form of a Dutch barn 40 by 44 ft., built of oak, ash, pine and spruce, with continuous plates. Price $50,000. The power-tool company's frame would have been the same but with machined surfaces and joinery. Price $60,000.

—Collin Aldous Nyle Beggs

Collin Beggs is a traditional timber framer in Canandaigua, N.Y.

A Mammoth Lesson

JUST an ordinary day. A day in mid-October of last year. I came home to find a call on my message machine from an administrator at the Monmouth County (N.J.) Parks Department. I got back to him, and I was given some news I did not want to hear at all. I was told that a week earlier a converted Dutch barn with a rotated roof had burned and almost none of its oak timbers remained.

Perhaps some readers will remember my discussion of this barn, "A Mammoth in Monmouth County" (TF 24, June 1992), because of its very impressive size. The anchor beams were 22 to 24 in. deep and the H-frame posts were over 20 in. wide at the top. The nave or center aisle was very broad at over 32 ft. wide, and the original width of the gable wall (before conversion) was determined at an unprecedented 57 ft. 6 in. It was a jewel among Dutch barns, and its dimensions suggested a pre-Revolutionary construction date. It's gone now.

I have to say I did record many of its features, but, as I look back over my records, I realize the documentation could and should have been much more extensive. Now I can't do anything about this important barn.

This is not by any means the first time this has happened to me. The golfer Jack Nicklaus had an excellent chance to capture an important tournament perhaps 15 years ago. He committed a particular type of faux pas that had apparently plagued him for quite a while. It was on a crucial play, and at the end of the match he was heard to say, "When will I ever learn my lesson?"

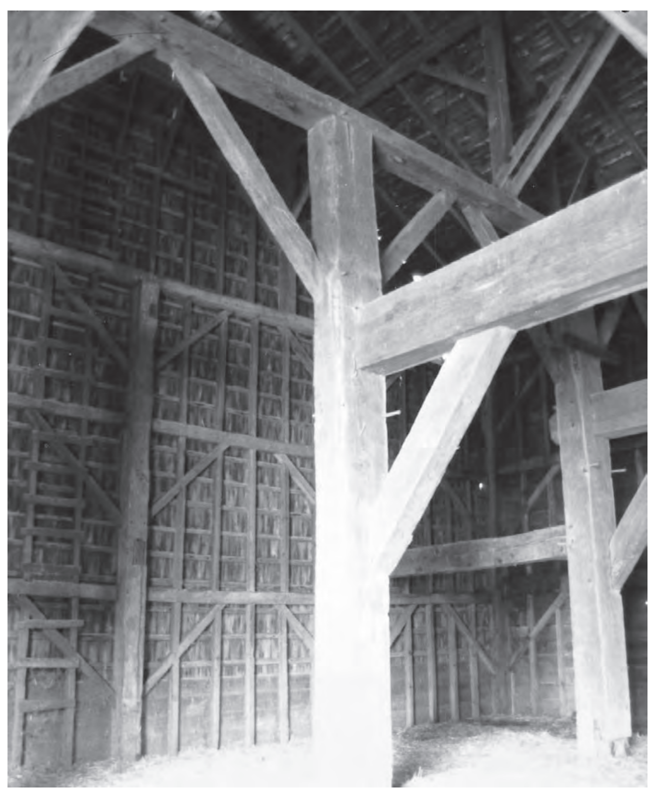
I feel precisely the same way—when will I ever learn my lesson? I do know that certain barns appear to be relatively safe. They are either in good private hands, the roofs are secure, or they are vital parts of farm operations. I can, at some point, come by and record them in fine detail. But some are in serious jeopardy. They are deteriorating slowly or rapidly with bad roofs or bad siding or both, or rotting sills. Still others are on land in the path of imminent development. This was the fate of the mammoth barn. The nearby house was only rented and a corporation owned 400 acres, and I did know for quite a while they wanted to develop (read: Red Flag Alert). The barn was tight with a very good roof, but it was obviously quite vulnerable. The barn was saying very loudly and clearly to anyone who would listen, "Can't you see I need a thorough recording before anything happens to me?" Who was there to do it?

I will tell you I wasn't there. I'm well aware that I or anyone else can't be everywhere all the time. That is not at all the point. The answer I now know more than ever is to set priorities. What is the big deal about making a list of really endangered barns, ones that are important to record, ones that may be lost forever, and then systematically doing what needs to be done? Obviously genius is required here. The barn gods for sure are looking down and asking, "Are you proud of your vigilance?"

I have to say now, a few months later, that I've started to do important things that can't be put off. Procrastination is a killer, if a slow one. Hey Jack—have you learned your lesson? I hope I've learned mine.

—Greg Huber

Greg Huber is editor of the Dutch Barn Research Journal in Wyckoff, New Jersey.



Greg Huber

One of the mammoth barn's 22-in. anchorbeams.

A Timber-Framed Dovecote in Suffolk

IN a recent survey of historic dovecotes in Suffolk, England, 30 examples were found, of which six are substantial timber-framed buildings of the 16th and 17th centuries. They are remarkable survivors from a material culture which has passed, and we might reasonably claim they are as interesting as houses or barns of similar age. In most cases they were built by the common structural methods of their time, differing from other types of buildings mainly in that the walls were wholly covered internally with nest-boxes. Auger holes of large diameter, usually 1 in. or larger, were bored at regular vertical intervals in the posts and studs, and battens were driven into them. These formed the horizontal supports on which the nest-boxes were constructed, made either of sawn boards or of wattle and daub. The dovecote at Badley is designed quite differently, and on present information is unique.

The practice of pigeon-keeping. It may be helpful to say something about the historic context of dovecotes. The keeping of pigeons on a major scale was common among English landowners, beginning in the 12th century and extending steadily until about the end of the 18th. The main product was a luxurious form of meat, highly valued by wealthy households already well supplied with other kinds of meat. A useful by-product was the pigeon dung that accumulated on the floor; it was collected at intervals for use as fertilizer and in the leather and gunpowder industries.

All domestic pigeons are descended from wild rock doves, *Columba livia*, which in the wild congregate on high cliffs, nesting in the dark recesses of caves and feeding mainly on the seeds of wild plants. The distinctive characteristic of the species making them suitable for domestication is that they breed several times a year, producing two young each time. Both parents feed the young birds, called squabs, until they are as large as adult birds, and at the age of four weeks the squabs are ready to fly. In the wild, the adults would then drive them off the nest. The art of the pigeon-keeper was to provide a building where these birds could continue to live and breed much as they would in their natural habitat. At frequent intervals he would search the nest-boxes for any squabs approaching maturity, and then wring their necks and deliver them to the kitchen or to the market. A squab taken just before it was ready to fledge weighed about one pound. As the flying muscles had not been used, the meat was extremely tender and could be cooked on a spit before an open fire. Household accounts of all periods from the 13th century to the late 18th century have been examined. They record that young pigeons were eaten from the end of March to early November; the greatest numbers were drawn from the dovecote in August, September and October.

One month's batch of squabs, known as a "flight," was allowed to grow to maturity to maintain the breeding stock. The birds were fed on grain and pulses in the depth of winter, and often for a short period after midsummer when there was little food on the ground for them. For the rest of the year, they were left to find their own food by ranging over the surrounding land, although this practice became restricted in the early 19th century.

BADLEY HALL, Badley, is an isolated manorial site 1½ miles northwest of the small town of Needham Market, approached by long dirt roads from east and west. Also on the site is a 16th-century timber-framed farmhouse, the remaining part of what was once a major manor house, as well as a large timber-framed barn of the early 16th century and a scatter of later buildings. Nearby is the medieval parish church, now disused. The dovecote is situated 50 yards east of the house, next to the farm pond (photo). It measures 18½ ft. square and 14 ft. high to the eaves, with a central door facing the house and a hipped roof with large gablets to east and west, now boarded over, through which the pigeons formerly entered. The walls are clad with lime plaster and cement render on modern lathing, and the roof is clad with traditional handmade clay tiles.

John McCann

The dovecote of Badley Hall, Badley, from the west.

The timber frame is wholly of oak, mounted on an original brick plinth, which stands a foot or more above ground. The ground level has built up substantially over the course of four centuries, so probably the groundsills were once 2 ft. clear of the ground, which accounts for their exceptionally good condition today. At 14 in. wide by 5 in. deep, they are massive compared with the groundsills of more familiar buildings. In each wall, great 2x14 planks are mounted vertically on the groundsills like fins and are tenoned and pegged to them (Fig. 1). These planks form the sides of the nest-boxes and serve also as the studding between the corner posts. The central plank of each wall is even wider. These planks rise to great girts 16½ x 5½ in. at mid-height, and similar vertical planks rise from them. The corner posts are jowled, and the tie-beams and wall-plates are constructed in what the late Cecil Hewett defined as "normal assembly." (1) In each wall there are two curved down-braces ¾ in. thick, each tenoned and pegged to the head of a post, trenched across two of the vertical boards, and tenoned and pegged to the third (Figs. 2 and 3). This style of bracing is common in Suffolk, and thus is often called "Suffolk bracing," although it occurs in Essex too, mainly in buildings of the first half of the 16th century. Its defining characteristic is that the lower end terminates at a stud rather than at a horizontal timber, as one might expect elsewhere.

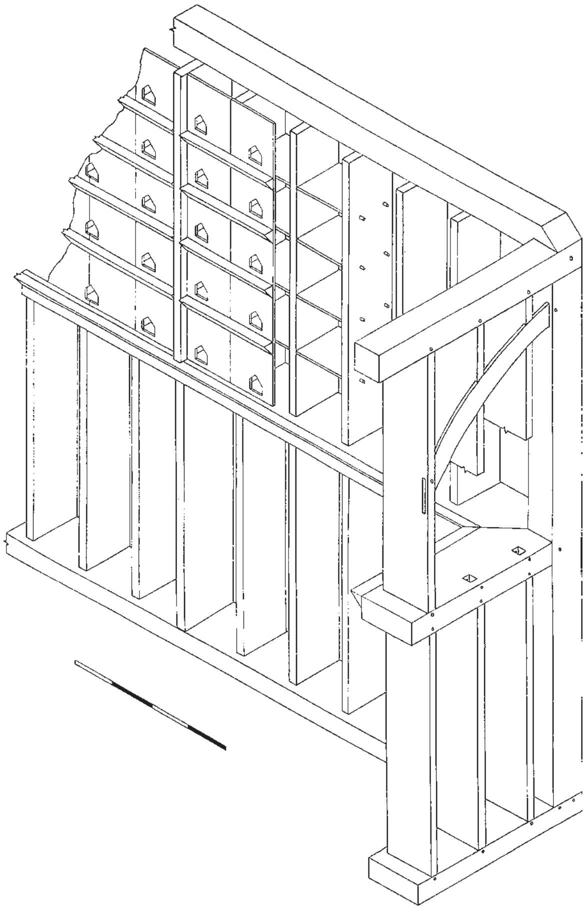


Fig. 1
Isometric drawing of part of the dovecote, showing how nest-holes were formed with baseboards supported on pegs passing through the massive studs. Scale in feet.

The doorway is now 7 ft. high by 3½ ft. wide, but it has been enlarged for later use as a stable (Fig. 2). Residual evidence shows that originally it was only 4½ feet high by 2 ft. 9 in. wide. In this it was not exceptional: the doorways of many early dovecotes, including those built of stone and brick, were about this size, which enabled the pigeon-keeper to block the doorway with his stooping body as he entered, to prevent birds from escaping.

The nest-boxes. Square pegs were driven through pairs of ¾-in. auger holes in the vertical planks, and left projecting on both sides. Thin, square boards were laid across them to form the floors of the nest-boxes. The boxes so constructed average 13½ in. square. Only one section remains of the boarding that formed the fronts of the nest-boxes. Oak boards of various widths were nailed vertically to the front edges of the nest floors, with a pentagonal entrance, 5½ in. high by 4 in. wide, near the left side of each nest-box, slightly raised above its floor (Fig. 1). Across the front, wedge-shaped members were nailed horizontally to form alighting ledges 3 in. wide for the pigeons. The girts at mid-height project beyond the fronts of the nest-boxes and would have formed adequate alighting ledges of themselves, but similar wedge-shaped members have also been nailed to them.

