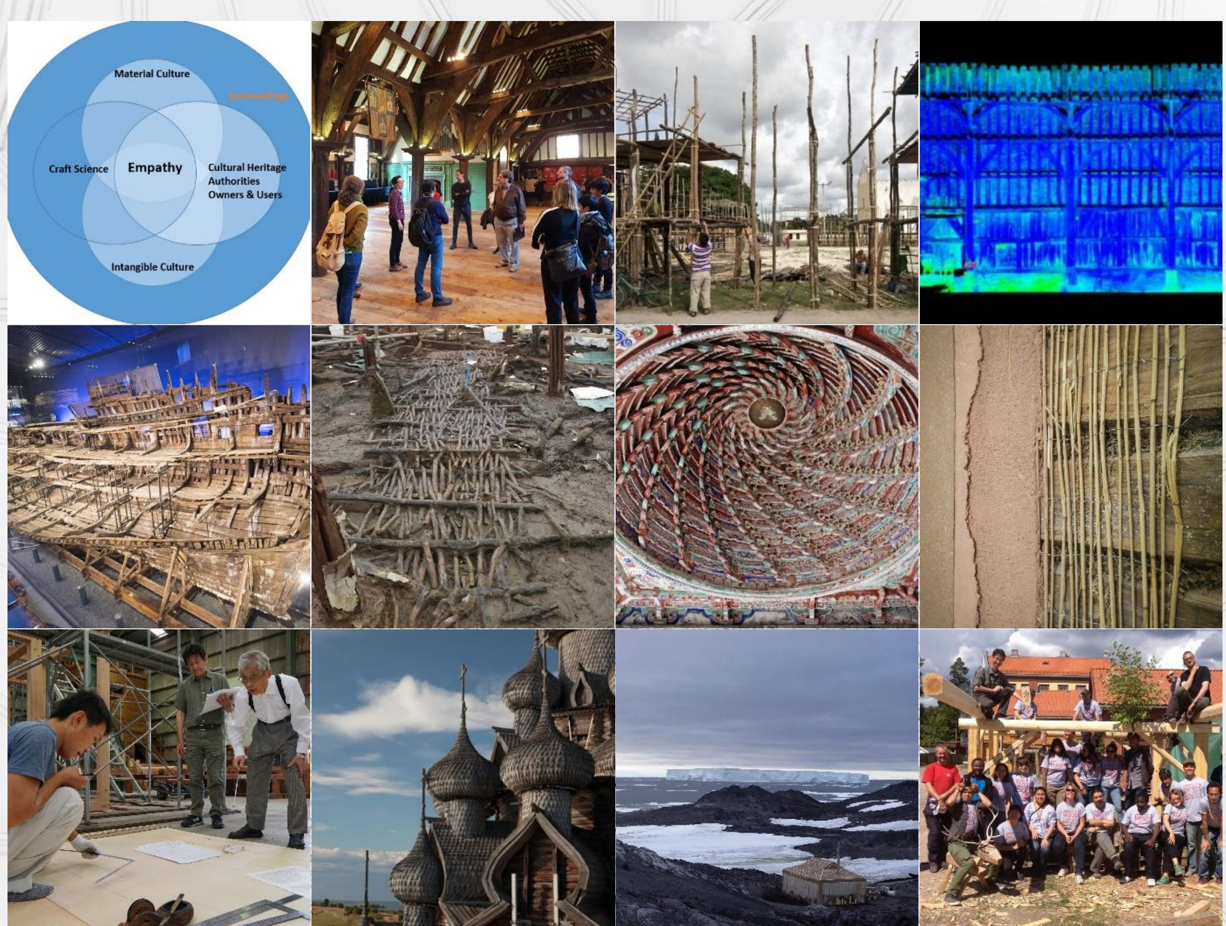
ICOMOS INTERNATIONAL WOOD COMMITTEE



New Horizons in the Conservation of Wooden Built Heritage 21st IIWC Symposium, York 2018

12 – 15 September 2018, York, UK

The 21st International Symposium of the ICOMOS International Wood Committee supported by ICOMOS-UK and York Archaeological Trust, and in association with the University of York, Historic England and York Minster

Proceedings Editor: Dr. Tanya L. Park, IIWC Vice-President (Oceania),
Southern Cross University, NSW Austalia

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Preface and Acknowledgements

The IIWC's 21st International Symposium, held in York, England between 12-15th September, 2018, wouldn't have been possible without the help and involvement of so many people and organisations. Their invaluable participation in York has helped the IIWC to bring awareness of wooden built heritage to a wider audience and to reach a more diverse range of experts, professionals and practitioners. They have helped ICOMOS to deliver its message to a wider variety of nations and cultures; and have helped ICOMOS-UK in its aim to provide a forum for all those involved in the conservation of cultural heritage in the UK.

York Archaeological Trust, which includes the Jorvik Group, provided venues, staff, catering, and organisational expertise. This obviously helped convince us to hold the symposium in the wonderful historic city of York; but YAT's substantial support also gave us the solid foundations on which to build the rest of the programme. So my first and most gushing thanks is to their CEO David Jennings for his kind and incredibly generous offer and for making this all possible.

Acknowledgements and grateful thanks also go to:

- ICOMOS-UK for their support and to their staff Anthea Longo, Caroline Sandes and Susan Denyer for their patience and diligence in helping us to organise and put on this event.
- the dedicated events staff of the Jorvik Group including Gareth Henry, the Jorvik presenters (everyone loved the evening, the Japanese and Chinese delegates particularly), John and John the IT guys (for their patience), all the catering staff at St Anthony's Hall (the food for our conference dinner was delicious), and finally and especially Emily Readman for her energy, dedication and skill in making such a complex event seem so effortless and go without incident.
- the University of York's Archaeology Department and to their staff Claire McNamara and Rhys Williams, for providing us with excellent lecture room facilities for our opening address and annual IIWC meeting, and for the brilliant reception at King's Manor.
- the Dean & Chapter of York Minster for letting us visit one of the world's most magnificent cathedrals, to Alex McCallion the Minster's Director of Works and Precincts for helping us coordinate and conduct the various tours inside the Minster on the day, and to Steve Bielby the Minster's Clerk of Works for sharing with us his years of experience and unique knowledge of the Mason's Loft and Chapter House roof. During our visit we also enjoyed insights into the remarkable collection of the Minster's stained glass from the conservator Dr Celeste Flowers; and enjoyed the brilliant Hugh Harrison and his discussion of the unique 12th century Chapter House wooden doors.
- the City of York for the tour of the 12th and 14th century Walmgate Bar, part of the York city walls, and to York city archaeologist John Oxley and structural engineer Robert Thorniley-Walker for sharing with us their involvement in the conservation works on the Bar completed in 2016.
- Merchant Adventurers' Hall, and to Lauren Marshall, hall manager, for her excellent tour of the wonderful medieval timber frame 14th century guildhall, the oldest and finest in York.
- Ian Panter, Head of Conservation at York Archaeological Trust for our workshop at YAT's conservation Laboratory, and to Steve Allen and Charlotte Wilkinson for showing us YAT's unrivalled laboratory facilities and sharing their valuable knowledge on the conservation of artefacts and structures from marine environments and especially waterlogged wood remains.
- Paul Bryan, Geospatial Imaging Manager of Historic England, for our workshop at HE's York offices, and to HE's Jon Bedford and David Andrews for demonstrating the geospatial surveying technologies currently available to the heritage practitioner and giving us advice and guidance on their practical application with wooden built heritage.

- York Archaeological Trust again for letting us use Barley Hall for a workshop location and to Peter McCurdy for his excellent seminar on the reconstruction of this important 14th century monastic hospice carried out by his company between 1990-93.

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- Members of the ICOMOS-UK wood committee, especially Dana Challinor, Mike Bamforth and Maggie Henderson, for their insights and help with so many of the details.

Many people spoke to me during the conference to thank me and say how much they were enjoying themselves. We plan these events to bring people together from as many different nations, cultures and professional backgrounds as possible. Ultimately the success of the event then is in part thanks to this varied group of people who come together, but they come because hopefully we have provided something special and unique for them to experience. I believe that everyone involved in organising and putting on the York symposium helped us to achieve just that.

Doug Evans
Chair, York Symposium Committee
Trustee, ICOMOS-UK and Chair, ICOMOS-UK Wood Committee
Vice-President (Europe) & Treasurer, ICOMOS International Wood Committee
London, June 2019

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Introduction

Doug Evans

Chair, New Horizons York Organising Committee

In a session of the of the 19th General Assembly of ICOMOS held in Delhi on 15th December 2017, the new IIWC **'**Principles for the Conservation of the Wooden Built Heritage' were adopted as ICOMOS doctrinal text. These new 'IIWC Principles' replaced those adopted previously in 1999.

Ever since the IIWC was established in 1975, the need for a set of conservation principles has been a continuous theme in the Committee's ongoing discussions and activities. The drafting of the IIWC's original 1999 'Principles for the Preservation of Historic Timber Structures' went through many revisions from 1992 until it was eventually adopted as an ICOMOS doctrinal text at the 12th General Assembly in Mexico, October 1999. At the 16th ICOMOS General Assembly in Quebec 2008 a revision and update of the 1999 Principles was proposed to take account of: recognition of a wider variety of wooden heritage including its intangible aspects; to better respond to the diversity of cultural heritage and the diversity of approaches to conservation, as embraced in the Nara Document on Authenticity (Japan 1994); to improve the organisation and applicability of the document; and to update its content adapting it to current concerns, knowledge and processes.

The theme for the 21st IIWC Scientific Symposium in 2018 was "New Horizons for the Conservation of Wooden Built Heritage". It was conceived of as a platform to promote the new IIWC 2017 Principles through an interchange of new research and technical advancements in the conservation of wooden built heritage.

"New Horizons" in York was open to both ICOMOS members and non-members alike. The events in York over the four days in September 2018 were designed to engage a diverse community of experts, professionals and practitioners with the common goal of exploring new multi-disciplinary perspectives and potentialities in the field of conservation. This holistic approach to conservation is at the heart of ICOMOS and its scientific committees and is embodied in the new IIWC 2017 Principles.

Papers presented at the York 2018 Symposium were selected to expand current perspectives in the conservation of wooden built heritage. We were very fortunate to have an excellent group of experts who spoke authoritatively on a broad range of themes including:

- **Education and training**: With papers presented by Dr. Margarita Kisternaia of the Russian Kizhi State Open-Air Museum; Anne Nyhamar from the Norwegian Riksantikvaren International Course on Wood Conservation Technology; and Yue Pan of Tongji University, College of Architecture and Urban Planning, China.

- **Heritage craft science**: With papers presented by Prof. Harald Collin Bentz Høgseth of the Department of Conservation, University of Gothenburg; Dr. Alejandro Martinez De Arbulo,

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Research Fellow at Tokyo National Research Institute for Cultural Properties; and Karl-Magnus Melin, carpenter and archaeologist form the University of Gothenburg.

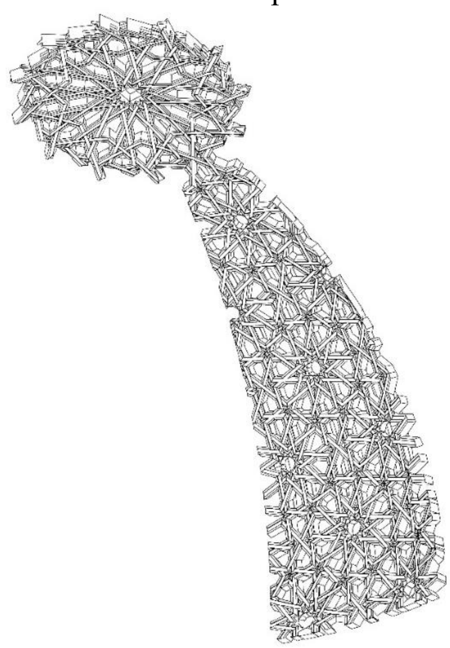
- **Maritime heritage and underwater archaeology**: With papers presented by Christopher Dobbs, maritime archaeologist and Head of Interpretation and Maritime Archaeology at the Mary Rose Trust; and Angela Middleton, archaeological conservator at Historic England.

- **Prehistoric waterlogged wood**: By Michael Bamforth, Project Manager of the Post Glacial Project, University of York.

- **Polar and arctic heritage**: With papers presented by Gord Mcdonald, Master carpenter/ Director of Heritageworks Ltd. in Canada; and Arnstein Brekke, carpenter, engineer and project manager from Norway.

- **Post-disaster reconstruction and conservation**: Papers from Jenny May and William Fulton on the Sacred Name Convent and Chapel in Christchurch New Zealand; and Natalia Burakowska on the reconstruction for the fire damaged C.R. Mackintosh Library.

- **New areas of research**: Upgrading of traditional wooden buildings in residential districts in contemporary China by Chen Gao, Southeast University, Nanjing, China; fire performance and energy efficiency of historic wooden structures in Tallinn Lithuania by Johann Liblik, Tallinn University; a conservation model for wooden mosques in Turkey by Suheyla Koc, Istanbul Technical University; restoration of Chinese wooden spiral Zaojings, from Jingxian Ye, École Polytechnique Fédérale de Lausanne; and on the classification of timber joints by Joe Thompson of the UK's Weald and Downland Open-air Museum.



CAD drawing of the interlaced wooden dome of the Ambassador's Hall Seville.

Credit: Landa-Ochandiano Arquitectos

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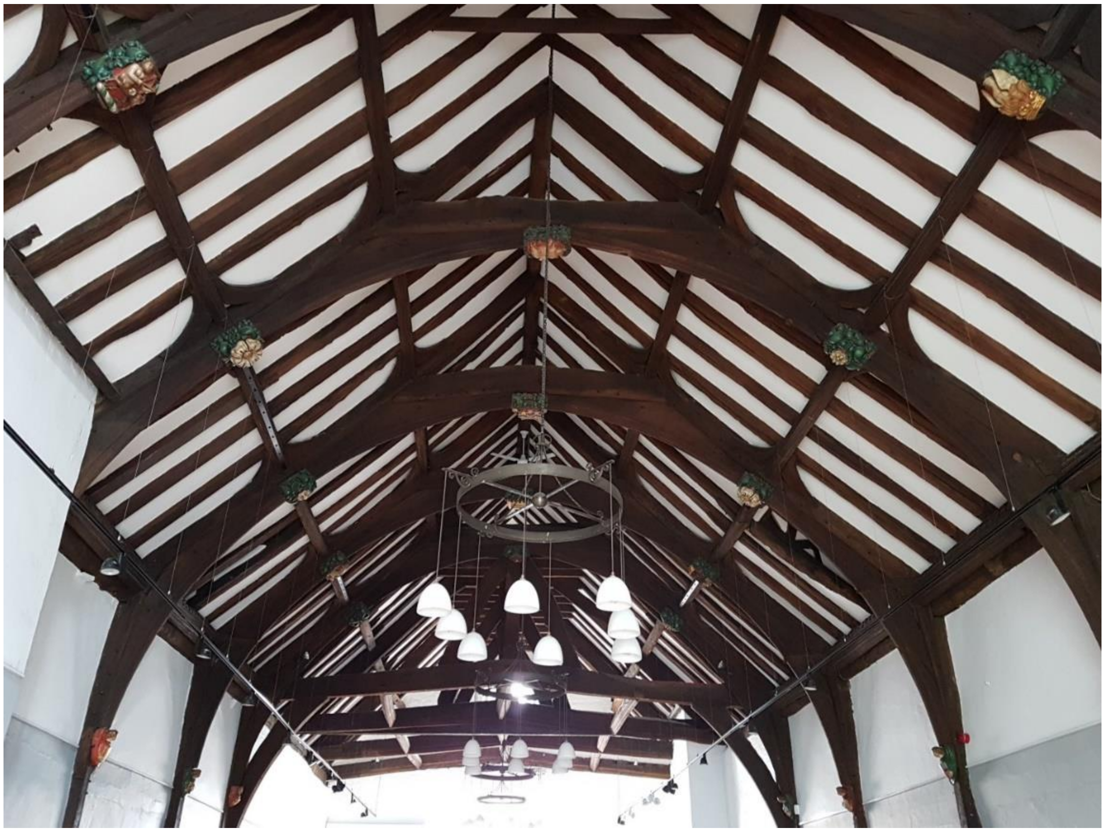
The Symposium's opening address and reception took place at the University of York's Kings Manor. The address by IIWC Mikel Landa on the interlaced wooden dome of the Ambassador's Hall of the Royal Alcazar in Seville was fascinating. The Hall was built in 1425 by master carpenter (and geometrician) Diego Ruiz. Mikel's drawings of the dome were mesmerizing.

The New Horizons Symposium also included a discussion panel chaired by IIWC president Mikel Landa on the IIWC's new 2017 Principles, and a presentation on the new IIWC working group for temporary architecture presented by Maria de Guadelupe Zepeda from Mexico. It was a privilege for us to enjoy all these presentations in the historic St Anthony's Hall, owned by York Archaeological Trust.



Mid-15th century timber roof structure, St Anthony's Hall.

Tours and Workshops

Prior to the speaker sessions, we enjoyed tours of some wonderful historic monuments in the historic city of York, and workshops put on by York Archaeological Trust, Historic England and ICOMOS-UK.

Visit to York Minster

On the first day of the symposium we were very fortunate to be able to visit York Minster and experience some of its most impressive sights.

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Tour of the Chapter House Roof and the Masons' Loft

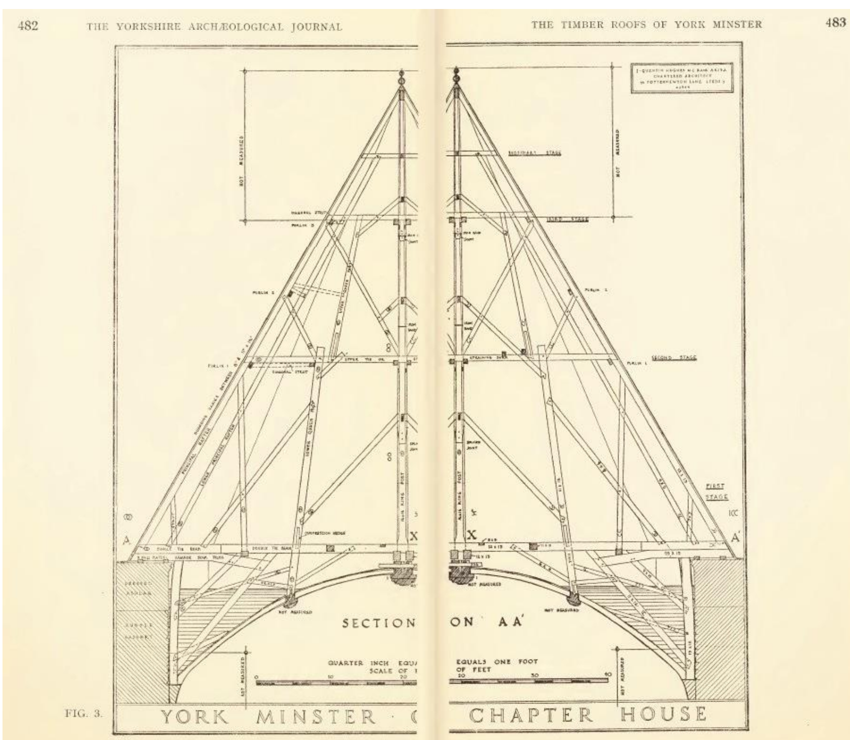
The Chapter House is an exceptional building with outstanding original medieval decoration – stained glass, sculpture and painting. It is one of York Minster's architectural gems and contains some of the Minster's finest carvings. In 1297 it was used as the location for the Parliament of King Edward I. This characteristic English octagonal Chapter House was built between 1260 and 1284.

All the major roofs of York Minster were constructed with timber vaults, instead of the more usual stone vaulting of the mediaeval period. Of those which now survive, only the roofs of the Chapter House and Masons' Loft, the North Transept, and the high Central Tower are Mediaeval, the rest having been destroyed in devasting fires in the 19th and 20th centuries.

Of all the Minsters' surviving roofs, the Chapter House roof is the oldest and still has its original structure.[i] The octagonal space of the Chapter House dates from the 1280s and its magnificent, vaulted ceiling is supported by the timber roof structure, instead of a central column, which is the earliest example of its kind to use this revolutionary engineering technique.

In his 1955 survey and study of the Chapter House roof, the architect Quentin Hughes PhD ARIBA described the timber structure of the roof in considerable detail:

The roof of the chapter house is a vast pyramid of timber which is built up in three stages and carries beneath it the timber vaulted ceiling. This form of construction with three diminishing stages was not new as the system was used in early Carolingian churches on the Continent…" [ii]



Hughes 1955. Section of Chapter House roof. ©Yorkshire Archaeological Journal

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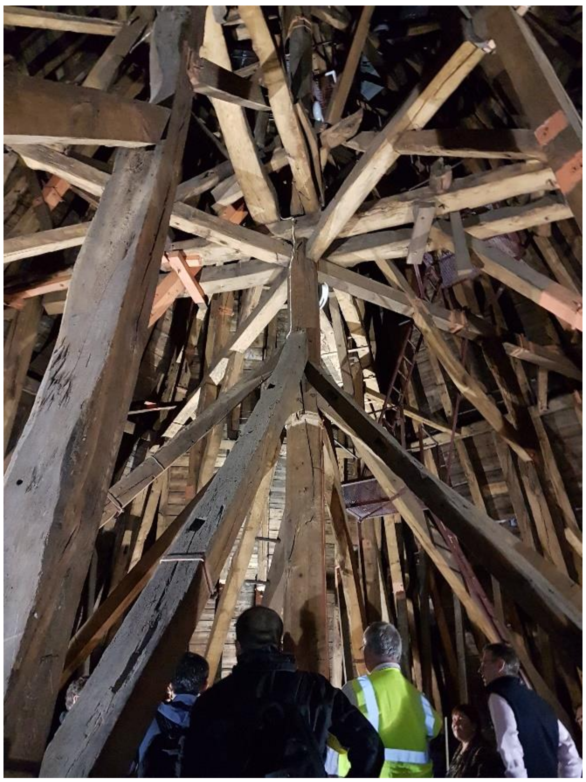
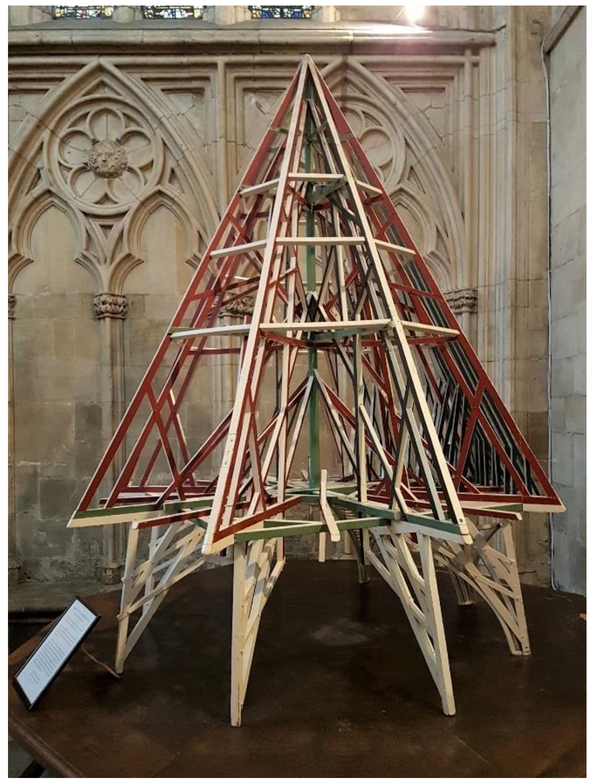
"The bewilderment at the complexity of the timber construction which is apparent on first entering the roof, slowly disappears as the symmetrical pattern which lies behind the design is noticed. The star shaped pattern of the plan can be seen clearly in the preliminary model which was photographed before all the subsidiary timbers had been put into place. The eight principal rafters radiate from the central post about 64 feet tall, to the corners of the octagon. The central post is sixteen inches thick at the first stage, and is made up of three baulks of timber, cut to an octagonal shape, joined by scarfed joints, and pegged with wooden pegs. Each pair of principal rafters, which measure 13 inches by 12 inches, encloses nine rafters which, instead of radiating from the centre, lie parallel to one another. The central post is firmly wedged at the three main stages between double tie beams…" [iii]



Chapter House roof structure.



Hughes' 1950s model of the Chapter House's timber roof structure.

