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Designing with Timber

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Designing with Timber embodies material from the Conference on Scottish Hardwoods held in New Lanark in March 2000. Organised by the Scottish Hardwood Timber Market Development Group, the event was sponsored by the following organisations.

Forestry Commission

The Borders Forest

Highland Birchwoods

Northern Periphery

WWF

Photo: Patricia MacDonald

Rhona Brankin MSP
Deputy Minister for
Environment and
Rural Development

WOOD IS GOOD. It is a natural, environmentally friendly material. It is non-toxic, biodegradable, recyclable and requires comparatively little energy to process. When it is grown sustainably – as it is here in Scotland – it competes strongly on environmental terms with alternative construction materials. Thanks to sustainable forestry practices in Scotland, we are growing more timber than we are harvesting.

Adding value to our own raw material in Scotland is an extremely important process, especially in rural areas, where it can provide skilled jobs. And, by encouraging people to buy Scottish timber products, we give Scotland's woodland owners a sound financial reason to look after woodlands essential to wildlife and the landscape.

I believe that a greater awareness of the qualities, availability and environmental credentials of Scottish wood and wood products will inform, inspire and enable architects to specify the material more often, and encourage them to explore the opportunities for using wood in exciting and interesting ways.

In *The development of a Policy on Architecture for Scotland*, the Scottish Executive emphasised how good design can minimise energy consumption, waste and pollution by making use of local materials. Promoting the opportunities for the use of home grown timber will help to fulfil these ambitions, and accords entirely with the aims of the Executive's *Forests for Scotland: The Scottish Forestry Strategy* which includes priorities to promote more use of timber and to develop products that meet market needs.

I very much welcome *Designing with Timber* which should encourage the architectural and forest industries to work more closely together. This should bring clear benefits to Scotland's environment, economy and people.

Introduction

Sebastian Tombs
Secretary and Treasurer,
Royal Incorporation of
Architects in Scotland

"WERE YOU BORN IN A BARN, THEN?" was a quip I often failed to understand as a young man. That it meant that I had left the door open came as a surprise, because I was indeed born and brought up in a barn. The fact that the barn was clad in timber, with a cedar shingle roof and a floor made from planks salvaged from the Queen's Coronation stand at Westminster all seemed perfectly normal to me then. That was in Sussex in the early 1950s and, with appropriate French chalk, the barn became the local youth club every Friday night. My father, an engineer, was often working on the house, or organising alterations.

Engineering and architecture go together absolutely naturally, and I was lucky enough to see that at first hand from an early age. From its beginnings, the RIAS has also taken a deep interest in the use of materials. Through conferences and other means, the Incorporation has consistently raised questions about the quality of design, particularly of housing in the countryside. A competition for lowland crofting in 1993 resulted in the publication of *Fields of Vision* – a collection of essays which included some discussion on the use of timber. This was taken further in John and Margaret Richards' 1994 report for the Scottish Office on timber-kit housing which focused on aspects of good design and, in particular, siting. The Scottish Office's 1998 Discussion Paper *Investing in Quality* took this theme further. At the same time, the RIAS was extending its interest in ecological matters, and in 1997 adopted its own Environment Statement (which focused specifically on sustainable issues) at its Convention in Findhorn.

Continuing development in conservation practice has also led to calls for greater production and use of indigenous timbers. In March 2000, a Forestry Commission conference at New Lanark on the use of timber – particularly the use of Scottish hardwoods in building and furniture design – confirmed there was an important job to be done in bringing together suppliers and processors with architects and craftsmen. Those who wish to use Scottish timber need reliable sources of consistent quality, and new approaches to growing and harvesting, marketing and specifying were all identified as areas for continued and coordinated effort. The creation of the Scottish Forest Industries Cluster is another indication of the seriousness with which all parties in the industry are pushing forward with this agenda. The cultural resistance to timber cladding of buildings from estates surveyors, mortgage lenders, planning officers and local councillors has to be challenged. There is much we can learn from our northern colleagues, particularly in Scandinavia where evidence from their Building Research Institutes on fire resistance, acoustic performance, insect resistance, and methods of detailing clearly shows that timber is one of the most sustainable and adaptable materials around.

The RIAS is keen to support initiatives which make greater use of Scottish timbers ... 15 Rutland Square is definitely not a barn and the door is always open.

Scotland's Lighthouse Museum at Fraserburgh, Morris and Steedman Architects

Sense appeal

Peter Wilson
Director of The Manifesto Foundation for Architecture

WHAT is it about wood that so touches our emotions? Certainly, it directly reaches three of our five senses – smell, sight (colour, grain) and touch (texture), but it also communicates feelings of warmth and reaches into our memories in terms of our architectural past. Wood has been a constant part of architectural development in all parts of the world since the earliest of times and, in these first years of the 21st century, continues to offer new possibilities for creative design. Part of its attraction is its versatility – it is relatively easily worked, yet has been the vehicle for the development of some extraordinarily complex designs as man has sought new ways of constructing ever larger buildings and structures made from wood.

In many parts of the world, timber is still the material of choice – in some instances because of a lack of modern technology, but more often because of the availability of extensive timber resources. It is difficult, for example, to think of Scandinavian architecture without thinking of wood: the two are virtually synonymous. Denmark, Finland, Norway and Sweden have contributed many of the buildings we consider to be icons of Modernism and, in so doing, have ably demonstrated that this traditional material can hold its own alongside more industrial products such as steel, concrete and plastic. Indeed, for aesthetic, economic and ecological reasons, timber has returned to the forefront of architectural thinking. Greater awareness of the long-term environmental cost of manufacturing and (eventually) disposing of man-made materials has made us more conscious of the ecological benefits of working with an endlessly renewable resource.

For architects in Scotland, there is perhaps something of an air of discovery in all of this – historians of the nation's architecture have so concentrated on our stone buildings that we have almost forgotten how much of our heritage has been founded on the use of timber. This architectural and cultural amnesia is beginning to be addressed, but there is much to do if we are to once again recognise the rich resource that Scotland's forests offer and the potential to stimulate new forms of architecture. A vital part of this process must be to bring the architectural profession closer to the forestry and timber-processing industries, for only by understanding more about wood can architects make more creative use of the range of timbers available and, in so doing, specify more of the native material and reduce our chronic over-dependence on imports.

A wide range of initiatives are emerging to encourage such a sharing of knowledge – awards, competitions, and Continuing Professional Development courses to mention but a few. But as architects well know, the most valuable way to discover how to use a material more creatively is simply to build, and to achieve this, clients receptive to timber's many positive qualities are required. Fortunately, the task of nurturing a wider appreciation of wood is not the architect's alone – many organisations in Scotland are now working together to create a unified timber industry capable of delivering the quality products and service the construction sector requires. The Scottish Executive's Forest Strategy and its plans for an architecture policy, for example, are complemented by the endeavours of Scottish Enterprise's Forest Industries Cluster Group, the Forestry Commission and the advertising muscle of the UK-wide 'Wood for Good' campaign.

In highlighting new technological developments and products as well as the structure of the forestry and timber-processing industries in Scotland, this document aims to encourage architects to make greater and more confident use of native hardwoods and softwoods. It is a compelling challenge.

Scotland's forests offer a rich resource and the potential to stimulate new forms of architecture

Appearances can be deceptive – a timber frame lies beneath the stone skin of this housing at Berkeley Street, Glasgow. Chris Stewart Architects.

Photo: Andrew Lee

Cutting edge

A Sawmiller's Thoughts on Designing with Timber
by Archie McConnell

Bouzy Rouge restaurant, Glasgow. Furniture by Paul Hodgkiss.

BECAUSE of the Golden Delicious apple, very few people have heard of the wonders of James Grieve, Kirton Pippin or Reineting. The Golden Delicious apple tree was found in the 1920s growing on a railway siding in a north eastern state of America. Within 50 years it completely dominated global apple growing, with around 80 per cent of all orchards in the world producing this one variety. James Grieve, Kirton Pippin and Reineting are all different apple varieties which have disappeared. In farming man has tended to use a limited number of crops and – more importantly – crop varieties to the exclusion of others perceived as being less economically viable. It is the same in every other field of human endeavour, including design – we learn to progress through evolution, and not very often through revolution. Evolutionary thought lays down pathways to follow while revolutionary thought jumps the tracks and hunts for new pathways. We can learn from both.

Timber was widely used in building construction during the medieval period. The length of timbers available always limited the size of gable ends. As street frontages along the busier streets were at a premium (especially inside fortified towns), timber-framed medieval housing had its gable ends towards the streets. This also occurred in areas of high commercial use, such as harbours, because oak beams are at their most economic in lengths of up to seven metres. In exceptional circumstances longer oak beams can be found (up to 24.5 metres in Ely Cathedral tower), but even in larger buildings shorter sizes were adhered to, such as in the Great Hall of Stirling Castle, where five to six metre lengths predominate. The width of the Hall dictated the original roof design, which in itself was governed by the lengths of oak timbers available at that time in Scotland. Incidentally, a proportion of the original timbers were imported from the Baltic.

While we usually associate the medieval period with the great hammer beam constructions, the barrel-vaulted roof should not be forgotten. Also traditionally made of oak, it made use of much smaller and bent pieces sourced from coppice plantations rather than the high forests (where larger beams came from). More elegant perhaps in both looks and engineering, it was really only suitable for narrower widths. Again, this was in response to the availability of suitable timber and the basic economics which dictated the design. In essence, this and the hammer beam were evolved designs brought about by an intimacy with the materials available.We tend to think that whenever a larger piece of wood was required in medieval times it was possible to simply go out and get it, but nothing could be further from the truth. Abbot Suger – to use a famous example, when building the new cathedral of St Denis near Paris in the middle of the 12th century – had to search widely for the ten metre lengths he required.

It is still possible to see local varieties and idiosyncrasies in the utilisation of timber, eg in the centre of France, where oak is still used for the main frame in roof construction and poplar for tiling battens. While the latter timber is never used for this purpose in the UK (we prefer softwood), it is perfectly suitable in that situation as it has great strength-to-weight ratio. In past times, transport was the key to timber usage. If near a navigable river or the coast, access to timber was not an issue.

Prairie Chicken House. Herb Greene. 1962.

In the centre of France or anywhere else for that matter, problems occurred with supplies if materials did not grow locally. In 1561, in response to the difficulties he found in obtaining long oak timbers in his vicinity of France, Philibert de l'Orme published *New Inventions for Building Well at Little Expense*. After much research, de l'Orme had the idea of producing arches from short pieces of oak instead of producing the usual hammer-beam construction – a quality design response to a serious supply problem. This archway – or hemicycle, as de l'Orme called it – was used in a variety of ways including the 19.5 metre span of a pavilion at the Chateau de la Muette.

In 1819, a Colonel Emy was asked to construct a roof for a new riding school in the barracks of Libourne (France), with the suggestion that he use de l'Orme's system. With 12.5 metres long pines and even longer firs available in the area (near the Pyrenees), he realised that although length was not a problem, a roof design more appropriate to the timber available in the region was needed. He proceeded to bend the timbers on a frame to produce an arch. The authorities, however, insisted the idea would not work and made him erect a practice span of 18.5 metres for a shed at Marac near Bayonne. As with all authorities, approval took time and it was not until 1826 that he finally constructed the Libourne riding school roof.

Round timber constructions have been in use since time immemorial, but the desire to bend larger roundwood is

The business of architecture is to establish emotional relationships by means of raw materials.

something of a modern-day phenomenon and is now being done in Scotland by Charles Gulland. In essence this is a development from the yurt and the work of Colonel Emy but, more importantly, it is a direct response to the huge amount of small diameter roundwood that exists in Scotland. Roundwood is now being used in rather more extravagant structures than small huts and shelters and recently a dome was built in Ae Forest near Dumfries with a diameter of 33 metres and a circumference of about 100 metres. This sort of project must herald a rethink in what is possible with roundwood.

Developments in timber bridge design mainly mirrored those in building construction, to the extent that the Victorians took up Colonel Emy's system to form the arches of bridges using huge Douglas Fir sections when they became available. This was a king of primitive 'glulam' held together with iron bolts and wooden wedges. The earliest known example of this in Scotland was James Slight's bridge over the Tweed at Mertoun, which – although originally intended to be an all-stone construction – used timber between the stone-built piers. This method was developed into regular usage in eastern Europe in the 1920s and 1930s but over the past half century, the advent of the now ubiquitous 'glulam', has seen the use of timber in large bent form tension virtually disappear.

The most radical change in timber structures began around 1825 with the appearance of factory-made nails and the railway system to distribute them. With the nail came the American ' balloon' structure, in which the reduced section size of frame components relied upon a large number of nails and an outside timber skin (thus 'balloon') to hold it all up. This is essentially how our modern 'timber-frame' houses are constructed. America had all the timber of the necessary quality it could possibly want, but this was not the case in Europe where a more inventive use of other materials was emerging. Yet even at a time when the 'new' materials of steel and concrete were leading the field, ideas about timber structure formed a key part of design thinking. In Germany in 1923, Herr Zolinger invented a diamond-pattern timber vault system which relied upon cheaper short lengths of timber, with only bolts and washers holding them all together. Although Zolinger's efforts were not mainstream they were still part of the canon of early 20th century design, and while he may have been influenced by the new engineering concepts which had begun to appear (eg Bruno Taut's Cologne Werkbund Exhibition of 1914), Peter Grund's church design (1926-8) or Nervi's Orvieto hanger (1936) owe as much to Zolinger's invention as to anything else.

The traditional method of clothing structure is timber cladding, with regional variations arising from the available timbers and cultural interests. It is often assumed that cladding simply comprises boards fixed to a frame in either a horizontal or vertical pattern, but timber has been used for many centuries as both side cladding and roofing. Old timber forts and castles (eg Stafford Castle) used plenty of vertical boards and tree trunks, as did Russian timber structures constructed prior to the reign of Peter the Great. Shingles and their various developments are the outstanding feature of these buildings. In Scotland, cladding was probably done using imported boards, with short lengths of vertical oak boards used up until the 16th century. This was followed by a switch to redwood and whitewood boarding – most of which was imported from the Baltic or Norway. There does not however appear to have been much in the way of available resources to produce anything exotic before stone overtook timber as the primary building material.

Modern developments in the use of timber cladding show how texture and pattern can be created. The past masters of this were Russians but, more recently, Americans and Hungarians have demonstrated considerable design skill in this area. With its long board roof cladding, Deszo Ekler's Nagykallo Harangod cultural summer camp (1989) appears to have medieval roots, while owing something also to the work of Herb Greene and his Prairie Chicken House of the 1960s. In comparison, Imre Makovecz's Roman Catholic Cathedral in Paks, Hungary (1987) is more studied and less raw, with radial cladding around the window to lift an area that would otherwise have been devoid of movement. The current masters of cladding and shingle work are arguably the modern Americans who bend their structures into forms not previously considered possible. Arthur Dyson's Lencioni Residence in Sanger, California (1986) began the leap in belief in cedar shingles that Bart Prince subsequently extended with his Corona del Mar (1884-9), the interior of which is surely one of the 20th century's more outrageous designs.

In terms of looks, designers tend to stick with what they know and work in one material or another. Few attempt to treat materials equally in the context of a design, but in terms of structure as well as appearance, Paul Hodgkiss, for example, has endeavoured to use timber, glass and wrought

Roundwood timber pole structure used in Kids in Need and Distress (KIND) Childrens' Centre, Balbeg House, Straiton, Ayrshire. Charles Gulland.

iron to unusual effect in his work. Windows offer another example where two materials work well together, but new and good design in this field is actually very difficult to find. Poor design, on the other hand, is often seen – the over-complicated roof, strapped together with quantities of stainless steel bolts, is commonplace, inelegant and silly. Decent joinery would normally suffice for the joints and very often a nail or a wooden peg would be adequate for most of the fixings if more appropriate detailing were applied.

This all brings us back to the story of the Golden Delicious – There are all sorts of different apples out there and greater knowledge will always increase possibilities. The better the understanding of timber, then the better the effect that one can create with it. In the words of Le Corbusier:
"The business of architecture is to establish emotional relationships by means of raw materials".

Archie McConnell
is proprietor of McConnell Wood Products

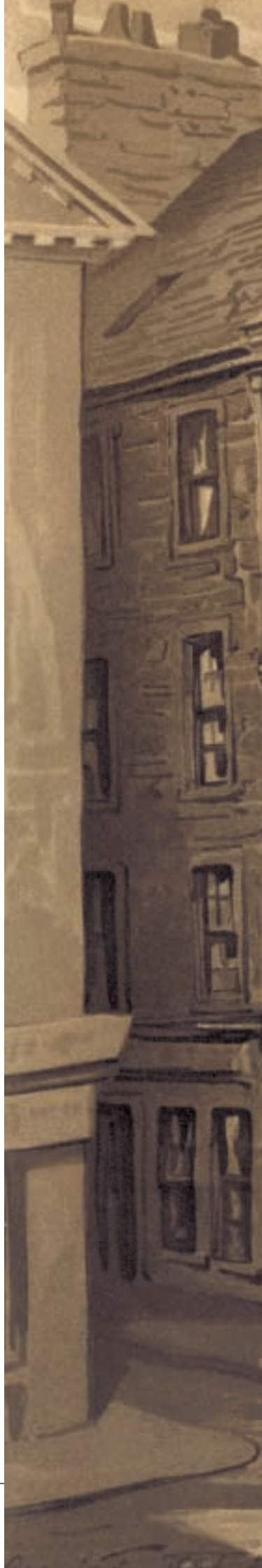
ABOVE LEFT
Furniture design by Paul Hodgkiss.

LEFT
Cologne Werkbund Exhibition Pavilion by Bruno Taut, 1914.

Traditions in timber

Scotland has a long tradition of building in wood, although the perception that timber has played only a minor role in the nation's architecture can be excused when consulting recent histories of Scottish architecture or looking at buildings in the countryside. This situation stems from the significant, but short-lived, use of stone for all types of building in the 19th century. To suggest that some reconsideration of the use of a material that has served the nation well throughout its history is not a plea for the reinstatement of outmoded design practices but for an exploration of new architectural forms based on a deeper understanding of the material and its appropriateness to Scotland.

