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Hearts of oak

Oak has long been one of the most essential materials of traditional construction in the British Isles. Charles Hippisley-Cox MCIAT, Chartered Architectural Technologist, looks at how this remarkable material was grown, cut and used.

In the climate of Northern Europe keeping warm and dry during the long winters is a key priority reflected in the form and materials of our traditional buildings. Builders have always been pragmatic when sourcing materials especially within the vernacular traditions and although large parts of the British Isles have used stone and cob, timber-frame buildings have always been the best response to the weather.

A steep roof pitch and a dry building platform enabled the creation space with potentially very satisfactory comfort levels especially if a fire can be safely deployed. Of all the trees available, it is the oak that has lent itself to providing the most suitable material to create such frames. Like all timber, oak has the ability to function within a frame structure in both compression and tension. Pegs, ties and braces combine to create stable structures capable of transferring all loads effectively and efficiently to the ground.

Our relationship with the oak tree

No other tree features more prominently in the folk-lore and psyche of the inhabitants of Northern Europe. This respect for the oak is probably based on the strength and durability of the timber for construction and ship building, but the usefulness of the wood is compounded by the bark to be used for tanning leather and for smaller branches to be converted into charcoal. The longevity of the individual trees and an association with fertility give the oak a prominent place in folk-lore and legends such as the green man who is usually depicted with boughs of oak emerging from his mouth. There are many examples of oaks over 500 years old and some (often with a history of being pollarded and/or coppiced) may be twice that age and have a girth of up to 12 metres.

The two types of oak tree

There are two predominant types of oak tree in the British Isles and of the 25 European species, these two have dominated the landscape since the end of the last ice age. Firstly there is the common 'robust' or 'pedunculate' oak, *Quercus robur* and secondly the 'sessile' (or Durmast oak), *Quercus petraea*.

There is a link between soil type and rainfall with the geographical distribution of the two types of oak tree, but there is also a correlation between the distribution of cruck-framed buildings and the taller, slimmer sessile oak. The author is also undertaking research to explore the relationship between crucks and timber conversion (specifically the deployment of water power and the technology of sash mounted rip saws).

Timber frame buildings have always been the best response to the weather

Cruck frames, post and truss frames etc.

The height of an oak is of considerable significance especially when there is a need for the trunk to be converted into timber for construction. With lengths of three-to-four metres being particularly useful for both box and 'post and truss' frames. However, longer pieces of timber are required for cruck-frames so the taller sessile oak is much more suitable.

Ideally, the tree will have a natural curve and when cut in two, the trunk can be opened to form an arch to carry the weight of a roof to the ground. Smaller oak trees will generate timbers that can be used for posts or beams in a modular pattern generating spans and rooms based on standard lengths of timber of rarely more than three or four metres.

Managed oak trees for post and truss timber frames were sometimes pollarded at about four metres to develop a thick trunk over two or three generations. The branches above the trunk being 'harvested' for other use (such as conversion into charcoal). Oak has the added bonus of being relatively easy to cut before it is seasoned. This is why timber framed buildings can appear rather twisted with wood being pegged together whilst 'green'.

The ability of this type of oak to produce a long trunk needs relatively little attention apart from the occasional removal of unwanted side branches. Depending on the density of the planting within suitably managed woodland, a sessile oak can easily produce a useful trunk of between 10 and 15 metres. A curve was sometimes induced by tethering the young tree to achieve the appropriate shape for of timber for cruck 'blades'.

The physics of a traditional timber frame

The weight of the occupants, chattels and any other superimposed loads (including the building fabric) need to be transferred through the frame. Pressure from wind and preventing potential 'racking' is resisted by braces providing rigidity in three dimensions. Bracing and the appropriate use of pegs will also enable the frame to resist other structural phenomena such as excessive bending, sideways buckling and shear. Beams (like cruck 'blades') will exploit the ability of timber to act in both compression and tension enabling the transfer of loads to the posts which will fundamentally be in compression.

The in-fill panels themselves add additional rigidity and additional wings, aisles can improve the triangulation making the frame more stable.

A cruck-frame behaves slightly differently with the cruck blades taking additional loads via purlins. The combination of tension and compression within a cruck truss can provide a very effective transfer of loads that might include very heavy roof coverings such as stone slabs common in the North of England.

Carpentry traditions and the conversion of timber

Traditionally timber would have been cut down and prepared using axes, with wedges used for splitting and adzes for finishing surfaces. The ability to produce wrought iron enabled the production of metal that could be shaped and toothed to form saws. Most early saws depicted in early manuscripts show artisans working in pairs at either end of a long blade. Sometimes the least fortunate of the pair (presumably the young apprentice) being underneath in a pit as the rip saw works along the length of the prepared tree trunk.