Hughes' description of the medieval roof structure continues:

> "The construction is then essentially that of a king post truss built upon three levels, and from it a timber star shaped vault is suspended. This vault gives no support to the tie beams. The timber vaulting ribs run into the central post and are pegged, the central boss having no structural significance and being simply (fixed to the post…. the posts are held above the tie beams by a couple of timbers forming a triangle. The roof truss is not only a king post, because beams project from the walls, and, rising diagonally, support the single beams of the tie. In this way they form a rudimentary hammer-beam truss. This introduces the principle of balanced construction. Inside this basic structure other timbers are added to stiffen the roof. A queen post truss is superimposed upon the king post truss with eight upper and eight lower queen posts terminating in the

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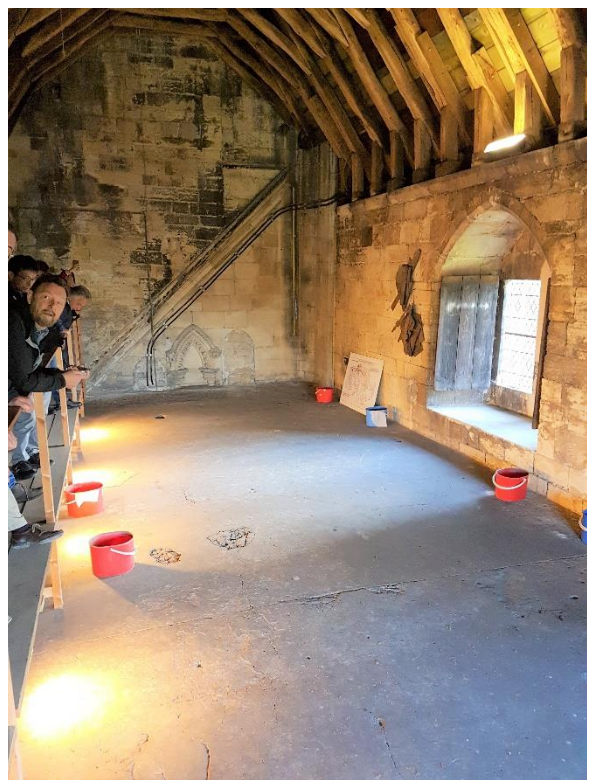
intermediate bosses of the vault. Like the central king post, the main posts are wedged between the double tie beams and compression wedges are driven down to ensure a firm attachment. On the second and third stage the centre portions of the main tie beams become the straining beams of the queen post trusses. Between the queen posts and the principal rafters, struts rise to support the first and second purlins. The third purlins are supported by struts which are notched into the king post at the base of the second stage. Other struts cross to form pyramids of timber, stiffening the king post between tie beams of the three stages. The common rafters receive additional support from seventy-two low struts, in addition to the three purlins and the beams of the top subsidiary stage. To overcome wind pressure, braces support the first and third purlins from the tie beams of the second and third stages… Almost every timber is inscribed with a carpenter's mark…" [iv]

On the way up to see the Chapter House roof structure, we visited the Masons' Loft, situated on the first floor of the L-shaped vestibule building connecting the Chapter House to the North Transept of the Minster. Originally, the vestibule's design was for a much lower, single-storeyed structure possibly with a timber vault, but in the early 14th century it was decided to change the design and create a room above the vault.[v]

York Minster Mason's Loft



Mason's Loft tracing floor

The Masons' Loft extends over both limbs of the Chapter House vestibule below and has one of the finest surviving 'scissor braced' timber roofs in the country.

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Besides the many other interesting features, what is really unique about the room is its plaster-of-Paris tracing floor that illustrates the procedure of masoncraft. Only two of these plaster tracing floors survive in England; the other is at Wells Cathedral.

Our tour was led by **Steve Beilby,** Clerk of Works and York Minster Assistant Director of Works.

York Minster's Stained Glass

York Minster holds the largest single collection of medieval stained glass in the UK with 128 windows, the oldest dating back to the 12th century. A short tour can provide only the briefest insight into the remarkable collection of stained glass present in York Minster. Our tour therefore focused on two windows significantly different from one another in style and iconography, and each with a unique history of intervention: the Great East Window and the South Transept Rose Window.[vi]

The Great East Window was completed in 1408 and is the largest expanse of medieval stained glass in the country, a masterpiece in glass and stone depicting the beginning and end of all things. For the last 12 years, the 600-year-old window has been the subject of a major restoration and conservation project – one of the largest of its kind in Europe. The South Transept Rose Window was constructed in the 13th century but is now filled with early 16th century glass; it was restored after the 1984 fire.

York Minster Rose Window, glass dating from 16th, 18th and 20th centuries.

Image: Nick Teed YGT June 2016. © Chapter of York: Reproduced by kind permission.

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Beginning in the South Transept, we looked at the Rose Window, frequently used as an icon to represent the Minster as a whole. From there we moved to the Lady Chapel to admire the Great East Window, a masterpiece of Medieval design. The tour examined the original design and construction of each window and their restoration history and we ended with an overview of current stained glass conservation projects at the Minster. Some of us we fortunate enough to have brought binoculars to get a better view and understanding of the details of the glass.

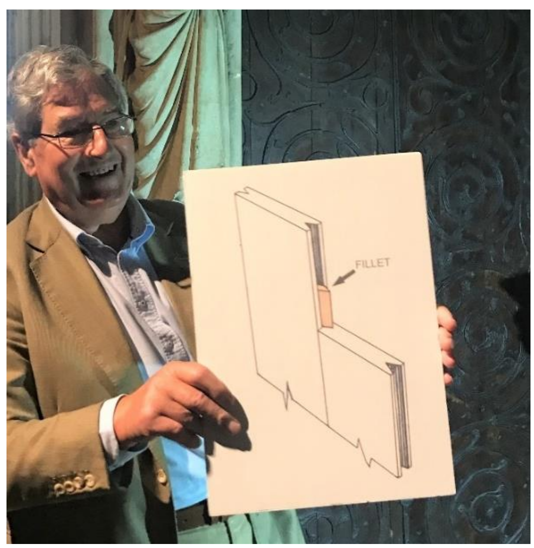
Our tour was led by **Celeste Flower PhD**. Celeste has a Master's Degree in Stained Glass Conservation and Heritage Management from the University of York; her dissertation topic was on the "Restoration History of The Rose Window at York Minster". She is an accredited York Minster Guide, specialising in tours for schools, Hidden Minster and Stained Glass tours. Celeste is also a freelance conservator with the York Glaziers Trust on projects including the Great East Window. Celeste gained her PhD in Philosophy in 1984 from the University of Warwick.

York Minster's Chapter House Doors

The doors to the Chapter House date to c.1285 and have many unusual features. They were constructed to a system that had not really changed for 200 years whereby a layer of vertical boards on the outer face were held together by horizontal 'ledges' or in this case a trellis of ledges that are nailed to the back. This is just prior to the 'frame system' which took over as the preferred construction method for timber doors in the early part of the 14th century.[vii]

The vertical boards are softwood and the trellis on the backs are in oak. This raises an interesting question: as no other examples of the use of softwood are found for doors of this status at this date or for another 400 years, are these boards a later intervention or original? The boards are jointed with lozenge profile tongues, another unrecorded jointing system at this date or any other. There is some evidence that the nails from the boards into the trellis were located to be hidden by the ironwork and the heads punched into the surface as though not to distract from a complex polychromatic decorative scheme. The ironwork is purely decorative and the hinges are fixed to the back of the doors.[viii]

Chapter House doors



Hugh Harrison. Photo: Chen Gao.

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Our tour was led by **Hugh Harrison**, director of Hugh Harrison Conservation Ltd. (@hh_conservation). Hugh was taught by the old craftsmen of St. Sidwells Art Works, Exeter, Devon which he then took over in 1972. Hugh has trained a new generation of craftsmen who in recent years have carried out major contracts in Westminster Abbey and Manchester, Bristol, Exeter and Winchester cathedrals and Kings College Chapel, Cambridge, as well as Kensington Palace and the Banqueting House, Whitehall. This team won the John Betjeman Award for Conservation for 2016.

Hugh has co-authored a book on the choir stalls in Amiens Cathedral and wrote the chapter in the English Heritage Practical Building Conservation Series: Timber volume on the conservation of woodwork. Hugh has served on the ICOMOS-UK Wood Committee for over 30 years and has contributed to ICOMOS missions to Beijing and northern Russia. He is a Fellow of the Society of Antiquaries.

Tour: Walmgate Bar, York City Walls

York's city walls are the most complete example of medieval city walls still standing in England. Remains of Roman period walls survive beneath the medieval stonework. In AD 866 York was invaded by the Danish Vikings who buried the Roman wall under an earth bank topped with a wooden palisade. The palisade was replaced in the 13th and 14th centuries with the stone walls we see today.[ix]

York's walls originally stretched over 2 miles encompassing the medieval city and castle walls and included 4 main gates or 'bars' (Bootham Bar, Monk Bar, Walmgate Bar and Micklegate Bar), 6 postern (secondary) gates and 44 intermediate towers. By the late 18th century the walls had fallen into disrepair and were no longer required as defences for the city. The narrow gateways of the bars were troublesome and the walls themselves were hindering the city's expansion and in 1800 the Corporation of York applied for an Act of Parliament to demolish them. [x]

However, the city officials met with fierce and influential opposition and by the mid-19th century the Corporation had been forced to back down. Regrettably, by then the barbicans at all but one of the gateways (Walmgate Bar) had been demolished along with 3 postern gates, 5 towers and 300 yards of the wall itself.[xi]

Walmgate Bar. 1807 etching by Joseph Halfpenny. Credit: historyofyork.org.uk

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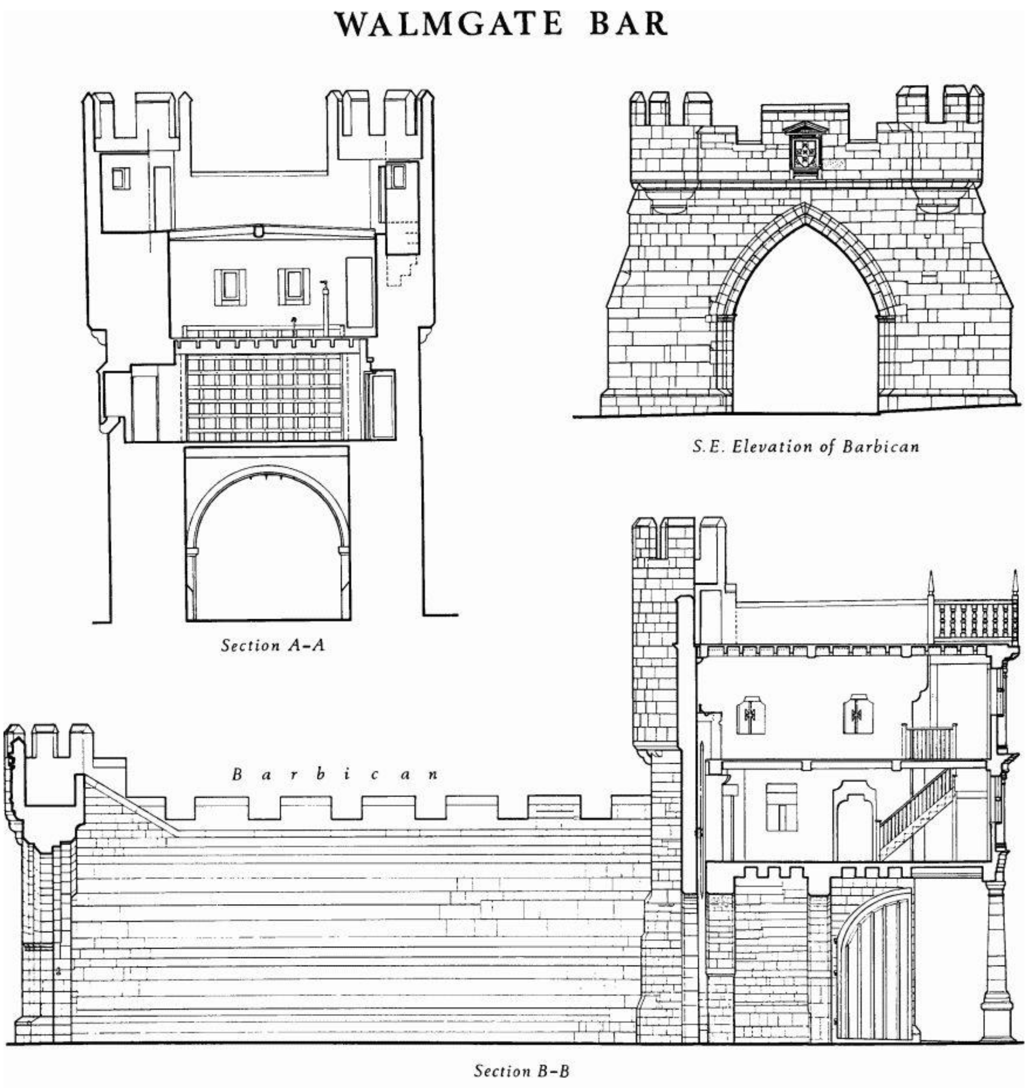
Walmgate Bar

Walmgate Bar is the most complete of the four main medieval gateways to the city and it is the only Bar to retain its barbican, portcullis and inner doors. Its oldest part is a 12th century stone archway; the walled barbican at the front dates from the 14th century, the wooden gates from the 15th century and the timber-framed building on the inside from the 16th century. The Bar was burned by rebels in 1489 and battered by cannon during the siege of 1644.[xii] Use of the gatehouse has evolved from a residence for the city watch, to a police house, a bookshop, and its current life as a coffee shop.



Survey of Walmgate Bar.

Credit: HMSO. An Inventory of the Historical Monuments in City of York 1972.[xiii]

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Tour of Walmgate Bar

Our tour of the Bar looked at the results of an innovative programme of conservation, stabilisation and enhanced public access undertaken by the City of York and completed in 2016.

Walmgate Bar had been exposed to damage from passing traffic for many years. Despite the recent exclusion of traffic through the historic gate passage, vehicle strikes continued, posing serious threats to the structural integrity of the timber-framed extension. Monitoring of the structure raised further concerns over the condition and vulnerability of the two stone piers supporting the timber-frame.[xiv]

Investigations identified that the stone piers and ornate external architectural columns had replaced original structural oak posts. This had led to gradual migration of load paths and deformation of the timber-frame. Engineering consultants Structural & Civil Consultants Ltd were appointed to design a scheme to address these issues.[xv]

The load paths were restored through a complex jacking operation. Plywood sheathing was installed that allowed the original timbers to act as either compression or tension members in accidental loading. A hot-lime hemp render, replacing an inappropriate cement render, was applied to the external elevations of the timber-frame. The decayed softwood balustrade, installed in 1990, was replaced in oak. The lead roof was repaired and a softwood deck installed to allow public access to the roof.[xvi]

John Oxley. Photo: Suheyla Koc

Group. Photo: Erika Koshi

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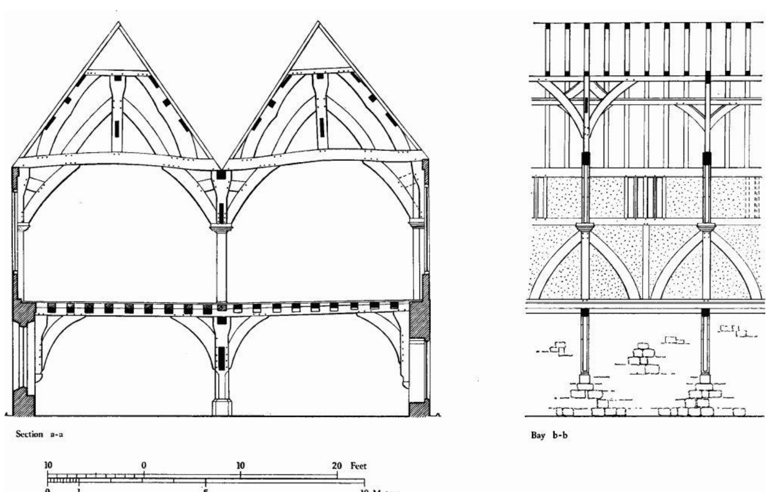
Our tour of Walmgate Bar was led by **John Oxley**, York City Archaeologist, and **Robert Thorniley-Walker** of Structural & Civil Consultants Ltd. John has responsibility for the conservation of York's City walls and for cultural heritage management within City of York Council. Robert is a conservation accredited engineer (CARE) and has been an active member of the ICE panel for the Forensic Journal; he has a particular interest in the conservation of historic timber, and the use of low-carbon solid timber for new buildings.

Tour: Merchant Adventurer's Hall

Merchant Adventurer's Hall is a large building, mainly of 14th-century origin, consisting of an Undercroft and Hall above. The Undercroft has walls of constructed of brick and stone, and is divided internally by timber posts into two aisles eight bays long. The Hall on the first floor, is also divided into two aisles, and is entirely of timber-framed construction. The roofs are tiled. Projecting southeast from the Undercroft is an early 15th-century Chapel. On the N.E. side is an early 17th-century addition, of two storeys and attics. A separate gatehouse of 17th-century origin fronting Fossgate has been mostly rebuilt in modern times.[xvii]

The Undercroft was used as an almshouse to help the sick and the poor until as late as 1900. The Chapel offered spiritual care to the merchants and the inmates of the almshouse. The Great Hall is where the medieval merchants first gathered to conduct their business and to socialise.

In 1357 important men and women of the city of York came together to form a religious fraternity and to build the Merchant Adventurers' Hall. By 1430 the members of the 'fraternity' had set up a trading association or guild. The Hall remains the everyday base for the 160 members of the Company of Merchant Adventurers of the City of York. A Merchant Adventurer was someone who risked or 'adventured' his or her own money in overseas trade bringing back goods and wealth to York.[xviii]



Sections of Merchant Adventurers' Hall.

Credit: HMSO. An Inventory of the Historical Monuments in City of York, Volume 5, Central. 1981.[xix]

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Our tour was led by **Lauren Marshall**, Hall Manager & Audience Development Officer. Discussions on English carpentry continued outside.

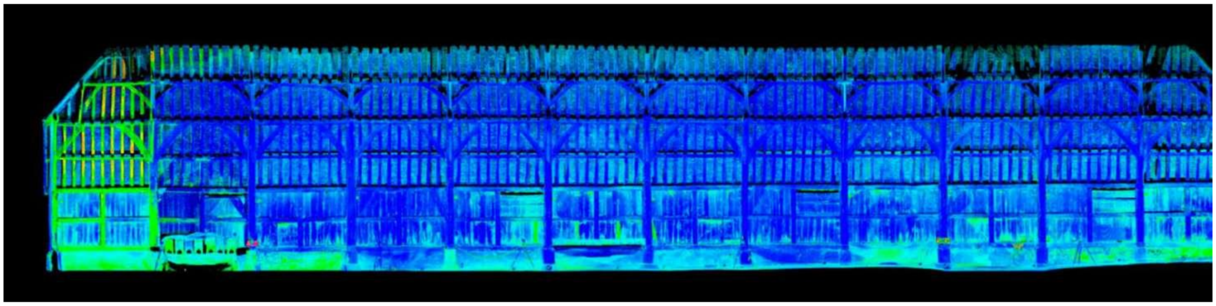
Photo: Huanyu Guo

English carpenter Andrew and Spanish architect Marieta.

Workshop: Digital Recording Technologies for Wooden Built Heritage

Location: Historic England, York Office, 37 Tanner Row, York YO1 6WP

https://historicengland.org.uk/research/methods/terrestrial-remote-sensing/specialist-survey-techniques/



Section through Harmondsworth Barn showing the intensity of the return pulse from laser scanning. © Historic England

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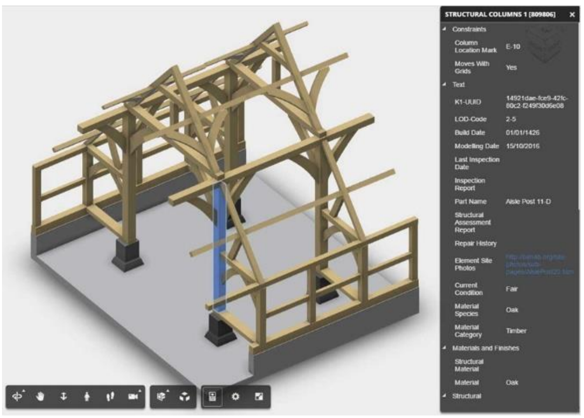
Specialist survey techniques including photogrammetry and laser scanning are an essential element of any heritage project. Often referred to as metric or measured surveys, they provide visual and metrically accurate base data for a variety of heritage applications including conservation planning, condition surveys, decay monitoring, recording, architectural analysis, archaeological investigation and site presentation. Using a combination of presentation, demonstration and case study application, the workshop looked at the geospatial surveying technologies currently available to the heritage practitioner. Advice and guidance on their practical application to wooden built heritage was provided. Demonstrations included the use of close-range structured-light scanners, static terrestrial & mobile laser scanners and 'Structure-from-Motion' photogrammetry along with post-processed examples from each technology to illustrate the variety of digital recording outputs that can be provided.[xx]



Model and sample metadata. Harmondsworth Barn. © Historic England

Image capture strategy. Harmondsworth Barn. ©Historic England

The workshop was led by **Paul Bryan**, **David Andrews** and **Jon Bedford** of Historic England's York-based Geospatial imaging team. The Imaging Team Research Group takes the corporate lead across Historic England on applying modern image and laser-based survey approaches across heritage. Paul Bryan, Historic England's Geospatial Imaging Manager, was awarded Fellowship of the RICS in 2013. Paul has extensive knowledge of image-based survey including photogrammetry, laser scanning, low-level aerial imaging using drones and is the Historic England lead on Building Information Modelling (BIM) for Heritage.[xxi]

Workshop: Conservation of Archaeological Wooden Remains

Location: York Archaeological Trust, Archaeological Resource Centre, 421 Huntington Road, York, YO31 9HT.

www.yorkarchaeology.co.uk

The Conservation Department of York Archaeological Trust (YAT) is a broad-based and integrated service; its primary purposes being retrieving, preserving, revealing and recording the true nature of archaeological objects and materials.

They are one of the UK's leading labs for conservation of artefacts and structures from a marine environment. Shipwreck archaeology presents intriguing and challenging conservation issues, not usually seen in terrestrial environments. YAT have built up skills and expertise over the last 20

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years, working on a diverse range of projects ranging from the timbers from the Swash Channel wreck outside Poole Harbour (17th Century Dutch vessel trading in the West Indies) and artefacts from a wreck off the coast of Oman.

The YAT labs offer unrivalled facilities and valuable knowledge on the conservation of waterlogged organic finds. Facilities for the study, recording and conservation of wet organics have been developed where YAT's experienced team of conservators and wood technologists are leaders in the field and have a range of freeze-dryers and treatment tanks capable of taking timber up to 4 metres in length.

Treatment tanks in YAT's conservation lab.

Steve Allen explaining YAT wood record sheets

Our workshop was held at YAT's Resource Centre which is a new facility providing a single site for the process of large-scale timber conservation and for the storage of YAT's archaeological collection. We were able to see samples in YAT's collection and the processes used in their conservation and cataloguing giving us an insight into the work of the curating archaeological wooden remains. The workshop was led by Ian Panter, Head of Conservation, Steve Allen, wood technologist, and Charlotte Wilkinson, conservator, from YAT's conservation department.

Ian Panter and freeze-dryer. Photo: Toshi

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York Archaeological Trust Wood Record Sheet	Site Code/ Accession No:	Timber or SF No:
Site Name:	Context No:	Area:

On Site Recording: Context Information

Co Ordinates		Reduced Levels:		8	
E	N	1		9	
		2		10	
		3		11	
		4		12	
		5		13	
		6		14	
		7		15	

Orientation:

Drawings and Images	Overall dimensions m/mm
Plan Nos:	Length:
Section/Elevation Nos:	Width:
Photo Reference Nos:	Thickness:
	Diameter:

On Site Recording: Interpretation.

Stratigraphic Position:	Physical Associations:
this context is	Dating/Phasing:

Function as Found:

Ancient or Recent Damage:

Special Reasons for Recovery:

Method and Conditions of Recovery:

Completed By:	Date:	Checked By	Date:

York Archaeological Trust Wood Record Sheet. © York Archaeological Trust 2010.[xxii]

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York Archaeological Trust Post Excavation Wood Record Sheet	Site Code/ Accession No:	Timber or SF No:
Site Name:	Context No:	Area:

Type:	Cross Section:
Condition:	

OA Dimensions m/mm:

Length

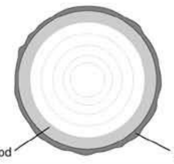
Width

Thickness

Diameter

Cross Section Sketch:

	Yes	No
Bark	☐	☐
Sapwood	☐	☐
Knotty	☐	☐
Straight Grained	☐	☐



Further Research Potential:

	Yes	No
Dendrochronology	☐	☐
Tree ring Study	☐	☐
^{14}C	☐	☐
Display	☐	☐

Species Identification:	Conversion:

Woodworking technology:

Tool Marks __________

Joints __________

Fixings and Fittings __________

Intentional Marks __________

Surface Treatment __________

Other __________

Reused: Y ☐ N ☐ Not Known ☐

Recommendation: Discard? ☐ Discard after further research/sampling? ☐ Retain and Conserve ☐

Checked:

Date:

Measured Sketch:

York Archaeological Trust Wood Record Sheet. © York Archaeological Trust 2010.