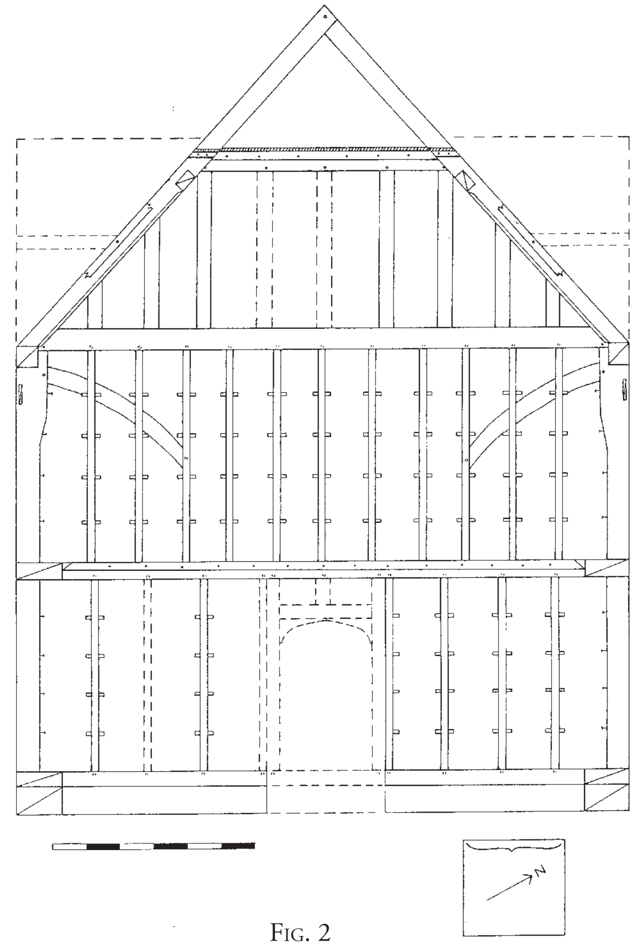


Fig. 2
Vertical section showing west wall from inside. Broken lines indicate the missing dormer frames and timbers removed to enlarge the doorway and to insert a window. Scale in feet.

Originally there were 10 tiers of nest-boxes, with 48 in a complete tier, so allowing for those omitted at the door, there were about 470 nest-boxes in all. The typical historic dovecote in England has between 300 and 1,000 nesting places. The number at Badley Hall seems small in relation to the size of the building and the importance of the site, but that is because the boxes are unusually large. Elsewhere, nest-boxes are commonly 6 to 8 in. high and proportionately smaller in plan. Evidently they were sufficient to fulfill the needs of the pigeons, for many continued in use for three centuries or more. Why the owner of Badley Hall chose to provide a relatively small number of very large nest-boxes can only be a matter of speculation.

The roof and flight platform. Full-length rafters rise from the north and south walls (Figs. 2 and 3), and collars are tenoned to them to form the gablets. Purlins are joined to these long rafters on the north and south sides, and other rafters overlay the purlins and are joined and pegged at the apex. There is no ridge piece. A full set of wedge-shaped sprockets remains *in situ*, nailed above the feet of the rafters. This is a rare survival, for in most historic buildings the sprockets have been cut short or destroyed by the addition of modern guttering.

Between the gablets is a flight platform of oak boards on which the pigeons could perch before descending through a hole 22 in. square into the main interior. At some time it may have been rebuilt, for the oak joists that support it are of 3x7 vertical section, more characteristic of later carpentry.

There is residual evidence of dormer windows in the north and south pitches of the roof (shown in broken lines in Figs. 2 and 3). Dormers were rare in England before the early 17th century, and most early dovecotes had very little illumination, so here they may represent a 17th-century alteration to a building originally built without windows. If so, the intention was to admit daylight into the building below the flight platform without reducing the number of nest-

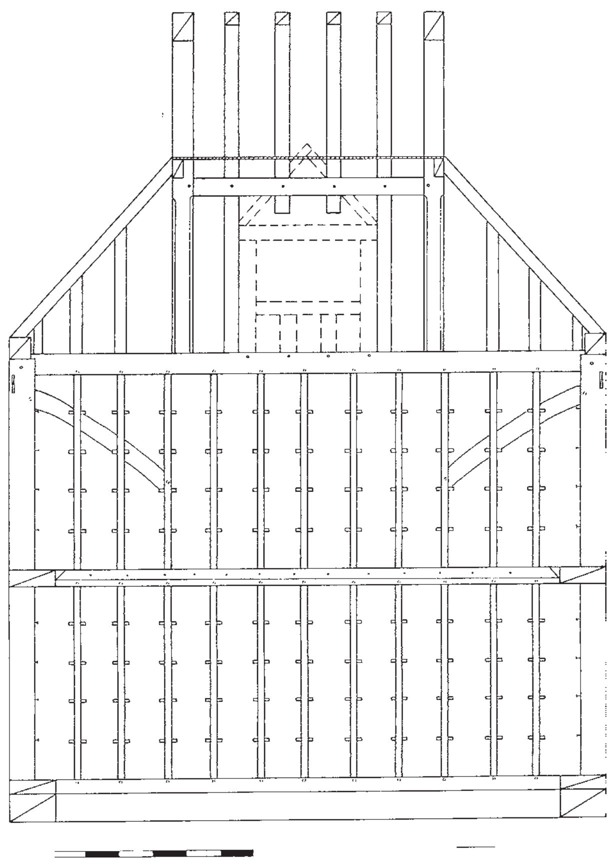


Fig. 3
Vertical section showing south wall from inside. Broken lines indicate a missing dormer. Scale in feet.

boxes. Later the dormers were removed, and the gaps left have been completed by thinner rafters than the originals. Useful though dormers were in certain situations, they always led to leakage eventually, causing decay in the wallplates. Indeed, their former presence can often be deduced from patches of decay in the plates.

WHEN this dovecote was built, the only rats present in Britain were *Rattus rattus*, commonly known as black rats or ship rats. Black rats are a tree-nesting and fruit-eating species, indigenous to southern India but introduced to Britain during the Roman period, wholly different in behavior from the destructive species with which we are more familiar. They were a nuisance in the towns, but there is no evidence that they were widespread in the countryside. They did not prey upon livestock, and, according to the contemporary literature, they were considered to be less harmful on farms than mice. (2)

This changed entirely with the introduction of another species in the 18th century, *Rattus norvegicus*, commonly called brown rats. They are burrowing animals indigenous in eastern Asia. Early in the 18th century, they spread overland to Russia and were introduced to Britain by shipping from Baltic ports. They were present in London by the 1730s and had spread to Suffolk by the 1750s. They had reached the east coast of North America by 1775. (3) Their arrival was often a disaster for pigeon-keepers, for, unlike *Rattus rattus*, brown rats could burrow under shallow foundations, and they could easily gnaw through the panels of timber-framed buildings. Where one brown rat found its way into a dovecote, it left traces that others followed, and within a short time the building was thoroughly infested and all the eggs and squabs had been destroyed. Pigeon-keepers (and householders generally) found that an effective defense against these rats was to fill the lower panels of timber-framed buildings with brickwork; the evidence is still to be seen in dovecotes, barns and houses.

At Badley this protection was achieved in a different way. Shallow paving bricks were laid on edge in the backs of the nest-boxes, to the full height of the building. This would not have been possible in most dovecotes, but here the nest-boxes were so large that the infill still left plenty of space for the pigeons. The pattern displayed to the outside is quite different from the decorative brick nogging which can be seen in the more prestigious 16th-century buildings in Suffolk. (4) Here the pattern is interrupted at 13½ in. vertical intervals by the floors of the nest-boxes (or, where they have been broken away, by their fragments). Many of the floors of the nest-boxes are now missing (probably burned as winter fuel when the dovecote passed out of use) and the bricks have fallen, but enough of them remain in position to indicate how it was done. A pattern of staining on the vertical boards indicates that the whole building was lined with bricks in this way and that the nest-boxes continued in use for long afterwards.

FROM the early 19th century, major changes in the economics of farming reduced the scale of pigeon-keeping for meat, and eventually ousted the practice from the English countryside altogether. Some dovecotes were pulled down, and others were reduced in capacity by inserting a floor at mid-height, converting the lower part to another agricultural purpose while retaining the upper part as a pigeon-loft. At Badley there is no intermediate floor now, and it is not clear whether there ever was one. Certainly the building has been converted for use as a stable. The doorway has been enlarged, rough poles and boards have been nailed vertically to the lower walls to form an inner lining, and a wooden manger is still present against the west wall. The building is now disused, but fortunately it remains in weatherproof condition.

The present cladding is of modern materials. Close examination of the vertical boards shows that there has never been any infill of wattle and daub between them. It is possible that originally the exterior was clad with horizontal boarding, but it seems more likely that it was clad with horizontal laths and plaster from the outset, much as it is now. Infill of wattle and daub was common in Suffolk buildings until the later 16th century, when it was generally superseded (or supplemented) by an external cladding of lath and plaster. The roofing tiles are of a type and size that has not changed since the 14th century.

Stylistically there is little by which to date this unusual structure except the curved down-bracing, in common use throughout the 16th century. The manor house was of conspicuously high quality, built in the 1520s or 1530s for Edmund Poley (1486-1549), originally around a quadrangle. It remained in the Poley family until 1735; there are many Poley memorials in the parish church. (5) It is possible that the dovecote is contemporary with the manor house and barn. Dendrochronology technique is expensive, and on the clay soils of East Anglia, in the part of Britain with the least rainfall, it does not always yield positive results. One day we may see this building accurately dated by dendrochronology (certainly the timbers are large enough), but in the meantime its origin remains open to discussion.

Evidently the master carpenter applied more creative thought to this dovecote than was common elsewhere, for he ingeniously used the great vertical planks and the sills and girts, both to form the main structure and to enclose the nest-boxes. At first glance it may appear that he used large timbers unnecessarily lavishly, but when one reckons the cost of the hand-sawn oak boards needed to make the nest-boxes by more familiar methods, the extravagance is less apparent. In any case, conspicuous consumption of good timber was very typical of the Tudor culture and generally associated with high social or economic status. Nothing like this building has been reported anywhere else in Britain.

—JOHN MCCANN AND LEIGH ALSTON

John McCann, now retired to Devon, lived in Essex for 30 years and was for some time Inspector of Historic Buildings for the county council. He has listed, relisted or examined over 2,000 historic buildings. This article draws upon the information in his recent book, The Dovecotes of Suffolk *(Suffolk Institute of Archaeology and History, Hitcham, 1998, and available from the Secretary, Oak Tree Farm, Finborough Road, Hitcham, Ipswich IP7 7LS, U.K., for £10.60 or $26.00 postpaid; the latter figure includes a bank conversion charge). The illustrations for this article were drawn by coauthor Leigh Alston, a well-known student of timber-framed buildings in Suffolk.*

Notes:

(1) C. A. Hewett, "Timber Building in Essex: some evidence of the possible origin of the lap-dovetail," *Transactions of the Ancient Monuments Society* 9, 1961, 33-56.

(2) J. McCann, "The Influence of Rodents on the Design and Construction of Farm Buildings, to the Mid-Nineteenth Century," *Journal of the Historic Farm Buildings Group (Britain)* 10, 1996, 1-10.

(3) E.H. Barrett-Hamilton and M.A.C. Hinton, *A History of British Mammals*, London, 1921, 610.

(4) J. McCann, "Brick Nogging in the Fifteenth and Sixteenth Centuries," *Transactions of the Ancient Monuments Society* 31, 1987, 106-133.

(5) "Excursions," *Proceedings of the Suffolk Institute of Archaeology* 37, part 2, 1990, 171-2, and Suffolk Record Office (Ipswich) HA1/DC3/1.

German Frame Typology III (Roofs)

THE traveler approaching a European village, town or city is greeted by a skyline shaped by clusters of roofs. Only after entering the settlement will the traveler find out what can be discovered below those roofs. Until that moment, the "roofscape" speaks for itself: towers that threaten possible invaders (or did so once), steeples competing for height, farms and warehouses simply trying to make the most of the space available. Halls and churches show their exposed structural timbers decoratively; the more common buildings are designed for more strictly economic purposes.