Bruce Walker, University of Dundee and Christopher McGregor, Historic Scotland



Our Lady Wark Stairs,
High Street, Dundee.
(Lamb 1895)

WHY Scots have been so reluctant to accept their timber building tradition is difficult to understand, but may result from the survival of a series of exceptional stone-built monuments and dwellings dating from as early as 3600 BC. These monuments, rather than being recognised as exceptional at the date of their erection, are now often accepted as the norm, and their existence has ensured a disproportionate amount of attention since they form a convenient progression of architectural and building skills which carry more weight than the archaeological and architectural reconstructions developed from the more commonplace sites.

The impression created by this group of stone structures, when combined with the effects of the great rebuilding of urban and rural buildings in the 18th and 19th centuries, is that Scots have always built using stone. Study of documentary sources, genré paintings, etchings, lithographs, book illustrations and 19th century photographs presents a very different impression, and one relevant to all building types throughout Scotland. Important buildings were often constructed in masonry as a sign of wealth, but the majority of Scottish buildings were timber-framed and generally linked to some form of earth construction. Only the timescale for change varies, with timber construction giving way to stone in parts of the Royal castles in the 13th century, spreading through all levels of society and eventually reaching the humble crofters' houses in the late 19th and early 20th centuries. This situation is reflected today in the vast numbers of timber-frame "kit" houses built in both rural and urban situations which, after erection, are clad in concrete block, brick or harling to give some impression of masonry construction. This illusion is often necessitated by planning officers refusing to allow timber finishes on the false premise that they are 'non- traditional'.

Tradition appears to be measured against the buildings illustrated by Macgibbon and Ross in their five-volume work of 1887-1892, *The Castellated and Domestic Architecture of Scotland from the 12th to the 18th Century*. In their description of 12th century castles, they describe the gradual change from timber to masonry:

Stokesay Castle, Shropshire

© B Walker

"It is curious to trace the history of the use of wood in the construction and defences of mediaeval castles. At first we find the whole of the erections in the castle, with its dependencies and enclosing palisade, constructed entirely from wood. The first change was the introduction of stone for the construction of the keep, or chief stronghold, which was thus rendered secure against fire. Then it was found desirable to prevent the enclosing fortifications from being easily destroyed by fire and a stone wall is substituted for the wooden palisade. Wooden defences are still adhered to but they are now raised to the top of the walls in the form of hoards ... By and by the engines of attack became powerful enough to throw missiles which destroyed these hoards, and fire-balls which set them on fire. It then became necessary to make the hoards of stone; but this change is introduced very gradually."

The castles described were of course those of the upper echelons of the nobility and it took a long time for masonry construction to become the norm even amongst the lesser nobility and rich merchants. Writing about the organisation of the building industry in Scotland during the 17th century, John G Dunbar noted:

"Considering how much information is available for the 17th century it is surprising how few published works are devoted to the subject. The works by Knoop & Jones and R.S. Mylne deal only with masonry operations and do not cover the whole field of building organisation. In many respects, the most useful secondary work is L.F. Salzman's *Building in England down to 1541* which, as its title clearly indicates, is not directly concerned with the building industry on this side of the border."

Similarly, CF Innocent's *The Development of English Building Construction* is considered more useful as a secondary work on Scottish vernacular building construction than anything published in Scotland, including Fenton and Walker's *Rural Architecture of Scotland* which simply catalogued previously published statements and other documentary evidence without providing a satisfactory interpretation of what was happening. The use of these English-based studies as secondary works does not infer that Scots were blindly following building practices developed in England. Indeed, many of the constructional techniques found in Scotland appear to have originated in northern European and Scandinavian forms of construction.

Evidence of timber architecture influencing the aesthetic of later masonry structures is all over Scotland. Pictish standing stones from 900-1000 AD are clearly carved representations of basketwork structures, in which the sculptors – rather than setting out the patterns geometrically – carefully copied the offsets necessary to weave these patterns with osiers. The aesthetic of putlog cantilevers and hoarding on the top of defensive walls is repeated in stone in the wall- walks and attic storeys of Scottish keeps and towerhouses. Even the jettying of floors, common in half-timbered construction, is reflected in the corbelling of the face of masonry walls in towerhouses and tall 'lands' (the Scottish name for buildings containing a number of houses, ie, apartments in separate ownership).

None of these tall timber structures survive in an immediately recognisable form, but a significant number are possibly

Important buildings were often constructed in masonry as a sign of wealth, but the majority of Scottish buildings were timber-framed and generally linked to some form of earth construction.

entombed in later masonry structures. While this has often been summarily dismissed by building historians, irregularities in planning can often be detected and – assuming that the external walls of the former house were half-timbered rather than masonry – further investigation might well reveal the form and construction of the former house. Foulis Castle (Evanton, Ross and Cromarty), is an 18th century mansion house which reputedly replaced a former castle burnt down in the 1745 rebellion. This would appear to be contradicted by the family history, however, which states that the new house incorporated a former dwelling within its fabric. The west end of the south range of the house contains rooms with 17th century-style panelling on the first and second floors. The L- shape formed by these rooms is repeated in both the attic and the basement as a series of stud and mud walls. Similar timber framed structures still survive in Scottish burghs, but are entombed in later masonry. Geoffrey Hay, writing on the subject of timber-framed buildings, states:

"In 1966, the Royal Commission had the urgent task of recording, prior to demolition, what may have been one of the last timber-fronted houses in Scotland with unrestored timberwork – the Kinnoull lodging in the Watergate, Perth, a building which dated probably from the early 17th century. It had undergone much alteration but its timbering possessed all the basic characteristics of box-framed construction; ie, it consisted of a system of horizontals and uprights framed together by pinned mortice and tenon joints."

Much of what Hay reports can be seen in extant examples of half-timbered construction in various parts of Europe, with examples as far apart as Normandy, France and Piedmont, Italy. He continues:

"A less obvious example of a timber-fronted house was recently found in the High Street, Kirkcaldy, Fife. Although the stone frontage of 225-9 High Street bore the date 1672, investigations revealed that the standing building originated 70 years earlier and the first floor plan revealed the tell- tale bresummer in a position defining the cantilever point for a galleried frontage. Moreover, another bresummer was found embedded in the rear wall of the house, and it was concluded that this house had originally been timber framed both at the front and rear."

The house has since been conserved, and further investigation of the timber structure has not been possible. Another entombed timber-framed house is 70-73 High Street, Dundee. This fronts a stone structure known as Gardyne Land, thought to date from 1560 and considered to be the firesafe for the aforementioned timber-framed building. Some indication of the number of these urban lands can be found in documentary sources, such as the *Statistical Account for Scotland's* description of 18th century Dundee:

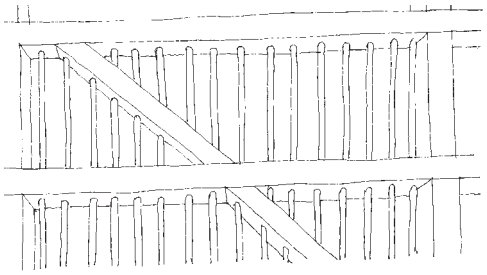
© B Walker

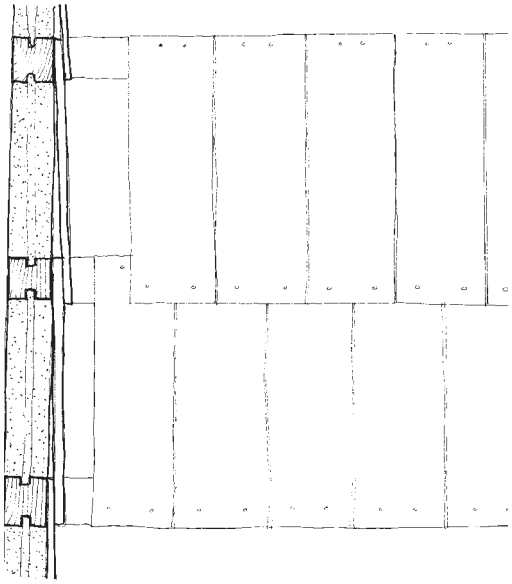
Foulis Castle, Evanton, Ross-shire. Section of timber armature.

© RCAHMS

Kinnoull Lodging, Watergate, Perth.

Normandy, France.
TOP Armature (half-timbering).
BELOW Timber cladding.





© B Walker

Gurro, Piedmont, Italy.
Timber cladding to half-timbered structure

© B Walker

"... even in the middle of the century, when it had a population of 6,000, there was ... not above four houses at the Cross completely built of stone, all the rest being partly wood."

A gradual development from the 11th century timber lands towards buildings constructed entirely of masonry took place through the introduction of stone 'fire safes' – masonry party walls to masonry shells with timber galleries to the street before the emergence of the masonry façade in the late 17th century.

The stone parts of houses were firstly the firesafes to the rear of the properties, followed by party walls as a result of building regulations, then rear walls, and finally the front walls. Timber buildings were demolished in a systematic way in the 19th century – new regulations prohibited the use of timber for external walls, and improvements in town planning provided ample opportunity to force demolition. By the third quarter of the 19th century there were few wooden lands left in Dundee. ' Our Lady Wark Stairs', near the centre of the burgh, was the last of these timber-fronted houses remaining in something resembling its original form (built c.1450, demolished 1879).

Progress towards masonry façades was being made towards the end of the 17th century – folios of drawings were published showing the streets and closes of Edinburgh, although seldom with construction details. Two of the most explicit sketches of Edinburgh are by James Drummond – Head of West Bow from Lawnmarket (1849) shows the north façade of a timber land where each floor is jettied and the external finish appears to be plaster. Another view from the High Street clearly shows the east façade clad with vertical planking.

The change from timber to masonry in housebuilding in the Lowlands is difficult to trace due to the lack of detailed descriptions, but timber buildings were still in evidence in the late 18th and 19th centuries. One early description however, comes from Jean Froissart, a Frenchman reporting on the Scots in 1385, who recorded:

"The French and Scots marched back (from a raid into England) the way they had come. When arrived in the Lowlands they found the whole country ruined: but the people of the country made light of it, saying that with six or eight stakes they would soon have new houses."

The large farmhouses in the rich farmlands close to Edinburgh were the subject of paintings and drawings by Alexander Carse (c.1770-1843) and David Wilkie (1785-1841). They depicted these farmhouses as large aisled structures similar in form and layout to the Netherlands' or north German' hallen-hus. Alexander Carse's *The Witches' Lyke-Wake* (1815) shows the kitchen of an aisled farmhouse with a group of women sitting round the kitchen table in front of the hearth, behind which is a large canopy-chimney. The body is laid out in a bed in the aisle to the right of the picture, with a group of men coming from the door to the best room of the house, which is situated beyond the hearth. The form of the timber framing is remarkably similar to a timber hallen-hus seen on the outskirts of Rastede, Germany.

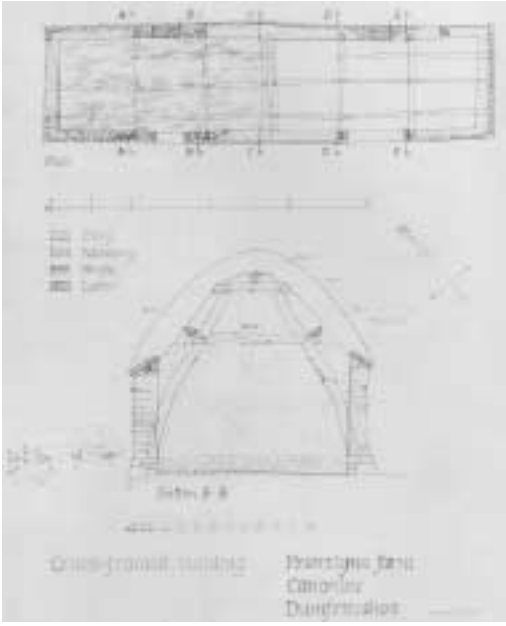
The survival of this aisled farmhouse close to Edinburgh at this late date is remarkable, since Scottish agricultural improvements – which involved the enclosure of fields and the

Many of the constructional techniques found in Scotland appear to have originated in northern European and Scandinavian forms of construction.

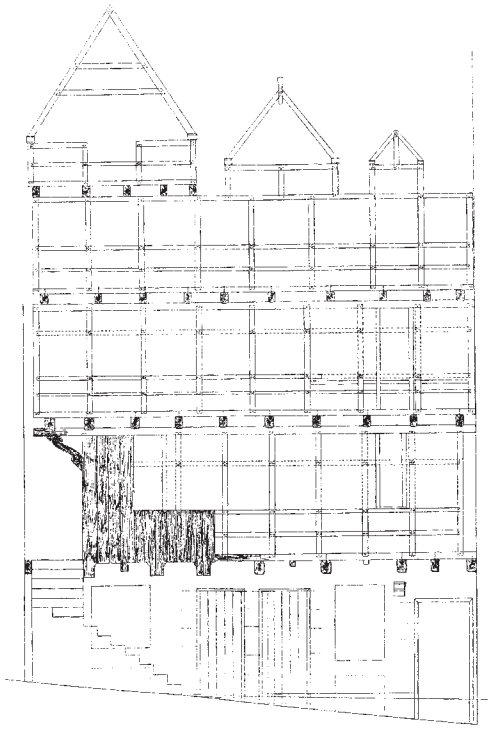
setting out of new farms – gained momentum in the 1770s and it was the largest farms (ie, the type of farm that might have supported a large aisled farmhouse) that were improved first. Further away from the main centres of population, change was slower and the farmhouses were smaller and less impressive. Paintings of these seldom show constructional detail due to the comparative darkness of their interiors and the smoke from the chimneyless fire – Sir Edwin Landseer's *Highland Interior* (c.1830) is typical of this style.

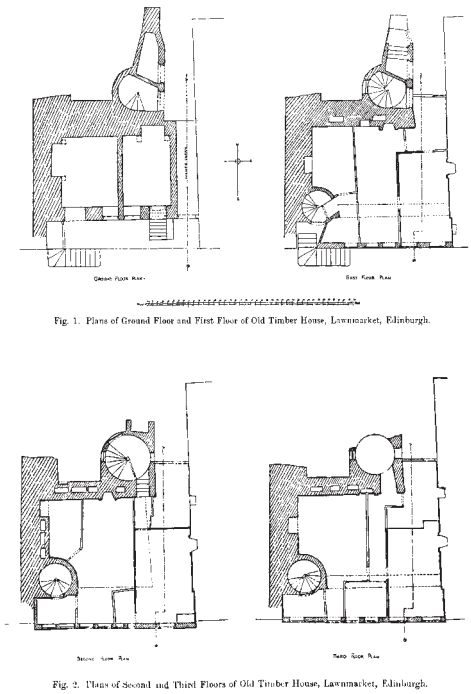
By far the most explicit drawing of a Highland house structure from this period is *A Sketch of a Sheep Cot lately erected at Coul* which appeared in Sir George Stewart Mackenzie's 1809 *Treatise on the Diseases and Management of Sheep*. Mackenzie explains that this structure is "constructed after the manner of Highland cottages." The cruck-framed structure with cabre or wattle lining illustrates a class of house commonly referred to as a 'creel house' in the 18th century but referred to as a ' black-house' in the 19th century.

Cruck frames were not generally recognised by Scottish building historians until 1960, although Innocent had written in 1916,"This method of construction is also found in Scotland, even in the western islands". He linked the use of crucks to any form of "roof-hut"- ie a building where the roof springs from the ground level – arguing that it is a small step from using straight poles inclined to meet at the apex to support a ridge tree, to

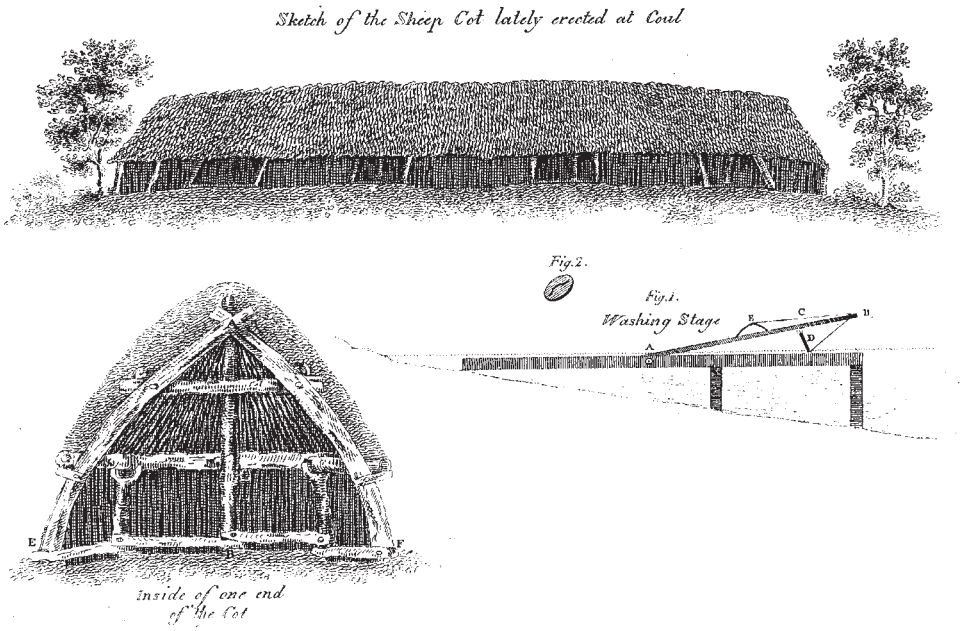


Priorslynn Farm, Canonbie. Cruck framed structure typical of Borders area





Lawnmarket, Edinburgh. Timber land. (Peddie 1884)



Coul, Sheep cot
(Mackenzie 1809)

The change from timber to masonry in housebuilding in the Lowlands is difficult to trace due to the lack of detailed descriptions, but timber buildings were still in evidence in the late 18th and 19th centuries.

RIGHT
Ancrum, East Lothian.
Lofted farmhouse interior.