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Workshop: Barley Hall - Reconstruction of a 14th century monastic hospice

Location: Barley Hall, 2 Coffee Yard, York YO1 8AR.

www.barleyhall.co.uk

www.mccurdyco.com

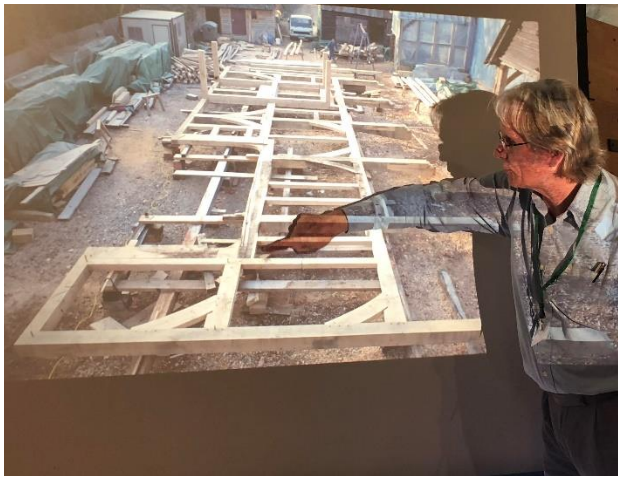
Our workshop was led by **Peter McCurdy.** Peter originally trained as an architect and for the past 39 years has been the owner/ managing director of McCurdy & Co., craftsmen, consultants and specialists in the repair and conservation of historic timber framed buildings.

Barley Hall is a reconstructed medieval townhouse in the city of York, England. It was originally built around 1360 by the monks of Nostell Priory near Wakefield and was extended in the 15th century.

The property went into a slow decline and by the 19th and 20th centuries was heavily sub-divided and in an increasingly poor physical condition. By the early 1980s, the building was in a dangerously unsafe condition and was scheduled for demolition to make way for offices and apartments. It was bought by the York Archaeological Trust in 1987, and renamed Barley Hall.

The York Archaeological Trust has restored Barley Hall as a living and working example of a medieval household. The reconstruction project was undertaken by McCurdy & Co. between 1990-93. McCurdy's carried out the archaeological analysis, careful repair and reconstruction of six bays, which make up the north wing, and the final re-erection of the completed timber frame.

Barley Hall, York



Peter McCurdy. Photo: Yue Pan

Peter McCurdy spent months surveying and recording all the timbers in McCurdy's Berkshire workshops before starting on a programme of repairs. More than three-quarters of the original timbers had to be replaced. Following historical research and traditional carpentry techniques these were individually cut and shaped using English Oak.[xxiii]

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The re-erection of the timber frame, in just ten days, was particularly challenging as the site at Coffee Yard was hemmed in and accessible only via narrow pedestrian alleyways or ‘snickels’. The team from McCurdy’s had to carefully ‘shunt’ the vast timbers through the winding streets on electrically powered transporter trolleys and then use an Italian designed, self-erecting tower crane to lift the timbers into place.[xxiv]

Receptions and Conference Dinner

On Wednesday evening the University of York hosted the opening address and a held reception for us at Kings Manor. King's Manor was built 1483-1502 to house the abbots of St Mary's Abbey, York. After the dissolution o the monasteries by Henry VIII, Kings Manor went through many owners and uses until in 1963 the buildings were acquired by the City of York and leased to the University. Today Kings Manor accommodates the university's Department for Archaeology, Centre for Conservation, Centre for Eighteenth-Century studies and the Centre for Medieval Studies.

On Thursday evening York Archaeological Trust hosted a reception for us at the wonderful Jorvik Viking Centre. Until the 1970s the only archaeological finds from the Viking-Age period in York were items dug up by chance. This changed in 1972 when small trenches in the Coppergate area were excavated. The dig area was extended to cover 1000 square metres which meant that between 1976 and 1981 archaeologists were able to trowel their way through 2000 years of history. During the next five years, York Archaeological Trust identified and recorded around 40,000 archaeological contexts.

Once the Coppergate dig was completed in 1981 York Archaeological Trust knew they had a duty to present these precious and unique archaeological artefacts to the public and educate them on the importance of the Viking on the history of York and the British Isles. Many ideas were floated around but one thing was clear, YAT wanted to create a heritage experience as unique as the artefacts that would be on show and as exciting as the period it would be showcasing. The result was Jorvik Viking Centre, a historic attraction that was more like a film set than a museum. Instead of walking around looking at exhibits, the visitor sits in specially designed time-cars, and moves around the “set” of a Viking village, taking it in from all angles, and witnessing Viking life up-close.[xxv]

Jorvik reception. Photo: Erika Koshi

Jorvik Viking village. Photo: Phoebe Gresford

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At the reception we were able to study some of the hundreds of artefacts on display in the Jorvik museum, and our visit through Jorvik's Viking village was thoroughly enjoyable, especially for our Japanese and Chinese friends.

On Friday evening we enjoyed a delicious conference dinner in Merchant Taylors' Hall, a stunning early 15th century guildhall. The timber roof structure is an unusual combination of two systems: it has one crown-post truss and four collared-rafter trusses with moulded arch-braces and inserted tie-beams. In 2014 a major dendrochronological investigation of the roof timbers of the Great Hall established its build date as 1415.

Conference dinner, Merchant Taylors' Hall

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Logged-on and hands-on; The International Course on Wood Conservation Technology

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Abstract

The International Course on Wood Conservation Technology - the ICWCT, or just *The Wood Course* for short is the easiest - was initiated as a response to a recommendation at UNESCO's General Conference in 1980, and it has been organized in Norway every second year since 1984. At the time there were no courses available addressing the issues of wood conservation, and Norway volunteered to host the first course. We did not volunteer to be the host for the next 30 years... but a seed was sown, and now it enjoys the reputation of one of the most established courses in the field, and its long tradition and good reputation is emphasised by us every year when we argue for our funding to be continued. So far, we have been fortunate to get the backing we need, but there is an element of suspense every year when the budget is discussed. The ICWCT is part of ICCROM’s course portfolio but financed entirely by Norway though *Riksantikvaren* - The Norwegian Directorate for Cultural Heritage.

Background

The course is one of ICCROM’s specialised training courses on heritage conservation and we value the international network we have access to through our partnership. As an intergovernmental organization with a vast network of conservation experts, ICCROM relies on institutional collaboration with organizations such as ours, and through ICCROM, we have access to their expertise and experience within the field of capacity building. By linking the course to ICCROM - one of the advisory bodies of the World Heritage Committee - we are also helping to fulfil Norway’s obligations in its ratification of the Convention.

As a World Heritage Committee member, Norway supports ICOMOS in advocating strongly that all decision-making, especially regarding new nominations, must be based on scientific fact and informed professional and expert opinion. By training young professionals and helping to enhance and specialize knowledge, our aim is to support and strengthen scientific expertise in the field of wooden cultural heritage internationally.

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The ICWCT provides the possibility for mid-career professionals to update and specialise their skills. It also provides an international platform where networking and exchange of knowledge with other professionals from all over the world can take place. Since 1984, 360 participants from over 80 different countries have completed the course (I hope you can make out the names of the different countries in this slide). We partner with The Norwegian University of Science and Technology to obtain academic accreditation and they supervise the final exam which gives 15 ETCs. This is the only one of ICCROM's courses which gives university credits, an added value which gives the course credibility and status.

The ICWCT covers a range of interdisciplinary topics, and theoretical and practical aspects of wood conservation are given equal consideration. The balance between buildings and objects is also considered carefully, as participants come from both architectural and conservation backgrounds. It is the material itself which forms the essence of the course; it's properties, qualities, use, care and repair. Both national and international experts in the field give lectures on different topics such as theory and principles, wood anatomy, biodegradation, climatology and the structural repairs both of buildings and objects like furniture, as well as surface treatment of buildings and a practical paint workshop.

The balance between theory and practise forms the cornerstone of the course; aiming to reduce the distance between academia and craftsmanship and encouraging interaction and dialogue between these two camps. We see that many course participants who come from an academic background, have never tried tools like handsaws, planers or chisels. Their understanding of the material as well as the building or object, suddenly deepens as they learn to view the material through the eye and hand of the maker.

Every year, we make some changes to the programme and curriculum based on detailed questionnaires and feedback from the participants. We try to keep up to date and reflect changes in conservation practices and challenges. In recent years, we have for example introduced the challenges of climate change as a separate subject and visited a recently started 50-year research project at Maihaugen Museum in Lillehammer, where climate loggers and monitors have been placed on a selection of Medieval buildings in the out-door museum.

During this years' course, held in Oslo in June, we made some rather fundamental changes which also reflect the world around us. From being a 6-week course, we moved much of the theoretical curriculum on-line, introducing 5 weeks' part-time on-line tuition and 4 weeks of full-time workshop-based tuition in Oslo, re-capping the theory covered on-line and implementing acquired theoretical knowledge into practical exercises. This way, the variations in prior knowledge was reduced amongst the students, they were better prepared, and less time was spent in a lecture-hall. The issue of getting time off work to attend the course was reduced, as was the stress of being away from families.

Students met their lecturers on-line first and then again in person in Oslo. They also met each other on-line, saw each other's presentations and had an active blog which helped create an instant group with its own dynamic from day one in Oslo. We felt the pilot worked and we will continue to try to improve the format. Amazingly – whether logging on from Zimbabwe or from Nepal or El Salvador, technical issues were few. We used the University platform called *Blackboard*, and it was not high tech. It was a regular file-sharing platform where primarily texts, articles and books were shared with the selected 20 students. This means that they also have access to a substantial library of reference material after the course, as well as a virtual meeting place.

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'Blackboard' is not interactive in the sense of other on-line courses available on the Web. To reach more students, the next step is to produce a fully on-line MOOC course. Of course, this will not take the place of the ICWCT, but we hope we can use it as part of the on-line component in addition to leading its own life, freely available on the Web. We are working with our course university partner The Norwegian University of Science and Technology in Trondheim to produce a course in wood conservation in *FutureLearn*. It will be specialised, focusing on the Stave Churches in Norway and using examples from the recently completed 10-year Stave Church Restoration Programme; Assessing damages, what were the main causes of deterioration, how the damages were repaired including material quality and selection, and the choices faced in the restoration process in relation to international guidelines.

The role of the craftsman in the Programme will also be a central theme, as it is in the ICWCT. The craftsmen play a crucial role and their expertise and experience usually guide the restoration process. The craftsmen select the appropriate timber for their required use in the forest and as far as possible, also use the same tools as were used in the original construction.

This approach is often quite new to an international audience - and playing such a fundamental part in the way we work, a philosophy we like to share. Back to the ICWCT Programme, I will just briefly share with you one of our practical workshops which illustrates this approach:

The group spent a day in a forest south of Oslo where we met with a Master Carpenter employed by the Regional Follo Outdoor Museum. He guided the group through the process of material selection - choosing the right tree for making exterior panelling for a listed house damaged by fire in the nearby town. A spruce was chosen, felled by axe and transported to a local farm where the group helped operate a saw. It was sawed to boards and boxes and then left to season for a couple of weeks.

Fig. 1. Per-Willy Fergestad sawing a log with participant Kit Wong from Hong-Kong

We met again later at Follo Museum, and working the wood that they had harvested, used axes, drawknives, shavers, planes, moulding planes, saws, etc. bringing the whole of the theoretical

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program into practical terms. They encountered wood technology and science issues first hand with difficult knots, grain direction and pitch pockets. They used all the traditional tools that were common in Northern Europe before the industrial revolution and would have been used in the production of the buildings on the museum site where we were based. This point caused much astonishment amongst several participants when it was noted. The simplicity of the tools and exercises undertaken accentuated the versatile properties of wood as a group of materials and allowed insight into its importance in the cultural heritage of all the nationalities present.

Another first in this year's course, was the introduction of the practical exam. The Universities' approach is now to assess how students implement acquired knowledge rather than memorise it. So, for the first time, rather than sitting in silent rows, the students were divided into carefully composed cross-disciplinary groups representing architects, engineers and conservators, and given a building and an a piece of furniture at the Folk Museum which they had 24 hours in which to interpret and give a full condition analysis, treatment and exhibition plan. The presentations were assessed by a panel representing the University, Folk Museum and the Directorate for Cultural Heritage, and also viewed by the rest of the group.

Fig. 2. Suheyla Yilmaz from Turkey and Daniele Baltz Fonseca from Brazil making paint

The International Course on Wood Conservation Technology has been held for over 30 years and incorporating the challenges of virtual tuition with practical teaching of - in our case – a traditional craft, will surely increase in the years to come. The web-based instruction resolved barriers associated with limited teaching time and provided an accessible curriculum, meeting the needs of adult learners with their motivation to learn a topic they value and apply this knowledge in their daily work. In addition, through digital access and social media, an alumni reference group has been created which already is using each other actively as an instantly available panel of advisors in daily work-places throughout the world.

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Fig. 3. Padma Sundar Maharjan from Nepal and Chiedza Zhahare from Zimbabwe working a plane

But in spite of the practicalities of on-line learning, our conclusion is that it can only complement and not replace. Nothing can be better and more insightful than selecting and harvesting your own material, feeling the resistance of the timber while it is being worked and experiencing for yourself the transformation it undergoes in its journey to finished product. And few things can compare to working in a cross-disciplinary, international environment representing colleagues from different cultures, approaches and experiences.

We look forward to being part of this journey and bringing the Wood Course into the future.

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Conservation and craft research, Ingatorps tithe barn - a corner timbered building from the 13th century.

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Keywords: Conservation, craft research, authenticity, participation, transfer of tacit knowledge

Abstract

Ingatorps tithe barn is one of the oldest extant corner timbered buildings in Sweden. It was ”discovered” as medieval in 2003 due to its steep gables and characteristic hewing marks on the timbers. A dendrochronological analyse dated one of the sills to the 1220s AD. In 2011 a project to save the tithe barn was established. Since the barn is one of Europe’s best preserved and least altered buildings from the 13th century it was decided to follow the ICOMOS Mexico document from 1999 and also take the document from Nara 1994 into account. Supplementary site specific principles were also established. The conservation were done in close cooperation with the parish, the diocese of Linköping, the National craft laboratory and the University of Gothenburg. Cooperation with other projects have also been essential. Especially the many synergies with the reconstruction of Södra Råda corner timbered church is discussed. The 20th century tile roof on the barn was too heavy for the roof construction. It was decided to document the worn shingles underneath the tiles and reconstruct the shingle roof. Material for shingles and repair timber were taken locally and treated with medieval woodworking techniques and replicas of medieval tools. Two courses for practising carpenters and parishioners were held in making shingles with traditional methods for the barn. Traditionally made tar was used and reinforced with charcoal using a receipt from 1790 in order to reclaim knowledge about more sustainable and thence more economical procedures to protect the roof. The barn has been thoroughly documented before and during its restoration / conservation. Traditional measuring, photography and video have been combined with both laser and photo scanning. The medieval craftsperson´s traces of tools and actions has acted as instructions and the involved carpenters have acted as their apprentices during the conservation.

The tithe barn´s restoration/conservation gained the Eksjö wooden city award of best conservation and architectural achievement in 2018.

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Introduction

The church in Ingatorp, situated in the province of Småland in the south of Sweden, is recognized as a high standard art nouveau church. The church was built in 1914 after a fire ruined the previous from the 19th century, that in its turn had replaced a medieval church. In the outskirts of the churchyard and close to the lake the corner timbered building in question is situated. Until 2003 this building was only recognized as one of the thousands of 18th century corner timbered buildings in the south of Sweden. The parish needed a good tool shed and therefore kept it in good order. It was filled with wheel barrows, ladders, old timbers and other stuff and quite hard to enter. By chance the building was identified as medieval in 2003[1]. Dendrochronological examination of the front sill resulted in a dating of the building to the 1220´s. If the complementary analyses of the rest of the building gives the same result it means that the barn is one of the oldest wooden buildings in Sweden and probably the most pristine corner timbered building in northern Europe from the 13th century[2]. Since the building seemed to be in good order no actions were made before 2011 when the Craft Laboratory[3] in cooperation with the parish arranged a seminar about the tithe barn and it´s future. The initial need of conservation concerned the worn shingles on the south wall. It was also discussed that the ladders, stored inside the barn, made ugly marks on the wall timbers and therefore should be removed. Considerable synergies has been gained through the cooperation with other projects. The most important cooperation project is the reconstruction of Södra Råda corner timbered church that was built around 1310 and burnt down in an act of arson 2001. The conservation of Ingatorp had not been possible to fulfil, in the way it was, without the craft knowledge gathered during the investigations and practical full scale reconstructions in Södra Råda. On the other hand knowledge gathered in the conservation of Ingatorp has been crucial for the reconstruction in many aspects, examples will be given below.[4] The project started with a seminar in 2011 and was completed in 2018.

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[1] Heritage officer Henrik Larsson recognised the tool marks as medieval during a visit.

[2] The dated sill turned out to be reused and not a part of the original structure.

[3] For more information about the University of Gothenburg and the Craft laboratory, see Harald Högseths paper in this publication.

[4] The practical reconstruction of Södra Råda is ongoing since 2007 and is planned to be finished in

2021. [5] Gullbrandsson 2010

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Fig. 1. Many locals attended the reopening of the medieval tithe barn in July 2018. Photo Karl-Magnus Melin.

The barn and the parish in the archives

The oldest written account of the parish is from 1337. A curious fact is that in 1666 Olof Verelius, the son of the priest in Ingatorp, became the second General Director of the National Heritage Board in Sweden. Fortunately he did not recognise the tithe barn as a medieval monument. If he had done so, the pristine medieval atmosphere almost certainly would have been lost, at least according to our modern conservation values. The first mention of a barn in the church accounts are from 1707. But several barns are mentioned so it is not possible to know when the written sources concern the actual barn5. The recorded mentions about barns are generally about maintenance and that the parish members being obliged to contribute with shingles. One of the major changes in the history of the building happened in the early 20th century. The cemetery was then expanded and it was decided to move the tithe barn around 40 meters. The parish moved the building in one piece. It is known from other sources that it was quite common to roll minor buildings on logs or even wagons. The barn was moved a few years before the church burnt down in 1914, after being struck by lightning. The move might actually have saved the barn from the devastating fire. Another big change was when the roof got tiles in the middle of the 20th century. Until then the only roofing material had been shingles.

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Forensic investigation

A plausible interpretation was that the barn originally was built as a tithe barn, even if this could not be proved by the archives. It was common in the medieval times to have a barn close to the church designated for the tithe tax. Tithe means one tenth and parishioners were supposed to pay 10 % of their income to the church. Since the monetary system was not so well established the payment in kind needed a barn. During examination we found indications that support this hypothesis. The staples for the doors iron hinges are folded so it is impossible to lift of the door, this suggests that the barn was built to protect something of value. Further indications are the many counting marks covering the walls, probably made when the tithe was delivered and counted. By forensic investigation we also got a lot information about architecture and woodworking techniques. What is notable is the relationship between the preserved medieval timbered churches. The sacral buildings, distinct from the profane medieval timbered houses, is characterised by the proportions, the tall constructions and steep pitched roofs, the extensive plane walls without protruding timbers in the corners and the use of cleaved roof boards and wooden shingles. One conclusion is that the tithe barn counted as a representative building. It was given a virile architecture by means of skilful craftsmanship.[5]

Originally the tithe barn´s outside consisted of bare timber walls that were preserved by thick layers of tar. But eventually there were problem with rot and the parish decided to put shingles on the walls to protect the building. Dendrochronological analysis of wall shingles tells us that they were made in the period 1560-1580. Before that some interim repair had been made by caulking gaps between some of the timbers with textile and a board had been nailed to hide a rat's nest on the south wall. The sills of the barn have been changed, most probably this happened after the wall shingles was put on the walls, maybe sometime in the period 1600-1800. In the 18th century a window was placed above the entrance door. The window has then later, probably in the 19th century been replaced with a simple shutter. The recorded information above and a lot more specific details were documented and interpreted.

The tithe barn in a national and European context

The tithe barn in Ingatorp is one of only six extant corner timbered buildings in Sweden that have been dendrochronologically dated to the 13th century. The other buildings are Granhults church; after 1217, Tidersrum church; after 1260, Tångeråsa church; after 1290, Hult tithe barn; 1249±20 and finally Älvdalen tithe barn; 1285/86. Älvdalen tithe barn is corner timbered with round logs and different in this way to the other buildings that are corner timbered without protruding corners and built with boxed timbers.[6] Of the known extant corner timbered buildings from the 13th century Ingatorp tithe barn is in the most pristine condition.

The heritage protection status of the barn is high. As a part of the church heritage it may not be altered without the consent of the County Administrative Board. The positive attention during the project and the massive participation in courses and seminars has granted a people´s local

[5] Almevik & Melin 2013, 2015 and Melin 2017.

[6] The tithe barn in Älvdalen seems to be built more in a profane manner than the other five buildings.

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protection awareness that is difficult to achieve only through laws. But the law in combination with the owner’s awareness and will to continue to preserve, use and maybe develop the use of this extraordinary building thus ensuring a thoughtful preservation for generations to come.
The tradition of making timber constructions with boxed timbers is not unique for Scandinavia. As a result of the project I got in contact with the Gordion archaeological project in Turkey. In a mound the world´s oldest extant wooden grave chamber is built with boxed timbers[7]. I visited the construction in 2017 and even though this construction was 2700 years old there was a lot of features in common.[8] There are also in Turkey medieval wooden mosques from the 13th century built with boxed timbers[9]. Closer to Scandinavia there are extant buildings as old as from the 1250s in Switzerland[10] built in similar technique as in Ingatorp. The extant buildings in Switzerland are of secular origin and architectonical quite different from the sacral buildings in Sweden. If there are any connection between these examples in time and space is not known, anyhow new knowledge appear when different traditions are compared.[11]

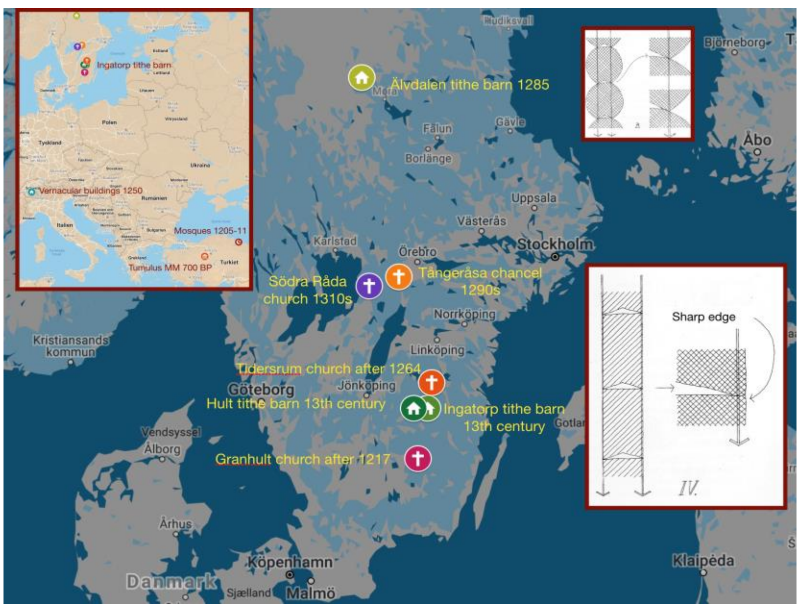

Fig. 2. The map shows the six extant timber buildings from the 13th century in Sweden and Södra Råda church from approximately 1310 that burnt down in 2001. All of the examples are made in sharp edge technique exept Älvdalens tithe barn as shown with the pasted sketches of crossections made by Peter Sjömar. The pasted map shows the examples of sharp edge timbered buildings, dendrochronologically dated to the 13th century or before, that are mentioned in the paper.

[7] Liebhart et al 2016

[8] Examples of shared features: boxed timbers, use of sootline, plankformed dowels, use of oak for dowels.

[9] Uzun & Çiftçi 2017

[10] Furrer 2016

[11] Examples from the 15th century and later are more common in different parts of Europe. Only known examples from the 13th century and older are presented in this paper.

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Principles

By following different ICOMOS charters, foremost the principles for preservation of historic timber structures and the Nara charter supplemented with site specific principles, we secured that appropriate techniques were used. One principle was that the building should ”decide” how a board or repair timber should be produced, by using the same techniques and material as the original suggested. In this particular project the most important principle was that replacement of original material should be kept at a minimum and the visible interior surfaces of timbers should be preserved to maintain the pristine medieval atmosphere. The close cooperation with the diocese of Linköping, the Craft Laboratory, the University of Gothenburg, Heritage officers and the outstretched time of the project secured that the principles could be followed and no hastily compromises had to be done. The planning of our next step was literally made at least a year before it was executed. One exception though was the tarring of the roof. The decision to use the receipt from 1790 was discussed intensively the month before it was executed, se below.

Documentation

Several methods of documentation was used before and during the conservation. In cooperation with the Lund University Humanities Lab. a laser scan and photo scan was made before the conservation started. During the work complementary photo scans were made so it in the future is possible to make a 3D model like a Russian doll where underlying details and surfaces can be studied. Traditional measuring were also made. When we did these drawings we got very close to the building and learned to know it better as we could do a damage control at the same time. We have during the process taken a lot of complementary photos and film clips to document details with before and after pictures and the process of work. The Craft laboratory made a film during one of the shingle courses that can be seen on their Youtube channel.[12] Two local filmmakers have voluntarily followed the project. Discussions to use the material for a documentary is ongoing with the Craft Laboratory.