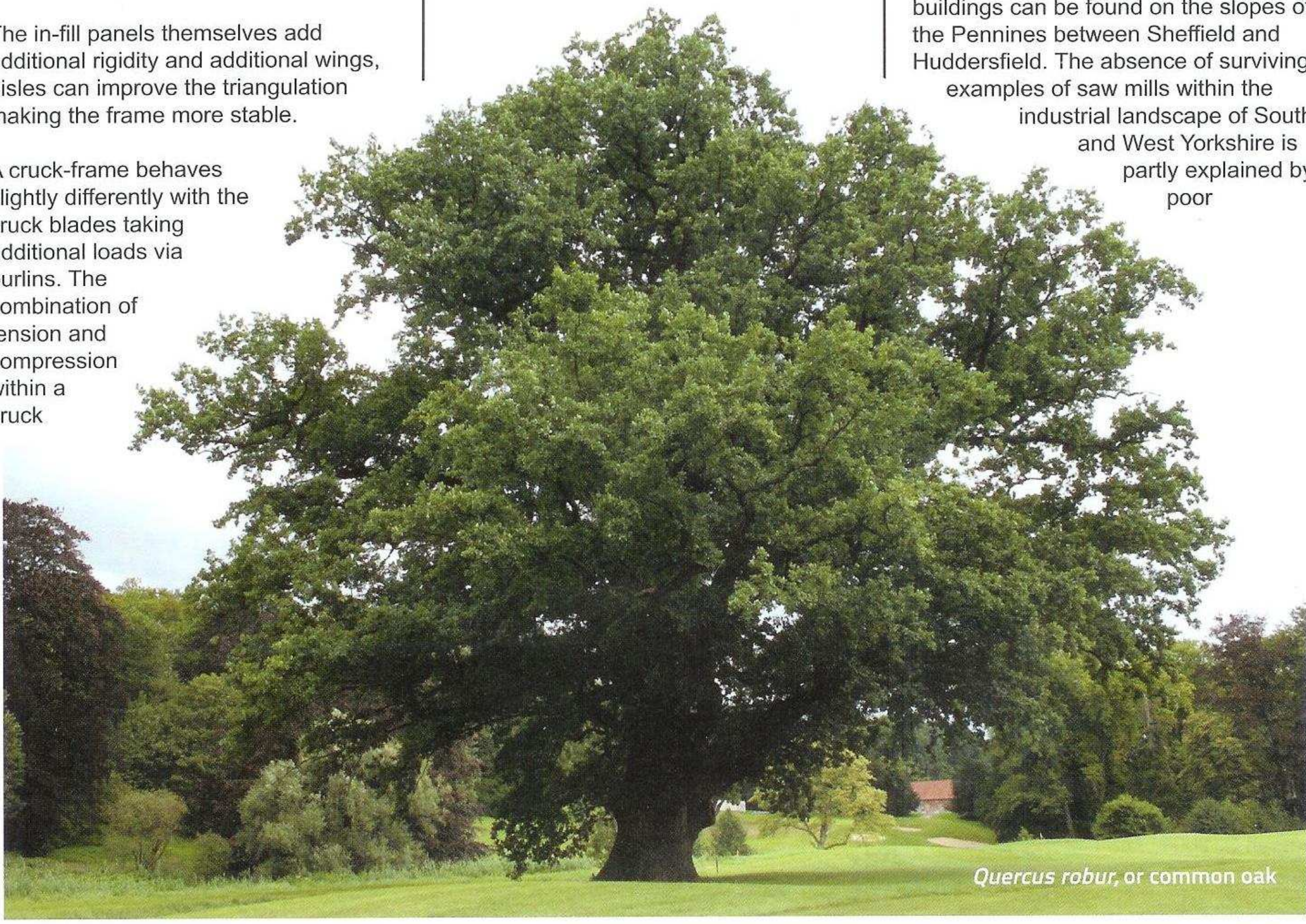
A rip-saw is specifically for cutting along the grain of a piece of timber with straight teeth that cut in a chisel-like action. Whereas blades for cutting across the grain, are sharpened differently and have teeth twisted alternately.

Prior to the 1840s and the introduction of rotating 'circular' saws, saw mills exclusively used a vertical movement for converting the trees into timber. Saw mills were traditionally powered by water, with the rotary motion of the wheel being transferred via a crank shaft to a rip-saw blade mounted in a vertical wooden frame known as a sash. The introduction of steam power would have also contributed to the demise of water power for timber conversion in the UK.

The sash-frame would be attached to a crank which pushed it up and down with a motion akin to the opening and closing of a window sash. Some mills used gravity driven weights to advance the timber whilst others had more sophisticated ratchet mechanisms with the timber mounted on a cogwheel-driven carriage. The water-powered blade would move at about 150 strokes a minute, so as to convert about between 500 and 3,000 feet of timber in a 12-hour day subject to the availability of sufficient water.