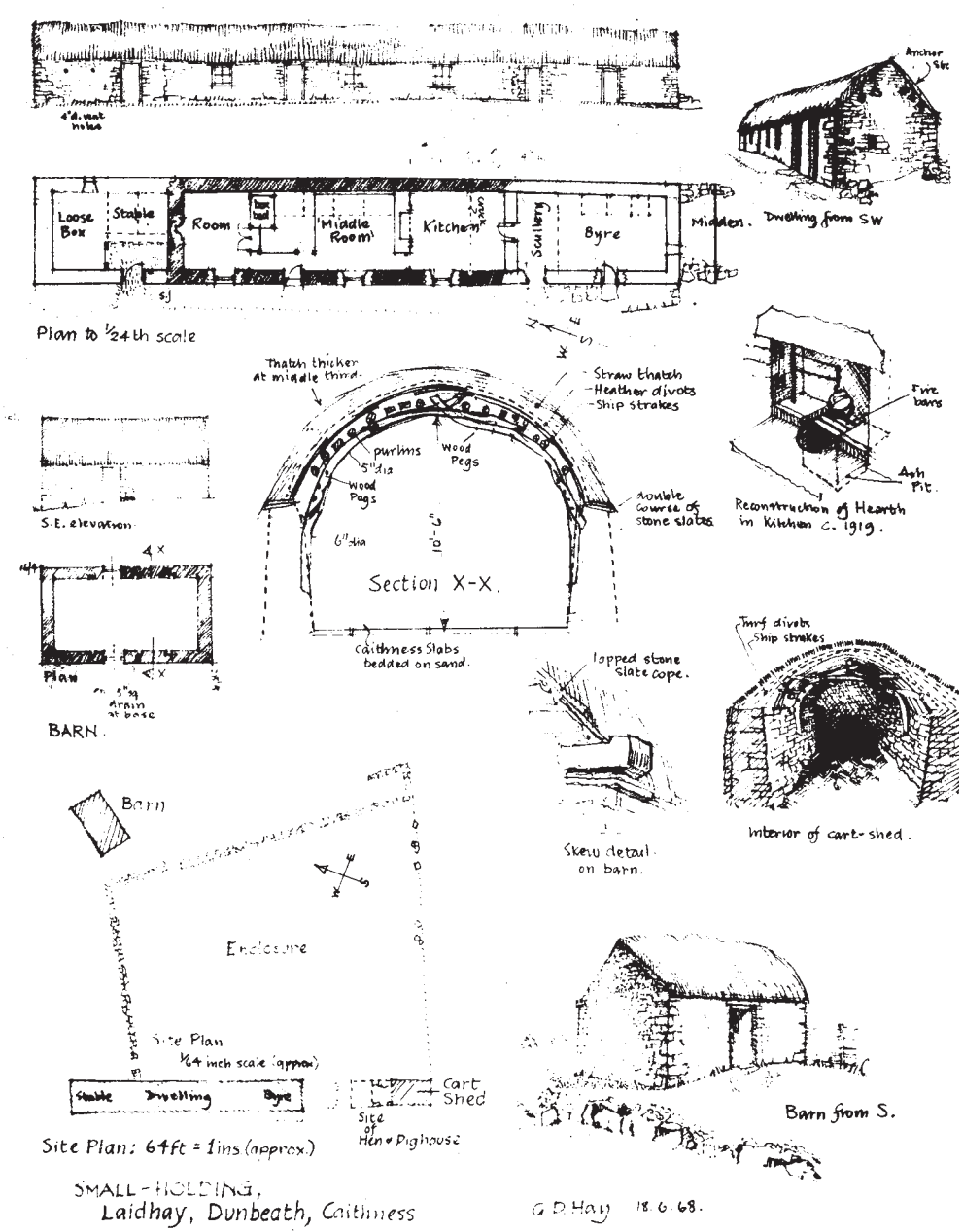
replacing these with curved timbers which can dramatically increase the headroom without increasing the height of the ridge. Cruck frames, when applied to dwellings, can result in several types of external form. In one type, the roof oversails vertical walls in the same way as is shown in the *Sheep Cot*. At the other extreme, the roof may have stopped near the inner face of the broad turf wall in the same manner as the roofs of surviving Hebridean blackhouses.

The first option of the roof oversailing slender walls is depicted in an 18th century illustration of *Rodrick McDonald's Inn, Ross-shire*, where the interior is wattled and the exterior is turf. The drawing clearly shows a diamond pattern over the façade. It is difficult to comprehend how this pattern could be achieved in turf and still be capable of withstanding the windspeeds encountered in this area, but it could be a form of vertical thatch of either heather or broom, restrained by external wands forming a diamond pattern. Escaping from the restraint, the lower fronds of the thatch material are lapped to give the impression of turf tiles. This is a walling technique well known in Hordaland, Norway where juniper- thatched walls are very densely thatched, while others are more lightly thatched with horizontal or diagonal wands to provide restraint.

The poorest forms of cruck surviving in Scotland are semi-circular bow types, made from up to seven pieces of curved timber – eg the barn at the Laidhay Croft Museum, Caithness. This type of cruck can also be seen in the survey drawings of Sammi houses from West Finnmark, Norway, an area with very similar problems to those encountered in the Outer Hebrides, Sutherland and Caithness. The Sammi houses fit the descriptions of creel houses in these northern regions of Scotland, and are particularly interesting since Sammi tents are almost identical to the now extremely rare bender tents used by travelling people in the highlands and islands of Scotland.

The final type of timber structure considered here comprises a row of posts carrying a head beam which, when infilled, forms the front and rear walls of the building. The roof is then applied using the head beam as support at either side. The roof timbers also form the tie to prevent the two side walls being pushed out by the thrust of the roof, and examples have been located at West High Street, Grantown-on-Spey and on the side of the old military road on the south side of Loch Ness.

Timber continued to be used in most parts of Scotland throughout the 19th and 20th centuries. Between WW1 and WW2, however, the emphasis moved from hardwoods to softwoods because of a shortage of good quality timber. Unfortunately the reduction in the numbers of timber buildings erected in the 20th century, together with the practice of cladding timber frames in brickwork or rendered blockwork, has given the false impression that building in timber in Scotland has ceased.



Laidhay, Dunbeath, Caithness. Barn section.

This essay is edited from an extensive paper given by Bruce Walker at the Scottish Hardwoods Conference held in New Lanark in March 2000

Photo: Patricia MacDonald

Focus on sustainable development precedes the 1992 Earth Summit in Rio de Janeiro, with recognition since the 1980's that a balance is required between the sometimes competing, sometimes complementary demands of economic, social and environmental interests. During the past decade the upswing in both interest and effort to achieve this balance has manifested itself with great vigour in the forestry sector. This is hardly surprising given the importance of forests to the health of the planet and the fact that when managed responsibly, forests can be the source of the ultimate environmentally-friendly and renewable material – wood.

Ever green

WE HAVE all seen images of forest destruction in other countries. This has had a powerful and enduring effect on the public. There is a widespread belief in the UK that forests everywhere are shrinking and amongst concerned buyers there is a feeling that they should avoid buying wood products, because to do so would contribute to forest loss. The issue is not so black and white. In Scotland and in the UK as a whole the forest resource is in fact expanding – as it is throughout almost all of Europe. Even in the tropics, Brazil, Indonesia, Gambia, and in many other countries, there are substantial areas of forests which are being well managed.

The Forestry Commission has long been active in promoting the sustainable management of all types of forests throughout the UK, and The Earth Summit gave this work added impetus. Since 1992, the organisation has worked with other countries in Europe to develop international criteria and indicators for sustainable forest management and has made a commitment to turn these words into action (ie how to define and measure). In 1998, following widespread consultation, it published the UK Forestry Standard, a benchmark for forest management. The Forestry Commission is committed to meeting this standard, both in the 2 million acres of woodland that it manages, and also in the hundreds of thousands of acres of new and existing woodland supported through its Woodland Grant Scheme, which aims to encourage sustainable management and expansion of forests in the UK.

The Forestry Commission has long been active in promoting the sustainable management of all types of forests throughout the UK. The Earth Summit gave added impetus to this work.

Forestry has an excellent story to tell, but too often the message is lost amongst the controversy. Notwithstanding the real issue of total deforestation, not being able to find a market for the products of well-managed forests is a major disincentive for their care and sustainable management. However, alongside increased interest in sustainable development is a growing awareness by the public that they can play a more active role in the future of our forests. Increasingly people want to use the products that forests produce, and the purchase of wood provides much of the income which enables owners to manage their forests in a way which protects and enhances the environment.

Tim Rollinson is Head of Policy at the Forestry Commission

Photo: Historic Scotland

Assured wood

Certification schemes provide independent confirmation that forests are being well-managed by using professional auditors to assess them against rigorous internationally-recognised standards. Products from certified forests can be tracked through the wood chain to the final point of sale where they can then carry a label. This label provides the consumer with the reassurance that the wood product they are buying comes from a sustainably managed source.

Oak beams for The Great Hall, Stirling Castle were sourced from sustainably managed forests throughout Scotland. Historic Scotland.

WANDER into any do-it-yourself superstore and examine the wood products on sale – garden tools from the USA, shelving from South Africa, curtain poles from Sweden, MDF sheets from Brazil, toilet seats from New Zealand, garden furniture from Bolivia, doors from Malaysia, parquet flooring from Sri Lanka. Each of these products is certified by the Forest Stewardship Council (FSC) as conforming to strict social, environmental and economic standards, with an identifiable point of origin in a well-managed forest. This assurance can be a powerful marketing attraction for environmentally-conscious consumers, and many retailers in Britain have developed or adopted a range of environmental policies. B&Q, Homebase and Boots, for example, joined the World Wide Fund for nature to establish the WWF 1995+ Group, thereby committing themselves to buying only certified wood products. In doing so they effectively stimulated a UK market demand for certification, and the 1995+ Group now serves as a model for the development of 'Buyers Groups' in many other countries around the world.

To be effective, certification has to be credible. In the past many different labels appeared on the shelves of DIY stores on furniture, on toilet rolls, and so on. These labels made any number of claims about the forests from which they came – some were true, but others were manifestly false and the resulting uncertainty undermined their effectiveness. So without clear certification, how do architects and other consumers ensure that the timber they specify originates from a well-managed, sustainable source?

The Earth Summit in Rio de Janeiro in 1992 gave real impetus to the need to develop internationally-accepted criteria and indicators for sustainable forest management as well as a commitment to turn these words into action. As a direct result, the Forest Stewardship Council (FSC) was established, an independent organisation made up of representatives of environmental, economic and social groups who share a keen interest in forestry. Between them they developed the FSC scheme in 1993 for the certification of all forests, and this has since prompted the development of a number of other national and international certification schemes.

In the UK, for example, the Forestry Commission worked closely with industry and environmental partners to develop just such a system of national forest certification, a process which resulted in the creation of the UK Woodland Assurance Scheme (UKWAS). In June 1999, all British forestry industry and environmental stakeholder groups signed up to the UKWAS Standard for forestry management, a world first. Crucially, the

Henderson Terrace, CiAO Architects.

7.2m lengths of SC4 graded timber sourced from Glenalmond Timber, Methven, Perthshire.

Stair tower and connecting corridor of extension to nursing home at B-listed Binny House, Ecclesmachan clad with Scottish green oak boarding detailed to weather naturally. Erdal Architects

FSC recognises forests assessed against the UKWAS Standard as being equivalent to the FSC's certificate of responsible management, allowing suitably-accredited owners of forests and woodland to use the FSC label. With over 1 million hectares of woodland in the UK now certified as sustainably managed, certification in Britain can be seen as credible.

What does all this mean for Scottish Wood? An increasing number of forests and woodland are being certified in Scotland, and it is clear that their standards are among the best in the world. Howie Forest Products based in Dalbeattie, for example, the largest single site sawmilling complex in Scotland (and probably Britain), sources its entire volume of sawlog material in accordance with the FSC Chain of Custody procedure. The current annual capacity of its two sawmills is around 300,000 cubic metres of logs, and is capable of rising to 500,000 cubic metres when output from supplying forests permits. To feed the site, Howie purchases round timber cut as sawlogs from Forest Enterprise (the majority) or private forests in Dumfries and Galloway, the Borders and Kielder, as well as the Forth Valley and Argyll.

There can be no question that fully-certified Scottish softwood timber is available. The Scottish forestry industry already produces 60 per cent of the UK's conifer harvest (around 4.8 million cubic metres of timber), and its sawmills output 42 per cent of British lumber production. By 2016 the Scottish supply of softwood is expected to have virtually doubled to meet anticipated demand. The days when it might be argued that it was difficult to obtain good Scottish timber – never mind from sustainably-managed sources – are fast disappearing. Of course, not enough wood is produced to satisfy all specifications, but architects and others who choose Scottish hardwoods and softwoods can be increasingly confident that they originate from properly certified sources.

Tim Rollinson is Head of Policy at the Forestry Commission

Timber – the Renewable Resource: The Environmental Edge

In these days of demanding environmental credentials, resource management is a major selection criteria for materials, and the Scottish forest industry has invested millions of pounds in some of the most modern sawmilling facilities in the world. Alongside this investment, the industry has developed its personnel and expertise to a sophisticated level, with a strong track record of collaboration with the major research organisations in the UK. In addition, a number of shared projects exist with overseas forestry companies, emphasising the international nature of the trade.

UK sawmills offer the market a wide range of construction grades products from treated tiling battens, floor joists, timber frame sections, special sizes to suit renovation projects, through to civil engineering timber such as shuttering. Great effort has been put into producing products of consistent and reliable quality, many of which are strength graded to European standards. Of equal importance are the efforts of companies to market timber, since buyers have a wide choice in an international marketplace, particularly from the Nordic countries, Baltic States and Eastern Europe, but also increasingly from Chile, New Zealand and South Africa.

UK and Scottish producers have two advantages in terms of product differentiation – their closeness to the market and their environmental credentials. Market proximity is not just about being within 100 miles of the customer – it is also about an ability and willingness to engage with customers, to anticipate and stock their needs, to understand and respond to local nuances of specification, and to be able to supply small amounts of graded dried timber at the right price to a merchant's yard anywhere in mainland UK within 48 hours. Market proximity gives access to end users, to developers, specifiers and architects, as well as to government and research facilities.

Increasing emphasis on life cycle analysis is further underpinning environmental credentials in the UK, since this takes into account the energy required not only to produce the timber in the first place, but also the energy necessary to bring the product to market, right through to product wastage, in use and ultimately disposal. Market proximity gives the UK producer an environmental edge.

Hamish Macleod is General Manager of Howie Forest Products and President of the UK Forest Products Association

Building responsibility

THE RESURGENCE in the use of timber in construction occurs within the context of international initiatives aimed at creating more sustainable construction practices. The Egan Report, ongoing work by DETR, the introduction of the Climate Change Levy and Landfill Taxes are the first steps in a major change in UK practice which – it is now recognised within government and the construction industry – is required over the next ten to 20 years.

All too few Scottish architects discriminate seriously in materials selection on the basis of waste production, carbon emissions, environmental pollution occupational and environmental health impacts and so on. However, the construction industry has huge environmental impacts – it produces 50 per cent of UK solid waste; 40 to 50 per cent of UK carbon dioxide emissions are attributable to buildings; and ten per cent (rising by five per cent per annum) of global carbon dioxide emissions emanate from cement production. All this at a time when governments around the world are increasingly committing to the reduction of such emissions. There is as much energy embodied in the construction of the average modern building as will be used by it over a 30 year lifespan. Throughout the world, architects specialising in environmental sustainability are investigating the potential of a range of materials to reduce these environmental impacts. Timber is an important one of these.

Nationally, coordinated efforts are being made to develop the use of timber in construction. The sizable Scottish timber industry is dominated by the efficient production of softwoods and, with most of its hardwoods exported to England, is working to encourage the development of a market for a wider range of home grown timber products. The industry is well placed to promote technical developments through organisations such as TRADA, while others such as Highland Birchwoods are actively developing new architectural products through small timber firms. A variety of interest groups are also promoting the development of more sustainable forestry management for ecological, land management or economic reasons and this will increase the availability of hardwoods, while highlighting important issues in the environmental impact of timber production.

The Scottish Executive, for example, is encouraging the reassessment of prohibitive planning guidance and policies at a local level. A government paper to be published shortly will help dispel the myth that timber was not a major material in traditional Scottish construction while showing how Scotland can learn from other northern European countries. The DETR has recently funded the monitoring of a leading edge sustainability project in Melrose which involves the use of clay/woodchip blocks as infill within a timber-framed house.

Within this global, national and local context there is great potential for increased use of native timber in Scottish construction. It can help reduce environmental pollution and resource depletion, create jobs in rural areas and re-establish a forgotten aspect of Scotland's architectural tradition. When well used, timber can provide beautiful and durable buildings with the potential for modern cultural expression.

Tom Morton is an architect based in Monimail, Fife

© John Reach

TOP
House at Plenploth, Fountainhall.
Sally Ruel Architect.

BELOW
Car free housing at Gorgie, Edinburgh.
Hackland & Dore Architects.

Photo: Patricia MacDonald

The appliance of science

Recent research into extending the ways in which native hardwoods can be used in new buildings has led to structural innovation and a greater awareness of the potential of these materials to produce an architecture which is distinctively modern yet ecologically sound. Here, Patrick Hislop outlines some of TRADA's research into timber for structure, cladding and other building components.

AFTER AN EXTENSIVE SURVEY in 1996 of architects' offices in the UK which demonstrated that there was very little knowledge amongst designers about the availability of British hardwoods or indeed any useful information available on their properties and possible uses, TRADA produced (in conjunction with the Forestry Commission) British Grown Hardwoods specifically for architects and specifiers.

The format of the booklet was based on preferences expressed by the architects who responded to the survey, and included a request to illustrate the native hardwood trees as well as the wood obtained from them. Unfortunately a lack of information from the trade made it impossible to include comparative prices for the various species. Lack of consistency on the likely cost of particular woods makes it difficult to cost-plan projects effectively, particularly when there is a high timber content. The problem is not that costs are unacceptable, but that they are unpredictable.