[12] The documentary can be seen on Youtube, link: https://www.youtube.com/watch?v=Bu9SkjfDivA

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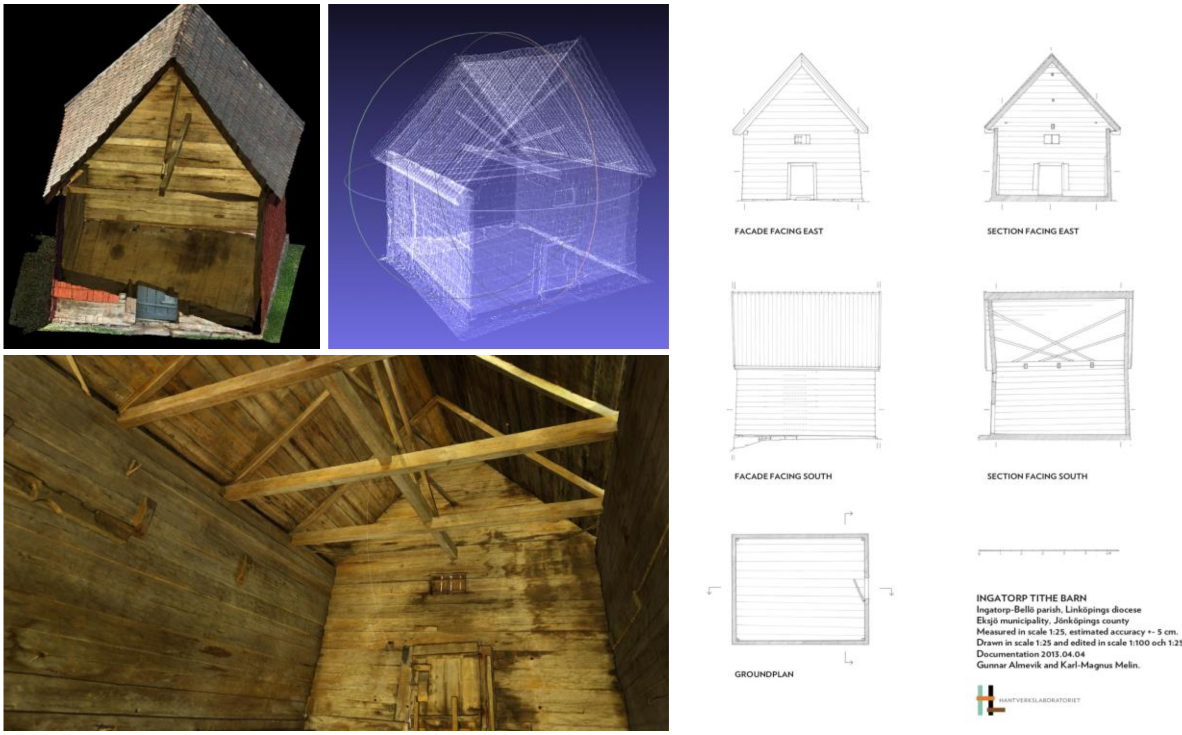

Fig. 3. Left, screen shots of the 3D model made by Lund University Humanity Lab. Right traditional measuring drawn by Gunnar Almevik.

Conservation using reconstructed historic crafts and skills

The use of traditional carpentry and blacksmith skills were essential for this project. Bu this barn was built in the 13th century and the originally used craft traditions differed from our contemporary, whose roots are in the 19th and 20th century.

In a sister project, where the Södra Råda church from 1310 is being reconstructed, a lot of effort has been used in deconstructing contemporary craft in order to reconstruct medieval craft traditions.[13] The craft research to achieve this can shortly be described as examining tool marks on original artefacts, studying medieval illustrations and making replicas of medieval tools. Thereafter doing craft experiments with the aim to get results that correspond to the examined original artefacts. By using this method we have gained considerable new knowledge about medieval traditional craft that differs from more recent traditions. In the case of Ingatorp we have used 13th century reconstructed techniques while making repair timber, 16th century techniques when making the wall shingles and 18th century techniques while making roof shingles and tar. Every layer has thence been respected and the building has ”decided” which tradition to use and when. As far as possible local material was used. Repair timber, of the same species and dimensions as the original, was taken from about 2 km away from the tithe barn. Dendrochronological analyses stated that the medieval timber was of local origin and the cleaving of repair boards showed that the local trees had been knottier than usual, in the 13th century and now as well.

[13] Almevik & Melin 2016, 2017 & Melin 2018.

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When necessary, modern tools and techniques has been used to make surgical repairs in order to preserve as much as possible of the original material and surfaces.

Fig. 4. Example of surgical repair of the front sill. The pasted photo shows the decay during cleansing. A pdf about the more complex conservation of the junction between tiebeam, rafter and wall plate can be found on the blog timmermanskonst.se. Photos Karl-Magnus Melin.

Participation and transfer of tacit knowledge

In total around 100 persons have been involved in the project. The involvement of the local community in the restoration has been essential since the start of the project and approximately 50% of the participators were from Ingatorp or the surrounding area. The main partner was the Ingatorp parish, custodians and owners of the tithe barn. The Diocese of Linköping funded the major part of the project. The Craft Laboratory has been involved in documentation and arranging courses. Many other experts have been involved in specific questions. The project has also been deliberately outstretched in time to be used not only as a temporary building workplace but also as a school and a laboratory. The project has combined expert led conservation practice with training courses for parishioners and local craftsmen, public events for awareness raising and research collaboration on materials and techniques. In the long run the local participators are the most important, and the ones that will be remembered. They will be included in new stories about the barn that anchor it to the community. When the church warden´s wife Gun Nilsson volunteered to straighten the old shingle nails we thought this was very positive. We thought she maybe would do 50 nails. To our astonishment she straightened more than 2500 nails. Våge Johansson, a local tradition bearer that have been making tar, wood coal and iron with traditional methods, visited us at least once a week, and he even contributed with some of the tar and coal he made some years

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ago. The list could be longer, but the important thing is that the local involvement has also raised the local pride of their cultural heritage that they and their forbearers has preserved and used. Ingatorp is a small village and its depopulation has been ongoing for decades. The last few years there has been a welcome and necessary inflow of new villagers, many from Syria, and it was very nice to see the mixture of new and old villagers at the reopening of the local heritage they share.

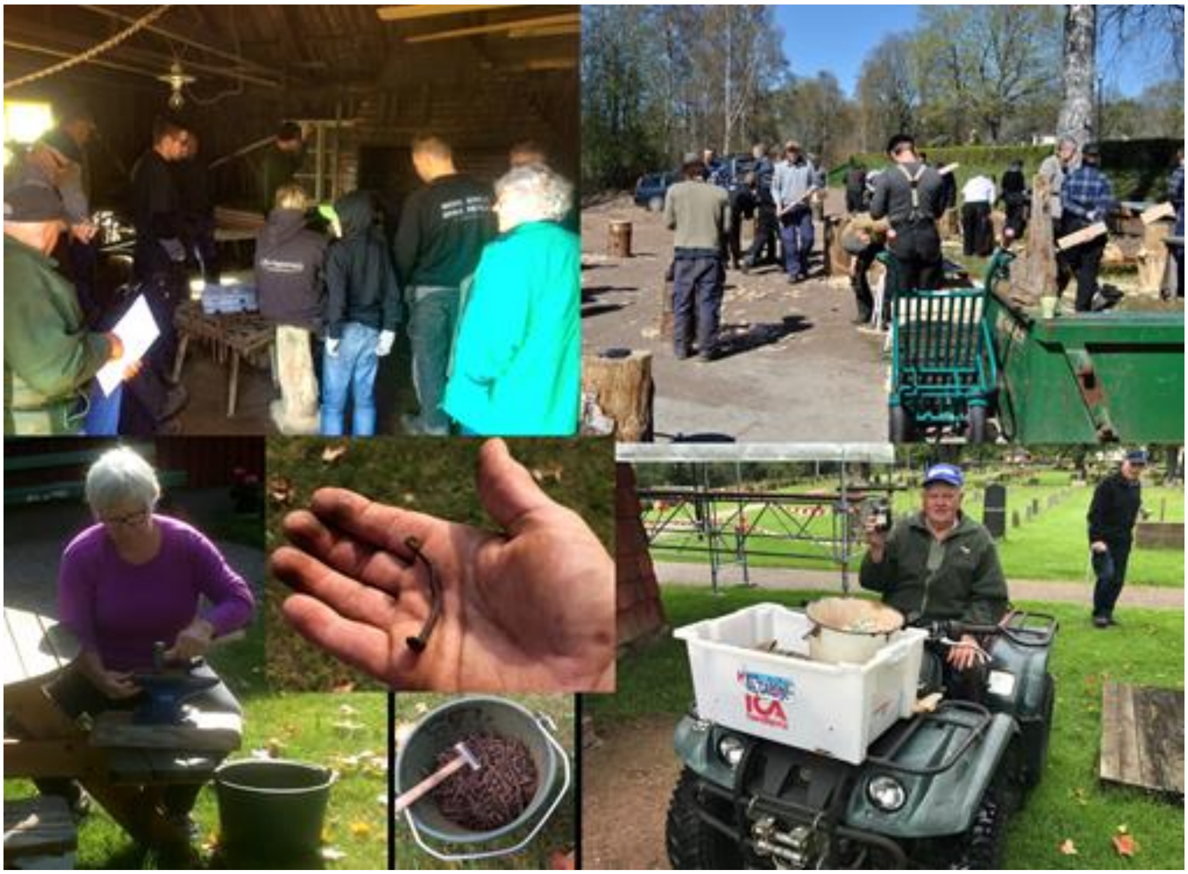

Fig. 5. Above left, locals are invited to try to make nails for the shingles, right more than 40 participators joined the shinglecourses. On the two arranged courses more than 400 shingles were produced. Below left Gun the Nailstraightner Nilsson and to the right Våge Johansson local tradition bearer. Photos, Anders Nilsson & KarlMagnus Melin.

Synergies with other projects

Cooperation with other projects has resulted in many synergies. The special connection to the reconstruction of the corner timbered church in Södra Råda can be mentioned. The reconstruction has by full scale reconstruction substantially increased the knowledge about medieval woodworking techniques. This knowledge has been used in the restoration work and the restoration could not have been completed with the same accuracy if the results from Södra Råda was not used. In the reconstruction of Södra Råda church the construction of the roof and the gables are least known since no photographs or in detail documentation was done in the attic. The forensic investigation of the timbered gables in Ingatorp has resulted in a full scale reconstruction of the intricate solutions done in Ingatorp to hinder setting gaps between the timbers. The

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cooperation with the ongoing diocese projects concerning historical carpentry in churches has also been of great value. The knowledge achieved in all of the projects will be used to better understand and preserve the extant medieval timber constructions.

Fig. 6. To the left, above a detail of the gable and the rafters with oblong holes. Left below screendump of 3D model by Camilla Melin of the barns gable. Above right, Ingatorps gable reconstructed on the Södra Råda reconstructions chancel. Photos Karl-Magnus Melin.

Examples of multidisciplinary synergies, and cooperation with experts outside the project, are that we seized the opportunity and saved a medieval rat nest inside a rotten wall timber. The nest which contained organic material turned out to be a goldmine for the archaeobotanist Jens Heimdahl who will use it in his research with no cost for the parish. Dry medieval organic material is very rare to find in archaeological circumstances and in contrast to wet material it can answer other questions. Another example is that medieval textile used to caulk some gaps between wall timbers was sent to Copenhagen University where a student could make an essay about it under the leadership of professor Eva Birgitta Andersson Strand, this also with no cost to the parish.

When the project started it was decided to make the roof shingles by hand from local material. Pine with a high value of core was chosen. But during the project we found out that the old shingles on the barn, and on other examined churches, had no sapwood at all. We also came to know how recent examples of shingled roofs had to be repaired after only a few years because of rot in the sapwood. Hence we decided to make the remaining shingles sapwood free.

Problems with modern techniques of tar on the shingles with essential costs for the maintenance has been discussed in Scandinavia the last decade. It is a growing opinion that the modern way of

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applying tar does not work so well. Therefore we decided to use recipes from the 18th century that had not been tested in modern times. It was not granted that it would work since the recipes seemed to contradict almost everything in the modern procedure. The tar should not be of fine quality, a lot of crushed charcoal should be added, it should be applied as thick *”as one could afford*[14]*”*. From a modern point of view there seemed to be a risk that the heat from the sun would make the tar to melt and stain the walls. Even if the tar would melt we could not foresee any actual harm to the barn excluding aesthetic values, so all involved decided to try the recipes. The tar application was done in the autumn. In the hot summer of 2018 I visited the barn and climbed up and put my hand on the tar. It was very hot but not sticky at all. There was not one single tar stain on the walls. The 18th century author was more right than us when he wrote *”The tar produced in this way becomes a fixum, which then forgets to melt.*[15]*”* The use of the 18th century tar recipes has been continued in other projects in Sweden. Hopefully these experiments, involving old tar recipes and techniques of application, will help to save large amounts of money in reduced cost for maintenance and reroofing of shingle roofs on the Swedish churches.

Fig. 7. Above, the shiny shingles after tarring. Below left the making of the tar. Below right, the tar is applied in ”stripes” with minor changes of the recipes to be evaluated. Right citations from the used recipes.

[14] K-M Melin´s translation of recipe from 1742 by anonymous author.

[15] Same as above.

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Communication

We believe it is important to keep locals informed about their heritage. Therefore the work place has been open for visitors. Seminars have also been held that have been announced in the press. More than 25 articles have been published in cooperation with local newspapers. The focus on local communication is intentional since it is very important to anchor the value of the heritage locally in order to preserve it for future generations. The project has also been presented for the academic society in peer reviewed papers, posters and presentations on international conferences[16]. Further, the project has been displayed on television, on the Craft laboratory's Youtube channel and some 3D models are published on sketchfab. On the blog Timmermanskonst complementary information about the project is uploaded[17].

Summary / reference letter

Instead of writing a summary I insert a reference letter written by the contemporary Director General of the Swedish National Heritage Board, Lars Amréus. He may not have the same connection to Ingatorp as his predecessor from the 17th century mentioned above, but hopefully the content in his letter gives a good summary that can be shared by others who evaluate the project now and in the future.

”The conservation works carried out on Ingatorp´s medieval tithe barn are characterised by a scientific approach to craftsmanship and an analytical approach to conservation principles. The conservation project has been thought out in object specific details of carpentry techniques, documentation and selection of materials, as well as in more general questions of planning, communication and management.

Collaboration with the local community, other conservation projects and relevant networks combined with an interdisciplinary approach has made the project significant in a larger context. Research results from the project have been communicated and made available through publications and education initiatives, which provide a basis for developing and preserving the knowledge.

The conservation of Ingatorp´s medieval tithe barn constitutes a good example of conservation practice which can be an inspiration for building conservation projects in Sweden and internationally.”[18]

Last words

The vast surplus of documentation will be useful for future research for a long time. The experiments with 18th century tar recipes will be evaluated over decades. The parish will also continue with their maintenance that has been ongoing for centuries. It can also be questioned if we in the project group invited the parishioners to participate or if we were the participants.

[16] Almevik & Melin 2013, 2016. Melin 2017 and this paper based on Melin´s presentation held at IIWC 2 in York 2018.

[17] www.timmermanskonst.se

[18] Citation from reference letter written by Lars Amréus 19 October 2018.

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UNDERSTANDING AND PRESERVING APOTROPAIC SYMBOLS ON TIMBER SURFACES

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Abstract

Apotropaic symbols were scribed by British craftsmen into timber building components from the 16th century onwards. Later symbols, burn marks and identity marks were added by other individuals. Recording these accurately presents challenges, especially if the original surfaces have become degraded. Assembling photographic images and translating them into accurate drawings encourages the owners to appreciate what they possess, and others to understand them. This then allows for discussion and the education of those who work with the timber heritage. It also leads to informed conservation and some elucidation of the hidden spiritual values of the occupiers of such buildings.

Key words: symbols, protective, craftsmen, tool marks

Introduction

It is not proposed here to discuss the origins or elucidate the meaning of the symbols found in historic buildings. These can be read about in many articles and books, some of which are collected together on the academia website; http://independent.academia.edu/TimothyEaston. The purpose here is to show, through a limited number of detailed images and descriptions and using three complete examples, how to 'read' these marked areas, often under difficult circumstances. The majority of the examples illustrated are from Suffolk, with one from Holkham, Norfolk, and one other from Anstruther in Scotland. For this paper the examination of symbols is restricted to doors and the long horizontal chimney beams over the hearth.

Apotropaic (protective) symbols on building components

Although such symbols were sometimes painted on, they are usually seen today as marks on the internal exposed timber surfaces, which were scribed using tools that left their 'signature' marks (Hutton 2016). The example taken from the 17th-century Hall beam in Cowslip Cottage, Bedfield (Suffolk), has some of the common symbols identified by their modern names (fig 1). Others were

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deliberately burnt into the surface using a lighted taper. This fireplace beam from 21 Shore Street, Anstruther, Fife, Scotland, had many burn marks applied after the original symbols had been scribed (fig 2) (SPAB 2012). One M symbol, made using a sharp pointed tool, is overlaid on top of a burn mark. Two possible interpretations could be considered. The original scriber might have applied this particular burn mark and then further marked on top of it. Alternatively, someone else might have added to the original builders' symbols at a later date. Careful recording of such combinations can indicate if these marks were made by craftsmen or householders.

Scribed marks could have been made when building from new, or when an existing structure was improved by, say, the insertion of new doors or chimney beams. Close examination of the lines should indicate if they were cut when the timber was still green, or after it had hardened. On green timber, the deeper lines, made with a carpenter's marking tool called a rase-knife, have assured edges (fig 3) (SPAB 2014). After the timber had dried out, the rase-knife blade was deflected as it crossed the hardened grain, leaving a broken or wavy line (fig 4).

The rase-knife markings that many people will be familiar with are the scribed numbering systems added by the carpenters to the jointed components of timber-frame buildings in the course of construction. For practical reasons, these are always in logical positions, but this does not apply to the apotropaic race-knife symbols, most of which-have no practical purpose.

The large arrow form seen on part of the hall beam in Saxtead Lodge, near the vertical centre line, has a smaller distinctive 'M' towards the bottom left side of the arrow (fig 3). These rase-knife symbols contrast with a mass of surrounding finer lines. The red-tinted oblique lines are much later and have no apotropaic meaning. There is another useful visual clue shown here to check if the cut lines are original. As the timber dries out in the first 10 years or so, horizontal splits rupture the surface. During this process, the lines of the symbols not only fracture, but shift sideways in some places, giving the lines at the top of the arrow a broken look.

The finer lines were more lightly made using either a scratch-awl, the tip of a knife, or a compass. The latter tool was usually used to create circular geometric forms, such as those on the door from Michaelmas Barn, Laxfield (fig 5). Some of these are individually named to be easier to classify, but collectively they are now categorised by the general term 'multifoils' (SPAB 2015).

The need for an accurate visual record

A careful study of all the lines on such surfaces may help us to understand how ordinary people felt about their chances of survival in an uncertain life. They might have wished to allay fears about possible life-changing circumstances that could affect their health and wealth. This need for reassurance and expected protection may have increased after religious practices changed in the mid 16th century. Before the break with Rome in 1536, there would have been images of saints to pray before, where their intercession with daily problems could be requested. It would appear that after that time of uncertainty some lay people – including builders – made use of symbols. Others applied texts to encourage Christian faith and a sense of security (Hutton 2016). So, one might 'read' these interrupted surfaces as silent affirmation that the interior spaces of domestic dwellings with their chimneys, as well as agricultural buildings, were sufficiently protected from entry

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through the open apertures by invisible mischief makers, as well as ghosts and witches, who were believed capable of affecting the daily routine.

Recording on site

The methods described here can be used by any person with rudimentary camera skills and a suitable light source. They are particularly useful in places such as pubs, restaurants and historic buildings open to the public, where the use of a tripod and fixed lights may not be appropriate. More advanced ways of recording will be discussed later.

The light source must be shone obliquely across each section of the surface. There will be variations from the brighter light given to one side of each sequential image taken, so a series of overlapping images is needed. These can be altered on a computer to create the whole picture (fig 6). This hall beam from Bonds Farm, Bedfield, shows a mixture of deeper-cut symbols and contrasting fine-lined marks.

The past treatment of a surface can be a help or, more often, a hindrance. A door shown here from Michaelmas Barn, Laxfield, was in more recent times covered with black paint (fig 5). After most of the paint had been removed, enough was left inside each line to make photography relatively straightforward. The task is easier if a door can be lifted off its pintles and taken outside where the light is brighter. Some additional pen work on the individual prints, before they are reassembled to produce an image of the whole door, allows for the overall scheme to be quickly read. The carpenter constructed this door around 1850 and it is most likely he would have added the symbols to protect the calves kept in their small outbuilding (SPAB 2014).

By contrast, a late-17th-century internal oak door, made for a dairy inside Hulvertree Farmhouse, Laxfield, has a mass of lines added with various tools. Three details are shown (figs 4 & 7). The rase-knife was used for the deeper lines and small circles, but the very fine lines are so lightly made, with sharp-pointed tools and compass, that it was only when inspecting the oblique surface in late-setting sunshine that they became apparent (fig 7). It then required some enhancement with fine chalk to enable the door's scheme of symbols to be photographed. It is likely that the carpenter made all these lines at the same time during construction. Unusually, however, he made use of two seasoned boards before adding his lines and then assembling the components into their present form. There are several pointers to this, but the jagged quality of the rase-knife lines demonstrates the difficulty caused by the hardened grain (fig 4). The lighter straight lines and the compass-made lines do not show this evidence so clearly, if at all (fig 7). The use of a fixed compass point makes curved lines appear as if they have been added to new timber, but sometimes with very close inspection minute splintering can be detected as the marking point crossed the hardened rays (SPAB 2018).

Overcoming difficulties

Because paint or stain can reduce the clarity of the symbols, it will be necessary to take several photographs of each symbol while adjusting the light source around it, to ensure that all the detail is recorded. Some paint surfaces may be near contemporary; others comparatively late. Internal

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17th-century paint layers are usually matt, because the pigments were mixed with size, whereas late examples are generally shiny. Apart from the paint thickness dulling the crispness of the lines, the reflective qualities of modern paint create added difficulties.

Such an example is illustrated from the stable block at Holkham Hall in Norfolk (fig 8). This image partly shows just one of several multi-arc circular symbols added to both sides of three internal doors in the area where the best horses were stabled. The doors are made from early 18th-century pine and there is every likelihood that early paint schemes exist under several layers of colour. The top coat is relatively modern, and its thickness combined with other coats below, and its reflected qualities, make recording under normal circumstances very difficult. What is illustrated here is a combination of two images, but there are many other arcs on this door, not shown here, that complete this particular pattern.

Arguably, the removal of late paint surfaces on doors and chimney beams might seem to be appropriate, particularly if there are good symbols to be revealed, but advice should be sought from experienced paint restorers to establish whether there are underlying schemes that may be earlier or original. These marked areas within buildings are often found to have early schemes. When examining the original colour layer, it may be possible to establish if the earliest scribed lines scratch through the first layer or whether that paint sits on top of the lines.

Sand and grit blasting, so frequently used in the later 20th century, also severely reduced the clarity of lines. The photograph, taken after cleaning by this method at Cowslip Cottage, Bedfield, during the 1990s, despite advice to the contrary because of the presence of original paint, is shown on the left (fig 9a). This is contrasted with the right half using enhanced light from above and further helped by overdrawing with a fine pen (fig 9b). These two show both the initial problem and the resolution for publication.

In important historical circumstances, there will be other more sophisticated methods of capturing and recording, such as those used by picture restoration studios and laboratories, that could reveal the marks.