It all started out with builders digging small logs into the ground at one end, then leaning the other ends against a horizontal branch, to create the skeleton for a tent-like structure. The more sophisticated version of this first roof would place a log into two tree forks, then from this ridge hang smaller trees by their butt ends, using one remaining root as a hook.

Translating this knowledge into present-day timber framing gives us the purlin roof or *Pfettendach*. A rafter in this system is called a *Rofe*, defined as a roof member mounted on a support structure, carrying the roofing material. The hanging *Rofe* described above is a "flexible" design originating in traditional log construction, where the log gable is subject to extreme settling as it dries. As the distance decreases between the ridge and the level of the wall plate at the top of the exterior walls, the lower end of the rafter has the ability to slide, avoiding the development of horizontal thrust that would spread apart the bearing walls.

The installation of posts to support the ridge solves that problem. Now both rafter ends can be secured, to the ridge and wall plates and possibly intermediate purlins, which last endows them with the added function of bracing the roof frame. Nevertheless, interior braces from posts to the ridge, purlins and floor joists remain a must to achieve rigidity.

The complete assembly of this support frame, comprising posts, braces, purlins and ridge, is called a *Stuhl*, which translates as chair. Single (ridge only), double (two intermediate purlins) or triple (ridge and two intermediate purlins) are the most common variations of the *Stuhl*.

Wind loads aside, this system deals exclusively with vertical loads, which makes it easy to design and cut. The support frame uses mortise and tenon and lap joinery only, with all joints laid out for compression. The rafters are mounted on the purlins with a simple bird's mouth and secured with a spike. This design using vertical posts, known as *stehender Stuhl* (standing chair), comes with two disadvantages. One is the lack of open space in the attic, which is filled with posts and braces, and the other is limited design flexibility in arranging the floors below, which must carry the loads from the *Stuhl* posts to the ground.

Interior walls are usually the simplest devices to transfer those loads floor by floor to the foundation. If framed with timbers, these walls can alternatively be designed as trusses to transfer the loads from above directly out to exterior walls. This technique comes in handy when there are still several floors to go until the roof load can reach solid ground. Each floor plan can be designed without being restricted by incorporated posting for loads above.

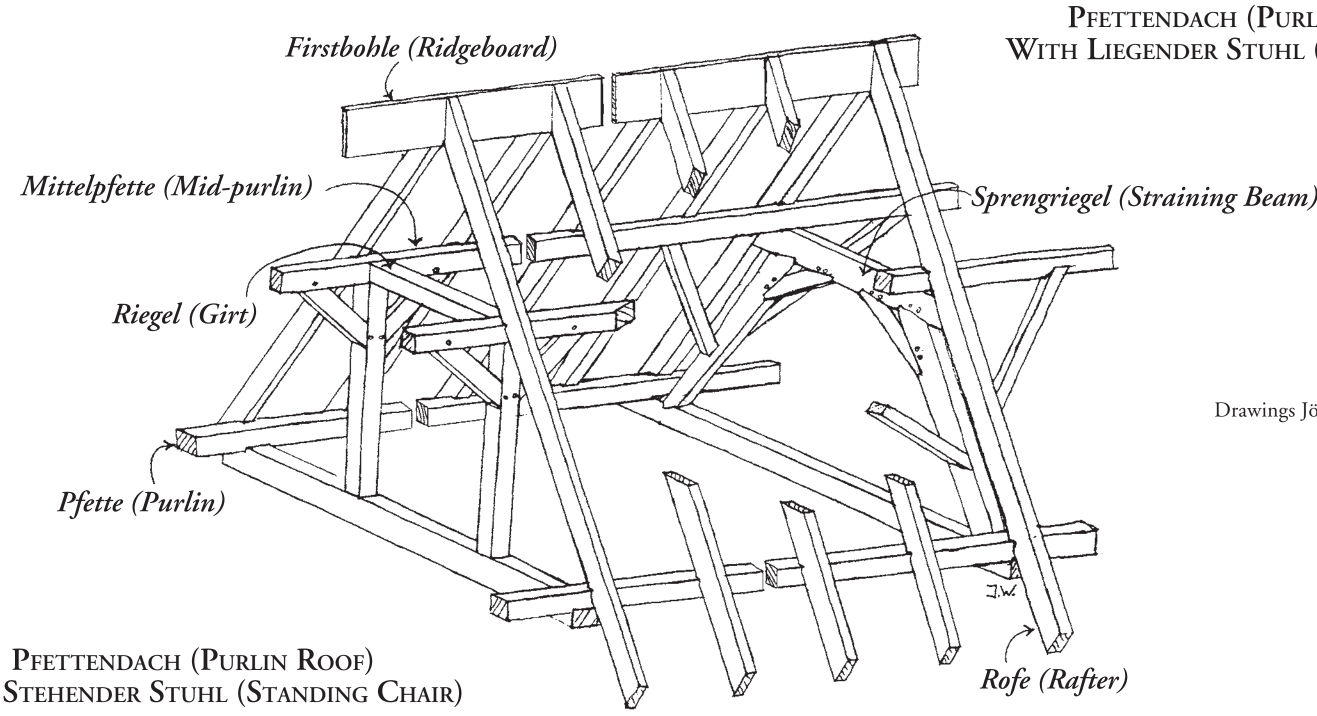
In a more direct approach to the problem, the standing chair was converted into a lying chair, or *liegender Stuhl.* The upright posts are canted over to become struts placed parallel, or nearly so, to the rafters, and springing from a beam resting on the wall plates. All roof loads are now immediately transferred to the exterior walls. The joinery of strut and transverse beam is crucial, because this is where the oncoming load is split into horizontal and vertical components.

The latter will be easily transferred through the beam onto the wall plates below. The horizontal load has to be absorbed by the beam itself. To avoid vulnerable tension joinery, these loads are transferred into the beam using a connection (called a *Versatz)* that pushes the ends of the beam in opposite directions.

This action distinguishes it from that of a dropped tie beam bent (characteristic in the American kneewall Cape), where horizontal loads *pull* at the ends of the beam. These loads originate in the principal rafters and are transferred by the posts to the tie beam. The height of the kneewall above the tie beam functions as a lever increasing the tension load in the tie beam joinery.

The canted posts of the *liegender Stuhl* avoid the doubtful kneewall construction and transfer all vertical and horizontal loads straight into the transverse beam beneath, which can still be well connected to the wall plates to tie the building together. In case of extreme vertical loads, an additional supporting bracket or brace can be placed below the beam at the exterior post .

Pfettendach (Purlin Roof)
With Liegender Stuhl (Lying Chair)

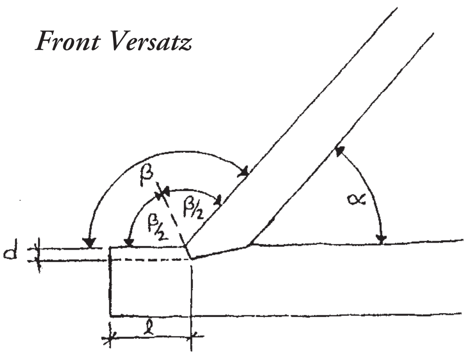


Drawings Jörn Wingender

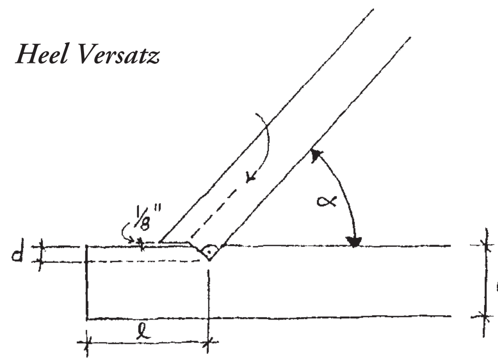
Pfettendach (Purlin Roof)
With Stehender Stuhl (Standing Chair)

THE *Versatz* connection is a common joint wherever loads need to be transferred in compression from one timber to another at other than a right angle. This joint is based on a mortise and tenon, with the shoulders of the tenon extended to fit a notch in the shoulders of the mortise. Dividing equally the angle β between the top surface of the strut and the top surface of the beam determines the cut for the notch and the tenon shoulders. The depth of the notch is dependent upon the angle α of the strut. If the angle is less than 50 degrees, the depth d should not exceed a quarter of the beam height. If it is greater than 60 degrees, the depth should not exceed a sixth of the beam height. The split of any received load into horizontal and vertical components is dependent upon the angle of the strut—the steeper the angle, the smaller the horizontal thrust and vice versa. At the extremes, therefore, an upright strut in a deep notch will break the beam and a low-angled strut in a shallow notch will excessively compress the fibers of the *Versatz* surface.

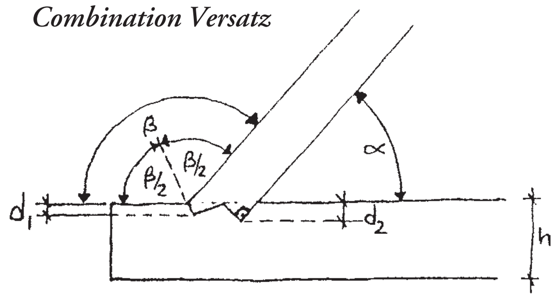
Front Versatz



Heel Versatz



Combination Versatz



At first sight, these guidelines seem to create a rather small surface for the horizontal loads to be transferred, but a closer look reveals the weak point of this joint to be elsewhere. The sturdy end-grain at the head of the *Versatz* is well placed to handle the imposed compression, but what about the shear strength of the fibers in the part of the beam exposed to the horizontal loads? If the section of the beam l outboard or forward of the joint (known as *Vorholz,* and which American framers would probably call *relish)* is too short, the wood fibers will shear off lengthwise under load.

To avoid this, a minimum length of 20 cm (8 in.) is recommended. A properly engineered connection would of course require knowing the beam section, the strut angle and section, the wood species and the loads. Nevertheless, longer is better.

In case the positioning of the strut does not allow for an appropriate length of material in front, the contact surface can be moved to the heel of the strut (shown below center). At this location, notch and shoulder are both cut perpendicular to the strut pitch, rather than on a miter as before. In addition, this variation of the joint should be cut with a 1/8-in. gap between the parallel horizontal surfaces of strut and beam to avoid splitting of the strut during drying. The load wants to be taken at the heel alone, with the rest of the strut acting as a stiffener.

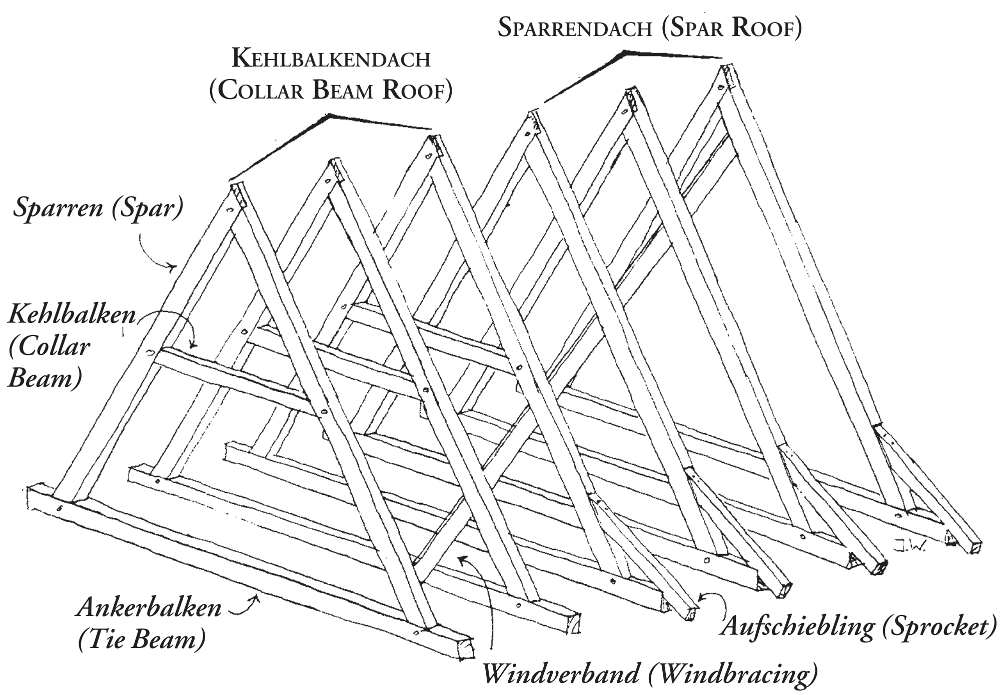
For heavy loads, both types of *Versatz* can be combined in one joint (below right). The depth at the forward notch should be 80 percent of the one at the rear to avoid a coincidence of the shearing planes. It is desirable to use only dry timber for this particular variation, to ensure a stable and accurate fit of each *Versatz*. Green timber is unlikely to stay seated simultaneously in both notches.