For ecological reasons, there is increasing interest from architects in the use of wood for cladding, decking and structural joinery. Although the use of temperate hardwoods is not limited to home grown wood – or more especially Scottish grown woods – there is unquestionably a potential market for British grown hardwood providing it competes on equal terms with imported

RIGHT
Oak window frame and cladding by Russwood Joinery Products Ltd.

wood. While many projects use softwoods such as Western Red Cedar or tropical hardwoods such as Iroko, there is increasing use of temperate hardwoods – often in a 'green' state – such as European Oak which is a sufficiently durable timber for external use. Imported European Oak from France, Germany and Eastern Europe does, however, represent significant competition but has additional transportation costs. Imported American White Oak does not offer serious competition because, although theoretically acceptable, the wood is generally over dried in the US for external use in the UK, a process which can lead to distortion and splitting.

TRADA has been involved in research projects investigating the properties of structural sections made from a range of home grown hardwood laminates such as beech, ash, and oak. The results have been impressive, and one of the first uses of laminated hardwood structural members is the Gaia Centre in Cornwall by Edward Cullinan Architects, where a large span 'diagrid' structure has been formed from laminated sections which use beech internally and oak externally.

TRADA is not only involved in the development of laminated hardwood structural members, however, but also in buildings where large solid hardwood sections are being used for innovative structures. Darwin College in Cambridge, for example, uses a post and beam oak structural frame in a modern context. The Bedale Drama Building by Feilden and Clegg uses an 'oak structural frame' – partially with traditional carpentry joints and partially in conjunction with steel lattice ties and braces – to achieve spans not possible in conventional oak frame construction.

A 'secret fix' method for 'open joint' hardwood cladding is also in development, and has already been used on one project in Ireland. The system needs further refinement to take into account the considerable shrinkage when 'green' wood is used (increasingly popular because it eliminates the cost of drying the wood).

Scottish forests are increasingly able to respond to the rising demand for hardwood from throughout the UK ... the actual cost of using native timbers can be competitive with imported hardwoods.

In conjunction with Coed Cymru in Wales, TRADA has developed window profiles in laminated European oak. A particular attraction of these windows is that European oak does not require a finish and therefore largely eliminates the maintenance costs associated with paint or stain finishes – always a concern of clients who contemplate using wooden windows. Some of these oak windows have now been in use for over five years and are performing well, bleaching to grey but remaining very stable and only suffering from minor surface checking, which is accepted by the client. There are now a number of firms offering laminated oak windows commercially, including Russwood Joinery Products Ltd who use Scottish wood. If more manufacturers set up to produce laminated 'blanks' in Scotland – in much the same way as specialist firms which exist in Scandinavia – the price of laminated oak windows could be considerably reduced. This is because the cost to joinery manufacturers of having to laminate sections for their own use on an ad-hoc basis is considerably higher than if they could buy standard blanks, and these blanks would need only limited machining to obtain the specific window profiles required.

Scottish forests are increasingly able to respond to the increasing demand for hardwood from throughout the UK and – providing that the process of extraction, milling, sawing, and supply can be sensibly rationalised to ensure more consistency in costing, the actual cost of using native timbers can be competitive with imported hardwoods.

Patrick Hislop RIBA, is an architect working with TRADA

Planter support, Earth Centre, Doncaster by ABK Architects and Buro Happold Engineers.

Case Study
Tom Morton Architect
Rose Duncan House, Blyth Bridge

The Rose Duncan House at Blyth Bridge by architect Tom Morton is an experiment in the maximum use of timber construction. The family residence of a commercial organic gardener, the two storey, 110 square metres house is situated in an isolated rural location adjacent to woodland. The sloping site was selected for its low value and agricultural potential.

Bedrooms are located on the lower floor which is designed to be slightly cooler than the living space above – one wood burning stove provides all of the necessary space and water heating. The main frame is constructed of unseasoned untreated Douglas Fir, with sub-frames of boron-treated softwood. Walls and roof are clad in semi seasoned, untreated larch boards, part of which were sourced on site. The floors are made of salvaged tongue and groove oak and pine boards. The construction is designed to breathe, with high levels of recycled paper insulation. All finishes are non toxic.

The house successfully passed its 12 month defects liability period and has settled in well. There has been no failure of the cladding, and although problems were anticipated with shrinkage in the main frame – with details developed accordingly – these turned out to be much less than expected and limited principally to elements immediately adjacent to the stove. The lower floor shows almost no shrinkage cracking at all.

Case Study
Carpenter Oak and Woodland Co Ltd
The Earth Centre Project, Doncaster

Carpenter Oak and Woodland Co Ltd established its Scottish base on a 12,000 acre estate owned by the North of Scotland Water Board. The site had a redundant sawmill on it, and from the beginning, the company has worked to a strict environmental mandate to create a stronger link between the woodland and further structures. From this location the company has been able to take on very large (and, with engineers, sometimes very experimental) timber engineering projects, producing some of the most innovative wood-based projects in the UK. The Solar Canopy at the Earth Centre in Doncaster (designed by Feilden Clegg Architects and engineers Atelier One), for example, is almost an entirely Scottish construction project – Scots-grown larch forestry thinnings were regularised by Hunter Wilson in Dumfriesshire and the metal nodes were fabricated by MSD in Aberdeen. The grid shells at the same project (designed by Andrew Grant Associates and engineers Buro Happold) were formed from 50x16 mm green oak laths – the seven shells range in size from 6x3 metres to 12x6 metres.

The company's understanding and use of green oak has manifested itself on a variety of major historic buildings restoration projects, for example in the recreation of the 16th century hammer beam trusses of Stirling Castle's Great Hall, and the replacement of the lantern roof from the same period at Windsor Castle.

Case Study
Andrew McAvoy, B@LAST
The Taransay Pods

The pods on Taransay are possibly the best known new timber buildings in the UK after the TV series, Castaway, brought their unusual shape and construction to the notice of the nation. Designed by Andrew McAvoy of architects B@LAST, the pods take their inspiration from the subtle curves of the nestled, rounded native buildings of St Kilda (apparently when St Kilda's High Street was reconstructed in the name of improvement, the natives were unable to sleep, the new buildings presenting themselves so abruptly to the wind).

Largely uninhabited since 1932, the island had only two late 19th century buildings (which were to become the McKay House and the schoolhouse for the new community), and new accommodation to house 36 people was required. The short development time permitted by the programme-makers' timescale, together with the variable weather conditions on Taransay and the lack of available building materials there, meant that the accommodation pods had to be designed and prefabricated and helicoptered to the island for speedy assembly – an instant village for the new Millennium, the inhabitants of which were due to arrive a mere 12 weeks after the architect's first site visit.

Working with Carpenter Oak and Woodland Co Ltd, the main frame of each pod is made from solid sections of oak curved, pegged and scarfed in sections, with studs and purlins of Douglas fir. Designed to withstand 12 months of highly changeable weather, the pods were dismantled and removed at the end of that period. Two of the pods have been re-erected as an artists' retreat overlooking Loch Long and Coulport.

Innovating with timber

Gaia Architects have been actively developing a number of timber details, specifications and procurement issues in order to optimise the potential ecological advantages of timber use in their buildings. Several projects, at different stages provide vehicles to develop these issues.

Scottish Sourcing

The new Visitor Facilities for the National Trust for Scotland at Glencoe by Gaia Architects aims to demonstrate that it is possible to use only Scottish sourced timber on a reasonable scale of contract – the overall cost of the development is approximately £3 million. Initial difficulties in finding suppliers – most of whom are not well known in the construction industry – and then achieving the required specification at the right price have been overcome, and the building is now on site. Increasing momentum from Scottish timber suppliers should enable this to become easier.

Local Community Sourcing and Labour

The lessons learned from the project at Glencoe regarding the procurement of Scottish timber are now being applied in the design for a Sports and Community Centre at Assynt. Gaia Architects made contact at an early stage with the local community-run woodland with a view to sourcing timber for the building from the nearby woods and, crucially – using local labour to extract and machine the timber. This is not a simple process, but by establishing dialogue at an early stage, it is possible to develop the design to reflect the local resource base and put in place the necessary contractual mechanisms which enable the use of this resource. Early discussions indicate that the majority of timber-use by volume can be met from local stock.

Roundpole

Due to the continuity of fibres, timber in the round – of a given cross-sectional area – can be as strong (and more predictable structurally) as a sawn beam section of the same area but much more efficient shape. The continuity of fibres is therefore as significant structurally as the sectional shape. The difference is that the roundpole is a structurally useful element after perhaps 20 years growth in the forest, whereas the sawn beam will be culled from a tree which has taken many more years to mature before being cut down and sawn up.

The economics of forest management do not always stack up well, and it seems sensible to investigate the potential use of roundpole in construction in order to significantly improve forestry's financial equation. Working with northern European designers, Gaia Architects have just completed an 18 month study in this area and have produced results which indicate that while the technical issues can be resolved, many of the potential advantages are unlikely to be realised in the present economic environment, although there are many fascinating examples of the technique to be found in both Britain and Europe.

Matching Species to Function

Many architects have little knowledge of the rich variety of characteristics of native timbers and, as a consequence, the potential to respond to almost any requirement without resorting to importation and chemical treatment is widely underestimated. Understanding both the advantages and limitations of different species can lead to more durable detailing and be more efficient in resource terms.

Responding to the Local Resource

Even a cursory study of the local – Scottish or UK – resource base reveals the limitations of the available palette of materials. Not having the range or amount of trees of countries such as Finland or Canada, a more creative look at how best to take advantage of what is available here is required. This involves dialogue with the forestry industry – how to detail and specify to suit what is available and thereby reduce subsequent wastage. This may involve using shorter lengths which are easier and cheaper to source and can, surprisingly, lead to higher quality since the one errant knot in an otherwise superb length can be simply cut out. Much of the best quality timber in Scotland is at present transported to England, and while it would be nice to be able to gain the added value in Scotland, it is also possible to reassess our designs so that it doesn't matter – for example, C16 joists at 400 centres can be substituted for C24 joists at 600 centres, at a stroke enabling the use of a local resource where previously it may have been difficult and costly.

TOP Straw bale office at Dunning uses large poles and recycled timber. Gaia Architects.

MIDDLE Reconstruction of traditional crannog using alder poles. Scottish Crannog Centre, Kenmore, Perthshire.

LEFT Glencoe Visitors Centre uses spruce (structure), larch (cladding) and oak and birch (flooring). Gaia Architects.

No Chemical Treatment

Apologists for the chemical treatment of timber argue that in prolonging its life, treatment of timber protects the forests from unnecessary consumption and is essentially environmentally beneficial. This is perhaps true if the timber is of poor quality, detailed badly and placed in a situation which puts it at risk from fungal or insect attack, but it is also possible to design timber buildings which are intrinsically protected from such attack simply by the way in which they are detailed and specified. Since it is known that the biocides present in treatments are hazardous, it surely makes better sense to develop ways of creating durable timber buildings without such serious health risks. Gaia Architects, for example, now manage to avoid any use of chemical treatment on timber in their buildings.

Using Reused Timber

The environmental – and sometimes architectural – benefits of specifying reused materials or recycled elements is clear enough, but this is often a client led decision and needs to be balanced against the potential benefits of new and eco friendly materials which stimulate the market. Whilst important, the development of an ongoing reuse tradition can be more interesting and more easily achieved.

Design for Reuse

With sufficient determination, most materials can be reused, but conventional detailing makes this difficult or impossible and as a result the reuse of materials is unlikely to become economically viable except for recognised 'high value' discreet objects. A number of techniques can be employed to make this possible, such as the use of joints weaker than the jointed elements and sacrificial layers, along with the routine specification of screwed or bolted connections in preference to nailed ones. Almost without exception, it is possible to specify from the outset monomeric or single-material elements and good quality materials which are worth reusing.

Design for Easy Maintenance

The vogue for requiring "maintenance free" materials can easily translate into "non-maintainable" elements which are impossible to repair once broken and actually present a long-term financial and environmental cost which is rarely factored into briefing documentation. It is more sensible – and of certain ecological merit – to develop a reasonable maintenance schedule which is neither costly nor difficult to achieve and which can lead to considerable savings in the long run. Timber lends itself well to this view of maintenance. In conjunction with a number of other concerns, Gaia Architects have developed a range of details and specifications which enable cheap and easy maintenance of timber elements (and the building generally) by ensuring that all elements are easily accessed, readily removable and 'layered' to take account of the differential weathering or wear of different elements in a building.

Design for Movement

One characteristic of timber is that it moves, both in response to directly-applied loads and ambient moisture levels. Taking account of this means designing buildings which are essentially flexible and which, where inflexible materials such as glass are used, are detailed to prevent this becoming a problem. Whilst seemingly a small issue, taking full account of this when designing fundamentally changes the way one thinks about buildings, especially in combination with the issue of 'breathability'. In this, much can be learnt from traditional detailing, most tellingly in those countries with a more explicit history of timber construction such as Norway.

Breathability and Hygroscopicity

The creation of healthy internal environments is a critical issue in design. There are several aspects to this, but one of the most important is the control of relative humidity. The ambient humidity in a room affects many of the biological, bacterial and physical causes of ill health, but controlling this through air-conditioning can actually increase the problem. Passive control of humidity relies heavily on the porous and hygroscopic nature of certain materials. Surfaces such as timber, plaster and earth will regulate ambient humidity as long as they are not given impervious coatings such as conventional paints and varnishes. To ensure the risks of ill health to occupants are reduced, surface coatings should be specified so as not to prevent the natural hygroscopicity of the materials.

Chris Morgan is an architect with Gaia Architects.

Student lodge for Parnham Furniture College, Hooke Park, Dorset uses low value forest thinnings (round pole thinnings are scarf-jointed). Edward Cullinan Architects.

Photo: Patricia MacDonald

Wood as a designer's material

Wood is hugely versatile, with many economic, environmental and constructional advantages over other materials. To get the best from it requires an understanding of the physical and chemical characteristics of the various hardwoods and softwoods available. Ivor Davies provides an *aide-memoire* to those issues which every architect and designer should consider when selecting and specifying timber.

Timber Structure and Mechanical Properties

Timbers from different tree species differ considerably in appearance, but from a structural point of view these variations are superficial, and the main distinctions between timbers lie in their densities. Most of the mechanical properties of different timbers are proportionate to their densities, and a dense timber like oak is generally stronger than a less dense timber such as spruce. The stiffness of different timbers also varies roughly in proportion to their density – good stiffness combined with relatively low density makes wood suitable for beams and columns. Thus furniture, floors, and bookshelves are generally made of wood, as are cantilevered elements like flagpoles and yacht masts.

Wood is comprised of large numbers of parallel, cell like tubes bonded together to create a strong fibrous structure which under magnification looks like a bundle of drinking straws. Across the grain these cells separate or crush quite easily (making the lateral tensile or compressive strength of timber quite low) – a low density timber such as spruce can be easily marked with a fingernail – but along its grain wood has a tensile strength which, weight for weight, is four times greater than mild steel. It can, however, be difficult to fully use this strength since tensile joints in wood are relatively inefficient.

Although timber is strong and stiff it will eventually creep, ie it will tend to permanently distort under sustained loads (the reason why a violin should not be left tightly strung). Conversely, wood is resilient under short duration loads, making it suitable for tool handles and tennis rackets. The strength and stiffness of a piece of sawn wood can be accurately assessed at the sawmill by machine (for normal construction timber), or visually by a trained sawmiller (for large or very specialised timbers). Strength graded timber should be used for all structural applications.

In cross section a tree trunk consists of two main areas – at the centre is the heartwood core, surrounded by a sapwood zone adjacent to the bark. Between the bark and the sapwood is a very thin growth layer called the cambium. The heartwood core begins to form when the tree is around 30 years old, increasing annually in width thereafter.

The chemical structure of all timber species is similar, with approximately 75 per cent composed of cellulose and other sugar molecules, and the remaining 25 per cent a resin like substance known as lignin together with small amounts of various toxic chemicals that protect the wood from damage by insects and fungi. Collectively, these chemicals are known as extractives (since they are extraneous to the timber structure and can be extracted with the aid of solvents), and it is their presence which gives distinctive colour to the heartwood of some timber species.

Moisture in Timber

Timber is a hygroscopic material, i.e. if drier than its surroundings it will absorb moisture, but will lose moisture if it is wetter than the surroundings. Eventually timber reaches equilibrium with the relative humidity of the surrounding air, a state known as the 'equilibrium moisture content'. In Scotland, timber protected from rain but otherwise exposed to ordinary moist air will eventually attain an equilibrium moisture content of around 16 per cent, whereas in Alaska (a very dry climate) moisture content is as low as five per cent. Changes in moisture content have a significant effect upon the durability, strength, shrinkage and swelling of timber.

Laundry House, Ethie, Arbroath.
Colin Smith and Judith Wilson

Shrinkage and Swelling

Most of the moisture in a freshly felled tree is held as free water within its cell cavities. Removing this free water has no effect on the timber dimensions, but once the moisture content drops to below around 27 per cent, all the free water has disappeared and further moisture losses must come from water absorbed by the cell walls. When timber dries below this level (the fibre saturation point), the cell walls begin to dry out and shrinkage occurs. Conversely, if a piece of dry timber becomes wet, the cell walls swell until completely saturated. To minimise shrinkage and swelling in service, timber needs to be dried near to the equilibrium moisture content of the environment in which it will be used. Moisture content levels can be predicted fairly accurately and are incorporated as recommendations in the British Standards.

Many failures of joinery products are due to insufficient care over moisture content being taken at the design stage. Wood shrinks and swells in response to changes in moisture content, but does not move uniformly in all directions. There is very little movement along the grain of the wood, but cross grain swelling and shrinkage can be considerable. Movement is further complicated by shrinkage around the circumference of a log being roughly double that in a radial direction – during shrinkage, growth rings have a tendency to straighten out, with the effect that a particular board will move in a specific way depending upon where in the log it was sawn from. These characteristics can be very important – eg manufacturers of door stiles or whisky barrels need very stable timber and will always choose boards (known as quarter sawn planks) that are sawn in a radial direction.