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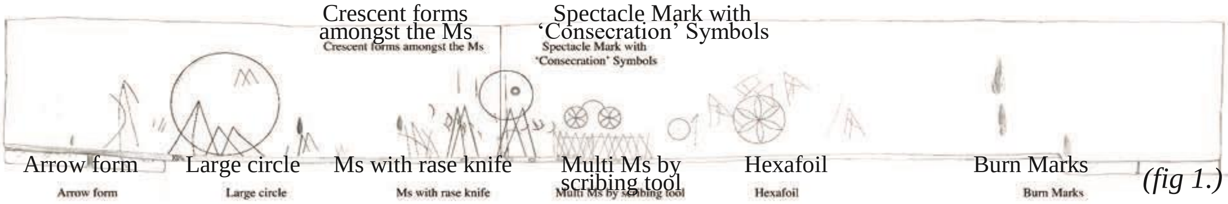
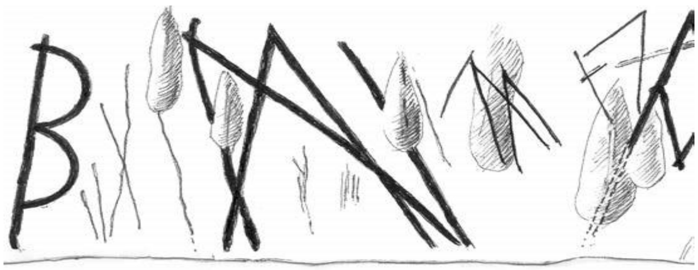
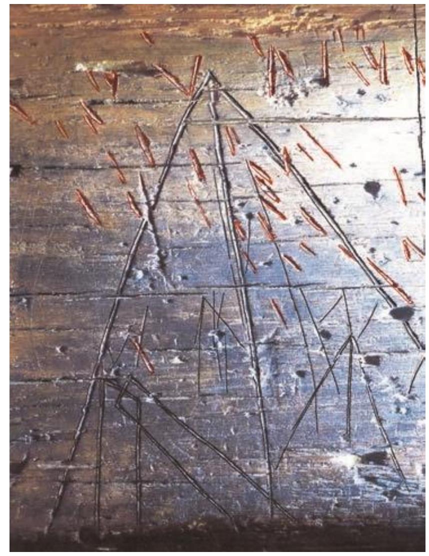


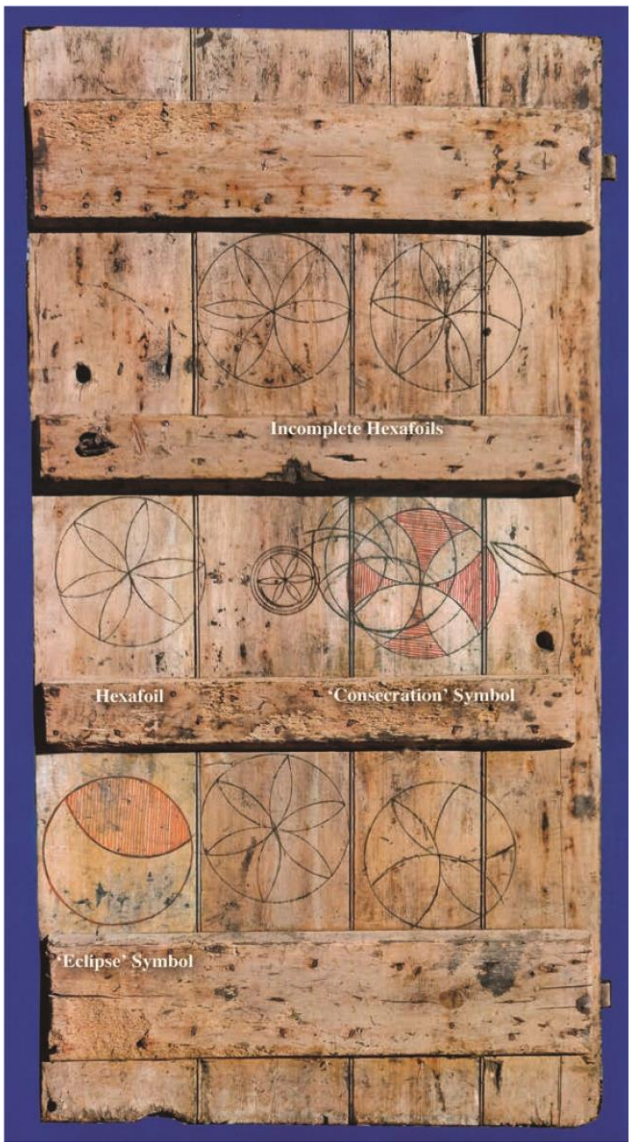
(fig 1.)



(fig 2.)



(fig 3.)



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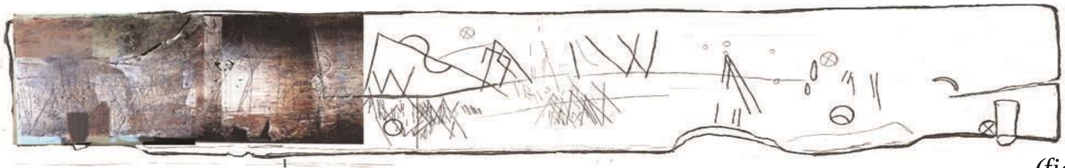

(fig 6.)

Fig 1. Cowslip Cottage, Bedfield, Suffolk, UK

Fig 2. Shore Street, Anstruther, Scotland, UK

Fig 3. Saxtead Lodge, Saxtead, Suffolk, UK

Fig 4. Hulvertree Farmhouse, Laxfield, Suffolk,

Fig 5. Michaelmas Barn, Laxfield, Suffolk, UK

Fig 6. Bonds Farm, Bedfield, Suffolk, UK

Fig 7. Hulvertree Farmhouse

Fig 8. Holkham Hall stable, Holkham, Norfolk,

Fig 9. Cowslip Cottage

Fig 10. Inspection lamp with 60 LED bulbs

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Making an accurate visual record

To overcome all these difficulties the following items are essential if the recorder lacks specialist knowledge and equipment:

a) To record on site: a digital camera, a tape measure for the dimensions, and a suitable portable light source of the right intensity with a wide even spread. For all these a long hand-held inspection lamp with 60 LED bulbs was used (fig 10). The lit area is 6” long, but gives a spread of illumination up to 11”. Since most symbols tend to be on the lower two-thirds of chimney beams, it is possible to pick up a wide view of the marked areas as the light rakes across the surface while photographing.

b) Adjustments to the printouts and final diagrams: to transfer screen images to paper, a computer and printer, and a series of fine drawing pens to enhance the parts on the prints that are not clear, but where certainty dictates the lines do exist. If these are then to be used for illustrating articles, good tracing paper is needed so the combined photographs can be overdrawn, reprinted and sufficiently enhanced to turn into a scaled-down drawing that can be read on the ‘page’. Sometimes, sensitive applied lines that follow the uncertain lines on the prints while being reconstructed do not register sufficiently when reduced down to diagrams suitable for publication, so will need heavier inked lines to strengthen. The ultimate purpose of the illustrations, particularly where a long, marked beam is involved, is to remove later scarred areas. Typical of these are the scotch marks cut out for keying in later plaster on the beam; the red-enhanced cut marks shown on the Saxtead Lodge beam (fig 3) are typical of these. Removing these allows the symbols to become more easily revealed and understood. Understanding leads to sympathetic survival, and restoration where essential. It is not uncommon for sections of historic beams to have been cut off during 18th to 20th century hearth reductions. Often, when the full hearth width has been reopened in recent times, the temptation has been to insert a full-length beam and remove the old marked portions, which may contain significant information.

c) Such an example was found and retained at Bedfield Hall, Bedfield in 1973. A hearth made for an early-17th-century kitchen wing retained two thirds of its chimney beam length, on which were apotropaic symbols; the other third was removed as recently as the mid 20th century. While replacing the missing portion in new timber, it was noted that the initials ‘TD’ had been stamped into what had been the centre of the original beam. From Manor Court documents it was established that Thomas Dunston purchased the Hall in 1620, having previously been a tenant farmer there. Later dendrochronology confirmed that the most recent timber for this wing was cut in 1619, allowing for this new building to be constructed the following year. So, Thomas Dunston literally stamped his mark on his new building and the evidence now survives. In the centre of the Cowslip Cottage beam, shown in fig 1 and directly under the multi Ms is a similarly stamped owner’s name, L(ionel) Pepper, a prominent farmer who resided in the house during the 17th century.

Today, in important historical circumstances, there will be other more sophisticated methods of capturing and recording these symbols, such as those used by picture restoration studios and laboratories. These should make it easier to reveal the marks. The methods described here will almost certainly be superseded by new technology. Computer analysis, after directly scanning the surfaces, will simplify the process. It may be hoped that, in the future, building historians will find

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this subject significant enough to commit the time and funds to meet such a task, and particularly to make a larger survey from over a wider area.

Sophisticated technological advances make it possible to produce clear images more directly than is possible with the hand-held equipment used for these illustrations. RTI (Reflectance Transformation Imaging) can show up details on worn surfaces of archaeological material and makes it easier to interpret the layered effects on and below the surface of paintings. Because this method is ~~a~~ very expensive, it is unlikely in the short term to be used for capturing the layers of symbols on beams and doors in either domestic or ecclesiastical buildings.

Recently, a simplified version of RTI has been pioneered by the Hamilton Kerr Institute near Cambridge. Whereas RTI uses its own dedicated software and a halo of lights on a rig, the ‘poor man’s RTI’ (‘RTI Style’ imaging) does not require special lights or software. It was developed for studios that already have Adobe Photoshop. Although a full report of this process will be published in 2019, the basic principle is as follows:

Four raking light images, set at the four diagonal corners in turn, make use of a fixed camera position between shots. The images from each are going to be overlaid, so perfect alignment is important. For shiny surfaces an additional set of four specular light shots is needed. On screen, the density and contrast of different layers can produce interesting visual changes and enhance the different depths of lines. Just two light sources could produce satisfactory results.

Summary

The geographical area from which of most of these beams and doors have been drawn may be exceptional for the range and number of surviving examples. Some of the symbols, like the multifoils and the hexafoil, are widespread across Europe, some former English colonies, and in countries as far away as Australia, America and India (SPAB 2016). These are not always on timber. I have restricted these observations to timber components for the purposes of this paper because it is on their surfaces that the input of builders can most reliably be distinguished from later mark making by others.

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Discussion on the protection and utilization mode of traditional wooden structure building in the historic district of South Jiangsu, China

A Case Study of the Protection of Qingguo Old Lane Historic District in Changzhou and the Former Residence of Ganxi in Nanjing

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Abstract

As a traditional cultural center of the city, the historical district of South Jiangsu has important wooden architectural heritage and a relatively complete architectural space pattern of traditional residential areas. Compared with the rapidly growing modern neighborhoods, it still retains traditional space, form and stand. Face and detail decoration, with unique traditional features and features. The historical block condenses information on various aspects of urban economy, politics, culture, architecture, urban appearance, and residents' lifestyle. It can be said that the wooden built heritage extends in space and time.

The wooden architectural heritage in the historic districts is often diverse, where traditional wooden buildings are preserved in different conditions, new and old, different historical periods of construction and renovation activities are layered together, and mixed systems and details become urban culture specimens of the heritage.

The historical block also has a large number of intangible cultural heritage, which is the carrier of urban historical information. Here, the historical environment, celebrity culture, traditional customs, etc., have quite important emotional significance, and also have important significance for the inheritance of urban historical culture.

The historical block is also a heritage of “live” that is still in use. The community participation and co-construction will help the continuation of the traditional life mode. The restoration of environmental facilities can be fed back to the aborigines. The coordinated development of the two parties can effectively inherit the inheritance.

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This paper takes two traditional residential restoration projects in the historical district of the old city in southern Jiangsu as an example to discuss the protection and utilization of the wooden architectural heritage in the historical district. The two cases are the Changzhou Qingguo Old Lane Historic District still under implementation. the Former Residence of Ganxi in Nanjing, completed in 2008.

Background

Qingguo Old Lane Historic District in Changzhou

Qingguo Lane relies on the city river on the south side - it was built in 495 BC, and the world cultural heritage, one of the oldest river sections in the Chinese Grand Canal, developed and became the origin of Changzhou city. In the nine years of the Ming Dynasty (1581), after the canal was rerouted, the green fruit lane was a place where the famous giants lived. For centuries, Qingguo Lane has preserved historical sites such as ancient streets, ancient alleys, ancient dwellings, ancient bridges, ancient rivers, ancient trees and ancient wells in different historical periods, as well as the Yihe and Bagui in the Tang House of Tang Jingchuan. The former residences of celebrities such as Zhao Xing, Song Jian, Li He Tang and Zhao Yuan Ren, Liu Guojun and Qi Hongyi, and the historical and cultural district of Qingguo Lane are the essence of Changzhou history and culture.

The Former Residence of Ganxi in Nanjing

Located in the south of Nanjing, the Nanbuting historical district is the largest existing historical block in the old city of Nanjing. It has a strong political and industrial culture in history. The former residence of Ganxi, a large-scale cultural relics protection unit, was built in the Qing Jiaqing period. It is commonly known as the “nine-nine-and-a-half-and-a-half-year-old”. It is also known as the Ming Xiaoling Mausoleum and the Ming City Wall. History, science and tourism value are the largest and most well-preserved private houses in Nanjing.

Both belong to the typical traditional wooden architectural heritage in the south Jiangsu province in the late Qing Dynasty. The difference is that the protection of the historical district of the South Capture Hall ten years ago focused on the maintenance of the former residence of Ganxi, the cultural relic of the district, and the historic district of Qingguo Lane ten years later. It combines planning and policy, design and construction, architecture and structure, and formulates specific protection and repair requirements for the protection of various levels of historical buildings and surrounding environment, and does the protection and utilization, inheritance and development of wooden structures. More discussion and response.

Survey and Research， Analysis and Evaluation

Protecting the wooden architectural heritage in historical blocks and restoring the history of change, it is necessary to combine traditional architectural history research with heritage protection, not just wooden building maintenance. It is necessary to investigate and analyze the status quo, evaluate the value, and clarify measures. Therefore, unlike the repair project of the Ganxi former residence in the historical and cultural district of Nanjing Nanchong Hall, the

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protection work of Qingguoxiang historical and cultural district is divided into the following stages:

In the first stage, an in-depth study was conducted on the status of land use, historical and cultural heritage, transportation system, infrastructure status, population and social economy, historical functions, historical elements, architectural patterns, street development, and historical and cultural blocks of Qingguo Lane. The texture evolution of the block, the age, stratum, quality, structure, style and land ownership of the existing old buildings in the block were investigated in detail. At the same time, through extensive consultations with residents and professional institutions and experts, as well as on-site questionnaires and online questionnaire surveys, extensive public consultation was conducted.

In the second stage, a scientific and accurate assessment of the quality and style of the old buildings in Qingguo Lane will be carried out. On this basis, four well-defined methods for the protection and remediation of old buildings will be formed – repair, maintenance improvement, modification and demolition, and one by one. Determine the scope for each method. We have carried out extremely cautious arguments and detailed documentation for the decision to demolish the building.

In the third stage, the style and process characteristics of traditional residential buildings in Changzhou were collected comprehensively. At the same time, research on the protection and repair of old buildings with emphasis on minimal change and historical protection and sustainable use was carried out, and the history of Changzhou was compiled simultaneously. Technical guidelines for building repairs. It provides basic design and construction reference frame for the repair of the block, guides the repair design, and provides an effective guiding basis for the inheritance of the traditional building process.

In the fourth stage, a special agency responsible for the protection and restoration of old buildings in Qingguo Lane was established, and the organization procedures for the protection and restoration of historical buildings were established. The construction contractor who identified the protection and repair work selected 8 sets of representative cultural relics to carry out experimental and exemplary protection and restoration work.

In the fifth stage, all remaining old building protection and restoration, reasonable functional replacement, population evacuation, improvement of residential and infrastructure facilities, and improvement of greening, landscape and public space will be completed.

Interventions

The specific implementation process of the protection measures for wooden architectural heritage in historical and cultural blocks will face practical problems such as originality and technology selection, material renewal and safe use.

Authenticity and technology choice

The original authenticity of the architectural heritage is: original shape, raw materials, original crafts. For traditional wooden buildings, the architectural structure is the foundation of the original

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structure, including the framework system, the mortise and tenon joint, etc., so we will try not to change the structural system. Maintenance measures.

In order to preserve the historical information of the timber frame to the greatest extent, it is necessary to avoid disintegration during construction. In the Ganxi former residence project, there is a group of two-storey wooden houses. The building floor needs to be raised. We have adopted the practice of packing and upgrading the wooden frame as a whole. The process of lifting is illustrated. The workers pull the pulleys on the scaffolding. It is very easy. Pull the entire roof truss up.

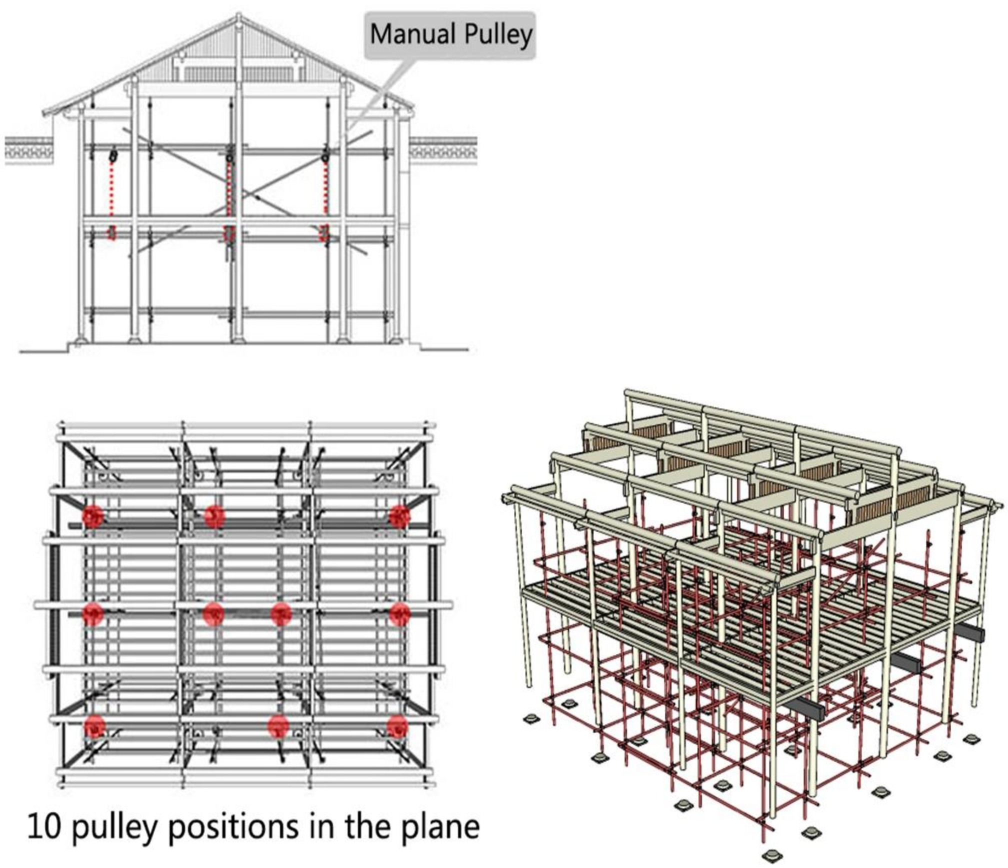

Fig. 1. Roof trusses and wood floor is a whole, after upgrading the pillars off the ground (images by author).

In the traditional building maintenance, there is a so-called "stealing the beams and pillars and replacing them with rotten timbers". Actually, structural members such as beams or columns are partially replaced under the premise that the roof trusses are not disassembled. For example, the replacement of the decaying girders in the main hall of the Yunxing Hall in Qingguo Lane has been removed, and the installation can be improved more easily. However, the beam-changing project of the library building of Ganxi's former residence was to use the scaffolding to lift the truss in the case where the roof was not removed.
The operation space was small and it was really a "stealing beam".

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"Change column", the common wooden post in the photo maintenance, is also to maintain the originality as much as possible, cut off the next part of the decay, splicing a new piece of wood, the joint will use this cross or simple slap In the traditional way, we will add two more hoops. In the repair of the former residence of Ganxi, we used the process of wrapping carbon fiber cloth at the joint, which not only satisfies the structural strength, but also does not affect the appearance after the water-mixing paint. In principle, the replacement of the wooden components is different from the appearance of the original components, and the same lacquering is not performed, and the recognizability is emphasized.

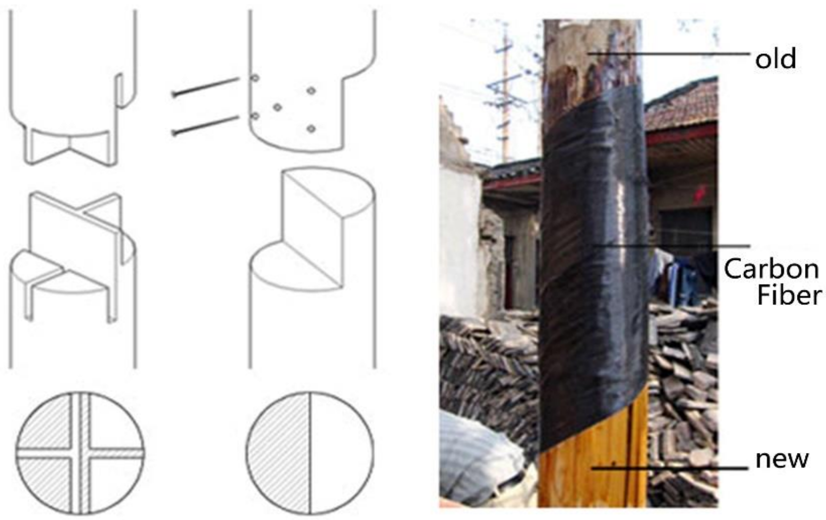

Fig. 2. Wooden reinforcement（images by author)

Fig. 3. Process of "Change column"（self-photography）

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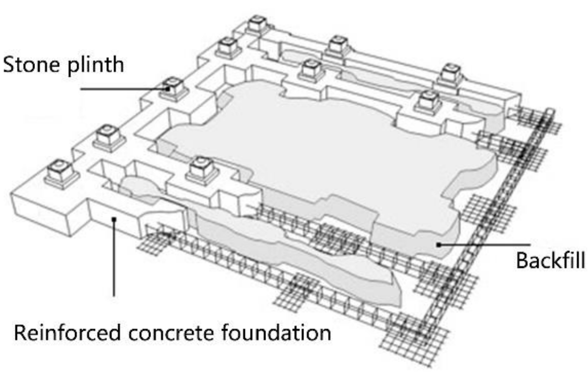
In modern construction, cheap modern materials are used in large quantities, such as low-cost, simplified lacquers instead of traditional lacquers. The materials used in the traditional oil decoration process are the unique natural finishing materials "oil" and "lacquer" in China. Oil refers to dry vegetable oils such as tung oil and castor oil; lacquer refers to natural lacquer, that is, raw lacquer. The development of the chemical industry has gradually replaced the varnish and the lacquer in the traditional way with clear oil, various blending lacquers and synthetic resin lacquers; these finished lacquers are mostly finished paints that can be directly painted without the need for additional preparation or grading. The price is also different from the lacquer by dozens of times.

Authenticity and technical regulations

Traditional building maintenance is inevitably contradictory to modern structural norms. Although it should not be used to meet the norms, it should still ensure its basic safety. In the maintenance of the former residence of Ganxi, the technical measures and the level of understanding at that time were not enough. For the maintenance and reinforcement of the traditional wall, the practice of redoing the reinforced concrete foundation and rebuilding the wall, adding the ring beam and constructing the column was adopted.



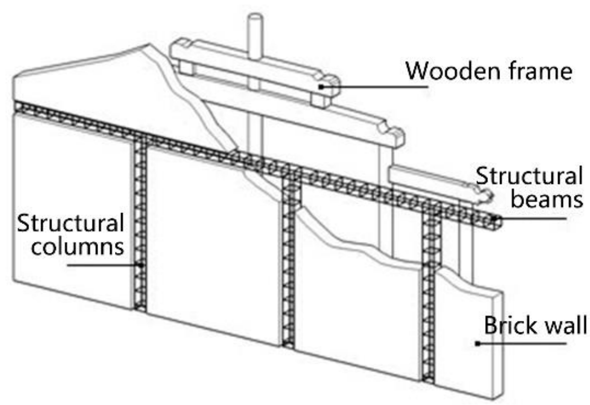


Fig. 4. Foundation reinforcement（self-painted） Fig. 5 Wall reinforcement（self-painted）

In the maintenance project of Changzhou Qingguo Lane, we realized that the surface texture of the traditional brick wall is also a historical information. In order to protect these historical traces, we have taken measures to reinforce the old brick wall. Including foundation reinforcement, reinforcement of steel reinforced lines in the wall, reinforcement of wall cladding walls, and wall rectification.

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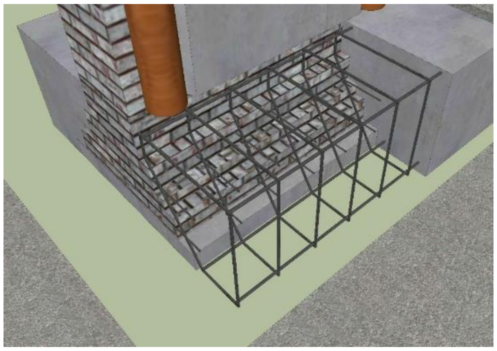
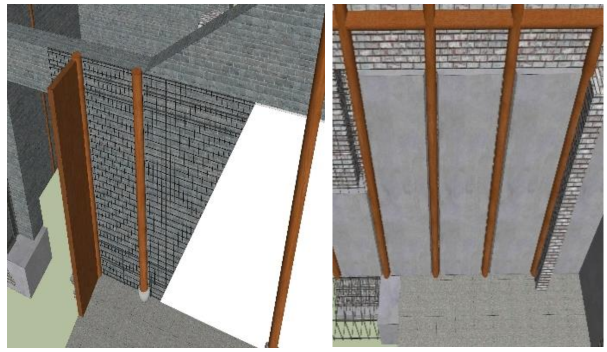

Fig. 6. Foundation reinforcement (self-painted)   Fig. 7. Wall reinforcement（self-painted)

Fig. 8. Wall rectification (self-photography）

Fire prevention is a great difficulty faced by traditional wooden structures. In traditional residential areas such as historical blocks, the building density is large, the scale of streets and streets is small, and the fire prevention problem is more severe. The protection plan of Changzhou Qingguoxiang Historic District has determined the spatial scale of maintaining the traditional block pattern. We use the existing roadway and courtyard wall to divide the building into small-area fire zones to reduce the fire risk.