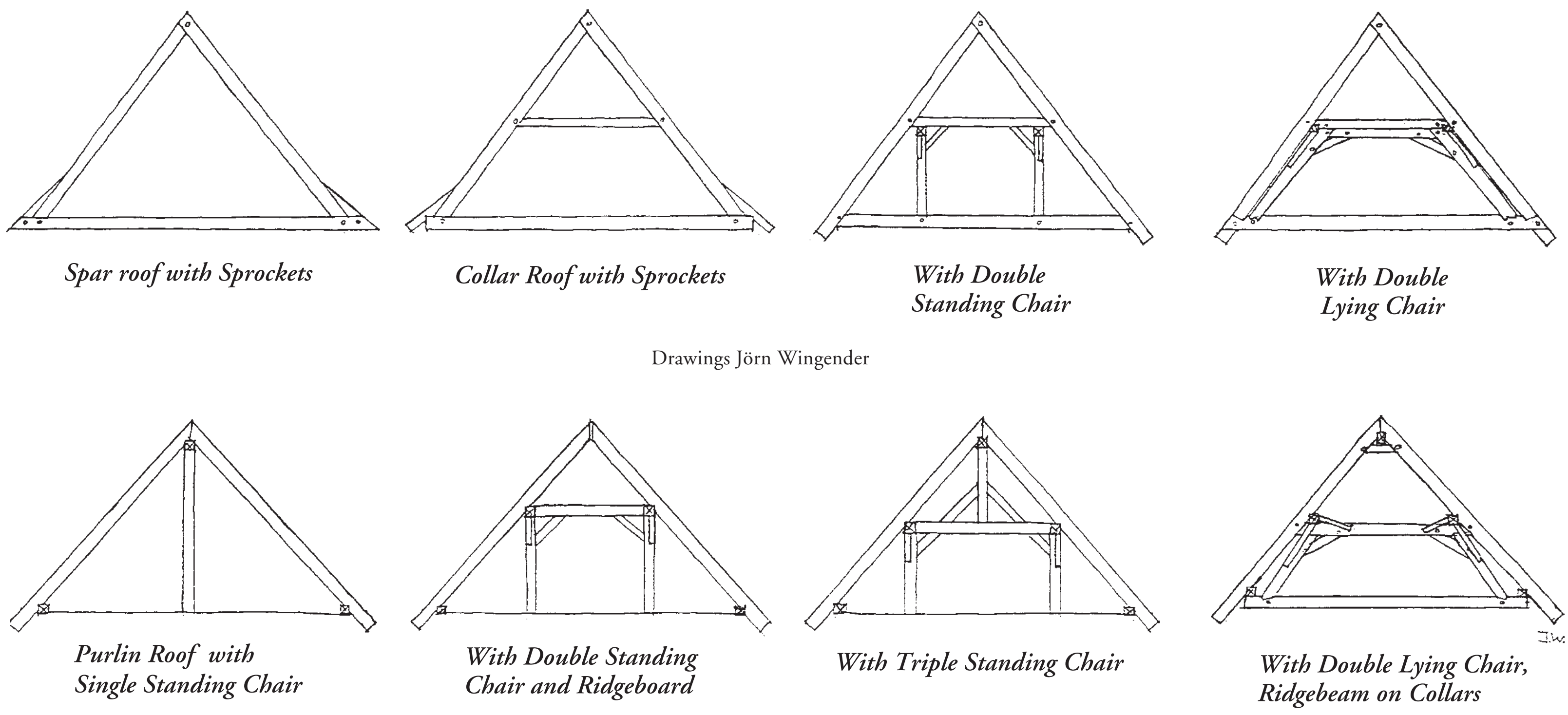
In steeper roofs (above 45 degrees) without knee walls, the struts usually run parallel to the rafters. For other roof designs, the pitch and rafter span determine the layout of the struts.

A *liegender Stuhl* in the purlin roof described is complete with the addition of a straining beam and bracing. The straining beam keeps the top ends of the struts apart and at the same time serves as a collar beam for principal rafters. The purlins are mounted on top of the straining beam, which is joined to the top of the struts using the same joinery as for the bottom. In order to create a sturdy, almost arched support frame, braces are installed between the struts and the collar. Numerous additonal braces run lengthwise.

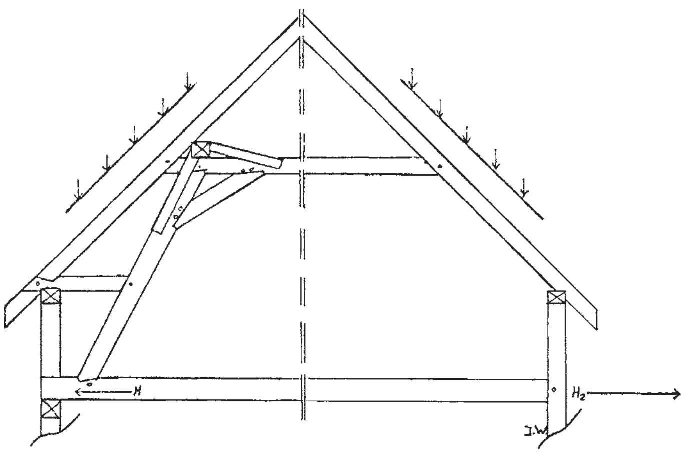
IN search of unobstructed storage space in the attic, a different type of roof evolved alongside the purlin roof. Called the *Sparrendach* (spar roof), it combines the support frame and the rafters in one system. Because the inclined roof members must serve a double purpose in this type of frame, they are labeled spars to distinguish them from their relatives the rafters.

Spars come in pairs connected at the top and mounted on a tie beam, using lap or mortise and tenon joinery. Spars with larger dimensions can use the same tie beam joinery as the *liegender Stuhl.* Together, the three members form a rigid triangle. A group of those triangles lined up creates a very open attic space perfect for storing bulk goods like hay. In some buildings, the triangles are found up to 8 ft. on center, which results in exceedingly long spans for the strapping under the roof covering. (Straw, thatch or clay tiles used to be common.) To avoid an unduly heavy section for the strapping, "floating" 2x3 cleats running perpendicular to the strapping are nailed to the undersides of the straps at mid-span between the spars to assist. Similarly, diagonal planks nailed to the undersides of the rafters lend lengthwise stiffness.





VARIATIONS ON TWO MOST COMMON GERMAN ROOF FRAMING SYSTEMS.
UPPER ROW, SPAR ROOF VARIATIONS. LOWER ROW, PURLIN ROOF VARIATIONS.



COMPARISON OF PLAIN KNEEWALL FRAMING WITH ADDED LIEGENDER STUHL FRAMING.

Significant horizontal load H_2 at tie beam joint (right side) results from rafter action compounded by kneewall length. Liegender Stuhl (left side) redirects loads down through strut to transverse beam where reduced horizontal thrust H is taken inside the beam and much of the vertical load is transmitted to the wall .

To minimize the horizontal loads from the constant spreading of the spars, the roof slope is generally 45 degrees or more. As a result, even narrow city buildings require long spars. With a carpenter's rule of thumb limiting clear runs to 5 m (about 16 ft. 6 in.), some necessary lengths push the timber to the limit. To avoid bending of the spars from their own weight, a *Kehlbalken* or collar beam is fitted between spars in a pair. Often mistakenly called a collar tie, the *Kehlbalken* does everything but tie things together. Its function is to reduce the effective length of the spars by pushing them apart and to distribute wind loads to the opposite spar in a pair. Consequently, this timber is in compression only. Such a collar turns a spar roof into a *Kehlbalkendach,* or collar roof. (See also the variations above and the back cover.)

While inspecting one of these frames, it is worthwhile checking out the end joints of the collar. In case the joinery shows signs of opening up (and a tap with a hammer confirms that there is a load on the timber), it's time to put your hard hat on. These are clear indications that the real tie beam below or its joinery has failed and the compression member *collar* has turned into a tension *tie.* Cutting tie beams without bothering about their exact function is common practice during the "development" of attic space, for example when installing a bigger staircase.

In wide buildings with steep roofs, more than one collar is added, creating a multi-story attic with increased floor space to store goods. These "collar joists" might require additional support, usually achieved by inserting one of the *Stuhl* frames into the roof system, as shown in the upper photo on the back cover.

A combination of *Kehlbalkendach* with a *liegender Stuhl* support frame with purlins used to be a popular form in the 16th and 17th centuries. Yet more timber and more sophisticated joinery is required to frame one of these structures. A pleasant consequence of this frame combination is added longitudinal rigidity. Before that, the *Sparrendach* and *Kehlbalkendach* were dependent upon the roof strapping, as well as the additional boards nailed diagonally underneath the rafters linking several at once, to improve their stiffness. The latter technique is a rather crude way to add stability to a frame, but it indeed prevents the roof system from acting like a flexible chain with many links. Anybody who has raised a set of bents connected only by girts and purlins running from bent to bent probably knows the necessity of adding stiffness to such a frame.

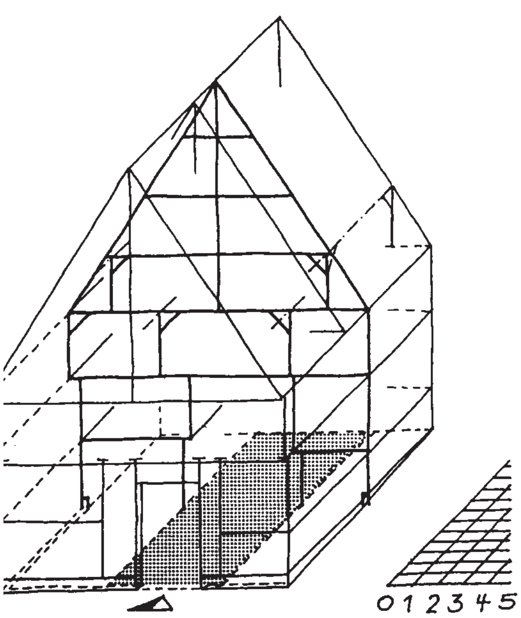
True spar roofs with large open attic spaces are mainly found in rural farm buildings. In the pre-industrial age of farming, bulk goods like hay and straw were simply piled up under these cathedral ceilings, without any need for individual floors. If there was need for expansion, space for another building was usually not a problem. In the cities, on the other hand, availability of space was always an issue. So dividing the roof framing into various levels to make better use of the attic capacity only made sense.

Haus Leck, Wolfhagen, Hessen. Framing scheme below.

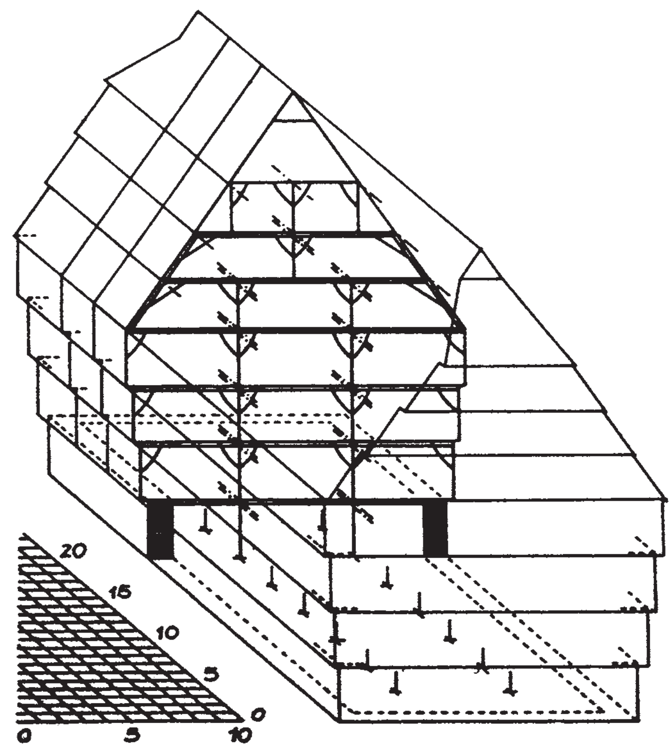
Photos and Drawings Klaus Thinius-Hüser

Der Bau, Geislingen, Baden Württemberg. Framing below.