Strength

Changes in moisture content affect the mechanical properties of timber. Freshly felled wood is saturated and has only one-third of the strength and stiffness of dry wood. Engineers generally wish to maximise the strength and stiffness of a timber structure, and so the wood is usually dried before use. In cases where the timber cannot be uniformly dried (for example – large oak beams), the engineer has to design on the basis of the reduced strength values associated with wet timber (unseasoned structures such as traditional English oak barns tend to become much stronger as they dry out in situ). An alternative to drying large structural sections is to use glue laminated structures. Built up from many small pieces of low moisture content timber, they are predictable and uniformly strong.

Fungal Decay and Insect Attack

Various insects cause damage to timber, especially in the tropics. In the UK the range of insect species that attack timber is limited by our cool climate and consequently fungi are the main agents of biological degradation. Unable to synthesise

In this abstraction of traditional Japanese agricultural frames, 'The Divided House' at Oshima, Japan uses individually curved and laminated oak ribs to form the primary structure. Benson + Forsyth Architects.

carbohydrates for themselves, fungi look to carbohydrate rich sources such as wood. They spread by microscopic spores (which are everywhere in the environment in Summer) and need moisture to grow – timber with a moisture content of over 20 per cent may be vulnerable to fungal decay. To minimise this risk, timber needs to be properly dried and have details designed to avoid the spread of water from splashing, capillary action or water entrapment. Regular maintenance is essential, since a fungal decay problem in a building can often be cured by ensuring that the timber is thoroughly dried and well ventilated and that all sources of moistures, such as leaking gutters are fixed. In severe cases, chemical treatments may be needed to control fungi while the structure dries out, but chemicals alone should not be relied upon to cure a rot problem.

Natural Durability of Timber

Different species of timber have evolved varying degrees of resistance to insect attack and fungal decay. This natural durability is caused by the presence of extractives in the heartwood. It is possible to classify timbers on the basis of heartwood durability, but these groupings are relative and only provide guidance to what will happen in the worst possible conditions. In less hazardous situations, the durability of a timber will be greater than the quoted figures, and in permanently dry conditions all timbers are at little risk from biological degradation, whatever group they occupy. Providing all the non durable sapwood is removed, the heartwood of naturally durable timbers such as European oak or European larch is perfectly suitable for use in areas likely to be exposed to risk of decay or insect attack, such as external timber cladding. Grading out sapwood however, is expensive.

Increasing Natural Durability through Chemical Treatment

Timber preservatives increase the durability of wood in areas prone to biological degradation. In an ideal world, the heartwood of naturally durable timbers would be affordable, making chemical preservatives unnecessary. However, in order to use timber that is available at an acceptable price, there may in some circumstances be no alternative than to use a preservative treatment. These are applied in various ways, but superficial applications such as painting or spraying are relatively ineffective and should usually be avoided. The most effective application methods involve the use of a pressure vessel to force the preservative deep into the timber (the depth of penetration is dependent upon the permeability of the particular timber species, its moisture content and the length of treatment).

The use of chemical preservatives raises many environmental issues and the chemicals industry – particularly in Third World countries – can have serious discharge problems at the factory. The quality of preservation plants vary, but providing best practice is followed – there are no insurmountable difficulties in the manufacture of preservatives. The potential for leaching and other contamination when a timber product is in use can be a problem but, again, this can be avoided by following best practice in manufacture, installation and use. Preservative treated timber is now regarded as hazardous waste, and should be disposed of accordingly. This raises significant environmental concerns but as with many environmental discussions, there are no straightforward conclusions regarding timber preservation, and specific situations frequently involve some compromise between ethical/safety considerations and cost.

Coatings

The old lead based paints provided a very durable coating (the lead being a strong pesticide which prevented fungal growth from damaging the paint) and their permeability to moisture helped reduce fungal damage by preventing excessive condensation build up under the paint. When lead was outlawed from exterior paints, its initial replacement was the general purpose 'gloss paint' which performed badly in outdoor situations. Nowadays, microporous exterior timber coatings perform almost as well as the old lead-based systems. Opaque finishes are more durable than semi opaque stains. A good modern opaque exterior coating should last about six years before recoating is required. Transparent exterior timber varnishes do not last very long and should generally be avoided.

Factors Affecting Wood Quality for Solid Timber Products

Timber is mostly built up from parallel cells which follow the direction of the trunk. When a board is cut, these cells are visible as the wood grain (normally roughly parallel to the edge of the board). Some timber may contain cross grained areas, with the grain not following the edge of the board. This occurs around knots and in boards sawn from crooked logs or other low grade logs. Cross grain is the most important factor to be taken into account when assessing strength.

Knots are the remains of branches in the log and are the hardest wood in the tree and always disturb grain direction, causing a reduction in the strength of the timber (which will vary depending upon the size and type of knot and where it occurs in the board).

Fast growth in trees produces wide growth rings and slow growth produces narrow rings. The width of these rings affects timber quality (particularly density) and varies between different species. In softwoods, fast growth tends to reduce density and makes the timber more difficult to machine or work by hand. Modern timber processing can take account of these differences but, for some specialised products (such as traditional sash windows made from Scots Pine), there is no substitute for the strength and stability of very slow grown timber.

For a small group of temperate hardwood species (including oak, ash and elm) – density and strength is increased by fast growth. These ring porous hardwoods are identifiable from a distinctive ring of large porous cells visible at the start of each growth ring. These characteristics have some implications in practice – a skilled woodworker will prefer fast growth ash for items which need to be as strong as possible (eg tool handles), but may select slower grown ash for fine mouldings because it is less dense and easier to machine. With most hardwoods,

OPPOSITE PAGE
'Behind the Wall'
Falkirk uses green oak sourced from forests in the Trossachs for its exterior cladding. Zoo Architects.

House at Bourne
near Aberfeldy.
Gaia Architects.

however, there is virtually no relationship between growth rate and density – fast and slow grown timber are similar. Timber technologists group these hardwoods under the heading – diffuse porous hardwoods, a term which includes virtually all tropical hardwoods and most temperate species such as sycamore, beech and birch.

Designing with Low Grade Timber

Low grade timber generally has knots, cross grain, colour variation and other characteristics which limit its application and market potential. It is, however, cheap and can be very decorative. Modern automated production lines can cut out knots and other defects, with the remaining good quality timber finger jointed and glued back together, allowing very stable products such as laminated flooring or kitchen worktops to be made from relatively low grade material, thereby improving the market for it and making woodland management more viable.

This approach is similar to traditional practice where, for example, in the 19th and early 20th centuries, the lower grades of Scottish birch were often sawn into small planks and then assembled into herring barrels. This market no longer exists, but hardwood flooring has been developed as a new outlet for large volumes of short and narrow standardised planks. The most common (and very successful high volume) approach to using low grade timber, however, is to reduce it to fine particles or flakes which can then be reconstituted as paper, cardboard, and a variety of panel products or highly engineered timber components. These products can offer many advantages, including consistency, cost, and very accurately defined technical properties.

Ivor Davies is a Director of Russwood Joinery Products Ltd.

The practicalities of designing with hardwoods

BECAUSE HARDWOODS are considerably more expensive than softwoods they have been much less used until recently. Their chief advantages over softwoods are their appearance, strength and – in most cases – durability. One or more of these properties might justify a design in overall terms when fabrication, transportation, and erection costs – common to all timber – are taken into account. Temperate hardwoods are diverse in their properties, however, and, aside from their durability (discussed in *Wood as a Designer's Material* by Ivor Davies) it is important to consider different species in terms of drying movements, strength grades, and their potential for jointing.

Movement

Hardwoods supplied 'green' are considerably cheaper than fully seasoned material. If the material is thicker than 100mm, kilning – even if it could be afforded – is impracticable. Drying movement is both inevitable and significant, and must be considered at the design stage (subsequent movements occur in response to changes in ambient moisture content). If the material has a significant slope of grain and the member is not braced, longitudinal distortions can occur. In addition, floor beams drying out under load tend to 'creep'. This is a difficult parameter to quantify, but creep deflection can be two or three times that calculated on an elastic basis.

HM Prison Edinburgh Visitors' Centre. Gareth Hoskins Architects

Photo: Keith Hunter

Strength Grades

The design strength of timber varies according to its species, its grades and, to some extent, its origin. Douglas Fir from the UK is a notch down from equivalent grade material from Canada, as it is faster grown (this is not, however, true for hardwoods). Structural grading rules are laid down in BS4978 (for softwoods) and BS5756 (for hardwoods). Essentially they place limits on relevant defects such as knots, slope of grain, wane, fissures/splits and distortion. For hardwoods, the first two defects are more critical in determining the grade.

Joints

Any timber design more ambitious than a simple floor joist will need to joint the members. Because of the marked anisotropic nature of timber, the joints of a frame are generally more critical than the members themselves. There are three broad categories of joints: traditional joints, with the members in one plane – passing loads from one member to another, primarily in end compression; 'dowel type' fasteners (nails/screws/bolts/connectors) which rely on lapping timbers and making a connection with the fastener in shear; and glued in bolts, using gap filling epoxy glues to embed a steel rod in a drilled hole.

Traditional joints were of course conceived for green timber (as illustrated by the ubiquitous king post truss), and temperate hardwoods are suitable for the full vocabulary of traditional structures. The dowel fastener can also be used, assuming the joint can be tightened to allow for cross grain shrinkage (which may continue after 'practical completion'). Information on the capacity of glued in bolts is based on dry timber at present, and it is unwise to consider their use with unseasoned material.

Glued Laminated Timber

The glulam process essentially makes large pieces of timber by gluing together small planks. The formaldehyde range of adhesives is very efficient, but requires dry timber. Most commercial softwood glulam used in the UK is made abroad, and although glulams can be made in the UK, they are generally 'specials'. Hardwood glulams made from kiln dried material are expensive, but to some extent the additional cost might be offset by the enhanced structural properties obtained from the laminated process.

Peter Ross is an Associate Director with Ove Arup and Partners

Engineered wood

Devotees of Trivial Pursuit may struggle to find a connection between the Vikings, World War Two and Dundee but the answer lies in the engineering of timber. The result of taking a tree apart and putting it back together again, the creative potential of engineered timber shows clearly that wood has far more to offer designers than just its green credentials.

THE STORY begins with the distinctive shape of the longboats used by Viking invaders to Scotland 1,200 years ago, and the innovative shipbuilding techniques they used. Essentially these elegant and extremely efficient boats were monocoque constructions – a structural solution in which skeleton, body and skin are completely interdependent. The ships utilised the very good strength to weight ratios of the nearest readily available material – timber – in an engineering solution which ably dealt with both compression and tension. The Viking longboat was an extraordinarily efficient (and relatively lightweight) structure in which timber ribs and overlapping plank skin worked together as one.

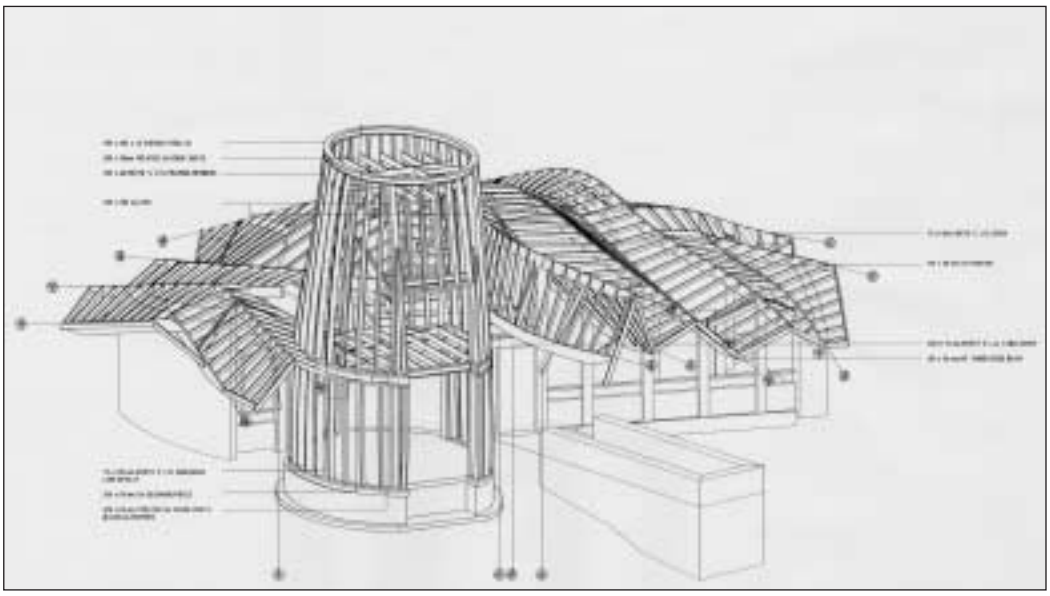
Of course, the Vikings did not actually calculate the structural capabilities of the wood used for shipbuilding, but fast forward to the middle of the 20th century and to a different method of transport – the aeroplane – to see the monocoque principle again used with wood to advance this particular aspect of engineered timber. The development of the DeHavilland Mosquito as a very light and fast aircraft was entirely dependent upon the technology used in its construction. Made from a double skin of birch plywood with the ply separated by spruce stringers in the wing and a layer of balsa in the fuselage, all of the timber components were glued together using resorcinal formaldehyde resin.

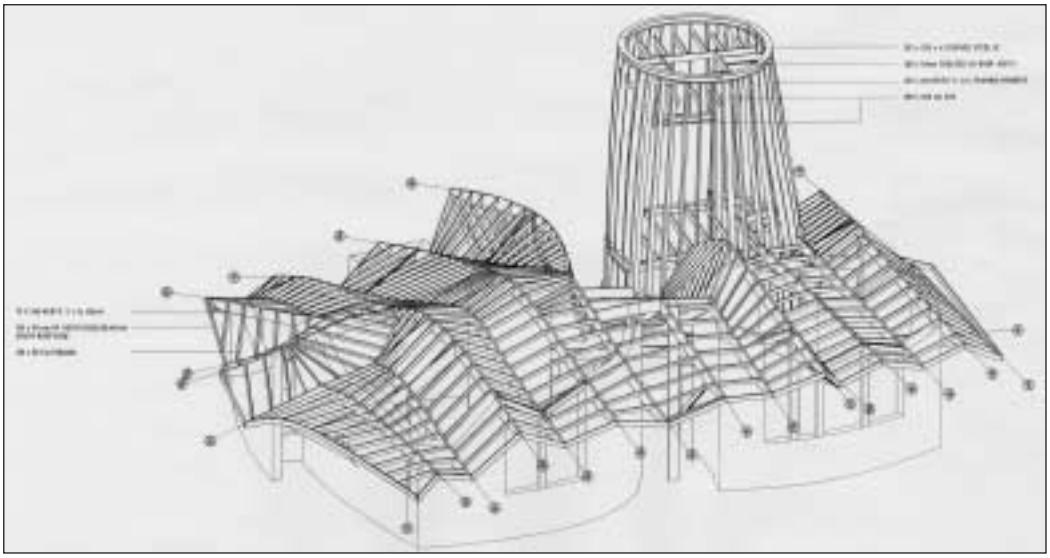
In between these developments, a great deal of experimental work in the engineering of timber took place although, it has to be said, with little input from the construction industry. Despite a fascination with the technological advance of the aeroplane in the early part of the 20th century, the potential benefits of engineered timber largely passed architects by until relatively recently. A number of factors have altered this, in particular a renewed interest in the applicability of monocoque structures to architecture and the capacity of the timber industry to produce new materials of astonishing versatility. The potential to create lightweight minimal structures of low embodied energy using engineered timber was ably demonstrated in the 2000 Stirling Prize-winning project – the monocoque reading pods of Peckham Library by Alsop and Störmer were constructed of Oriented Strand Board and Laminated Veneered Lumber.

Which brings us neatly to Dundee and the striking design by Frank Gehry (architect of the Guggenheim Museum, Bilbao) for the city's Maggie Cancer Care Centre. The building's saw-tooth roof is distorted in both plan and section and, because of the way the beams are constructed, the use of a two way curve using traditional glulam would have been difficult to achieve. Laminated Veneered Lumber was specified by Glamis' practice, James F Stephen Architects (executive architects for the project) since it is stronger and lighter than laminated plywood.

At present Laminated Veneered Lumber is not manufactured in Scotland, but the country is a leading centre in the production of other forms of engineered timber such as Oriented Strand Board (OSB), Medium Density Fibreboard, and Particleboard, each of which has become so well established within the construction industry that their individual characteristics and potential for innovative design might easily be forgotten.

Oriented Strand Board, for example, has particularly strong environmental credentials, since the timber used comes from forest thinnings sourced from sustainable fast-growing forests in Scotland. FSC Approved, there is little or no wastage – the manufacturing process uses virtually 100 per cent of the log, with the bark used to supply energy/horticulture use. The logs are cut to length, debarked and processed into precise strands averaging 78mm long and 25mm wide. The strands are then dried, blended with resin binder and wax, and laid in a precisely oriented fashion to form large continuous mats. To increase strength, the strands are oriented in cross-directional layers, then bonded with moisture resistant resins under high heat and





Structural axonometric
Maggie Cancer Care Centre,
Dundee. Frank Gehry Architects.
(James F Stephen Architects,
Glamis – executive architects)

pressure. to produce a uniform board. Used in the construction industry mainly for structural panels, roofing, wall sheathing and flooring, it can be argued that OSB's full potential in architecture has still to be discovered.

On the other hand, precision made, resin bonded Medium Density Fibreboard (MDF) is now so commonly used that it hardly needs description. The material was first produced commercially in 1966 in the USA, with its European manufacture beginning seven years later. In Scotland, 'Caberwood MDF' is produced from Scottish softwood (mainly debarked spruce), and is engineered within the independent control and assessment of the BS EN ISO 9002: 1994 Quality Assurance Scheme.

In response to the demands of the housing market, special forms of high density Particleboard 'Caberfloor' have been developed for use in flooring. Large areas can be laid quickly and easily, providing a dimensionally stable substrate for subsequent floor laying operations. The primary raw material comes from sustainable softwood resources of the forests of Scotland and Northern England – an increasingly important factor in environmentally sensitive design, since comparative data shows that, per tonne, timber and wood-based panel floor systems contain around half the embodied energy of alternative materials.