At the same time, in response to the improvement of the fire resistance of the wood itself, we carried out the test of the transparent fireproof coating. The experiment proves that the water-soluble fireproof coating of the coating and the wood base layer does have the effect of burning without open flame, smokeless dust and slow burning speed, but on it. After the traditional oil-based paint is applied, the effect is greatly degraded. Traditional building oil decoration materials have a strong combustion-supporting effect. For example, the fire-proof performance of the wood itself is difficult to improve due to the principle of raw materials. Therefore, we have made a targeted arrangement in the setting of fire-fighting facilities: setting indoor and outdoor fire hydrants, sprinkler facilities, fine mist barriers and other small fire-fighting equipment suitable for small-scale roadways.

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Fig. 9. Fireproof Paint Test (self-photography)

The moisture-proof and waterproof of the building will be compensated by the structural design if the performance of the traditional material cannot be met: for example, the outflowing of the raft and the grounding of the ground, the illustration is the brick ridge of the former residence of Ganxi. The traditional roofing method is also to look at the bricks without making backs, direct tiles, high process requirements, and inevitably leaks. In Changzhou's project, the ground moisture and roof waterproofing are all used to increase the waterproof membrane, so as to ensure no leakage and leakage in extreme weather, which is conducive to the protection of wood structure.

Community Involvement

The protection of Qingguo Old Lane Historic District is different from the maintenance of Nanjing Ganxi's former residence ten years ago. During the initial stage of the implementation, the residents and professional institutions and experts were invited to conduct seminars and consultations, as well as on-site questionnaire surveys and online questionnaire surveys. For residents who have the willingness to reserve and meet the requirements, the experts and the aborigines will jointly determine the maintenance plan to ensure that it does not affect the style of the historical blocks and meet the needs of the aborigines. The introduction of modern facilities and equipment in the protection of historical and cultural blocks has effectively improved the three aspects of house reinforcement, fire prevention and use functions, and the protection of old buildings with historical protection and sustainable use as the aboriginal life of traditional wooden structure residential areas. Providing protection, community participation is no longer an empty talk.

Technology Inheritance

It has been ten years since the Nanjing Ganxi Former Residence Maintenance Project to the Changzhou Qingguo Old Lane Historic District Protection Project, the development of technology and the need of social practice, forcing tools to innovate and improve. In the modern construction of ancient buildings, the cutting, grinding and piercing tools have long been replaced by mechanical tools. Woodwork, bricks and stone can rely on mechanical tools to complete the main cutting and grinding of materials, and then manually. Fine processing such as engraving. The use of modern tools saves time and labor, and can improve the precision of the process, but with the gradual elimination of traditional hand tools, the old craftsmen who master the traditional craftsmanship become rare, and the hard mechanical traces replace the vivid craftsmanship. Therefore, the evaluation criteria for the quality of traditional construction projects should increase

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the element of aesthetic value, and encourage artisans to use traditional hand tools to pass on manual techniques.

The empirical regional characteristics of traditional Chinese building technology make it difficult to accurately and comprehensively express expressions in the form of words, symbols, graphics, etc., which results in the lack of construction and construction of traditional buildings, especially local traditional buildings. Unified process and technical specifications. In the past, the inheritance of traditional architectural techniques with the characteristics of "empirical technology" relied mainly on the "speaking and preaching" of the masters. This model of master-student inheritance has its limitations, the way of life and values of modern society and the craftsmen and crafts of the past. The historical background on which people depend for their livelihood is very different. How to mobilize the enthusiasm of craftsmen to inherit technology and cultivate new technical talents is of great significance to the traditional construction industry.

Appendix

The traditional building repair technical guidelines are divided into four major categories: courtyard layout, wooden structure, wood decoration, and masonry structure and detail. The preparation of the guidelines is based on site and surveying, surveying, and accumulation and understanding of the characteristics of the area. Based on the basic methods of architectural history and wood structure research, it is found that the establishment of rules and characteristics within the region can improve the accuracy of value judgment in regional protection work, provide basic design and construction reference frame for repair, and guide the repair design. The inheritance of traditional building techniques provides an effective basis for guidance.

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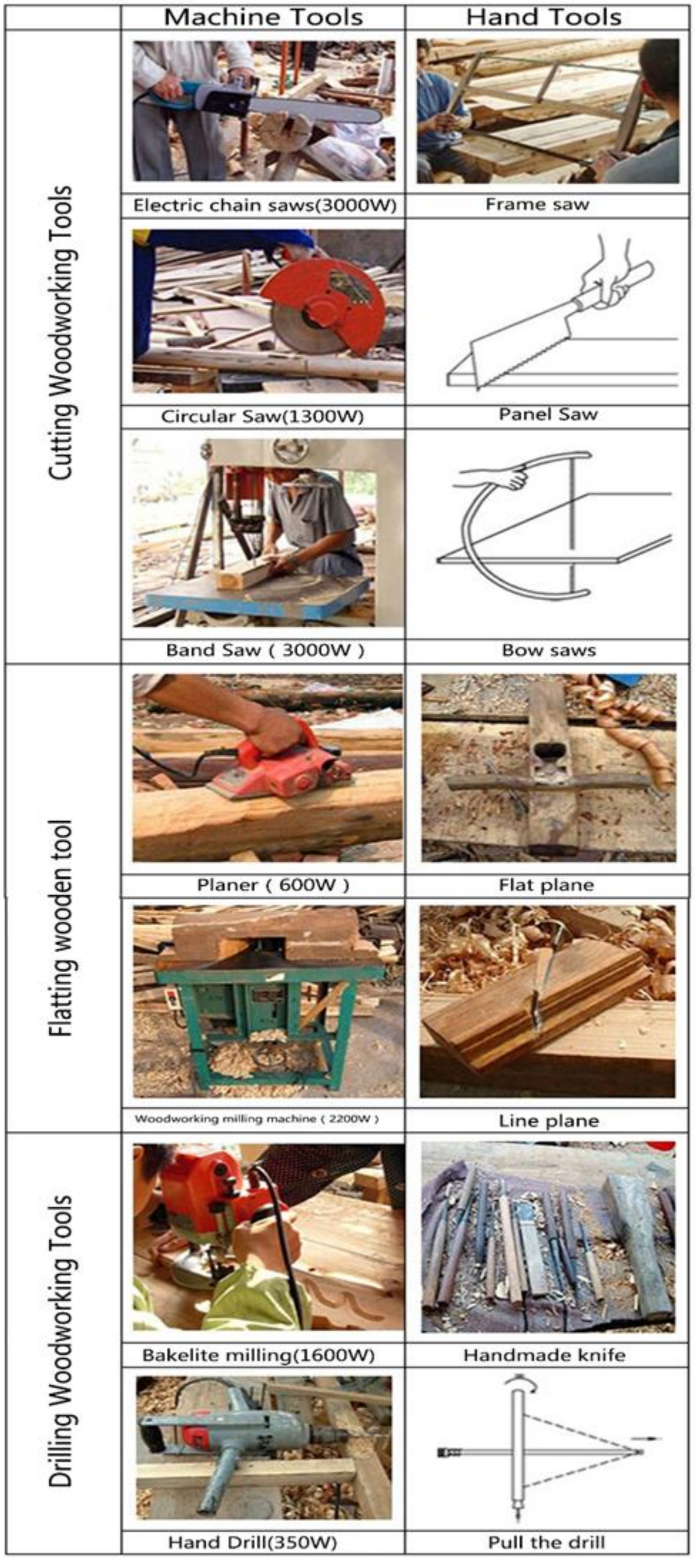

Fig. 1 Tools Comparison Chart (self-painted)

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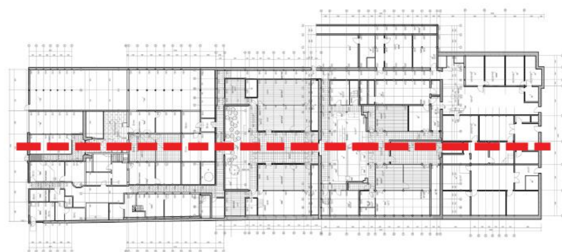
<tr><td colspan="2">Axis</td><td colspan="4">
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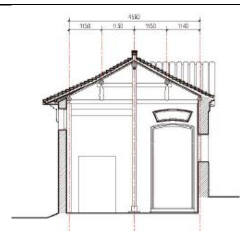
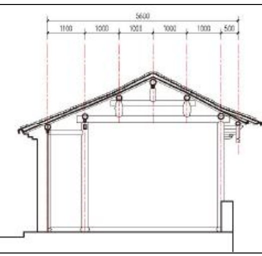
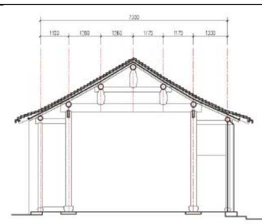
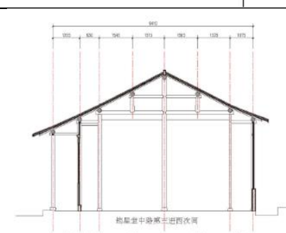
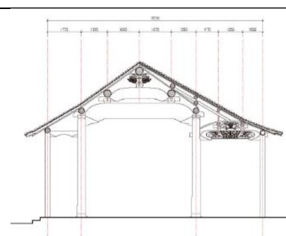
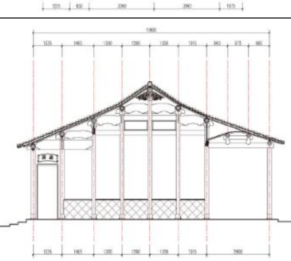
<tr><td rowspan="3">Wood structure and structure system</td><td rowspan="3">Structure type</td><td>Four spans</td><td></td><td>Five spans</td><td colspan="2"></td></tr>
<tr><td>Six spans</td><td></td><td>Seven spans</td><td colspan="2"></td></tr>
<tr><td>Eight spans</td><td></td><td>Nine spans</td><td colspan="2"></td></tr>
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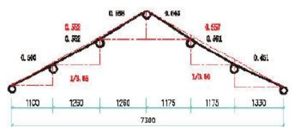
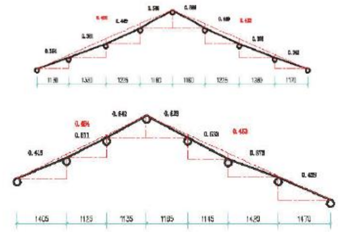
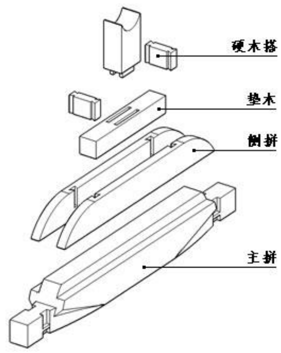
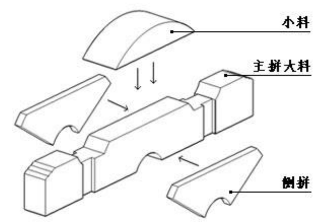
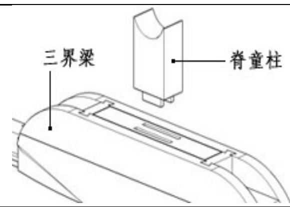
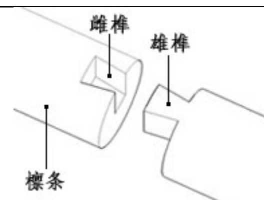
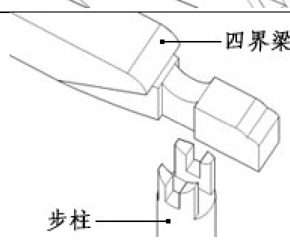
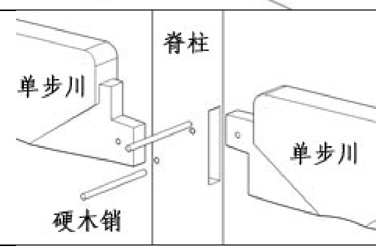
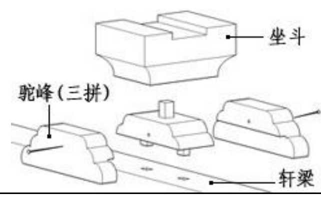
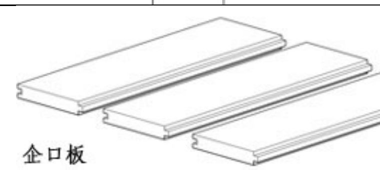
	Roof Structure	Six spans		Seven spans	
	Structural member	Flattened beam		Flattened beam	
	Construction node	Mortise and tenon joint			
					
					

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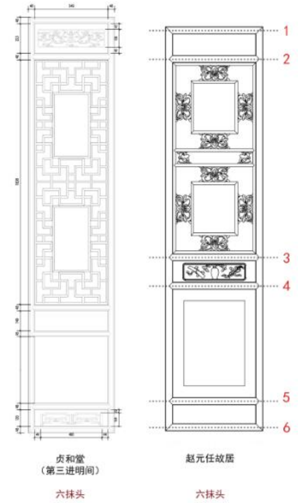
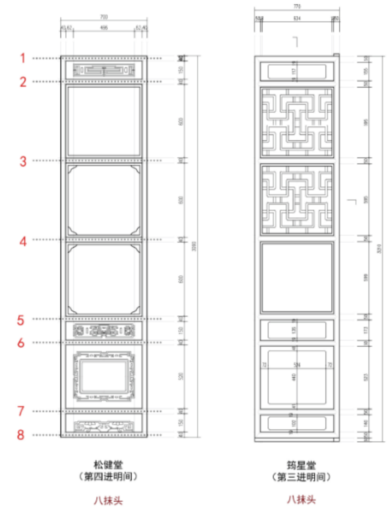
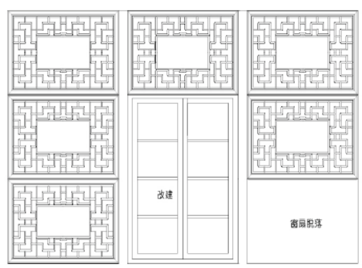
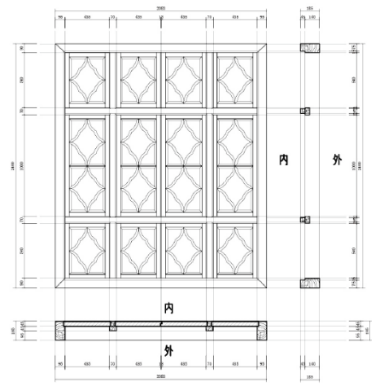
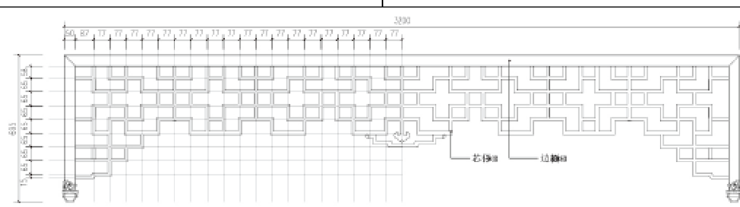
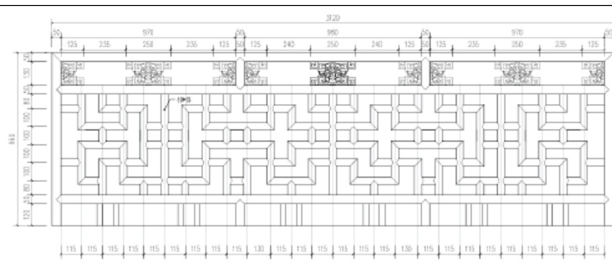
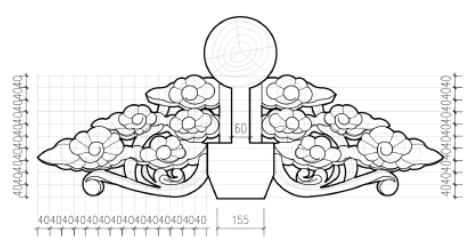
Wood decoration	Wooden door		
	Wooden window		
	cartouche		
	railing		
	Wood carving		

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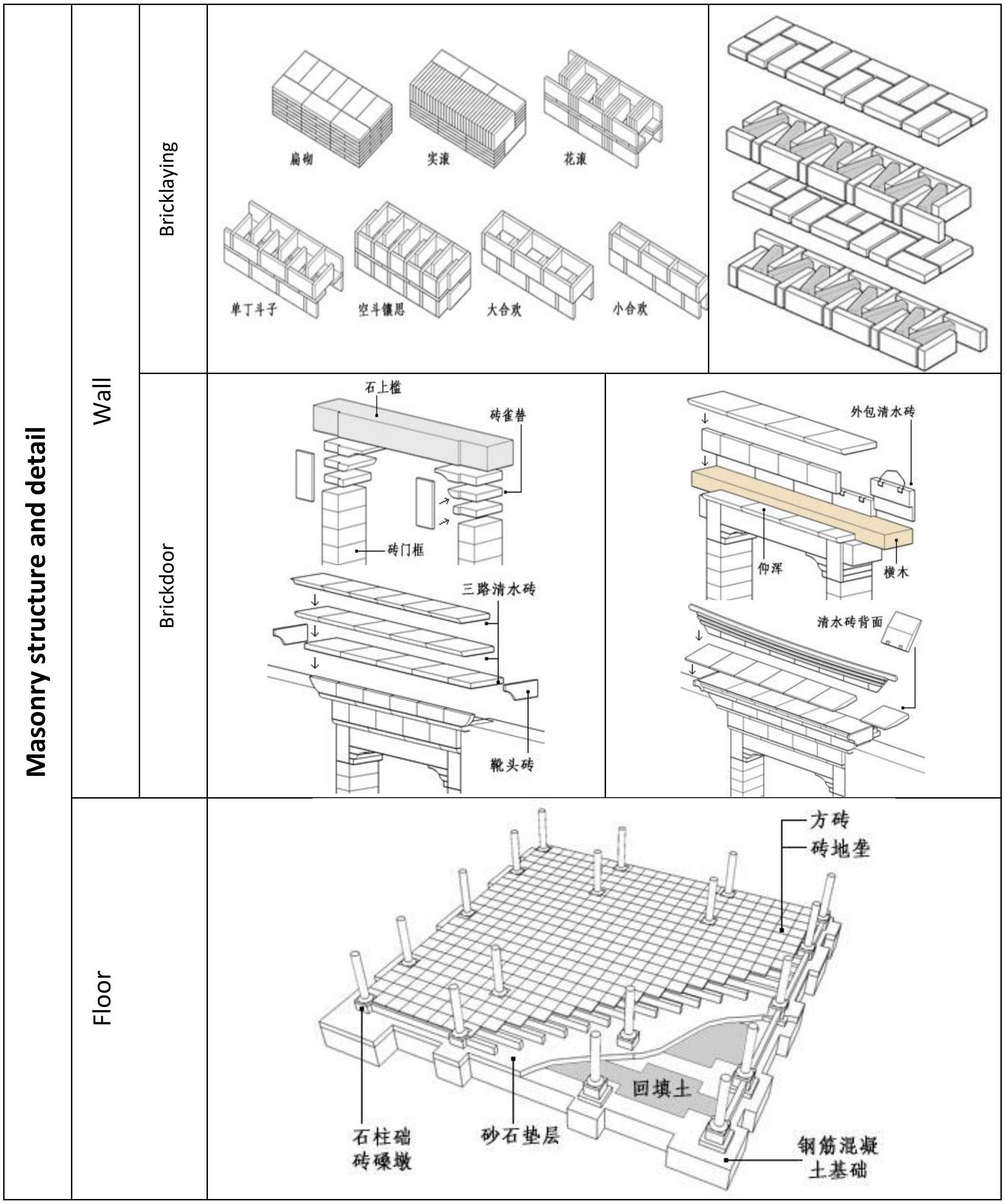

Fig. 2. Historical Building Repair Technical Guidelines (self-painted)

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Shiver Me Timbers! - Polar heritage in a warming global climate: implications for the conservation of wood and timber at Arctic and Antarctic sites

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Abstract

It is ironic that the use of wood as a building material is so ubiquitous in polar regions where there are no living ‘forests’. In the Antarctic, the dominant pre-war building material was wood; preferred for its low cost, modest weight, and the ease with which it could be modified to suit other purposes including fuel for heat. In many parts of the Arctic wood rivalled snow, stone, bone and turf for making permanent and nomadic shelters. Whether the remote expedition bases of the Heroic Age of Exploration, or the timbered homes of the Thule People who inhabited the far north more than a millennium earlier, wood has been used extensively to provide structure and enclosure, furnishings, tools and transportation throughout both polar regions. Until recently these objects were literally ‘frozen in time’: stable in their cold, dry polar climates, and relatively immune to the sorts of decay processes that are common in warmer latitudes. Climate change requires us to re-examine these traditional assumptions and consider that polar heritage is now uniquely threatened. This paper explores polar heritage in the context of a rapidly warming global climate and considers the implications for the ways that we investigate, record and repair wooden buildings and objects.

We don’t yet understand why the temperatures at the poles are rising more swiftly than elsewhere on the planet, but the implications for cultural heritage are alarming: sea-ice loss, coastal erosion, thawing permafrost, increased visitor impacts and biodeterioration of historic fabric are some of the more predictable outcomes (IPCC 2018). Because most polar heritage sites and monuments are situated along coastlines, they are particularly vulnerable to decay processes stimulated by the rising temperatures associated with climate change. This is especially the case with Visitor Heritage because early European explorers, sealers and whalers typically accessed and resupplied their camps by ships; navigating polar seas during the brief summer months when they were free of ice and constructing buildings within easy access of the water.

In a changing climate, we must learn to act more swiftly and decisively than we are naturally accustomed to as conservators and archaeologists. While there are great risks associated with hasty interventions, we must, by necessity, learn to become risk-takers.

Keywords: Antarctica, Arctic, Climate Change, Polar Heritage, Wood

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Wood in Polar Heritage

That wooden artefacts appear in the archaeological record across the breadth of the Arctic is quite remarkable in a land where the largest tree is the arctic willow (*Salix arctica)* which grows only 15 cm tall. Similarly, the irony of being a heritage carpenter in Antarctica where the only forests are 230 to 280-million years old and petrified, is not lost on me (McLoughlin, 2011)!

When we think about wood in the context of polar heritage, it is the ships and expedition huts of the early explorers Franklin, Peary, Scott, Shackleton, Nansen, Amundsen, Mawson and Borchrgevink that come to mind (Larsen, 2011; Sale, 2002; Wheeler, 1999). These iconic wooden objects are the material legacy of the so-called Heroic Age of Exploration, but they represent only a very small part of the wooden heritage in polar regions (Barr, 2004; Chaplin, 2004) (fig.1-4).

Fig. 1. Shackleton's Nimrod Hut at Cape Royds with Tabular Berg, Ross Sea, Antarctica. Author's image 2007

From whaling stations and expedition bases in the Sub-Antarctic Islands to mining sites and hunters' cabins of the Svalbard Archipelago, wood is the dominant building material; a light and inexpensive material that was familiar to ships carpenters and which had an additional benefit that it could be burned as fuel when times got tough (as they almost always did) (Barr, 2004; Barr, 2011; Chaplin, 2004). European adventurers of the 18th, 19th and early 20th centuries left an anthropogenic legacy at both poles that includes: buildings, shipwrecks, processing and habitation sites, provision caches, graves and landscape modifications (Barr, 2004; Chaplin, 2004). However, the European preference for wood as a building material was nothing new in the Arctic: the prevalence of wooden objects in the artefact record of the far north indicates the widespread use of wood during the past 1500 years (Alix, 2005), and even prior to the western Thule migration, the Dorset people were hafting stone micro blades with wood (Owen, 1987). It was the proto-Inuit Thule people however, who truly mastered the use of timber as a structural material and used it to

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make the first wooden buildings in the Arctic of North America (Mouel and Mouel, 2002). By 600-800 CE large timber structures were being constructed in north eastern Alaska using 0.4 m diameter logs, 12 m long (Alix, 2005; Harmsen, 2017; Larsen, 2001; Norman et al., 2017). Whether or not the diverse Paleo-Eskimo or Dorset people had much contact with the Norse and their familiarity with timber technology (Park, 2014), the later Thule people certainly did (McGovern, 2018; Schledermann and McCullough, 1980). By 1000 CE the Norse coexisted with the Thule people they named *Skrælingjar* and shared their technology with them (Harmsen, 2017; Sutherland et al., 2014). The tradition of large-scale timber construction using driftwood continued in the Canadian Arctic from the 15th to 20th Centuries (Friesen, 2014), as the 6m x 7m cruciform house excavated at the Pembroke site in Nunuvut in 2008 demonstrates. Dyke (1997) explains that driftwood is even more abundant in the Svalbard Archipelago than in the Canadian Arctic Archipelago, owing to the Transpolar Drift, the north polar gyre that delivers wood from the Russian taiga down the coast of Greenland towards Iceland, Norway and Finland; a journey that typically takes 4-5 years (Alix, 2005).