The early 17th-century Haus Leck in Grebenstein (above) and the early 16th-century Der Bau (a grain warehouse, above right) in Geislingen are examples of how early builders dealt with such challenges. Haus Leck—residence, stables and barn in one—had to accommodate various needs under one roof. The rather random positioning of the posts reflects that multi-purpose design. The posts of the double standing roof frame are not directly supported by other posts beneath. The vertical loads at those points were obviously of no major concern to the framer. Even the roof center posts (*Spitzsäule*) connecting ridge, collars and anchor beam are not supported. In this collar roof design, the vertical roof loads are transferred by the rafters into the tie beam, thus leaving the collars with minor floor loads from stored goods generated by this small farm.



Der Bau, on the other hand, was constructed with an open floor plan as a storage facility for grain. This is reflected in its straightforward three-bay design, carried through up to the first attic floor, which features a collar roof supported by a double *liegender Stuhl* and two additional summer beams for the collar-joists. This chair assembly is repeated in the second attic floor and replaced by a double *stehender Stuhl* in the third attic floor. All in all, a truly functional design making the best use of the space available. It's just a shame that the only people who really got to enjoy this framing were the warehouse keepers.



Illustrations this page from Klaus Thinius-Hüser, *Historische Holzkonstruktionen* (Karlsruhe: Bruderverlag, 1998), used by permission of the publisher.

Klaus Thinius-Hüser

Above, substantial three-story Zwerchhaus in Tübingen, Baden Württemberg. Ordinary dormers are framed between rafters as sheds. Below, Zwerchhaus in Korbach, Hessen.

TODAY most attics are not open to the public, but they can still reveal a lot of framing details on their exteriors. Low pitch and horizontal timbers supporting big overhangs are clear indications of a purlin roof. A change in pitch in the lower section of a roof slope (2 ft. to 3 ft. from the eaves) is a sign of a spar or collar roof. One typical way to join the spar to the tie beam is by mortise and tenon, but not right at the end (as with late English tying joints). The relish left between the tip of the rafter and the end of the tie beam is awkward to bridge with the roofing material. Instead, short rafters or sprockets (*Aufschiebling)* are mounted on the end of the tie beam and nailed to the main rafter.

Openings in the roof itself or at the gable ends offer a variety of information about the original use of a timber frame building. Numerous small shed dormers, or ornate holes in the gable ends, for example, are signs of a storage building in need of significant ventilation.

Hatches at gable ends received goods hoisted to upper floors. This was common practice as long as it was possible to locate the gable towards the street. The orientation changed when the narrow gutters between city buildings were eliminated in favor of street drainage, and better fire protection was sought by building all-brick gable walls butting against each other in a row. Once the ridge line was turned 90 degrees to place it parallel to the street, hoisting access to upper stories had to be gained some other way.

Thus the design of the so-called *Zwerchhaus*, a wide gable dormer resting its gable on an exterior wall (compared to a standard dormer mounted solely on the roof frame), which an American would call a façade dormer. To keep things simple, the regular dormers are usually designed as shed dormers placed between two rafters, especially if their main purpose is ventilation of the attic.

The larger *Zwerchhaus*, on the other hand, demands a bit more framing if it is introduced into a spar or collar roof. These roof types are generally not very receptive to valley joinery because it disturbs the rigid triangles that make up the system. However, a support frame in the form of a *Stuhl* usually solves that problem.

To make good use of the additional valley joinery and support framing, a *Zwerchhaus* can give access to more than one attic floor in the roof system. This renders it ideal for conversion into residential spaces, now that most timber frame buildings have outlived their original tasks.

—JÖRN WINGENDER

The author operates Zimmerei Wingender (handwerk@netidea.com) in Nelson, British Columbia. This article is the third in a series on German timber framing (see TF 49 and 51). The photo on the cover of this issue of the journal depicts a modified German-style frame built at Invermere, B.C., to fit an exisiting architectural design. The kneewall roof is classified as a double standing Stuhl *with ridgeboard. Down braces are half-lapped at the posts. Kneewall posts are discontinuous with posts below.*

Jörn Wingender

The Voyages of Oatman: Cambridge and Warwickshire

I STRAYED off the timber frame trail and spent a couple of days absorbing some polite architecture in Cambridge. A lot of major players had a hand in this city—700 years of English architecture stacked in a square mile. In the 12th century, several religious orders established monasteries and schools, which disaffected students from Oxford and the University of Paris started attending in the 13th century.

Kings College Chapel is considered to be one of the finest examples of medieval architecture in all of Europe. The first stone was laid by young Henry VI in 1446. Young Henry became old Henry and was laid away himself before the chapel was completed in 1515. The fan-vaulted ceiling, in which all the ribs springing from a single pier have about the same curvature, is truly amazing: thousands of hand-wrought pieces of stone fitted by craftsmen under the supervision of maverick mason John Wastell, who veered from the previous plan of a lierne vault, in which minor ribs running from node to node form net and star patterns. In the 19th century, William Wordsworth called the ceiling "a branching roof self-poised, and scooped into ten thousand cells where light and shade repose."

The late Cecil Hewett described the woodwork of the roof above the ceiling as "a supremely important work containing the earliest example of tenons with diminished haunches." These were used on the purlins of the then unfinished bays by carpenter Richard Russell, who had earlier been in charge of carpentry at Westminster Abbey. The chapel roof was completed in August of 1512.

Trinity College, founded by Henry VIII in 1546, and now the largest of the Cambridge colleges, houses the noted library designed by Christopher Wren (1632-1723), an architect in touch with his materials. In 1923, the historian H. M. Fletcher found during a maintenance inspection that the oak floor frame of the library (which stands a story above ground level) includes elaborate trussing and bolting of the timbers, evidently to resist deflection from the expected weight of the rows of tall bookcases above. The natural light that permeates this structure is flawless in its purpose.

The building was completed in 1684 under mason Robert Grumbold. The library's collection includes some of the finest manuscripts ever written, on shelving adorned with limewood carvings by the genius Grinling Gibbons, and if that's too highbrow for your tastes you can browse over the original manuscript of Winnie-The-Pooh. The Hall at Trinity boasts a roof supported by a hammerbeam truss, but only members of the college may enter. I couldn't pass.

I visited other colleges, but I won't bore your wooden hearts with all their fancy stones. I did get a shot of the one exposed timber frame in the city proper but did not take a picture of the Mathematical Bridge, a 20-ft. span footbridge. I had walked over it on my way to Queens College to see the half-timbered Queens long gallery, which turned out to be closed to the public that week. I almost went back the same way to take shots of the aforesaid bridge, but the prominent and annoying metal hardware that kept it together kept me going another way. I was later to learn that the bridge was built in 1779 without a nail or bolt, and some 'I gots ta know' Victorian took it apart and couldn't put it together again without metal reinforcement.

FROM Cambridge I hitchhiked to Coventry in the next county, Warwickshire. The expression "sent to Coventry" is used all over the British Isles today, and it means no one will talk to you. During the Civil War, Royalists were sent to prison in Coventry, and the parliamentary townsfolk of Coventry would not speak to them. Another expression, "true blue," has its origin in this city. Cloth made in Coventry in medieval times was noted for its durable blue dye, which withstood many washings. This blue cloth inspired the saying, "as true as Coventry blue," which meant dependable and faithful. The term was reinforced in the 17th century when Scottish Presbyterians who fought for their religion called themselves Covenanters and selected blue as their flag color. Those on their side were referred to as "true blue."

Photos Paul Oatman

Spon Street, Coventry.

Lady Godiva (1040-1080), an Anglo-Saxon noblewoman, persuaded her husband Leofric, Earl of Mercia, to found a Benedictine Monastery here. According to legend, she obtained a reduction in taxes levied by her husband by riding a white horse naked through town. Part of the deal was that the townsfolk would remain indoors and close their shutters, but, as we all know, there is always "that 10 percent," in this case fewer than one percent, in the body of a tailor named Tom who had to peep. This fellow was the original Peeping Tom and he was rewarded with blindness for peering at the Lady's pelt.

By the 14th century, Coventry was a trading center known for its textiles. The weaving trade declined in the 17th century, to be supplanted by clock- and watchmaking. In the 20th century, Coventry became the Motown of Britain (Jaguar perhaps its most famous marque) and the home of the now defunct Triumph motorcycle. Coventry was hit hard during the Second World War, and in the early 70s, timber frames from different parts of the city were dismantled and reconstructed on Spon Street. The halls of these reconstructed buildings are small, but in the rear of the buildings they are open from the ground floor to the roof and house the spirits of England in a glorious pub setting.

Two outstanding timber-framed almshouses still stand in Coventry—Ford's Hospital and Bond's Hospital, both built in the early 16th century. Here is Rule Number Seven, from the *Orders to Be Observed By the Almsmen of Bablocke in Coventry*: "They shall be noe alehouse hunters spending theire time and mony in sitinge drinkinge playing there, but rather if need require, shall send for there drinke and vitalls into ye towen unto theire house." No time-wasters they! Ford's Hospital was badly damaged during the war. On October 14th, 1940, a bomb fell on the Warden's room and she, a maid and six old ladies were killed. The building was hit later with another bomb and, after a public appeal for subscriptions, the building was restored in 1953. One of the finest examples of jettied, close-studded timber framing survives in the Golden Cross Inn built circa 1583.

The ruins of Coventry Cathedral mesmerized me. At first sight, one senses the fear and pain caused by the bombs of World War II—it's that dramatic. A new church rises from the south wall and has been written about with glowing phrases, but I was unimpressed with this spaceship hood that hovers over the south wall of the war-torn ruins.

I RENTED a car in Coventry and headed south to Warwick, which, aside from a number of townie timber frames, features a castle only second to Windsor with a view second to none. William the Conqueror built the moat in 1068, and construction went on until 1901. I couldn't help reflecting on the scene of children gleefully running though the torture chambers, up and down the towers and the ramparts, and the sense of history they grow up with. On the left coast here in California, if it wasn't built last week, it has little merit. On a talk show here a couple of weeks ago, a man was asked his favorite city and named Las Vegas. "I grew up in southern California and Disneyland nurtured me," he explained.

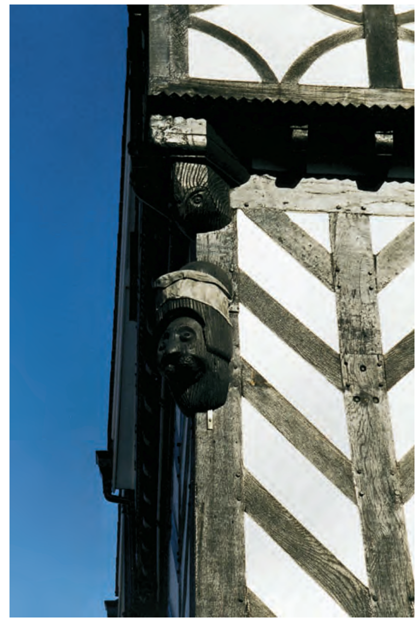
Ethelfleda founded Warwick in 914. John Leland, on his mid-16th century antiquarian tour of England and Wales, described it thus (quoted by Nikolaus Pevsner and Alexandra Wedgwood in *The Buildings of England: Warwickshire)*: "The town of Warwick standithe on a rokky hille, risynge from est to west. The beauty and glory of the towne is in two streets whereof the one is caullyd Highe Strete and goith from the est gate to the west. . . the other crossithe the middle of it, makynge Quadrivium, and goith from northe to south." Warwick, not much changed, has no industry to speak of and the town has remained small. The great fire of 1694 took its toll but many timber frames survived. For the traveler, towns such as Coventry and Warwick give the student much to explore in style and elaborate design.