This concern for the environment has once again brought timber to the fore of design thinking and with it, a requirement that wood's traditional limitations of spanning distance and strength be removed. Engineered timber offers the potential for real design innovation in these areas, making it a true material for the 21st century.

Bare facts

Scotland's Forests and Timber Industry in Context

With the increasing availability of Scottish grown timbers, architects can once again address themselves to the design of buildings in which timber is not regarded as a secondary material. It may be some time however before they are able to match the panache of the Earl of Atholl who accommodated James V and the Pope's ambassador for an elaborate royal hunt in 1531. To celebrate the occasion, a palace of green timber was built in the forest in strict imitation of Linlithgow with its great corner towers. After three days of hunting and nights of 'banqueting and triumph', the huge structure was deliberately set ablaze as a great firework.

Flat extension, Marchmont, Edinburgh.
E & F McLachlan Architects.

FIRST THE STATISTICS.

Forests cover about 33 per cent of Europe's land area. In Scotland the figure is around 16 per cent, with softwoods such as Sitka Spruce and Scots Pine the main commercially grown species. Around 48 million cubic metres of timber are used in the UK each year – equivalent to 0.82 cubic metres per person, of which 80 per cent is softwood. The UK is one of Europe's largest importers of forest products, with 85 per cent of its timber needs being met from abroad. UK forests currently produce around 9 million cubic metres of timber, a figure forecast to rise by 65 per cent over the next 20 years, reaching a peak of around 16 million cubic metres in 2025.

Softwood processing in the UK is a world class industry and can be grouped into several product sectors: sawnwood, wood based panels, paper and board, and other wood. In general, larger diameter and better quality logs go for sawnwood products while smaller diameter or poorer quality logs supply the other markets. A small amount of very good timber is also sent abroad to be cut into thin sheets of veneer. The market for hardwoods generally has diminished – in Scotland, sales of hardwood logs are currently around 40,000 cubic metres per annum. As there are currently no large hardwood sawmills in Scotland, the bulk of this timber is sold into the English market to return in a fully or semi processed state as veneer, boards or battens. There are however, over 20 mobile and small, static mills in Scotland which deal largely, or exclusively with hardwoods. This decline in hardwood markets can be attributed to several factors – the reduction in bulk outlets such as mining, the increasing substitution by other materials such as plastics, the opening up of eastern Europe, and the strong pound have all contributed in making UK timber less competitive.

Yet paradoxically, there has been an increasing demand from architects for hardwood timber over the past ten years,

and Scottish sources are now able to provide all grades of hardwood timber suitable for the construction and building trades, though large volumes and short lead times can pose challenges. Species such as oak, ash, sycamore, lime, beech, and elm are available (although the latter is becoming increasingly difficult to access due to the ravages of Dutch Elm disease). Grades of timber vary from first quality veneer and planking grades down to material suitable for flooring specification.

To better understand the design potential of the timber that is available, it is useful to know some of the terms used in the roundwood and sawn hardwood trade:

- Butt lengths – these are the clean first lengths of a tree from which the best quality of sawn timber will ensue. They need to be visibly clear of old knots, inclusions and side branches and very clean in appearance. The very best are sold for veneer.

- Second lengths – the second lengths of a tree are graded into various specifications according to their quality and species. In the case of oak and elm, they may include beams, fencing and flooring grades.

- Special characteristics of some trees can add greatly to the visual appearance of the timber and hence its value, such as 'Pippy Oak', 'Brown Oak' and 'Burr Elm'.

Both construction and cosmetic types of sawn timber are available in many forms including: beams – square and wany edged, character grade and square edged planks. Through and through sawn (sometimes used 'bark on') for outside cladding, usually in elm.

Saw millers prefer high quality trees to be felled in winter. This is when the tree is in its dormant period and does not carry a high sap content. This is particularly important in the case of sycamore butts which are required to produce almost white sawn material. A small amount of sap in sycamore logs will have an effect in colouring the sawn timber from white to orange/brown or even black on contact with the atmosphere and will degrade the product considerably.

With a few exceptions, all timber felled throughout the UK, including that on privately owned land, is regulated by the Forestry Commission. The Forestry Commission can grant permission to fell by means of a conditional felling licence or through a Woodland Grant Scheme (WGS) arrangement. In both instances the Forestry Commission insists on the replanting of felled broadleaves with broadleaves, thereby helping to sustain the supply of UK grown hardwoods.

Water of Leith Visitor Centre, Edinburgh
Malcolm Fraser Architects.

Photo: Keith Hunter

Donnelly House extension, Bearsden.
Chris Platt Architect.

Darwin Centre, Edinburgh Zoo.
Smith Scott Mullan Architects.

The most common commercial tree species in Scotland are:

Softwoods readily available from most large sawmills and distributors

Sitka Spruce

Pines (mainly Scots Pine, but also Lodgepole and Corsican)

Larches (mainly European and Japanese)

Douglas Fir

Norway Spruce

Hardwoods generally available from smaller specialist sawmills

Oaks (pedunculate and sessile)

Beech

Sycamore

Ash

Elm

Birch

Lime

Timber products

Timber Frame

Timber frame has long been the favoured method of house building in Scotland, and ever stricter standards of thermal insulation in the UK (Building Regulations Part J Scotland, and Part L England) make its use even more appropriate since it is far easier to install insulation in a hollow framed wall system than in traditional masonry construction. With the insulation contained within the thickness of the frame, overall wall thickness can be reduced by 75mm.

Timber frame's advantages are in its speed of erection, its thermal efficiency, and an increasing emphasis on the environmental and sustainable aspects of construction. Factory produced timber frames combat two other important issues – the need to build defect free structures, and a general shortage of skilled labour. Moving more of the production off site can be more easily achieved with timber frame, with commensurate standards of quality assurance guaranteed. Another key point is the low embodied energy quotient of timber frame construction.

There are other advantages – timber frame's relatively light construction usually only requires lightweight foundations, which on brownfield sites can sometimes eliminate the need for piled or deep trench foundations. This can be especially advantageous on land which has been contaminated as less soil needs to be excavated for foundations, thereby reducing the risk of releasing contaminants into the environment. And timber frame's light loading combined with its speed of erection makes it particularly suited to situations where existing buildings restrict space and access.

A more recent development is multistorey timber frame, with work being carried out at BRE Cardington on timber frames up to six storeys high (TF2000 Project). Working in partnership with government and the timber frame industry, the Building Research Establishment has assessed the performance of six storey timber frames against current UK Building Regulations (both English and Scottish), examining questions of acoustics, fire, stability and disproportionate collapse.

The versatility of this technology has been demonstrated in Scotland by Chris Stewart Architects, whose project for CUBE Housing Association in Glasgow's Berkeley Street uses a timber frame kit (designed in association with Stewart Milne) to construct a five storey building clad in stone. Preassembled off site, the kit was transported into the city centre and quickly craned into position – an important consideration when trying to reduce disruption in urban locations. The building's ecological performance is particularly good, with a 'U' value of 0.18 W/msqK and very low heating costs for the residents.

Photo: Andrew Lee

Photo: Kenneth Bayne

Shingles

Scotland has a long history of shingle usage which is only now being researched and documented. This renewed interest in shingles is due to recognition that their aesthetic and low-maintenance qualities make them very suitable for both traditional and modern buildings. They are also a sound long-term investment, which, although relatively expensive, represents good value over the lifecycle of the material. Support structure costs are also reduced because shingles are much less heavy than tiles.

Shingles weather well, aging to a silver-grey appearance and - If properly maintained - can have a significant lifespan (Around 80 years for sawn oak,50 for western red cedar; in cleft form both last around 20 years). And because it is a natural material which needs to breathe, sarking felt is not essential since air flow from the ventilated space circulates around the underside of the roof covering. The absence of sarking may produce visible staining on the underside of the roof, however, and incorporation of a breathable sarking membrane may be desirable. Since shingles swell, careful fixing details are essential in wet or humid conditions, with expansion gaps between adjacent shingles. In traditional construction techniques, the bonding of the overlayers of shingles is usually sufficient to eliminate water ingress in suitably ventilated cold roof conditions. Cedar shingles should be laid angles of around 21˚, while oak shingles should not be laid at angles below 40˚.

ABOVE Chris Platt's garden shed in Govanhill
LEFT Timber frame housing at Berkeley Street, Glasgow. Chris Stewart Architects.

Cladding

It is something of a truism that Scotland is a timber building country which uses other materials for cladding. Yet Bruce Walker's essay on timber building traditions in Scotland shows that this has not always been the case, and while there has been renewed interest in the past few years in the use of wood for the exteriors of new projects, architects turning to the material for the first time are not always well versed in the rich vocabulary of details which should accompany this natural and durable cladding material. Its performance is not always fully understood either. Essentially there are two fundamentally different approaches to the design of exterior wall systems in most buildings: the weather shield approach and the rain screen approach.

Recent searches for improved energy performance have led to the design of timber frame buildings with what are effectively weather shield wall assemblies: unventilated cavities, completely filled with insulation and exterior surfaces sealed at every joint. A number of building failures have emanated from this, particularly in areas with mild wet climates where wind driven rain is a common feature. Heavy wetting of the cladding invariably occurs under such conditions and, at the same time, large pressure differences appear between a building's exterior and interior. In a weather shield system, the sealed outer skin prevents the equalisation of pressure, relying instead on the imperviousness of the cladding and the integrity of the gaskets/sealants to keep the water out. Any failure in these components allows water to infiltrate the wall. Typically, this water becomes permanently trapped, and any perishable components in the wall system begin to degrade or decay. The failure of an impervious cladding system on wood frame buildings is potentially catastrophic.

Rudimentary rainscreens first appeared in the earliest uninsulated wooden framed buildings. Semi porous materials, such as wood shingles, provided an effective first line of defence against rain penetration (although the inner surface of the cladding eventually became wet) with the simple nature of frame construction ensuring ventilation to (and drainage from) the interior cavity. In recent years, rainscreen cladding systems have gained enormously in popularity with architects, primarily because the open joints between panels provide crisp straight lines. The rainscreen also provides the cladding with two lines of defence: the outer layer, which due to open joints, sheds approximately 95 per cent of incident rain and takes the burden off the inner, protected waterproof layer. The success of rain screen systems relies not on sealants, but on minimising rain penetration by careful attention to design details, particularly in the wet temperate areas of Scotland.

Photo: Keith Hunter

Timber rainscreen to housing at Graham Square, Glasgow. McKeown Alexander Architects.

Decking

The growth in gardening programmes on television has perhaps contributed to the recent fashion for timber decking in the domestic environment, allowing raised and terraced areas to be created without the use of heavy building materials or elaborate foundation structures. Increasingly, larger scale installations are emerging in relation to architectural projects (eg the public roof terrace of the Museum of Scotland), with the basic materials sourced from Scottish forests. The critical element in deck design is to ensure that air flow is maximised through and around the construction to ensure good ventilation since this will avoid long term saturation and subsequent wood deterioration.

Deck structure at Braehead near Glasgow. Building Design Partnership.

Photo: Keith Hunter

Furniture and product design

Scotland is extraordinarily well off in designer craftsmen able to bring the best from the country's native hardwoods and softwoods. From the small one man firm to larger, more commercial operations, the common link between them all is a real understanding and appreciation of the characteristics of the fine timbers available and the need to make more of this rich resource. The work ranges from the handcrafted, unique design to the highest quality furniture for the corporate boardroom.

IT IS A STANDARD COMPLAINT of furniture makers that architects and designers often specify items without having any real idea of the cost of the process or the raw materials involved. When tender prices are returned, the costs turn out to be nothing like the budget which exists. Early dialogue with furniture makers as to how best to realise design intentions within the monies available could not only alleviate this problem, but is also likely to have a beneficial effect upon the quality of the design and construction of the product. Many furniture makers, of course, not only produce bespoke work, but also design their own highly individual pieces.

Paul Hodgkiss Design has been in existence since 1986, but it wasn't until 1992 that Paul began to market individually tailored furniture featuring a blend of timbers with metalwork and glass. The inspiration then – as now – was the unique, indigenous Scottish timbers which although readily available, were rarely used to their full potential. Now the work of the Glasgow-based production and design led workshop is in considerable demand, particularly in the west of Scotland where a plethora of clubs, bars, restaurants and visitor centres feature his highly individual craftsmanship. More recently his furniture has penetrated the domestic world, as people seek more individual pieces responsive to their lifestyles. Paul Hodgkiss describes his style as: "evolving from the wood's own grain, complementing the flow of natural edges and time worn knots and hollows", with each item aiming to highlight the range and natural beauty of homegrown wood.

Charles Taylor Woodwork is lodged in unusual circumstances – the West Church in Dalkeith, built by architect William Burn in 1840. Formed in 1985, the company moved to its current location six years ago, having outgrown the industrial unit it previously occupied. From the outset, the philosophy of the business has been to provide high quality craftsmanship combined with a design service, and the company produces a wide range of work including architectural conservation joinery, cabinet making, fitted and freestanding furniture and individual commissions. Recent larger projects have included the Hub

Furniture
by Woodschool

(the headquarters of the Edinburgh International Festival, by Benjamin Tindall Architects) and the National Trust for Scotland's premises in Edinburgh's Charlotte Square (restored by Simpson and Brown Architects).

Further north, at Braco Castle Farms near Dunblane, *Out of Wood* began life in 1989, producing architectural joinery and bespoke furniture from homegrown woods. The company eschews the use of plywood and MDF, preferring to combine its good workmanship with the outstanding beauty of native Scottish timber. Traditional jointing methods – such as dovetailing and mortice and tenon joints – are employed to produce robust construction with a long life span. Out of Wood is aptly named, since it not only produces furniture and kitchens, but also building components such as hardwood doors, windows and conservatories, as well as supplying mouldings, architraves and flooring direct from its own sawmill.

Ben Dawson Furniture might be considered to be at the opposite end of the scale, the company finding most of its customers in the corporate sector, where demand for its boardroom tables and executive furniture continues to expand. Recently, the company found itself commissioned to fit out a debating chamber at Canary Wharf in London – a project which came about as a result of an enquiry to its website. As Ben Dawson points out: "not many furniture companies can demonstrate experience in this area", but the company's work to produce the seating and desks for the assembly chamber of the Scottish Parliament's temporary headquarters at the Mound in Edinburgh has borne unexpected fruit. Its reputation for high quality and well designed furniture now well established, more and more enquiries for the company's products are coming from outside of Scotland.

Farrell Furniture in West Lothian began life rather differently. Alex Farrell's interest in watersports led him to become one of only three manufacturers in the world specialising in the production of multi-laminate power boat skis and other items such as kayak paddles. Alex Farrell Furniture's high quality veneering and laminating work is in great demand for bespoke board room tables and executive desks but the company is not averse to questioning specifications such as 'solid cherry cill boards', since it believes such a lack of understanding of the nature of the material would require huge numbers of trees to be felled to fulfil the order. Like many furniture manufacturers, Alex Farrell suggests architects need more direct experience at the workbench to stop them blindly copying the kind of National Building Specification clauses which ask for 'shake free' timber.

It is a refrain echoed at *The Woodschool*, a collective of furniture makers based in the Borders near Ancrum, Jedburgh. The eight resident designers work to produce contemporary furniture using waste timber from Borders' forests. The material, which would otherwise be used as firewood or left to rot, is turned into high added value products, such as the Speakers Chair for the Icelandic Parliament. Increasingly, the makers at the Woodschool are manufacturing high quality furniture for a number of well known architectural practices as well as developing a range of products capable of serial production. Evangelists for the increased use of Scottish hardwoods, the Woodschool has also sourced some of the oak required for the new Scottish parliament building, and its furniture makers and director, Eoin Cox, are in great demand around the world to advise on setting up operations similar to their own.

Certainly, their example is laudable, since the Woodschool re-invests part of its profits in replanting areas of the Borders with new trees, and thereby ensuring future supplies of raw material (as Cox points out, birch trees can be used within 15 years of planting) as well as providing ground cover and new habitats for the wildlife of the area. As a talent base and centre for the development and maintenance of the craft skills necessary to work with home grown timbers, the Woodschool has no real equal, and for architects no visit to the Borders should be complete without visiting its showroom and workshops for inspiration. The Woodschool's endeavours deserves the patronage of the whole profession.