Fig 2. Stevenson's Screen in the Environs at Cape Royds, Author's image 2007

Regardless of its origin, wood is vulnerable to a variety of non-biological decay mechanisms such as ultraviolet (UV) light, salt corrosion and wind erosion, and it is particularly vulnerable to biological deterioration (Farrell et al., 2004). Once again there is a tangible link between the temperature of the site environment, and the risks to historic building fabric. Fiber-situation point (FSP), is only possible for most commonly used wood species above -1.1°C , and above 90% RH

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(FPL Wood Handbook, 1999), and it is only at FSP that such plant pathogens as the wood-aggressive fungi Cadophora (the species of wood-aggressive fungi most commonly found at heritage sites in Antarctica) (Held, 2013) can propagate (Farrell et al., 2004). The sensitivity of organism such as Cadophora to even very small (plus or minus 1° C or 5% RH) temperature and humidity variations is important to quantifying the risks posed to wooden objects and artefacts in polar regions.

Fig. 3. Artefacts within Shackleton's Nimrod Hut at Cape Royds, Ross Sea, Antarctica. Author's image 2006

North and South Polar Regions

The circumstances of the polar regions are unique and distinct. The Arctic for example, is an area of frozen sea surrounded by land while the Antarctic is the (polar) opposite. The Arctic contains a diverse range of fauna including many large land mammals such as polar bears, reindeer, and muskox, while the largest land animal in the Antarctic is a wingless midge (Usher and Edwards, 1984).

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Another key distinction of these two places is the people: there are approximately four million of them living in the circumpolar north (Arctic People - National Snow and Ice Data Center, 2017), while the year-round population of Antarctica is less that 1,000 (CIA - World Factbook, 2017). The indigenous people of the Arctic include the Saami, Nenets, Khanty, Aluet and Inuit (Inuupiat, Inuvialut and Kalaallit) (University of Lapland – Arctic Centre, n.d.); they have existed there for millennia, but it wasn't until the 17th of February 1898 (Larsen, 2011) that the first people camped overnight in Antarctica (coincidentally they were also Saami) (Sale, 2002). Humans are relative newcomers to the south polar region, and Cook is generally regarded as the first to safely return from south of the Antarctic Circle in 1773 (Sale, 2002). In contrast, there were people migrating across the Arctic following the end of the last ice age, and in 2012, archaeologists with the Russian Academy of Sciences excavated the frozen remains of a mammoth at Yenisei Bay in northern Siberia (almost 72°N) and found multiple hunting lesions on rib bones containing lithics, proving the mammoth died from spear wounds approximately 45,000 years ago (Pitulko et al., 2016).

In terms of polar heritage, I propose the most significant distinction between north and south polar regions is temperature: mean elevations in the Arctic, where the North Pole is at sea level, are thousands of meters different than those of the Antarctic where the South Pole is located at 2,300m (CIA - World Factbook, 2017). Owing to the dry adiabatic lapse rate of the Antarctic, temperatures drop an average of -9.6° C per 1,000 meters of elevation gain (NOAA – Lapse Rates, n.d.), making the relatively high altitude of Antarctica one of the reasons that it is so much colder that the Arctic. The annual mean temperature at the north pole is +1.6 and the water a few meters beneath the pole is -1.8°C (NOAA – Arctic Program, 2018), compared with the south pole, where the annual mean temperature is -49.3°C (ASMA5 – Climate, 2012). Antarctica's topography also contributes to the famous katabatic winds that pour down towards the coast from the polar plateau, reaching speeds over 300 km/h (ICECUBE – South Pole Neutrino Observatory, n.d.). It is no surprise that the coldest temperatures on earth have been recorded in the Antarctic, where the current record stands at -93.2°C (NASA – Science Visualization Studio, 2013; Perkins, 2013). The temperatures of the north and south poles are as different (50.9° C) as the north pole is from El Azizzia in the Libyan desert, where the world's highest temperature was recorded (Khalid et al., 2013).

Where it was once convenient for us to regard all polar heritage as a single typology, this no longer serves us. The regional distinctiveness of the north and south polar regions, and the uniquely different ways that they are responding to climate changes, presents significantly different challenges in the north and the south. While cultural heritage in the south remains relatively stable, the rate of changes in the north outstrips our capacity even to document it before many sites will be lost (Olynyk, 2004; Friesen, 2016; Friesen, 2017)

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Fig. 4. The Author at Work, Scott's Discovery Hut, Ross Sea, Antarctica. Alasdair Turner 2013.

Climate Change and Polar Heritage

As global air temperatures continue to rise (NASA GISS – GISTEMP, 2017) both polar regions are undergoing environmental changes that negatively impact the cultural heritage sites they contain. Some of these impacts are self-evident such as the thawing of previously frozen grave sites and shorefront foundations at Hershel Island in the Yukon Territory (Olynyk, 2004), while some are less intuitive, such as the increased visitor impacts to historic sites resulting from improved ship access in polar waters (Barr, 2012). Data gathered by the National Oceanic and Atmospheric Administration (NOAA) as part of their Arctic program, shows that the poles are warming more than twice as fast as the rest of the planet. Collectively, the circumstances of polar sites and monuments are changing more swiftly than in most other places on earth (Hansen et al., 2010), and the relationships between temperature and polar heritage are therefore important for predicting and managing the risks that threaten them (Martens, 2017).

There is also a mysterious disparity between sea-ice behavior in the north as compared to the south polar region. Satellite observations of sea ice in the north, show that sea ice has been retreating at a rate of 13.2% per decade since 1978, with a record low in 2012 (NASA – Global Climate Change, 2018). During this same period Antarctic ice has steadily increased, achieving a record maximum in 2014 (NASA – Goddard Space Flight Centre, 2017). These gains in the south represent only one third of the 53,900 square kilometers that are annually being lost in the Arctic (the global trend is consistent with rising temperatures and net losses of sea-ice) but serve to emphasize the differences in behaviors between northern and southern polar regions.

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Challenging our Traditional Assumptions of Stability

Until recently, most polar monuments and sites (north and south) have been relatively stable because of their cold dry environments. But some time around 1976 this began to change: that was the last year that the earth was cooler than the 20th-century average, and since then we have been warming (SOTC – National Snow and Ice Data, 2017). This assumption of environmental stability has influenced our philosophical approach to conservation in cold climates during the previous 50-60 years and resulted in a prevalence of investigation and stabilization.

Defining the polar regions by temperature is useful when considering tangible cultural heritage (UNESCO – Areas of Action, 2017) because temperature changes above and below zero degrees centigrade are the chief drivers of decay to wood and other organic materials in polar environments. It is within this narrow temperature range that freeze-thaw activity causes permafrost to move, resulting in landscape deformation. In addition to disturbing building foundations (Olynyk, 2004), these changes also impact groundwater movement (Watson, 2011) and cause cryoturbation; the churning of material from different soil and ice horizons, that can damage the archaeological record of a site (Wolff, 2013).

A Way Forward

Sadly, there is nothing we can do at a local level that will sufficiently impact the natural environment swiftly enough to alleviate the impacts of climate changes at hundreds of sites across the western arctic. Our only options for those locations are rapid survey, triage and in some cases collection, i.e., relocation or loss.

A new methodological approach to these sites might include greater collaboration with the public who are increasingly able to visit the arctic as sea ice recedes. Groups like CITiZAN, the Coastal and Intertidal Zone Archaeological Network, or Scotland's volunteer driven Rock Art Project have proven how effectively the public (with specific training and support from professionals) can perform meaningful, opportunistic, heritage work at remote sites (CITiZAN 2018; Historic Environment Scotland 2018).

Technology may also play an important role by facilitating rapid data capture by both laypeople and professionals, especially when site access is limited. My colleague Ben Gourley and I have recently been experimenting with photogrammetry to capture data from remote sites when, for whatever reasons, we cannot travel there ourselves. In 2016 for example, we used online screensharing to deliver a brief training session to staff from Antarctica Heritage Trust (AHT) in New Zealand who then successfully captured images of Scott's memorial cross on Observation Hill in the Ross Sea, Antarctica. The wooden cross is a 3m high monument to the memories of Scott, Wilson, Bowers, Oates and Evans who perished on their return from the South Pole during the 1910-1913 Terra Nova Expedition. It is made from laminated Jarrah *(Eucalyptus marginata)* planks that have been fastened together using bronze dowels peened over iron washers. The cross is set into the socket of a precast concrete base sunk into the earth of the hill. When the AHT images were subsequently uploaded to us via a satellite link from Scott Base (Antarctic New Zealand's on-ice base of operations), we were able to construct a parametric model of the cross at our desks in Canada and use this information to feedback information to the field event staff and

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to the Christchurch-based joiners in almost real-time. In this instance, the information was used to construct tight-fitting winter covers for the historic monument. This example demonstrates how, with a small amount of preparation and training, highly-accurate spatial data can be captured from remote sites using nothing more than the digital cameras that most field events carry with them. In this way conservation professionals and planners can potentially interact with multiple remote sites in meaningful ways, without the costs and logistics associated with travelling there in person. In the context of so many rapidly deteriorating sites across the arctic, this may help with the documentation at least.

Summary

The impact of increasing temperatures upon polar landscapes cannot be overstated. All the bare land in Antarctica (NSIDC, 2017) and approximately 23 million square kilometers of the north; representing 25% of the northern hemisphere and all the north polar region, contains permafrost (International Permafrost Association, 2015). Because permafrost is ubiquitous throughout both polar regions, all polar heritage is therefore situated on either sea-ice, glacial ice or permafrost (National Resources Canada, 2017). In the context of global climate change, this is profoundly important to the assessment of risks posed to polar heritage and the strategies that can effectively be used to mitigate them. For the last 50-60 years we've based our approaches to cold climate conservation on an assumption of environmental stability: long, cold, dry winters with brief shoulder seasons between short summers; stable permafrost; predictable sea-ice formations driving low relative humidity; immunity from soft rot fungi and wood aggressive insects. This has resulted in an approach to polar conservation that is primarily focused on investigation, documentation and stabilization. While these strategies may continue to work in the Antarctic for the next few decades, they no longer fit the circumstances of the polar north.

Professor Robert A. Blanchette, Department of Plant Pathology at University of Minnesota has first hand experience of polar sites in both Arctic and Antarctic context. He feels that one of the major issues facing wood in the warming Arctic, is the increased time that decomposition can take place. Defrosting permafrost holding wooden artifacts is also causing concerns because some of this wood now spends a greater amount of time each year unfrozen, resulting in longer periods of decay and commensurately greater decay rates. With increased temperature, Blanchette warns of greater threats by more aggressive decay fungi that are increasingly able to survive in Arctic conditions. (R. Blanchette 2018, personal communication 1 June).

Our approach to the conservation of cultural heritage sites in the north must now focus on rapid site assessment, documentation and artefact recovery as the highest priorities. The loss of hundreds if not thousands of sites is inevitable, and it only remains to be seen how many of these sites we can visit and record before they vanish. Limited resources mean that the decision to save one site will likely come at the expense of many others. While technology can accelerate our assessments and improve our understanding of a site's pathology, our decision to act (make interventions) or not, must often take place within a single season of field work given the rate of changes that we are experiencing. This means that new and faster ways to prioritize our actions are needed.

In the emerging paradigm of heritage triage, we must develop new methodological frameworks to help us focus our limited resources on those few sites that we might hope to save or record, just as

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we must accept that many more sites will be lost. But this mustn't become our only focus. We also need to study these sites so that we can learn to predict which sites will next be imperilled. Predictive modelling offers us the chance to behave proactively to save polar heritage rather than simply responding to sites that are already too far deteriorated.

There's no question: the circumstances of global climate change are complex and extraordinarily challenging. Like it or not however, it falls to our generation to determine the extent of these changes. To quote the great polar explorer Ernest Shackleton, "Difficulties are just things to overcome, after all." (Shackleton, 1910)

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Restoration of ancient Chinese opera spiral wooden domes, accounts of field practice

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Abstract

The zaojing is a wooden construction system that covers opera stages for rain protection and sound control. Zaojings in China display a diverse range of geometric expressions, delicate manufacturing, structural behaviours, and acoustic qualities. Despite their uniqueness and patrimonial interest, very little literature is known to exist, and it lacks comprehensiveness. Based on the fresh field investigations in North- and South- China, at least six kinds of zaojing types have been collected. From the view of geometry, construction, structural behaviour and renovation process, this paper attempts to introduce one of the unique type "spiral zaojing" comprehensively and intensively. Through the interview with three local carpenter masters, the field practice in contemporary rural China could also be brought to light.

Keywords 17th-20th century, South China, Zaojing, Ancient shallow wooden dome, Spiral type, Wood-only construction

Introduction

The zaojing _ shallow wooden dome

The *zaojing* is a typical ancient architectural element that is widely found in various public buildings, such as temples, pagodas, palaces, and theatres. It is a richly decorated sunken "dome" with a shape of a round top and a square bottom set into the ceiling and assembled by a large set of pieces with purely wood-to-wood connections. And they were usually applied at the centre of the building, directly above the religious statue, main throne or opera stage.

The literal meaning of the *zaojing* (Chinese: 藻井; pinyin: zǎojǐng) in Chinese is "algae well". "Algae" refers to the aquatic plants, and "well" means the water source. Therefore, the *zaojing* is traditionally the symbol of a steady flow of water, hoping to suppress the trouble caused by the fire-devil and to protect the safety of the wooden buildings.

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In this paper, the *ancient shallow wooden dome* is also employed as the English special term of *zaojing*.

Opera zaojing

In ancient times, the secular activities, like festivals, gatherings and celebrations, were always closely related to religious worship. Accordingly, an opera stage was usually arranged with a temple together. They consequently formed the most important public place in the area. In these ancient opera stages, *zaojing* was greatly adopted for the role of structure, aesthetic and acoustic.

In South China, the ancient opera stage and *zaojing* prevailed mainly in ancestral temples where sacrificial ceremony, gathering and clan's meeting took place. The complete edifice was donated and supported by one clan and its refinement and grandiosity usually demonstrated the capacity and prestige of the clan in the local and it is, therefore, one of the most complex and exquisite architectural elements (Kaiying 2009). Whenever important festivals and events, particularly in the season of fishing or harvest, and in the ceremony for wedding or funeral, the opera performance generally lasted for several days (fig.1). This custom has been preserved so far.

Fig.1. An opera performance at the opera stage of Hu'shi Ancestral Temple, Auhu Village, in Ninghai, built in 1920s. Ref. ZJ-01© Xiao Wang Shushu

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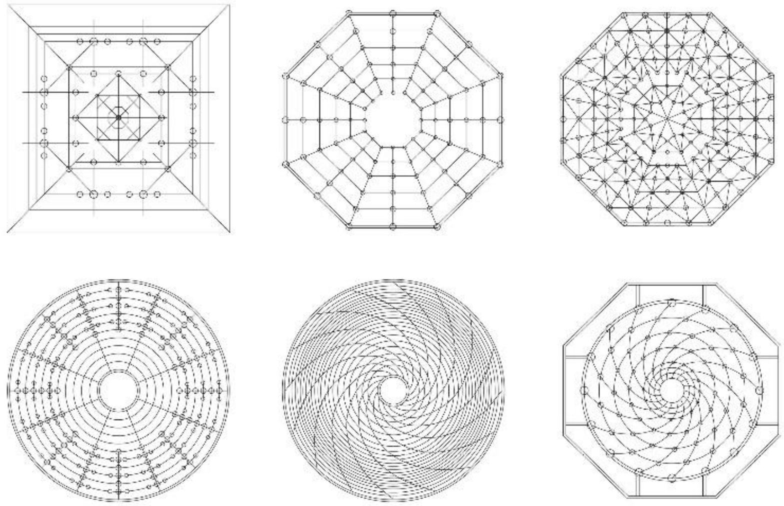

Fig. 2. Six kinds of *zaojing* types collected in the field investigation. Above: Reciprocal, Spide-web, Ru-yi gong; Down: Round-cap, Spiral, Mix with Octagonal and Spiral. © Jingxian Ye

Also, regional variations of construction techniques and styles contribute to a diverse range of geometric expressions, delicate manufacturing and structural behaviours. Based on the field investigation of the existing opera wooden domes in Shanxi province (north) and Zhejiang province (south), at least six types could be summarized and catalogued (fig.2). Among them, the spiral wooden dome is a unique local type.

This paper is particularly focused on the spiral *zaojing* in Ningbo area of Zhejiang province. Through the introduction of the surviving examples (fig.1, 3, 4, 5), the new-built examples (fig.6), the renovation process (fig.16 to 27) and the involved construction technology (fig. 13) and its evolution (fig.15), the field practice of surviving traditional wooden construction in rural China will be discussed with a particular emphasis.

Fig. 3. Spiral *zaojing* (chicken-cage type) in the opera stage of Qin'shi Ancestral Temple, in Ningbo, built in 1925. Height: approx. 2.25m; Diameter: approx.5m. Ref. ZJ-02 © Jingxian Ye

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Fig. 4. Spiral *zaojing* (chicken-cage type) in the opera stage of Yu'shi Ancestral Temple, in Ninghai, rebuilt in 1911. Height: 1.46m; Diameter: 3.8m. Ref. ZJ-03 © Jingxian Ye

Fig. 5. Spiral *zaojing* (ox-hair type) in the opera stage of Wei'shi Ancestral Temple, Xiapu Village, in Ninghai, built in 1890. Height: 1.15m; Diameter: 3.3m. Ref. ZJ-04 © Ninghai Lvyou

Fig. 6. Spiral *zaojing* (chicken-cage type) in the main hall of Baoguang Temple, Zhanqi Village, in Yinzhou, built in 2017, by Carpenter Master Liqun Zhang. Height: 2.25m; Diameter: 5.2m. Ref. ZJ-05 © Jingxian Ye

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The spiral type

The spiral wooden dome is constructed in the form of a counter-clockwise spiral, embedded in the centre of the ceiling. In the surveyed area, more than 20 surviving ancient spiral wooden domes have been recorded. They were constructed or reconstructed from the Mid-Qing Dynasty (approx.1750) to the early modern period (early 20th century). The existing spiral types are of similar sizes, with an average span of 3.5-4 meters, a height of 2 meters. Among them, the ancient opera spiral dome in Qin'shi Ancestral Temple (ZJ-02), completed in 1925, has reached a remarkable span of more than 5 meters.

In the local, two spiral variations could be catalogued. One is a chicken-cage-spiral type (ZJ-02, 03, 05) since it looks like the local bamboo chicken cage. Another one is an ox-hair-spiral type (ZJ-04), which provides a more expressive and dynamic perception because of the intensive movement in the spiral geometry, but certainly with a higher requirement on geometric generation and construction.

During the investigation, carpenters with the ability to construct a new purely spiral chicken-cage wooden dome have been found as well. A representative example (ZJ-05) is located in the main hall of Baoguang Temple, just completed in 2017 by carpenter Master Liqun Zhang in Yinzhou of Ningbo area Zhejiang province. Therefore, one approach to the construction of a new spiral chicken-cage type could be documented.

Geometry of the spiral type

Sketching is the first step for a new spiral *zaojing* construction. It should be noted that the sketching graph is conducted from the view of the producer, i.e. behind the wooden dome. It is opposite to the rotation direction of the pattern from the perspective of a viewer. The sketching tools are almost leftover pieces of timber on the site: one wood board, one wooden strip with a through passed steel nail and one pencil. The geometric data of all circles and curves are engraved on the wooden strip. (fig.7)

Circle and Division. The spiral wooden dome is regularly divided by the spiral lines, which is called "Yangma" (阳马) locally. In most cases, it is evenly divided into 16 parts by 16 spiral lines (fig.10), sometimes by 20 ones. The corresponding points of division are well distributed on the inner- and outer- circle, basically positioned on the midpoint-principle. Compared with the geometry in Europe, there existed no concept of angle in ancient China (Baozong Qian 1998, Juncan Liu 1990). Consequently, the great adoption of midpoint-principle contributed to the distinctive characteristic of even and symmetry in traditional Chinese construction.

Spiral Line. The spiral wrap line is the curve connecting the points of division on the inner- and outer- circle, which determines the visual expression of a spiral wooden dome. The curvature of the spiral line is controlled by carpenters themselves. For Master Zhang, a spiral line is composed of three arcs; the first and second arcs are both completed by the radius of the outer circle, and the position of the centre of the second arc is moved outward compared to the first one; the last arch is hand-painted to connect the inner circle (fig.9). The closer to the centre of the dome is, the

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greater the curvature is (Master Zhang 2018). Unfortunately, the principle of positioning the arc centres has not yet be offered.

Layer. A spiral wooden dome is evenly divided into 16-24 layers by a series of concentric circles as well, with an average height of 8 to 9 centimetres. The construction with 20 layers is the most common practice.

In general, the actual dimensions and radians of each component could be obtained from the sketch on a scale of 1:10 (fig.7). Therefore, Master Zhang strongly emphasizes the precise of the sketch and empirical adjustment in construction. Sometimes, other local carpenters from different factions used to sketch a scale of 1:1 directly on the floor below the proposed wooden dome (fig.8).

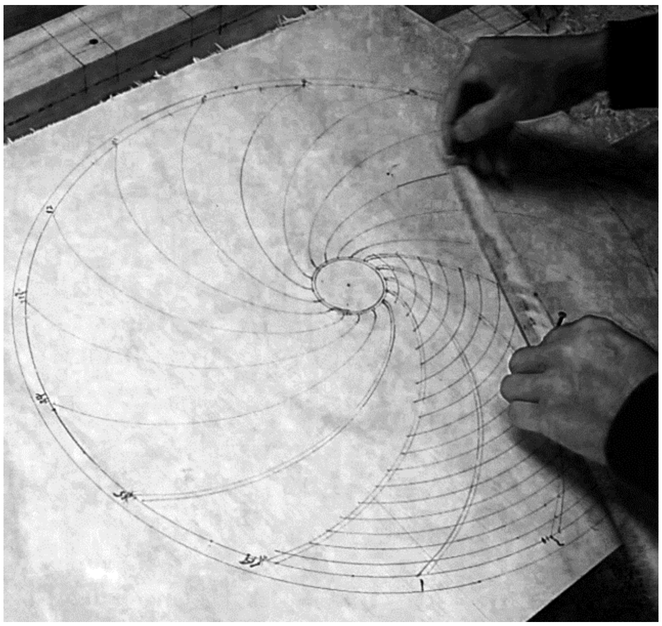
Fig. 7. Master Liqun Zhang was demonstrating the sketch of a new-built spiral *zaojing* on site, scale of 1:10. © Jingxian Ye

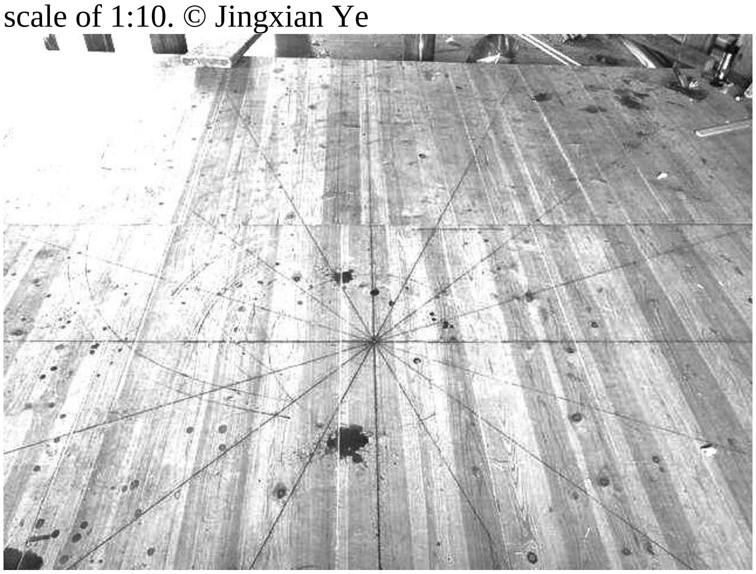

Fig. 8. Master Shichun Wang was demonstrating the sketch of a new-built spiral *zaojing* on site, scale of 1:1. © Lenka

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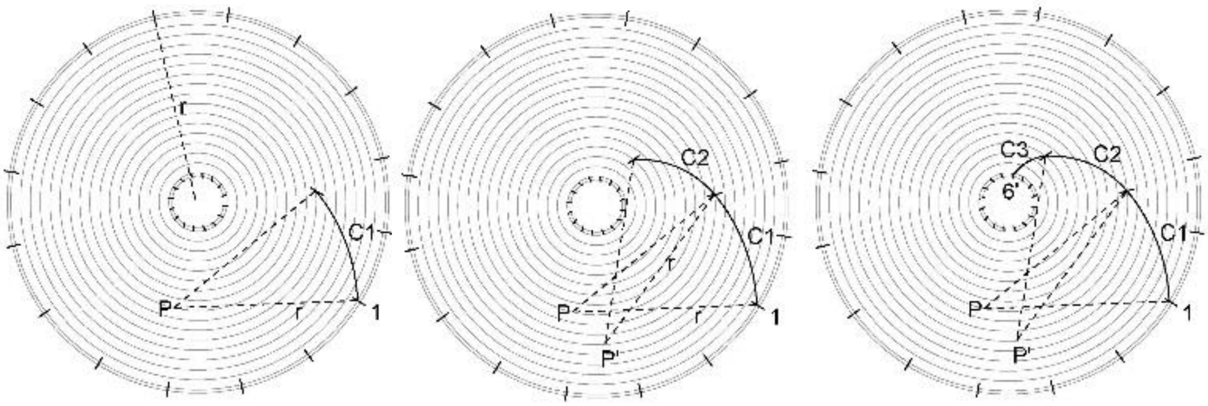

Fig. 9. Form-finding principle for the spiral-line. © Jingxian Ye

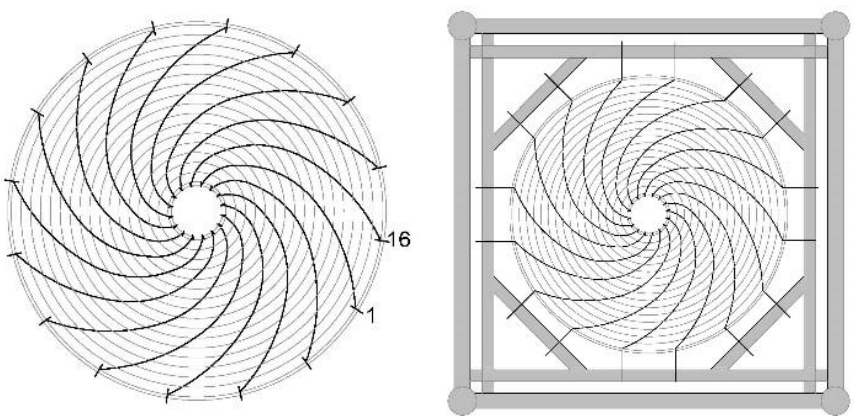

Fig. 10. Distribution of its weight over the edge beams. © Jingxian Ye

Fig. 11. The space between the roof and the spiral *zaojing*, built in the 1920s, in Ninghai. Ref. ZJ-01 © Jingxian Ye

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Structure of the spiral type

Geometric symmetry plays an important role in the structural stability of the ancient wooden domes. The square beam frame with four diagonal beams forms an octagonal frame (fig.10 right). Every two ridges are positioned on one beam-member through the wood-only joinery (fig.11). The weight of the *zaojing* is evenly distributed through 16 ridges, each representing a spiral warp line. Accordingly, the spiral form was placed carefully to be able to match the position of the supporting beams on the bottom. However, for the spiral type with 20 spiral lines, there is currently still no opportunity to observe the structure and construction behind.