Jettied close studding at the Golden Cross Inn, Coventry.

Whereas today commercial buildings are tilted up as cheaply as possible, in the past—even in the recent past—a merchant would show his wealth by advertising it in the glory of his structure. In central England one sees the close studding of the east, the box panels of the west, and the long curved braces of Kentish framing combined with decorative square panels in the most elaborate frames.

An unusual building I found in Warwick seemed to be of German framing with its second story jetty done in the German Wildman pattern (overleaf), braces splayed left and right. I should note here that jetty-style buildings are mostly confined to towns. There are many theories to explain this, and perhaps the best is that the style provided more domestic space for a given lot. The Wealden

Light and shadow in Warwick.



Above, herringbone strutting in Warwick. At left, Mason's Cove, a Wealden-style house with recessed front and square panels.

house (above) also shows itself in this area, characterized by an open hall and jettied end chamber or chambers under one roof.

Warwick is about 10 miles south of Coventry, and 10 miles south of that is the Bard's digs, Stratford-upon-Avon. This town has probably made more people aware of timber framing than any other in the world. In 1817, 24 coaches a day showed up here. A word to the wise: stay out of this town from June until Labor Day and you will enjoy it and actually enter the famous buildings all in one day. I watched a worker ripping out some damaged infill on a side street (below right). We got to talking, and he invited me three houses down the street to climb what is purported to be the original staircase from the Shakespeare house. It was moved to its present dwelling almost 300 years ago. This house is now owned by a woman from Manhattan who prefers to catch the Royal Shakespeare Theater before it hits the road to second-run cities like London and New York.

There are five houses that make up the house tour. Hall's Croft is late 16th century and named after Shakespeare's son-in-law, Dr. John Hall. Shakespeare's Birthplace (restored in 1858 on the evidence of a 1769 drawing) was the home of his father, John, a glovemaker in the 1550s, and where the poet came into the world in 1664. Nash's House was owned by poet Thomas Nash, who married Shakespeare's granddaughter. Ann Hathaway's Cottage, partly 15th century, is a mile out of town and has at least one cruck-framed truss, exposed between the hall and the east wing. Finally, Mary Arden's House—she was Willie's mother—stands about four miles from town, an early 16th century dwelling with close studding and a herringbone strutted gable.

But my favorite building was Harvard House, a small affair with a one-bay front adorned with carved friezes, bressumers and just about everything else, right next door to the Garrick Inn, not exactly plain itself. Love those carvers! The date 1596 appears carved over the doorway, together with the initials of the original owners, Thomas and Ann Rodgers. Tom was a butcher, and on the right-hand corbeled post is a smiling bull's head. The other post bears the smiling head of a dog who must be thinking, *table-scraps*. Thomas Rodgers' grandson was John Harvard, the Cambridge graduate who emigrated to Boston and willed £780 (half his estate) and all of his 260 books to found Harvard College in 1638.

The best T-shirt I found in my travels—and I do seek them out—was in the Shakespeare Bookstore (39 Henley Street, Stratford-upon-Avon CV37 6QW, tel. 01789 292176). The shirt is black

The Wildman pattern (arms and legs askew) seen far from home.

Long-term maintenance in Stratford.

Above, façade detail of Garrick Inn, Stratford. Below, carved details of the Harvard House next door, once a butcher's premises.

and displays a *red, embroidered* timber frame ("Shakespeare's Birthplace"). I wish I had visited the Avoncroft museum of historic buildings, about 20 miles west of Stratford. It's open from March to November and touts itself as spanning seven centuries of English life.

—PAUL OATMAN

Paul Oatman's previous voyages in these pages have taken him to Hessen, Chartres, The Netherlands, Suffolk and Essex.

Square panels in Warwick (above) and Stratford (below, on the Thomas Nash house). At bottom, modern life in Stratford.

Highland Reminiscence: Ahkio to Trébuchet

ON a cold and blustery January afternoon in northern Finland, during the few hours of daylight, I pushed my way through a forest, waist deep in snow. With an axe and a saw, I was determined to find and fell the first of several birch trees needed to build an *ahkio,* a Saami sled. The *ahkio* has been used commonly for transportation in northern Scandinavia since the Stone Age. Last year, I lived in Rovaniemi, Finland, researching sleds, working with old sled makers and, finally, building two *ahkiota* myself using traditional methods. This reenactment combined with the actual experience of living in the Arctic provided me with insights about the makers of the *ahkio* and their lifestyle which cannot be learned through books or lectures. As a student of anthropology, I have discovered that making cultural objects by using traditional techniques brings me more in touch with the original makers and gives me a greater insight into specific aspects and details of lost or fading cultures.

In late October, I found myself on the shore of Loch Ness, beside the ruins of Scotland's Urquhart castle, under a parade of rainbows. I had joined 40 Guild craftsmen and a dozen European timber framers to help build two medieval-style siege machines, or trébuchets. Rain soaked and muddy, standing on a 50-ft. oak log, I chipped away with an axe. In the two weeks I spent in Scotland, so much happened it seems now almost like a dream, but the process of transforming that oak log into the octagonal throwing arm for the articulated trébuchet still stands out in memory. In my mind, it was a perfect example of experiencing history through making.

The task of transforming tree into throwing arm was placed in the hands of Jim Kricker, a tall, thin, calm, patient man and a notable millwright with expertise in restoring and building windmills and water wheels, which can require precisely measured rounded members cut from rough logs. I was honored to help.

The process began by placing the log onto two long, level bunks that became its cradle while we mapped, marked and hewed the log into its new form. We could easily turn the log to work on all sides, while the cradle also prevented the log from rolling down the hill over some of our fellow framers and into Loch Ness.

Photos Rick Brown

Above, Jim Kricker measuring offsets, Cormac Seekings hoping the rain will stop. Below, log-rolling with cant hooks.

Our first goal was to find the theoretical central axis as it ran from one end to the other. This particular piece of oak was quite curvy, so the process of finding its center was slow and tedious. We attached boards to each end of the log with one nail on points designated "assumed centers." These points defined a trial central axis. Because they were held by single nails, the boards could swivel around the ends of the log and hold a taunt string at a constant distance from the trial central axis. Once this string was in place and tight, we took many measurements from the edge of the log to the string. These measurements allowed Kricker to map the curvy log three dimensionally and to understand how it could be laid out to optimize the size of the final arm. In our case, the assumed centers were not in the best location, so we had to move them and check again. This process involved a good amount of standing by with cant hooks ready so the log could be rolled, measured and rolled back.

When the mapping was finished, and the assumed centers were considered sufficient, the layout began. It was a given that the curve of the log would be in the vertical plane, the plane of rotation for the throwing arm. Additional orientation was determined by looking at the location of the knots. The side of the log that had fewer knots was rolled upward toward the sky and declared the top of the arm. The topside needed the clearest grain because it would become the tension side of the arm, holding most of the weight during cocking and firing.

The log was chocked against rolling and a centerline string was pulled on the top. Layout required marks equidistant from the centerline string, difficult to make because the log was not round, straight or smooth. On the uneven surface, the points snaked up and down even though the resulting face would be flat and vertical when cut.

AT this point, Kricker stepped aside and in came big Dave Dauerty, a cuddly teddy bear in an André the Giant suit, who selected one of his many axes, climbed on top of the long oak log and began to swing away. As others joined in, the sound of axes echoed across the Loch, through the fog and rain, in a steady beat. When one person tired, another would jump up and fill his shoes to continue the long concerto of steel on wood.

We began by standing on top of the log with long-handled felling axes, juggling away the majority of the material. When the rough hewing was finished, we changed to broad axes with offset handles to smooth the faces. When one pair of sides of the log was finished, the chocks came out, the log was rolled over and the cycle of marking and hewing continued. This happened four times until the log was a well-shaped, tapered octagon, 24 in. across (flat to flat) at the butt and 12 in. at the tip. The natural shape of the log persisted in the smooth S-curve in the last 15 ft. toward the tip.

I never was able to see that throwing arm launch a stone. Its first fling was on the day after I (and a majority of the framers) had already left. Similarly, the snow had melted in Lapland before I had a chance to ride my *ahkio* behind a reindeer. Seeing either of these devices in action is a satisfying sight, I'm sure, but the process of recreating these pieces of history was enough to provide me insight into their original makers. The mapping and layout process that Kricker followed may not have been exactly the same process followed by the builders in medieval times, but it made us aware of the challenges and problems to be solved while building a throwing arm.

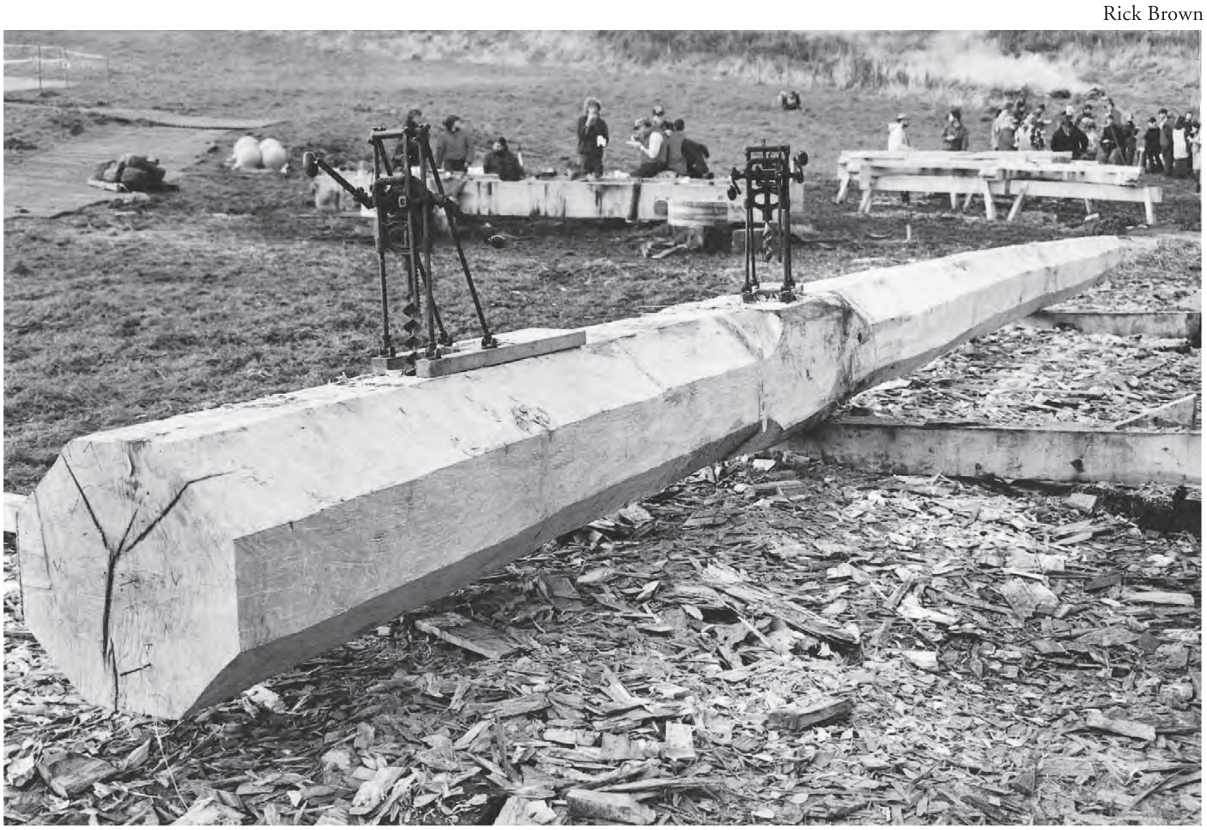
In its simplicity and monotony, hewing a log brings you very close to the material and the process. The sound of the axes striking and the impact of steel and wood vibrating through your entire body let you feel and hear what was heard and felt by a builder of old. Adding the Scottish landscape of mountain and forest, the sound of rain falling into the Loch, the smell of smoke from the nearby forge and the cold bite of my mud-soaked feet, the imagination could run free.