Organisations mentioned in this article

Paul Hodgkiss Design
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Out of Wood
Braco Castle Farms
Dunblane FK15 9LA
Tel: 01786 880215
Fax: 01786 880215

Farrell Furniture
West Harwood
West Calder
West Lothian EH55 8LF
Tel: 01506 873990
Fax: 01506 873991

Charles Taylor Woodwork and Design Ltd
West Church
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Dalkeith
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Tel: 0131 654 2221
Fax: 0131 654 2884
Email: charles@ctww.co.uk
Web: abel.co.uk/~ctww

Woodschool Ltd
Monteviot Nurseries
Ancrum
Jedburgh TD8 6TU
Tel: 01835 830740
Email: enquiries@woodschool.ltd.uk
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Ben Dawson Furniture
Eskmills, Musselburgh
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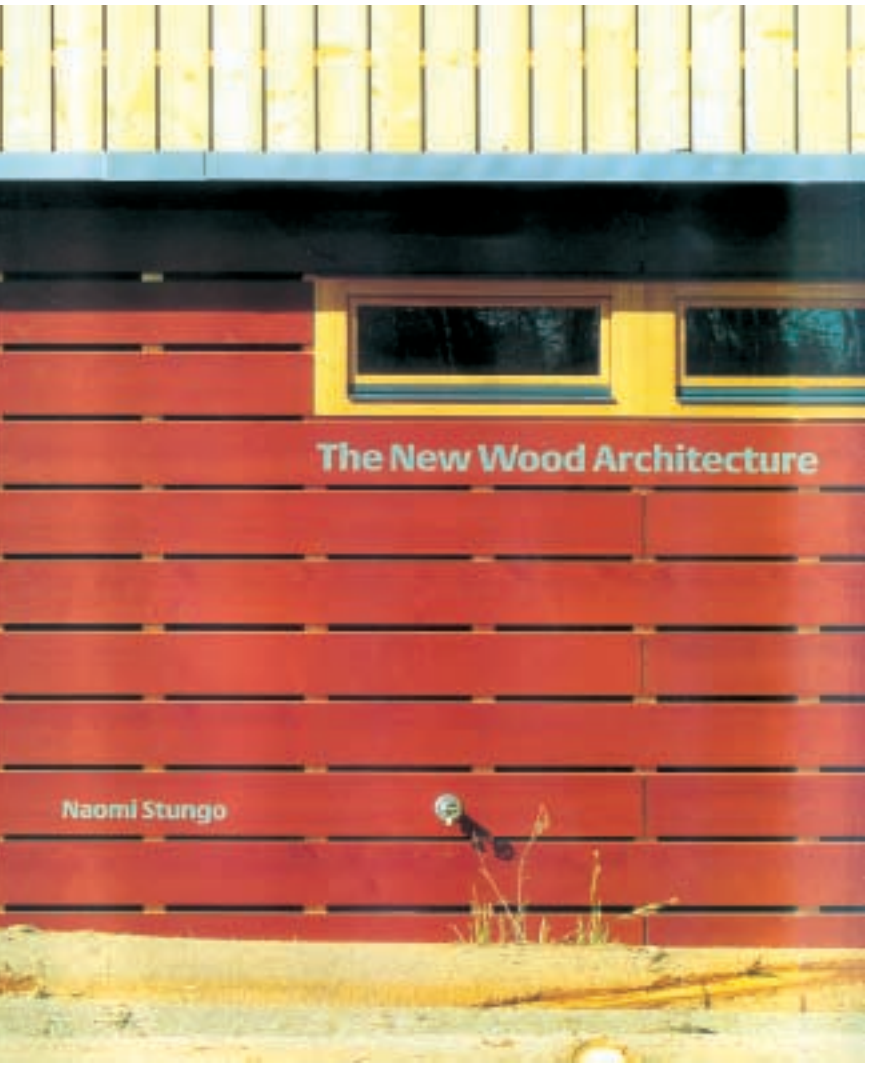
Books

Increasing interest in recent technological developments in timber engineering as well as advances in contemporary design thinking about this infinitely renewable material has led to a surge in published information about wood. While some of it is more technical in character, many new books contain an extraordinary range of examples and ideas, stimulating a strong desire to get out there and build with wood. For architects and engineers, there is no shortage of inspiration to be found in the books reviewed here, and for those serious about designing with timber, obtaining the best current information is a critical first step.



Timber Futures

THE NEW WOOD ARCHITECTURE
By Naomi Stungo
Published by Laurence King Publishing
£45.00 (hardcover 240pp), £25.00 (softcover)
ISBN 1 85669 1284

In the Amazonian rainforest a tree is felled every few seconds, a rate of destruction which, if continued, will see the world's once-largest rainforest disappear within the next 50 years. In Europe, around 62 per cent of the original woodland has been lost, a figure which rises to 88 per cent in the Asian-Pacific region. Inhabitants of the developed world may be scandalised by such environmental destruction, but for 40 per cent of the world's population, wood is still the primary source of energy and accounts for half of all the timber harvested around the globe. Christian Affentranger's introduction goes on to list other shocking statistics on deforestation, forcibly making the point that re-afforestation is extremely difficult in areas once they have been denuded of trees.

Yet wood has been used as a building material for thousands of years, and in seeking to define contemporary approaches to designing with timber, the author does not confront this pressing ecological question, introducing instead five categories ('the new aesthetic', 'structural possibilities', 'green buildings', 'relating to nature' and 'vernacular updated') which, while not exactly architectural philosophies, do provide an accessible framework for the book. It is not always clear, however, why some of the 31 projects were selected, nor why they are included in one category as opposed to another – a criticism particularly affecting those defined as 'green' or ' relating to nature'. Each project is described simply, rather than given serious analysis of its use of wood, which is unfortunate, since the architecture throughout is beautifully illustrated and merits deeper investigation of the underlying design ideas.

Nevertheless, this is a visually attractive publication, offering a pictorial summary of recent developments in timber architecture. For those coming to the subject for the first time, the newly-published paperback edition offers an inexpensive introduction.

Between Tradition and High Technology

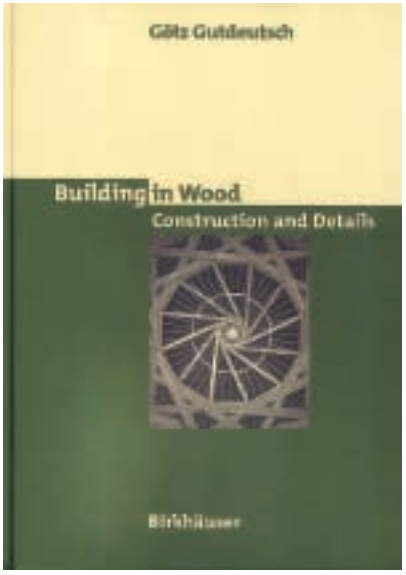
NEW WOOD ARCHITECTURE IN SCANDINAVIA
By Christoph Affentranger
Published by Birkhäuser
£54.00 (hardcover 240pp)
ISBN 3 7643 5458 5

From a Scottish perspective, the nearest tradition of timber building from which we can learn is that of Scandinavia. Indeed, the architects of Denmark, Finland, Norway and Sweden almost defined the role of timber in the modern architecture of the 20th century, developing indigenous solutions to building problems through a clear understanding of the character and potential of their native raw materials. Giants like Alvar Aalto emerged, finding new uses and deploying technical advances in timber lamination to produce a more human form of modernism. This level of invention has continued and been assisted by a forestry industry unafraid to invest in research and development, with the direct links to architecture most obviously manifested in the expressive use of wood in each country's forestry museums, timber research facilities, experimental housing and temporary exhibition pavilions. The lessons for the forestry and timber processing industries in Scotland are obvious: practice what you preach and invest in the country's best architectural talent to produce exemplary projects.

19 projects are illustrated in detail here – each inspirational in its own way, while cumulatively embracing the full gamut of wood construction techniques. A series of introductory essays, together with texts relevant to the various approaches taken in the five individual countries (Iceland also appears here) provides the reader with the philosophical and theoretical foundation to modern Scandinavian timber architecture. 71 other projects are included in a final summary to give some indication of the rich heritage of timber architecture in Scandinavia, and of the important historical and cultural role it plays in each country. This is not only valuable, but indicates how much work needs to be done to create a similarly focused approach here in Scotland. We perhaps need to begin by properly researching and documenting the history of our own timber architecture, while getting on with the business of creating new projects which reflect our contemporary cultural and social values.

In the meantime this book offers a clear model to aspire to: architecture which is modern and exciting, yet appropriate to its situation and environmentally sustainable. The Scandinavian achievement so elegantly documented here is awe- inspiring in the consistency of its quality.

Joined Up Thinking



BUILDING IN WOOD – CONSTRUCTION AND DETAILS
By Götz Gutdeutsch
Published by Birkhäuser
£45.00 (hardcover 150pp)
ISBN 3 7643 5277

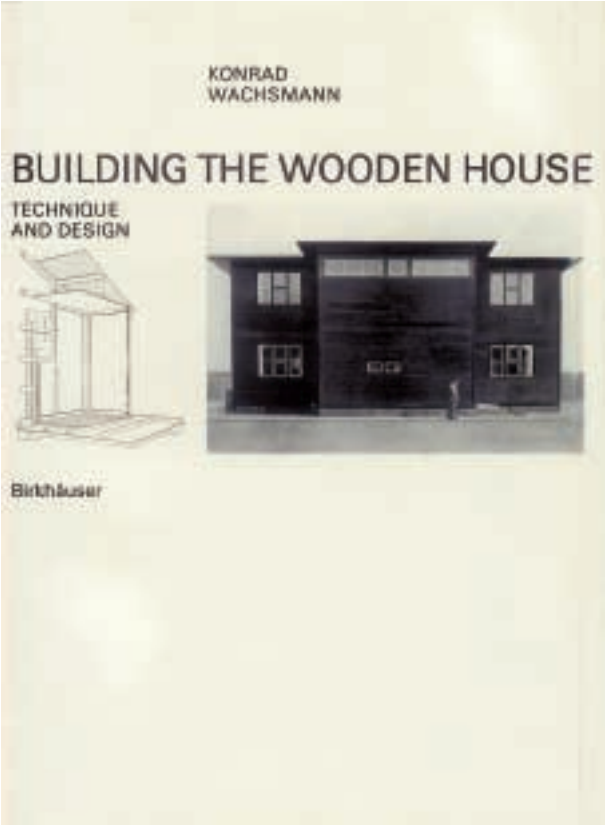
The black and white production of this book sits well with its practical organisation: an introductory essay divided into eight short sections, followed by 26 projects analysed in terms of their subject, design, structure and detail development. Such a simple framework could easily give the impression that this is simply a catalogue of building types, but this would be to deny the book's considerable strengths. The opening essay is a model of concision, yet it manages to set out the history of timber building, the traditions involved and the international cultural importance of wood construction. In pointing out that every structure has a personality of its own which is reflected in its details, the folly of examining these details in isolation from their whole is made clear. Climate, local building methods and available skills, engineering requirements, durability, cost, even personal design preferences, all contribute to the creation of a language of construction which is specific to each building's situation.

Modern technology has greatly widened the scope of this most traditional of materials: in an age which demands more environmentally-aware technologies, the author opines that timber – as an organic building material, is beginning to reconquer the construction sector with technically advanced and aesthetically ambitious designs. Certainly, the range of building types and structural solutions included here make clear that the most innovative architects and engineers no longer regard timber as useful only for domestic construction, and the inclusion of clear plans, structural diagrams, design details and site photographs should satisfy – and inspire – even the most inquiring of readers. This is a valuable reference guide to some of the most challenging projects constructed in the past 20 years.

Books

The Meaning of Precision

BUILDING THE WOODEN HOUSE – TECHNIQUE AND DESIGN
By Konrad Wachsmann
Published by Birkhäuser
£40.00 (hardcover 141pp)
ISBN 3 7643 5134 9

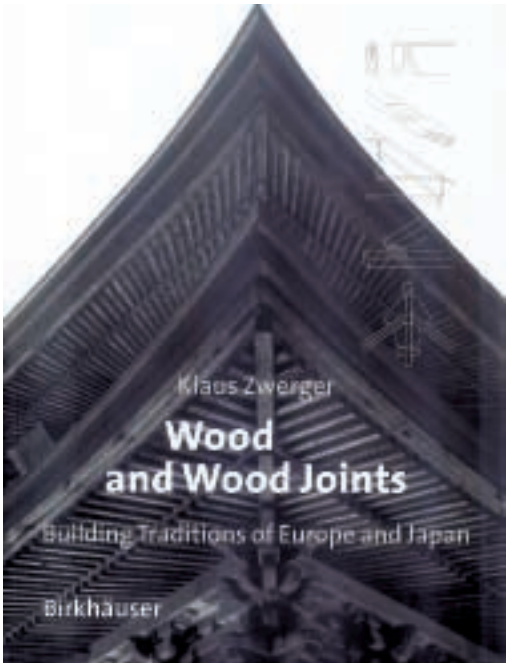


There are surprisingly few books on architecture which can be considered as 'classics', but this is one. Written in 1930, it has – astonishingly – only recently become available in English, yet its influence on contemporary luminaries such as Foster, Rogers, Piano, Isozaki and Hollein is well known. Wachsmann himself lived and worked in Germany at a time of astonishing architectural invention, and listed amongst his friends and partners some of the key names of Modernism – Peter Behrens, Bruno and Max Taut, Walter Gropius, Heinrich Tessenow, Mies van der Rohe, and Erich Mendelsohn. He was also acquainted with Bertolt Brecht, George Grosz and Albert Einstein, for whom he built the highly influential wooden villa which became the source of his subsequent fame.

Wachsmann produced two seminal books, Holzhausbau (Building the Wooden House) and Wendepunkt im Bauen (Turning Point of Building), in which he made plain his desire to incorporate into architecture the revolution which had been ushered in in politics, art, literature, music and technology. While he understood the need to maintain the continuum between new and old methods of construction, he was primarily interested in standardisation and industrialisation, and in this respect considered wood to be as important to the times as steel and stone.

The first part of Wachsmann's book is a relatively short and clear text in which he sets out his polemic for modern construction in wood. This is followed by simply-annotated photographs and plans of wooden buildings which he groups into three types: the on-site wood frame method, the panel method, and the log house method. At first sight this might seem a basic picture book approach, but in his brilliant introductory essay, the Swiss architect Christian Sumi (who has himself made extensive studies of timber construction) provides a perceptive analysis of the function of the photographs in propagandising Wachsmann's ideas – a continuing influence that can be seen when comparing Wachsmann's Berlin Public Transport Authority building with Burkhalter and Sumi's kindergarten at Lustenau in Austria of 1992-4.

Wachsmann went on to become Professor of the Chicago Institute of Design, and a recognised pioneer in the field of architectural engineering, but for anyone interested in exploring the beginnings of wood use in contemporary architecture, the story begins here.



Timber Connections

WOOD AND WOOD JOINTS –
BUILDING TRADITIONS OF EUROPE AND JAPAN
By Klaus Zwerger
Published by Birkhäuser
£31.00 (softcover 278pp)
ISBN 3 7643 6333 9

For anyone seriously interested in the nuts and bolts of building with wood – or more accurately, how to construct timber architecture without reliance on adhesives and metal connectors – this is the book for you. Unlike other publications on wooden buildings, this one emphasises the knowledge and skill of the carpenter with hundreds of stunning black and white photographs and exploded isometric timber joint details. The text is a fascinating history of the development of joints, from an understanding of the material, through the types and functions of wood joints and the ways in which they have evolved, to an exploration of their role in expressing aesthetic values. The really unusual – and illuminating – aspect of this study, however, is the continuous comparison made between the wood building traditions of Europe and Japan.

The art of wood jointing unquestionably reached its zenith in Japan, but Europe too has provided its share of highly influential forms. By looking at several hundred examples from Japan and 18 European countries, the history of timber architecture is comprehensively set out. Particular attention is paid to the properties of the material as well as the climatic, technical, woodworking and artistic influences which have affected the development of joints. This evolution is made clear by placing a Japanese equivalent alongside every example chosen from Europe. Astonishingly, this ingenious method succeeds in making several hundred years of timber architecture more easily comprehensible.

The novelty of the book's approach perhaps arises from the author's own unusual background as an art historian and carpenter. His passion for the subject is evident, and in recapturing an almost forgotten dimension of architecture, he highlights the skill of the craftsman. This is research of a high order, beautifully presented.

A Scientific View of Wood

TIMBER: ITS NATURE AND BEHAVIOUR
By J.M.Dinwoodie
Published by E & FN Spon
£29.99 (softcover 257pp)
ISBN 0 419 23580 9

Finally updated and reprinted in a 2nd edition 20 years after it was first published, this is an essential reference source for anyone serious about designing with timber. This might not appear immediately obvious to architects, since it lacks any photographs of buildings (the book is primarily aimed at students of structural engineering or materials science), but persistence with the text will unquestionably lead to a fuller understanding of the nature and behaviour of wood.

Timber does not fit conveniently into any one class of material and, unlike others used for construction, cannot be manufactured to a particular specification. Instead, best use has to be made of the material nature provides, although it is possible from the wide range available to select timbers with the most desirable range of properties. This book gives the information to understand what those properties are.

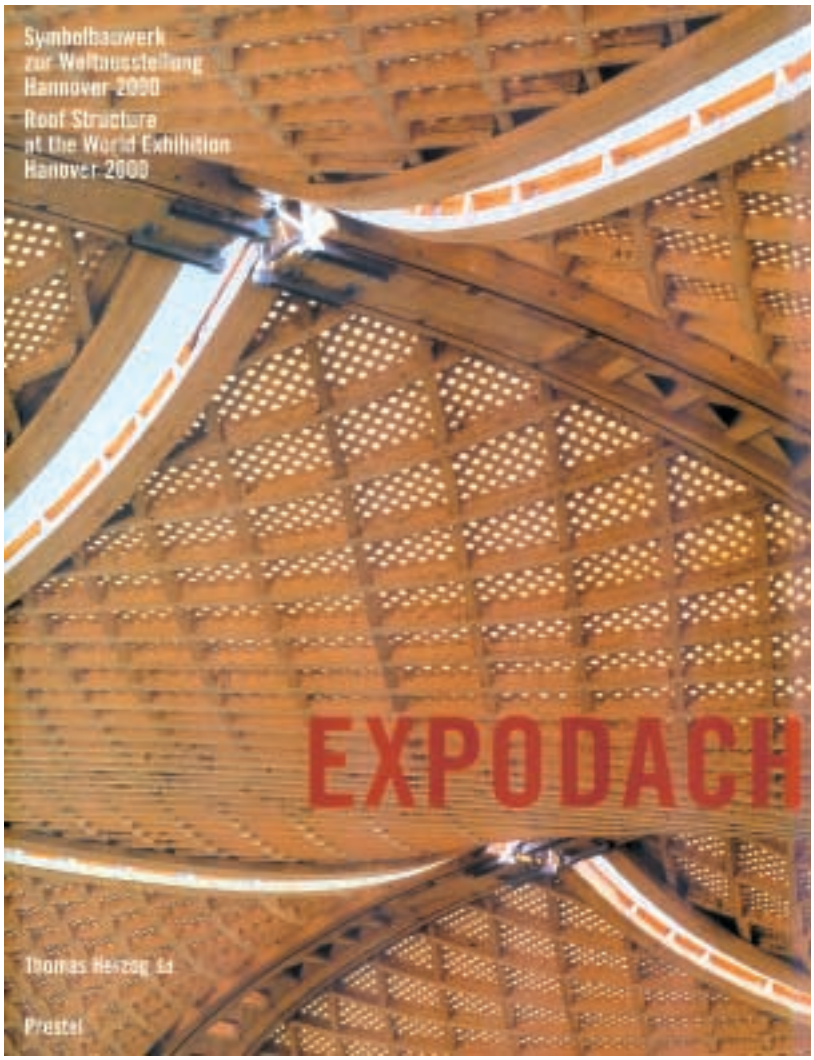
Wood is a low-density, cellular, polymeric composite, and in terms of its high strength performance and low cost, is unquestionably the world's most successful fibre composite, with four orders of structural variation – macroscopic, microscopic, ultrastructural and molecular. From this starting point the author sets out in a no-nonsense – but easily digestible – way to help the reader understand the chemical and physical composition of timber. Its appearance is then quickly dealt with before returning to the more serious business of mass-volume relationships, movement and dimensional change. The concept of flow in timber is given lengthy treatment, before structural matters of deformation, strength and failure are tackled. Thereafter, timber's durability and performance in fire are examined, helping the reader to second-guess how various pieces of legislation are likely to be interpreted by building inspectors and fire officers. The final chapter on processing offers brief summaries of how modern composite materials such as particle board and glulam are made, concluding with a review of chemical processes and finishes.