The cruck frames on the eastern slopes of the Pennines

One of the type-areas for cruck-framed buildings can be found on the slopes of the Pennines between Sheffield and Huddersfield. The absence of surviving examples of saw mills within the industrial landscape of South and West Yorkshire is partly explained by poor



Quercus robur, or common oak

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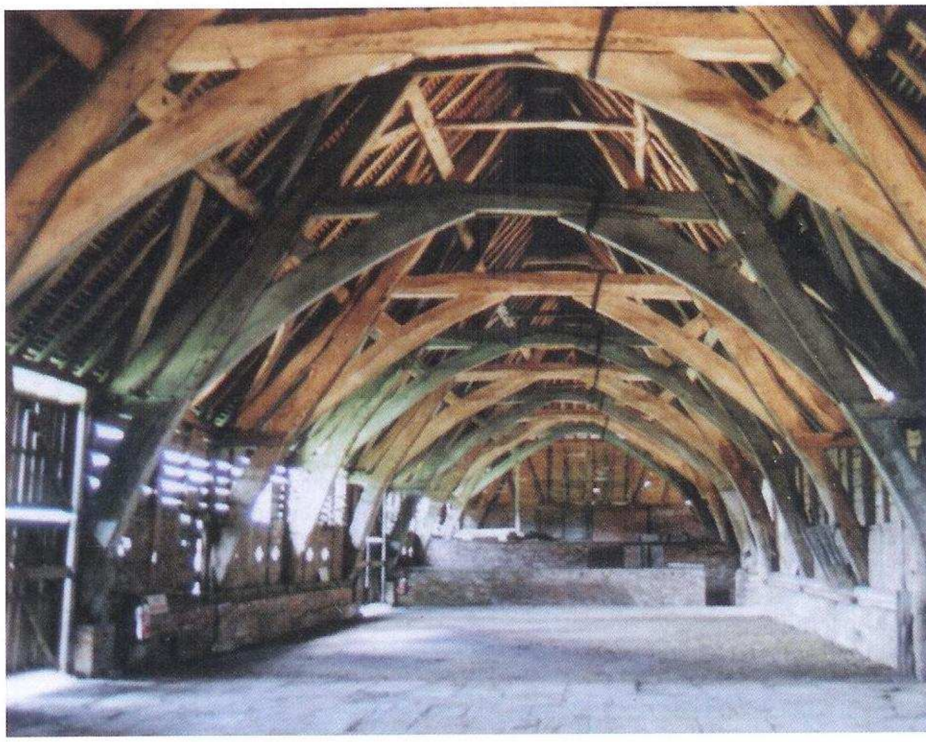
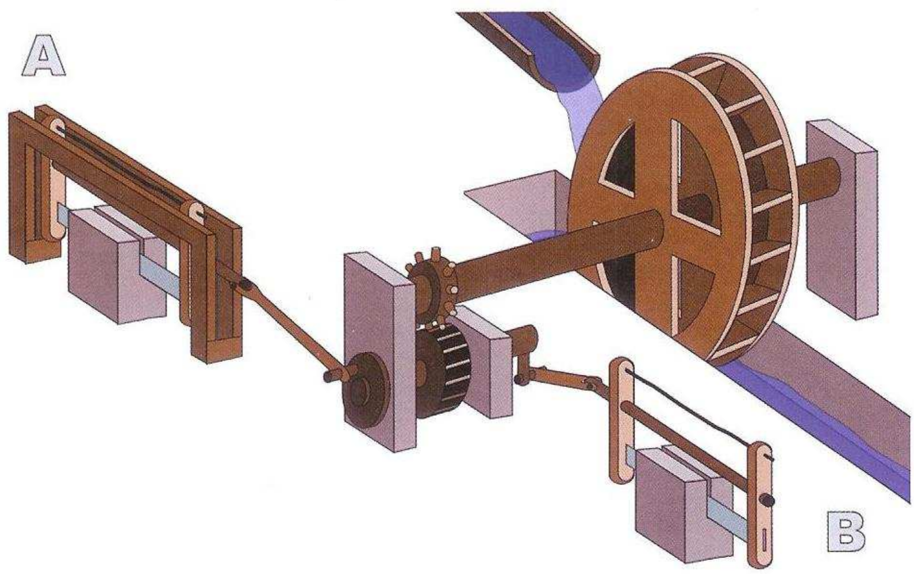
documentation and the fact that mills often had more than one function and would (in the case of Sheffield) have defaulted to tilt hammers and/or mills for grinding and polishing.

However, there are some examples to be found in Europe and North America. Five water-powered saw mills survive in Norway including the one located near Bjørkedalen. The waterfall turns a wheel to power a vertical frame that houses the rip-saw blade. The advancement of the log is also water powered. This type of saw mills is believed to have been introduced to Norway around year 1520 by German migrants.

A British example is Gayle Mill in Wensleydale, although originally a mill for spinning, now uses the water-powered turbines to operate belt-driven machinery for cutting timber.

In North America, the technology of converting timber using water power was taken to the colonies by the very first settlers. There are surviving mills that continue to use the vertical motion of the sash-frame system. Restored examples preserving the pioneering spirit include the mill at Bertolet, Pennsylvania and the recently renovated complex at Herrling, Wisconsin.





Top: Cruck framing at Leigh Court Barn, Worcestershire.

Above: Roman design for a water powered saw mill. The same basic principle was in use in British saw mills until the industrial revolution.

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About the author

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