—WYLY BROWN

Marie Brown

Above, juggling off the waste with felling axes preparatory to hewing with broad axes. Below, the octagonal arm with portion left square for the axle mortise. In the background, lunchtime.

Rick Brown



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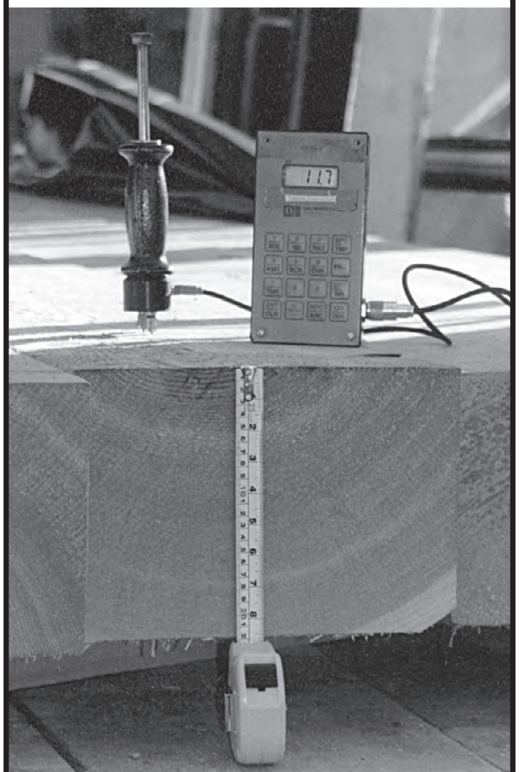

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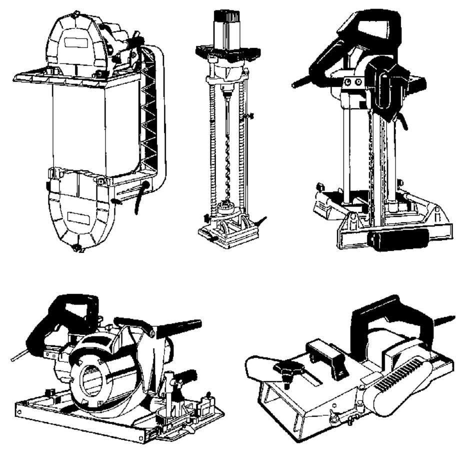

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BOOKS

Timber Construction

Timber Construction for Architects and Builders, by Eliot Goldstein with Stephen Smulski, Ben Brungraber, Fred Severud and Phillip Pierce. New York: McGraw-Hill, 1999. 7.5 x 9.5 in., 461 pp., copiously illustrated. Hardcover, $59.95. Also available from Ben Brungraber (603-352-0395) signed by him.

TO a woodworker, bolted timber framing looks like repair work or ignorance. To an architect designing a public building, it looks safe. To some architects, it looks beautiful as well, and to Eliot Goldstein AIA, bolted connections provide an opportunity for ornament. Designer of the Montvale, N.J., public library, which gained the attention of *Engineering News-Record* in 1995 and which Goldstein himself wrote about at length in 1996 in *Joiners' Quarterly,* he has now produced a closely detailed manual of timber construction that deals primarily with bolted work yet also aspires to embrace "traditionally" joined work and even covered bridges.

But the book was written for architects and builders who plan to work with timber as an alternative to steel and concrete in the design and construction of nonresidential buildings. In his introduction, the author is quite clear about each of those restrictions on the inclusive title of the book, and the reader is fairly warned that the author is likely to praise engineered timber and bolted connections. Nevertheless, Goldstein, an M.I.T. Architecture graduate and a second-generation architect of 20 years' experience, including timber buildings and truss work, has chosen to include substantial information about the nature of timber and to invite specialists to contribute certain chapters likely to interest readers of this journal.

Stephen Smulski, PhD, who has spoken at Guild conferences and who runs Wood Science Specialists (Shutesbury, Massachusetts), wrote the chapter on wood decay and its prevention. Ben Brungraber, PhD and PE, whom a very few people in timber framing may still be unaware of, is Operations Director at Benson Woodworking and wrote the chapter entitled "Traditional Joinery," as well as providing "a wealth of information and feedback during the evolution of this book." Fred Severud, PE, who wrote the chapter on lateral bracing, has frequently worked professionally with the author and teaches civil engineering at the University of Missouri after a career as a structural engineer responsible for large projects such as the 50-story Blue Cross headquarters in Philadelphia. Phillip C. Pierce, PE, whom I am surprised to be unaware of, has, according to Goldstein, led over 100 bridge projects, and wrote the chapter on covered bridges.

For purposes of this review, I read the first seven chapters (including Smulski and Brungraber)—about half of the book—and glanced through the rest, so there are no doubt further treasures to be discovered and quarrels to be picked. My first quarrel is with McGraw-Hill, whose copy editor does not recognize (for instance) the difference between "reeve" and "rive" (7.21), nor between "effect" and "affect" (2.16), nor the disagreement between a plural subject and a singular predicate (2.10). No buildings will fall because of these errors, but editors must keep the language in repair.

In his chapter on the nature of wood, Goldstein, showing practical experience, is capable of an elegant (and entirely accurate) discourse on the material and functional differences between a ripsaw and a crosscut saw. But he seems unaware of the important structural difference between the "Douglas fir-larch" of the Western Wood Products Association, and the premier wood of European and American traditional timber framers. For that material—oak—and for its ring-porous, deciduous kin, ash and hickory, chestnut and locust, it is not true, as Goldstein says repeatedly and absolutely for all timber, that the slower the tree grows, the denser (and stronger) its wood. One need only heft equal-sized dry samples of fine-grained (slow-grown) and coarse-grained (fast-grown) oak to realize that the fine-grained piece is noticeably less dense.

Ken Rower

After 45 minutes in the kitchen oven, the slow-grown, fine-grained sample of southern red oak (22 rings per in.), above left, calculated out at 28.4 lbs. per cu. ft., the fast-grown sample at right (4 rpi) at 45.6 pcf. The coastal Oregon fir samples below right yielded 25.8 pcf for the fine-grained piece (32 rpi) and 34.8 pcf for the faster-grown (average 9 rpi) piece. All pieces began at shop equilibrium.

The explanation is visible on the end-grain surface of the oak pieces, where it becomes evident that the proportion of latewood (relatively dense and strong) to earlywood (porous and weak) is normally much higher in the faster-grown, or "thrifty," sample than in the fine-grained sample. Goldstein does understand that this ratio is the essence of the matter but does not acknowledge that this ratio can be independent of growth rate.

White ash turning squares for professional baseball bats are rejected by the famous makers Hillerich and Bradsby in Louisville if the squares reveal too many (more than 14) rings per inch of end-grain. Stock will also be rejected for too few rings (fewer than seven), but that is because the wood, while exceedingly strong, is "simply too dense" and may lack toughness.

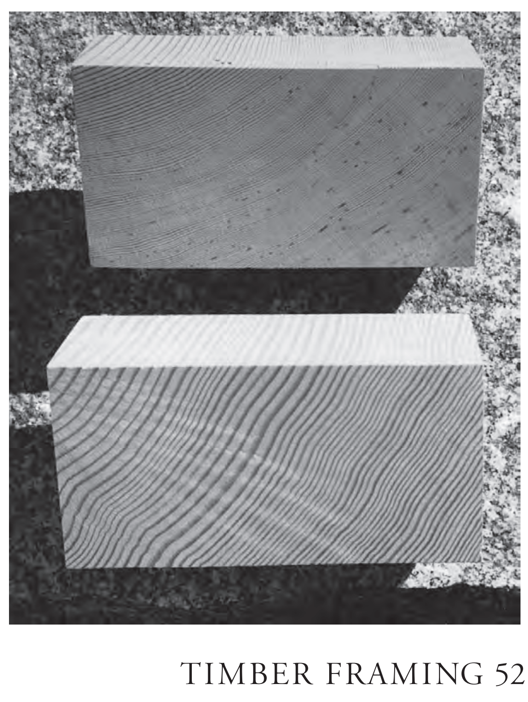
For architects designing nonresidential structures, Goldstein's error is unlikely to cause harm, as the architects will be specifying Douglas fir or perhaps Southern Yellow Pine, which do, more or less, obey the rule the author cites. But the application of the rule is not straightforward, as the fir photos show.

There is in this chapter another dictum, that longitudinal shrinkage in wood is insignificant for building purposes. It certainly seems insignificant when expressed as a percentage—a range of 0.1 percent to 0.3 percent change along the grain from green to dry (Forest Products Laboratory, *Wood Handbook*, Madison, 1955). This may sound tiny compared with cross-grain shrinkage approaching 8 percent. But when we realize how many sixteenths of an inch there are in the length of a timber, the picture changes. Taking the lower value of 0.1 percent, what is the reduction in length of a 12-ft. timber from green to dry? A strong eighth of an inch. That is not necessarily an insignificant quantity, even if we choose to ignore it because usually it will disappear in the connections.

GOLDSTEIN'S writing style is engaging and personal. Sometimes this approach is very instructive, as for example in his almost avuncular discussion of modeling a timber beam with strips of cardboard glued together, and then observing its loaded behavior (5:16). But the author is fond of distracting analogies and equations and likes to rearrange standard information in personal ways. For example, in the chapter on bidding he opens with "what I call the four Q-factors: *quantities, qualities, qualifications* and *quotations"* (11.3). Italicized words and phrases also appear unneccesarily on many pages to emphasize already-clear distinctions.

The impersonal discursive style of Smulski has some advantages. Here is Goldstein on the sapwood-heartwood issue: "Heartwood is more resistant to decay than sapwood, which explains why, for example, all-heart redwood makes superior siding. Sapwood, on the other hand, is more absorptive, enabling it to more easily accept decay-resistant preservatives" (2.6).

And here is Smulski: "Only the heartwood of a tree may possess appreciable natural resistance to decay because of chemicals called *extractives* that form in the heartwood of some species. Regardless of the kind of wood, sapwood lacks extractives and has no natural resistance to decay" (3.7).



You can't put Goldstein's information to use—you don't know what he means, exactly. With Smulski you know exactly where you stand. While it is true that Smulski's task is largely an exercise in classification, and Goldstein's largely an exercise in analysis, Smulski's style is as clear as a fine autumn day, and from him we learn the vast range of alarming threats faced by timber once in place, and the reasonable steps a builder or householder can take in defense. He is blunt about the decline of wood quality. As "engineered wood products. . . . may be almost all sapwood, they lack decay resistance. Only preservative-treated engineered wood products should be used in exterior and other high decay-hazard applications" (3.11).

In Goldstein's chapter "Code Issues," almost entirely about fire, we get a sense of what an architect is up against in designing a nonresidential and especially a public building. These are no trivial questions. Firewalls between buildings and fire separation walls within buildings receive detailed exposition. Goldstein usefully analyzes the superiority of heavy timber to steel in resistance to collapse during the first hour of a fire and even suggests putting steel connectors inside rather than outside the timber (4.20), a technique used occasionally here, more so in Europe, with considerable appearance benefits (Fig. 6.14) as well as increased fire resistance.

It is fairly well known that heavy timber posts and beams are conventionally chamfered, even in apparently utilitarian structures, not for decorative reasons but to increase their fire resistance. Goldstein elegantly explains the underlying principle of surface area to volume—the greater the ratio, the greater the fire susceptibility—and points out that the ideal fire-resistant timber form is a cylinder.

In his next chapter, which takes up in detail the structural use of timber and surveys wood's properties along and across the grain, he demonstrates that the cylindrical form also provides the ideal section for resistance to buckling in the case of a post connected only at top and bottom. Of course, the contribution of intermediate lateral connections to bracing or girders complicates the picture.

In presenting the necessary shear and bending calculations for beam depth, Goldstein takes a tributary-loading approach and provides interesting ratios related to intervals as well as spans, emphasizing a kind of whole-membrane understanding of a roof or floor (5.22-23). As for materials, the great appeal of glulam to Goldstein is its predictability. A glulam beam can be deliberately constructed to take account of the stresses it will experience in service. The best material can be selected for the lower, tension edge, which will be the most heavily loaded. The next best material can be used for the upper or compression edge, which in service does less work, and at the middle, where not much of anything happens, the lowest grade of timber can be employed—sawdust would be almost adequate there, Goldstein remarks (5.37).