For those who regard timber as an important material in the creation of a more sustainable architecture, this is an illuminating read which whets the appetite for an even deeper understanding of the many qualities of wood.

Books

Raising the Roof

EXPODACH: ROOF STRUCTURE AT THE WORLD EXHIBITION HANOVER 2000
By Thomas Herzog
Published by Prestel
£19.95 (softcover 72pp)
ISBN 3 7913 2382 2



The World Exhibition in Hanover in 2000 was dubbed 'Germany's Dome' in reference to its cost, over-optimistic visitor projections and the dated notion of world fairs. Despite this preventing more objective appreciation of individual pavilion designs, the EXPODACH should be recognised as a remarkable symbol of architectural courage and technical innovation in the use of timber.

The Federal German Foundation for the Environment and the Federal Ministry for Education and Research set an agenda for promoting the use of timber as a raw material; activating the potential for technical innovation in timber technology; and making new wood products appropriate for all conceivable applications. This, in a country which – with refreshing candour – admits here to a history of regarding timber buildings as inferior, short-lived and only for the poorest and most transient in society.

The EXPODACH designers set out to create an architectural symbol to embody 'Humankind – Nature – Technology', the World Exhibition's motto. Analysis of what building a roof means and symbolises led to state-of-the-art engineering science being applied to the design of a load-bearing structure and membrane skin which combined modern methods of prefabrication with trade skills. The resulting canopies resemble huge free-standing sculptures and demonstrate the scope for using timber on an impressive scale. Its ten canopies are 20m high and 40m x 40m square, covering 16,000 square metres. The lightweight double-curve lattice shells are constructed of nailed and only partially-glued stacked planks, and cantilever out on all sides from powerful central structures assembled from tree trunks. Using structural, processing and environmental criteria, the architects and engineers decided where to optimally exploit the specific characteristics of solid timber members, glued laminated timbers and laminated wood sheeting. The result is a structural and aesthetic balance between the lightness of timber and the bold dimensions of the construction elements.

The three-part construction process (masts, cantilevered girders and lattice shells) demonstrates how, with a sensible division of responsibilities and the co-ordination of activities, it is possible for medium-sized, family-owned timber processing and construction firms to collaborate with each other to build ambitious, innovative, large scale structures which employ state-of-the-art technology. What better lesson could a single book offer a renascent timber industry in Scotland? For architects, engineers, and everyone with an interest in timber, this didactic account of the design and construction of the biggest, broadest spanning timber roof in the world is inspirational.

The Pragmatics of Production

LAMINATED TIMBER CONSTRUCTION
By Christian Müller
Published by Birkhäuser
£40.00 (hardcover 208 pp)
ISBN 3 7643 6267 7

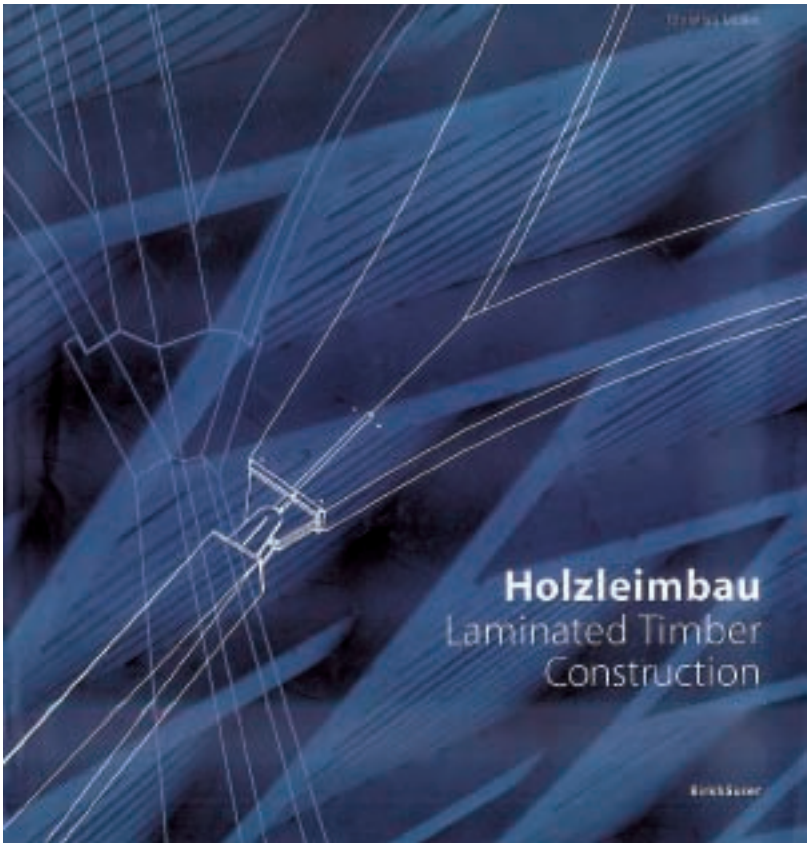
For many architects, knowledge of laminated timber begins and ends with the work of Alvar Aalto – indeed, few architects with pretensions to be 'modern' are without those quintessential laminated timber artifacts, the Aalto chair or stool. In documenting the history and engineering scope of laminated wood construction, this book challenges perceptions of Scandinavia as the natural home of this truly 20th century material.

Christian Müller's book began life as a doctoral thesis and, as a civil and structural engineer, he has taken a straightforwardly didactic approach, beginning with a brief but interesting history of the material, before marshalling his subject into strict topological order – roof, sheds, trusses, girders, lattice shells, domes and – finally – bridges. Unfortunately, this approach permits the avoidance of conclusions, and no summary is given of where laminated timber development stands as we enter the 21st century.

Fascinating information is offered, such as the fact that the first tests on glued timbers were carried out in Weimar in 1900 as a result of a building boom which had led to shortages of the larger sizes of timber and, consequently, price rises. The author even traces the idea of timber lamination back as far as a 1561 publication of French architect Philibert de l''Orme. Despite these illuminating moments, however, the book skips any simple explanation of what laminated timber actually is or even how it is manufactured, assuming instead some prior knowledge of the material and of timber engineering generally.

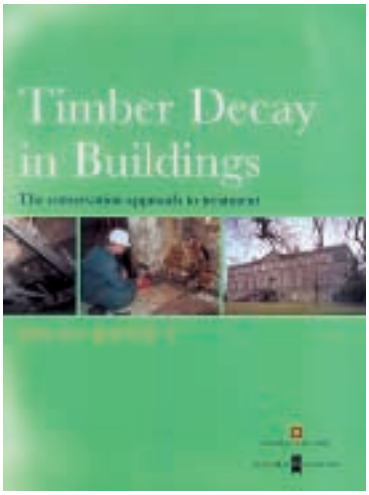
The examples given throughout the book tend to be German, Swiss or Dutch, with the occasional American or Scandinavian illustration. While illuminating, projects included for reasons of chronology are treated equally with those that are architecturally interesting, and even the extraordinary laminated canopy at Hanover's Expo 2000 is merely bundled into the 'Suspended Shell' section. In similar vein, a rather dry description of Niels Torp's beautiful 'upturned boat' skating hall at Hamar for the 1994 Winter Olympics forms the opening to the chapter on 'Trusses, Girders and Beam Grids'.

Given the surprising dearth of publications on the subject, ' Laminated Timber Construction' provides a valuable body of knowledge for those interested in this remarkable material. It does, however, concentrate on the pragmatics of laminated wood design, leaving a complementary tome on the poetics of the material still to be produced.



Avoiding A Load of Rot

TIMBER DECAY IN BUILDINGS – THE CONSERVATION APPROACH TO TREATMENT
By Brian Ridout
Published by E & FN Spon
£30-00 (hardcover 232pp)
ISBN 0 419 18820 7



In the foreword to this book, an analogy is made between the development of medicine and the ways in which we have treated decay in wood. Remarking on the practice in the early19th century, when illnesses were poorly understood, of simply cutting off injured limbs to prevent infection. If diseases spread, noxious potions were used in vast quantities, some so strong as to cause further injuries. Nowadays of course, less invasive surgery techniques have been developed, with the emphasis moving still further towards preventative medicine and healthy living. And so it has been with timber. Simplistic approaches to the treatment of insect and fungal infestation have been the real cause of serious damage to older buildings, with perfectly healthy features hacked out in the search for the dreaded dry rot. Fungicides and insecticides have often been applied in such high concentrations occurred due to the mobilisation and crystallisation of salts. Prime examples of our built heritage have been disfigured and dismembered in the name of conservation.

As with medicine, approaches to timber conservation have been slowly changing, and this publication sets out to offer guidance on best contemporary practice. Timber decay involves more than a simple relationship between wood and pesticides: it is also a complex series of interactions between wood, decay organisms, and the building environment. Understanding of these interactions can minimise and perhaps help avoid destruction or potentially harmful interventions, and help to maximise the retention of original building timbers.

While aimed primarily at the world of building conservation, this timely publication provides extremely useful background and technical information of equal importance in the consideration of new timber building design. In this case, a little knowledge can be an extremely valuable thing.

Timber Agencies and Organisations

ASSOCIATION OF SCOTTISH HARDWOOD SAWMILLERS (ASHS)
Hotline tel: 0870 241 2350
Email: info@scottish-hardwoods.co.uk.

ASHS is an independent association of small companies supplying Scottish hardwood timber and timber products. Through its co-ordination facility, ASHS is able to: increase the proportion of home produced hardwood reaching the Scottish market, support the management and development of Scotland's broadleaved woodlands amd supply users with a quality product and an efficient and reliable service.

BUILDING RESEARCH ESTABLISHMENT (BRE)
Kelvin Road, East Kilbride
Glasgow, G75 0RZ
Tel: 01355 576200
Fax: 01355 576210
Email: stuparta@bre.co.uk

The BRE carries out extensive research, development and consultancy work for the construction industry, with its Centre for Timber Technology and Construction (CTTC) nowadays maintaining the organisation's long tradition of high-quality timber research. CTTC's primary focus is to promote and develop the effective use of timber and its 26 professional staff offer an internationally recognised consultancy service. BRE has recently established its timber consultancy at East Kilbride – its Scottish base for over 50 years – to provide a local focus and local knowledge, but with ready access to the wealth of expertise at CTTC.

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Edinburgh, EH12 7AT
Tel: 0131 334 0303
Email: enquiries@forestry.gsi.gov.uk

Forest Enterprise is an agency of the Forestry Commission responsible for the management of forests and woodlands owned by the nation. Its aims are to maintain and increase the productive potential of the forest estate, increase the opportunities for public recreation, increase the conservation value of its forests and increase the net value of commercial activities.

FOREST INDUSTRIES DEVELOPMENT COUNCIL (FIDC)
53 George Street
Edinburgh, EH2 2HT
Tel: 0131 220 9290
Email: mail@fidc.org.uk

FIDC is a partnership of key organisations and businesses across the forest industry. The partnership embraces the whole industry 'wood chain' from forest nurseries through the growing and services sectors to those producing timber products. It is thus able to speak for the whole industry with a single voice. The Council's mission is to spearhead the sustainable development and promotion of an internationally competitive multi-objective forest industry throughout the United Kingdom.

FORESTRY COMMISSION
231 Corstorphine Road
Edinburgh, EH12 7AT
Tel: 0131 314 6156
Email: enquiries@forestry.gsi.gov.uk

The Forestry Commission's National Office for Scotland is the Scottish Executive's forestry department, providing policy advice to Scottish ministers and the Scottish Parliament on forestry. In addition, the National Office, together with its six Conservancies (covering the Highlands, Grampian, the Perth area, Strathclyde, South West Scotland and Lothian and Borders), carries out its regulatory and grant support functions.

SCOTTISH FOREST INDUSTRIES CLUSTER
c/o 53 George Street
Edinburgh, EH2 2HT
Tel: 0131 220 9292
Email: scotcluster@fidc.org.uk

The Scottish Forest Industries Cluster aims to establish wood as the natural choice for sustainable and innovative customer solutions. Established as a partnership between the Forest Industries Development Council and Scottish Enterprise (the Government's economic development agency for lowland Scotland) the goals are for the forest industry to: become a demand-led industry that is competitive with the best in the world; grow and develop markets for higher value products and services; encourage a domestic wood-using culture where wood is the natural choice of customers; build a connected and innovative industry that understands and responds to new consumer demands; and be recognised as an industry that makes a valued contribution to communities and the environment as well as the economy.

TIMBER FRAME INDUSTRY ASSOCIATION (TFIA)
Office 30, Stirling Business Centre
Wellgreen Place
Stirling, FK8 2DZ
Tel: 01786 445075

The TFIA is an independently constituted company limited by guarantee whose aim is to promote timber frame construction to the public and to the construction industry. To this end TFIA provides information and publications, lobbies for the industry, promotes quality and organises training. All TFIA manufacturing members are required to be quality assured.

TIMBER RESEARCH AND DEVELOPMENT ASSOCIATION (TRADA)
Stocking Lane
Hughenden Valley
High Wycombe
Bucks HP14 4ND
Tel: 01494 569603
Web: www.tradatechnology.co.uk

TRADA is an internationally recognised centre of excellence serving the timber and woodworking industries, their suppliers and customers. It works with its members to develop new market opportunities for timber and to safeguard and protect existing ones. The work programme generates information and best practice guidance which is disseminated through publications and electronic media, via the internet and the technical helpline as well as seminars and training courses for timber companies, construction design professionals, practitioners and clients.

TIMBER TRADE FEDERATION
(FORESTS FOREVER)
4th Floor, Clareville House
26/27 Oxenden Street
London SW1Y 4EL
Tel: 020 7839 1891
Fax: 020 7930 0094
Email: jfaleiro@ttf.co.uk

Established in 1892, the Timber Trade Federation is the leading trade association for timber and is recognised in the UK and overseas as the voice of the timber industry.

All TTF members have had to satisfy strict criteria before joining. They are expected to adhere to a high standard of working practice and business methods.

The timber industry is proud of its strong environmental credentials and recognises its responsibility to protect forests for future generations.

UK FOREST PRODUCTS ASSOCIATION (UKFPA)
John Player Building, Stirling Enterprise Park
Springbank Road
Stirling, FK7 7RP
Tel: 01786 449029
Email: ukfpa@compuserve.com.

Membership of the UKFPA is drawn from companies throughout the UK whose principal activities encompass the harvesting, sawmilling, processing, merchanting and distribution of British grown softwood and hardwood timber and forest products. The Association maintains strong links with a wide range of organisations in the public and private sectors, and networks with related organisations at regional, national and international levels.

WOOD PANEL INDUSTRIES FEDERATION
28 Market Place, Grantham
Lincolnshire, NG31 6LR
Tel: 01476 563707
Email: wpif.panelboard@virgin.net.

The Wood Panel Industries Federation is the representative body of the wood based panel manufacturing sector in the United Kingdom and the Republic of Ireland. Membership comprises companies holding about 90 per cent of the wood panelboard production capacity in Britain and Ireland. The Federation's remit is to define, develop and advise on the panelboard industry's technical and environmental database through standards, guidelines and research.

Useful Publications

BRITISH GROWN HARDWOODS: THE DESIGNERS' HANDBOOK
Prepared and published by TRADA Technology Ltd, 1996
ISBN 1 900510 02 2
For more information contact TRADA on Tel: 01494 563091

CONSEQUENCES: THE ENVIRONMENTAL IMPACT OF TIMBER THROUGHOUT THE LIFECYCLE
Published by the Timber Trade Federation
For more information contact
the Timber Trade Federation on Tel: 020 7839 1891

EXTERNAL TIMBER CLADDING
By PJ Hislop RIBA and TRADA Technology DG 3
Published by TRADA Technology Ltd, 2000
£20 (softback 46pp)
ISBN 1 900510 30 8

FORESTS FOR SCOTLAND: THE SCOTTISH FORESTRY STRATEGY
Published by Scottish Executive, November 2000
ISBN 0 85538 4549
For more information contact the
Forestry Commission on Tel: 0131 314 6144

FRAMING UP FOR THE FUTURE
Published by The Association for the
Protection of Rural Scotland, 1999
For more information contact the APRS on Tel: 0131 225 7012

ROOTS FOR GROWTH: A STRATEGIC FRAMEWORK FOR ACTION FOR THE SCOTTISH FOREST INDUSTRIES
By the Scottish Forest Industries Cluster
Published by Scottish Enterprise, August 2000
For more information contact the Cluster Support Unit,
Forest Industries Development Council on Tel: 0131 220 9292

RESPONSIBLE TIMBER PURCHASING
Published by Forests Forever, July 2001.
For more information contact
Forests Forever on Tel: 020 7839 1891

TIMBER DECKING MANUAL
Prepared by TRADA Technology for TRADA
and the Timber Decking Association
Published by TRADA Technology Ltd, 1999
£40 (softcover 76pp)
ISBN 1 900510 22 7

TIMBER FRAME CONSTRUCTION
Published by TRADA Technology Ltd, third edition 2001
£38 (softback, 256pp)
ISBN 1 900510 32 4

TIMBER IN BUILDING: THE ENVIRONMENTAL CHOICE
Published by Forests Forever, 1999
For more information contact
Forests Forever on Tel: 020 7839 1891