The elegance of the steel I-beam is that a very high proportion of its material is concentrated near the upper and lower edges. A beam of uniform-thickness timber, glue-laminated or sawn, may lack that elegance, but its strength-to-weight ratio may be comparable for a specified load and span. In the case of glulams reinforced with plastic fibers inserted one lamina in from each edge of a beam (presumably for abrasion protection), the composite product may exceed the steel in strength-to-weight ratio (5.35). Goldstein is clearly interested in promoting the use of wood as an alternative to steel, and even if we are dismayed by the appearance of bolted connections, large, open-framed structures are for most people relatively more pleasant to spend time in and to contemplate when framed with wood, even engineered wood.

Goldstein's frequently graceful use of steel in combination with wood—as displayed abundantly in the Montvale library (figures throughout the book) but also in other New Jersey work such as a police headquarters in West Orange (Fig. 5.17), a railroad station in Elberon (Fig. 8.11) and a utility building in Newark (Fig. 9.10), and in a residence not identified as to location (Fig. 8.17)—demonstrates a more than usual sensitivity, and of this we can be respectful.

But the heart of his book is engineering, and for anyone seeking quantitative understanding and methods of analysis for the members in a timber structure, and for the behavior of the structure entire, there is plenty to learn here. There is also a lot of practical advice on sequence and procedure in the design and construction process. As for bolts (Chapter 6), there is a whole world in a blade of grass.

RATHER than "Traditional Joinery," it might have been fairer to call Ben Brungraber's chapter "Woodwork Joints." Brungraber, and Benson Woodworking Company generally, no doubt were chosen by Goldstein to explain wood-to-wood timber framing because of Brungraber's engineering background and—remembering this book is for those who contemplate nonresidential building—because of the company's unique nonresidential experience (some 30 structures).

But much work from Tedd Benson's shop over the years has been innovative, in that it looked away from the European and especially English system of domestic wall framing with continuous plates, instead revising the late-19th-century, post-industrial arrangement of American barn frames, in which bents are connected one to another with short girts and plenty of indispensable braces. The barn system does not require long timber and in theory allows a building of any length. (Goldstein's Montvale library is such a building in its central aisle.) Benson's shop also has favored preassembling bents complete unto rafters, again nontraditional (and hair-raising), often including the infamous rafter-end to post-top joint, which has no pattern that I know of in traditional joinery (and which is, surprisingly, illustrated in Brungraber's chapter). The heavy common purlins typically installed between rafters in "Bensonite" structures follow not English traditional roof framing but late-18th-century American practice.

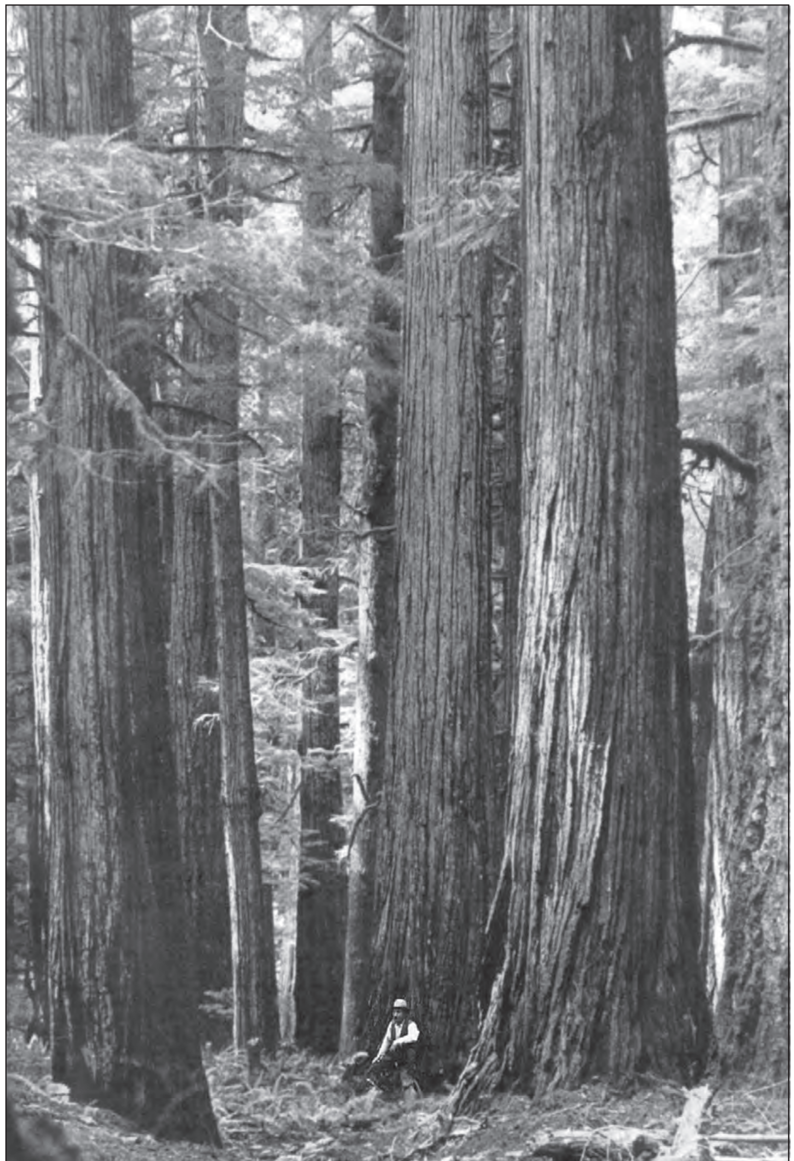
It is too sweeping of Brungraber to speak of the timber frame revivalists of the 1970s taking their inspiration from the colonists who had brought with them the traditional practices. A great deal of evolution in American framing took place between the beginning of the 17th century, when the colonists arrived, and the end of the 19th century, when American timber framing paused. Much of Benson's repertory, and that of his school of influence, came not from the beginning of this period, but from the end, by which time the carpentry here was much changed and definitely American. How young can a practice be and still be called traditional?

There is nothing traditional, either, about pulling a timber frame together with comealongs and then extending the pinholes through the tenons. Ben's asseveration that drawboring has been a topic of debate for centuries carries no citations in support. What can he have been reading? Drawboring a mortise and tenon joint, by offsetting the pinhole slightly closer to the shoulder of the tenon than the path of the hole across the mortise, is a simple, reliable tactic, and a far more elegant assembly aid than clutters of comealongs. It was and remains a natural accompaniment to English Scribe method, which involves preassembly, and offers an easy option in American Square Rule method, which does not. Pegging is certainly important, and the subject of intense scrutiny by the latest generation of timber engineers here as well as in Germany. Brungraber is absolutely right to mention the need for quality in the peg material, but omits the vital information on what makes a strong peg.

This chapter is otherwise full of fair comment about the mortise and tenon joint, its limitations and the necessity to develop more precise descriptive information about it. Brungraber is frank, as he is about all else, about his distaste for much bolted work: "The simplistic, all-inclusive steel gusset-plated connection, riddled with bolt holes, has not proven generally pleasing to my eyes." (7.28) But his pleasure in woodwork joints is tempered by an engineer's heightened sensitivity to the strength of materials. "The real art in designing traditional joinery lies in striking the right balance among the mutually exclusive options" (7.28). On the question of nontraditional dovetail-notched versus traditional tenoned connections between joists and girders, Brungraber explains very well the superiority of the tenoned connection, though regretting the assembly difficulties it produces.

While the chapter is rich in useful information, and numerous common joints are illustrated in Brian Smeltz's clear line drawings, the architect or builder not already intimately familiar with timber framing will be rather lost in judging the arguments about drawboring and horizontal tenoning (both unillustrated). They will be quite baffled (as I was) by an mysterious passage about a suspended beam suddenly dropping out of a nut (7.29), and equally by the final sentence and photograph (7.25) of the chapter, which allege a relationship not at all obvious on inspection. Does McGraw-Hill check anything?

—Ken Rower



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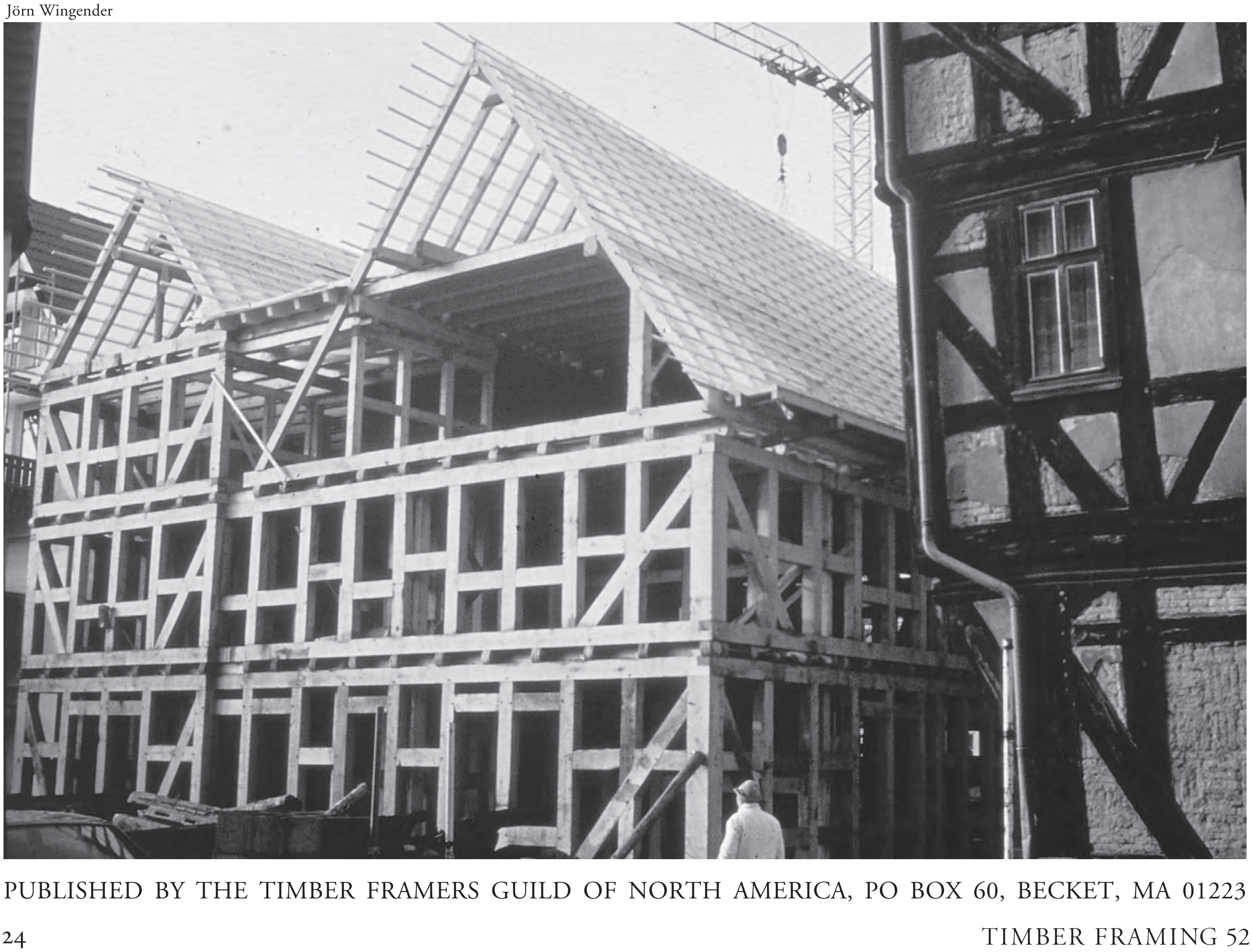
Two German frames in the state of Hessen. At left, new collar beam roof with typical wind bracing and sprockets (Burgwald). Below, reconstruction of timber frame with spar roof on double standing Stuhl and ridge beam on short collars (Frankenberg). See page 7.

Jörn Wingender



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