In our investigation, the *zaojing* part in South China is detached from the roof structure of the opera stage completely (fig.11). Conversely, in North China, the *zaojing* is exactly the roof framework, which plays a crucial role in the roof shape generation and structural construction (fig.12). This is the fundamental difference between the ancient opera wooden domes in North- and South- China.

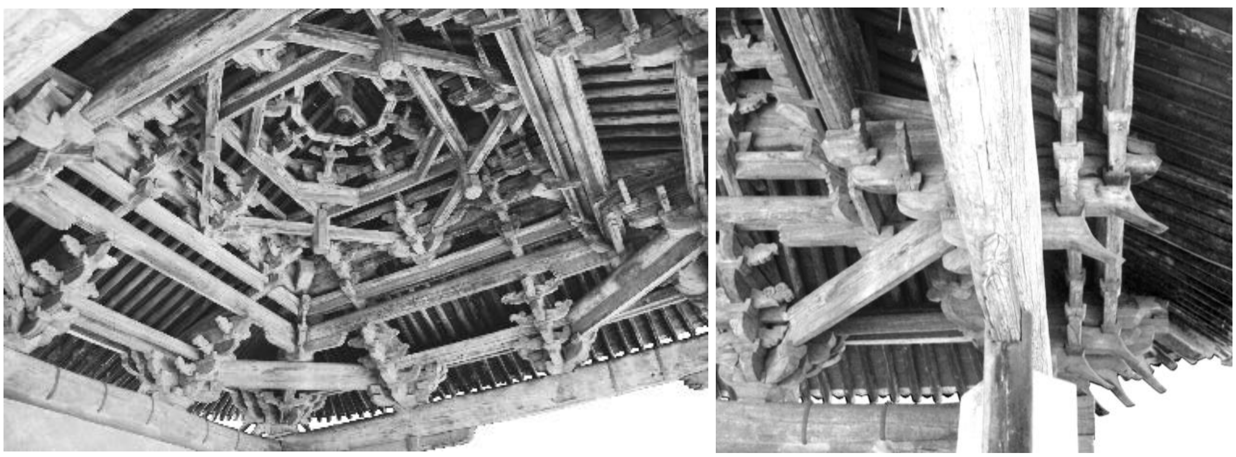

Fig. 12. Reciprocal *zaojing* in the opera stage of Niuwang Temple, rebuilt in 1283, in Linfen of Shanxi province. Height: 3.79m; Width: 7.45m; Depth: 7.42m. Ref. SX-01A © Jingxian Ye

Construction of the spiral type

The spiral type is an addition of three main components (A, B, and C; fig. 13). Component A, the longitudinal cantilever member, and component B, the peripheral curved slat, are assembled up to generate the shape of a hemisphere. Component C performances as the decorative member. Components A are cantilevered layer by layer, and they are jointed by the "Go-Through Tenon" (通榫), which could be easily observed from the renovation process of the spiral opera *zaojing* in Family Ye's Ancestral Temple (fig.14). Nowadays, this part has been purposely evolved by Master Zhang. He adds a "Dovetail Joint" between every two cantilevered components A to improve the tensile capacity (fig.15 left). The socket part of this dovetail joint is also produced penetrable especially for future disassembly or component replacement (fig.15 right).

In most cases, the "Straight Tenon" (直榫) is applied to connect Components A and B. For Master Zhang, in some exquisite projects, a "Sliding Dovetail" will be adopted for this position.

Despite the dome is latitude evenly divided, the curvature of the spiral line is changing from the edge to the centre. The closer to the centre, the larger the curvature of component A is. At the same

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time, the thickness of components A gradually decreases from the bottom to the top. In the example of Baoguang Temple (ZJ-05), the components A slowly transit from 5 centimetres at the bottom to 3.5 centimetres at the top in width, from the consideration of both aesthetics and structural performance. The thickness of components B in different layers is basically the same, only their length and curvature are changed layer by layer.

In the latest investigation, it is confirmed that the component C works mainly as the decorative part, rather than structural or constructional significance. The component C is attached to the component A, the “Straight Tenon” is usually applied in between, nevertheless the “Sliding Dovetail” is applied in Yinzhou by Master Zhang. This implies the difference in the order of construction.

It is worth noting that the new-constructed wooden spiral dome in Baohuang Temple (ZJ-05) in 2017 by Master Zhang has also reached the remarkable span of more than 5 meters. Whether such performance is related to his extensive use of the “Dovetail Joint” needs further analysis and confirmation. On the other side, in the late 1980s, Master Zhang had once participated in the renovation project of the ancient opera spiral wooden dome in Qin’shi Ancestral Temple (ZJ-02), which with the largest span in the existing records of ancient spiral examples.

In brief, from the interview with Master Zhang, carpenters’ knowledge and judgment of size, shape and weight are still relatively empirical.

Fig. 13. Components A, B, and C. Spiral *zaojing* in opera stage of Wei’shi Ancestral Temple, Xiapu Village, Ninghai, built in 1890. Ref. ZJ-04. © Jingxian Ye

Fig. 14 The renovation process of spiral *zaojing* in the opera stage of Ye’shi Ancestral Temple, Ninghai, 2017. Ref. ZJ-06. © Xiaodong Chai

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Fig. 15. Master Liqun Zhang was demonstrating the joints between every two components A of a spiral *zaojin*g, 2018. © Jingxian Ye

Renovation of the spiral type

The restoration of ancient spiral wooden domes mainly consists in replacing damaged elements. The renovation of the spiral *zaojing* in the opera stage of family Ye's ancestral temple (fig.16 to 27) is a unique case. It was a thorough process involving disassembly, repair, and reassembly, which provides a rare opportunity to observe the inner structure, construction, and wooden-joints of the chicken-cage spiral type.

Preparation. According to the local convention, a sacrificial ceremony is required before the operation, to pray for the blessing of the ancestors. Part of the roof structure over the *zaojing* is first disassembled. Components such as tiles and wooden beams with good properties are reserved for future reassembly. Several wooden beams are left to be used as a stand for the carpenters during the operation (fig.16).

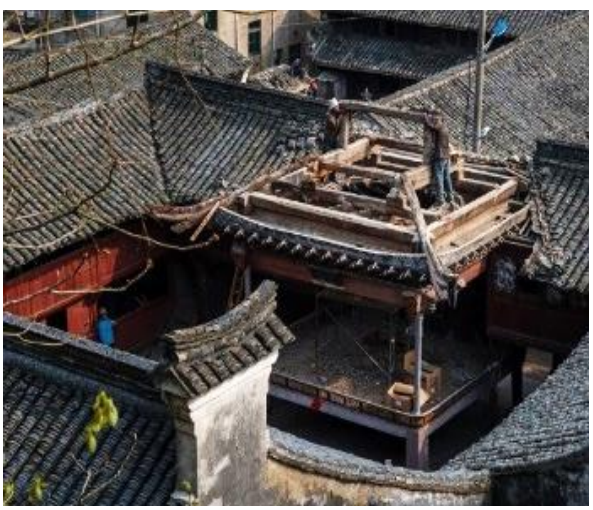

Fig. 16. Disassembly of the roof © Xiaodong Chai

Fig. 17. Removal of top plates © Xiaodong Chai

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Fig. 18. Hammering of the zaojing © Xiaodong Chai

Fig. 19. Dismount of the 18th layer © Xiaodong Chai

Fig. 20. Same-layer components are tied up © Xiaodong Chai

Fig. 21. Components are cleaned up © Xiaodong Chai

Fig. 22. Measuring with bamboon strip © Xiaodong Chai

Fig. 23. Manufacturing of new tenon tongue © Xiaodong Chai

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Fig. 24. Carved new component
© Xiaodong Chai

Fig. 25. Hammering of the reassembled zaojing
© Xiaodong Chai

Fig. 26. Close to completion
© Xiaodong Chai

Fig. 27. Close to completion © Xiaodong Chai

Disassembly. It appeared that the top plates of the *zaojing* are fixed with ancient handmade nails (fig.17), and the rest is constructed with wood-only connections. Layer after layer, the tangential curved slats are removed first, followed by the radial cantilever elements. Each element is numbered clockwise before its dismount. A wooden hammer or stick was used to tap upward to make the wooden construction loose and avoid damage caused by locally concentrated forces during disassembly (fig.18, 19). The dismounted components of the same layer are tied up together to prevent future confusion (fig.20).

Repair and remanufacture. At this stage, each component is checked and cleaned with a brush (fig.21). If the damaged area is longer than a third of the whole length, or if the critical joint is seriously destroyed without a possibility of repair, a new component is manufactured and replaces the original one (fig.22 to 24). The remaining part is kept as source material for the manufacturing of other small elements.

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Reassembly. The assembly sequence is just the reverse of the disassembly sequence, from bottom to top. In order to ensure the fitting of all elements, a trial assembly is performed beforehand. After all the members are installed in place, the gap between each joint is immediately checked (fig.25 to 27). The small cracks are filled with tiny lumber, in order to ensure that every node works effectively and a tight construction. The repair or new construction is generally chosen in autumn to avoid the rainy season in South China.

Material Principle

Basic principle

As the saying goes "North Pine and South Fir", wooden construction in North China commonly used pine wood, while in South China carpenters preferred Chinese fir.

Zhejiang, the surveyed area, is located in the southeast China. Most areas here are rich in pine wood. Still, all regions in Zhejiang preferred to use Chinese fir. It is indeed related to the local wet and rainy climate, which is in favour of serious termite disaster. Pine is easily infested, in contrast, Chinese fir is not susceptible to the insect. The other advantages of Chinese fir are listed as follows: the grain of Chinese fir is very straight; uneasy to be deformed; light-weighted but with high intensity; tough but easy to be processed. Furthermore, compared to other wood materials, the Chinese fir is able to undertake the fluctuations of temperature and humidity more frequently.

Meanwhile, "Locally resourced" is also the basic principle of the material adoption in the ancient Chinese wooden construction. Yew, camphorwood and mulberry were local commonly used building materials in Zhejiang as well. Interestingly, the principle of specific timber material application is according to the position of components in construction, clearly related to the structural performance of different timber material. Based on the interview with Master Zhaolong Ge, an empirical principle of materials adoption are summarized in *Table 1*.

In general, before the construction, three years is needed to deal with the timber, such as drying, disinsection and baking with charcoal. When dealing with wood nails, boiling or roasting should be done to increase their hardness. The method of boiling is as follows; put the wood nail into the pot and boil; once the pot boils dry, add water to continue, so repeated, probably for 16 or 17 hours until the surface of the wood becomes black and with the sound similar to metal when knocked. In the case of fire-baking, the wood material is placed on the fire, roasted and rotated. Regarding the bamboo nail, frying in tung oil is a favoured method to manufacture a more solid one without corrosion and insects (Master Ge 2017).

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Components	Wood type	Principle
Beam (horizontal component)	Pine Camphor	Performance good at tension
Pillar (vertical component)	Chinese fir Chinaberry	
Wood nails	solid beech, elm, Chinese Mahogany, or bamboo	solid wood
Rafter	Pine	
Window frame/ Furniture	Phoebe	
Elements for carving	Camphor Pine	easy to be processed

Table 1. Principle of wood material application according to the position of components (Master Zhaolong Ge, 2017)

In particular, the principle mentioned above should be considered as the empirical knowledge rather than a norm or a standard, since it is greatly influenced by the factors beyond construction like the economy, transportation, climate and culture etc (Master Ge 2017).

Nowadays, for the construction of the new wooden spiral dome, camphor is usually adopted as the primary material by Master Zhang, since camphor is fragrant and insect-resistant, as well as suitable hard to be processed.

Material principle of the spiral type

One typical feature of the spiral wooden dome is the curved member manufacturing. It is obviously a material-consuming way if all members come from usual straight logs. For this problem, Master Zhang indicated that he chooses the naturally curved log purposely in order to produce more curved components, instead of artificial bending handling. From a scientific perspective, the use of timber in its natural form could increase use of natural timber biomass and reduce economic resources for irregular trees that originally have no value in timber structures.

This approach is similar to the recorded ancient European shipbuilding technology in the maritime era, which took the advantage of irregular tree trunk geometry. Interestingly, the surveyed district,

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where spiral wooden domes prevail extensively, is exactly suited in the coastal area and used to be China's sailing centre hundreds of years ago. Whether the processing of curved members in architecture is related to traditional shipbuilding still needs to be verified.

Typical construction policy

"Split construction"

A typical construction policy translated as "split construction", has been carried out for hundreds of years in Ninghai district. The traditional Chinese buildings are usually axisymmetric. Along the axis, the part of the project that was first constructed was divided into two parts by the client, who asked two different construction teams to build one half each, including the construction of the structure, the carving, and the painting. Their work would eventually be combined and tightly merged. However, in the meantime, the contrasts in construction and crafts between two sides were easily distinguished. The "split construction" process consequently allowed the client to pick the best carpenter master out of the two candidates.

"Zhaomian-Arts"

The field survey showed that the circles of existing spiral examples were frequently imperfect in geometry. However, the local carpenters actually do not care about this defect. In Chinese traditional wooden construction, there existed no mapping system with exact dimensions like in the West. Under such conditions, when the Chinese carpenters constructed the form of a circle or a hemisphere, proportions and relationships of the components were valued over accuracy. It can be read from several rare original sketches by a local carpenter master for the web-type *zaojing* (fig. 28).

However, in the traditional timber practice, under the condition without accurate mapping system, some typical tools for measuring and recording have been developed and applied for thousands of years. In one or several strips, the geometrical and dimensional information of all the components were marked, and their positional relations are expressed by the unique symbols, i.e. there exists a modulus relationship between all components in construction. In other words, if one kind of component is sized, the dimensions of other components are determined immediately.

This approach is called as "Zhaomian" (罩篾) in Zhejiang province (fig.31), as "Zhangchi" (杖尺) or "Gaochi" (篙尺) in other Chinese areas (fig.32), and as "Kiku" (规矩) in Japan (fig.30). Normally, it is considered as the essential knowledge of carpenter works, and only the carpenter master in a team has the right and ability to define the dimensions. Therefore, the tools "Zhaomian" usually could only be mastered by the carpenter master, who held the strip and directed the workers to produce different components at the same time and to assemble them into a whole structure. As such, a reasonable workflow and management system has been formulated (fig.30).

The way of measuring and symbolizing changed greatly in different regions and carpenter factions. The knowledge of dimension is passed to the apprentice through oral traditions, and the set of tools 'Zhaomian' is carefully preserved by the carpenter master in his lifetime.

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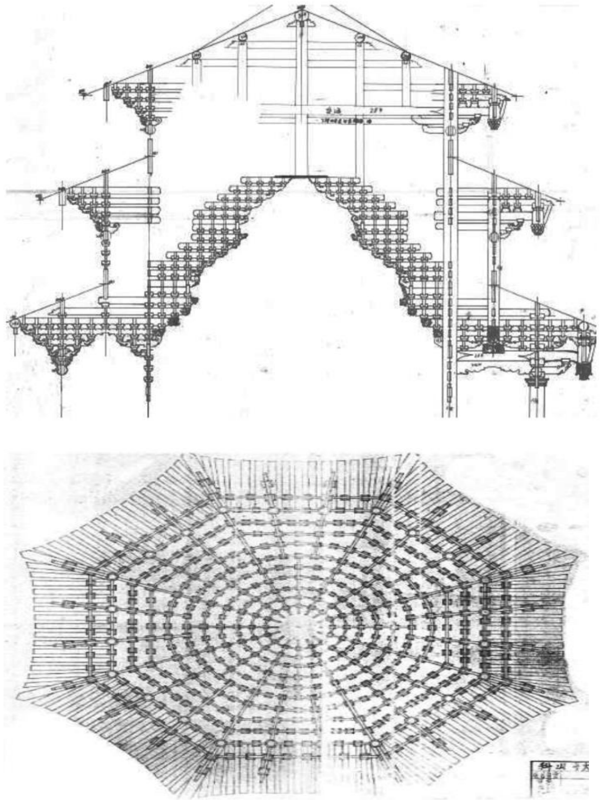

Fig. 29. Original sketches of web *zaojing* in the main hall of Keshan Temple, Xidi faction, Fujian province © Master Shimeng Wang

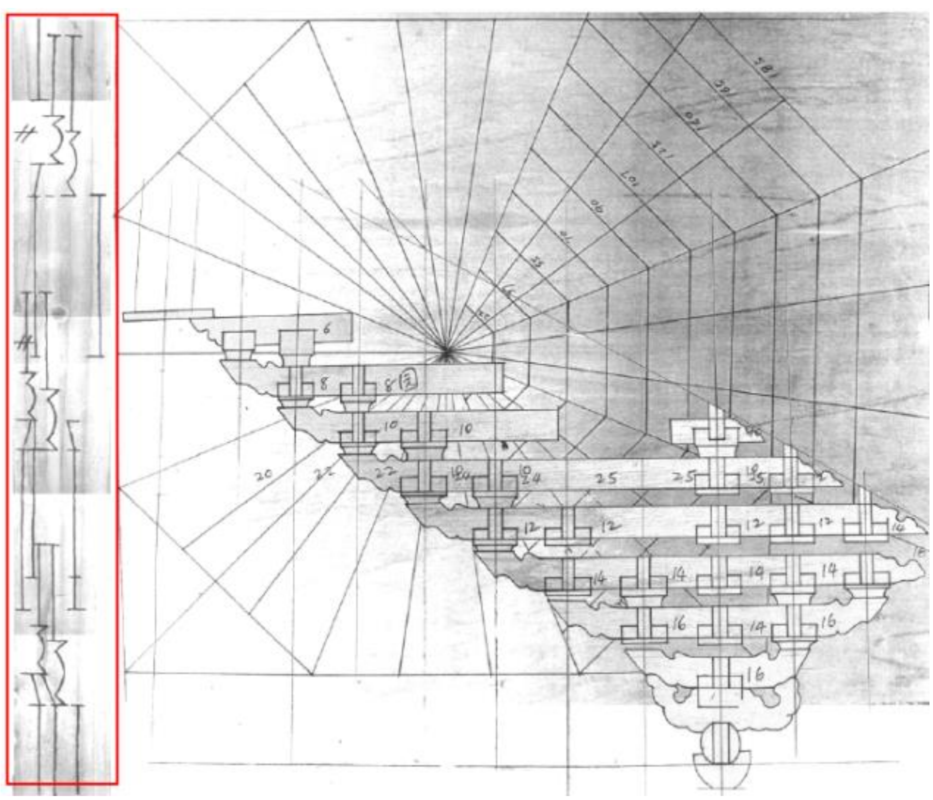

Fig. 30. Original “Gaochi” and the section of web zaojing, Xidi faction, Fujian province © Shuxian Hong

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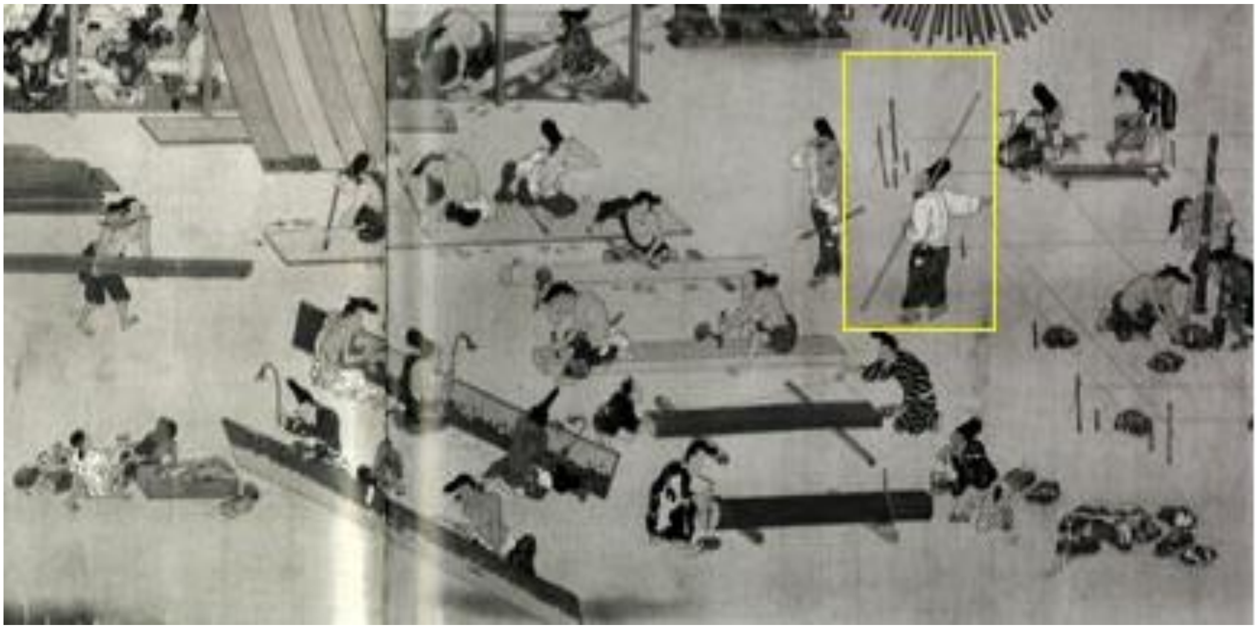

Fig. 31. Kasuga Gogen Genki E. painted by members of the Fujiwara clan, early 14th Century (Kamakura period), Japan.

During the field investigation, the tools "Zhaomian" especially for opera spiral *zaojing* and skilled carpenter master have been luckily found.

Fig. 32. Tool of Zhaomian for the spiral zaojing in Ninghai © Yaping Zhang

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CONCLUSION

Following a field survey and an extensive literature review, this paper brought to light a unique wooden construction typology in China. These *zaojing* are unique masterpieces of wood joinery. Much more have to be understood about them today in order to ensure their long-term preservation.

Note

Zaojing, the Chinese shallow wooden domes were initially published in the name of *the caisson* in the authors' paper *The caisson – review of a unique wooden construction typology in China* for 2018 International Congress on Construction History (6ICCH) in Brussels, Belgium. After discussion with the experts, its Chinese pinyin pronunciation *zaojing* (Chinese: 藻井) is adopted for further research publications.

ACKNOWLEDGMENTS

We would like to thank the protectors of these ancient wooden domes, for their efforts and persistence for decades. We would like to thank Mr. Xiaodong Chai who provided us with the pictures generously. We are sincerely grateful to the carpenter masters Mr. Liqun Zhang and Mr. Zhaolong Ge who provided the component samples and explained the wood-only construction knowledge without reservation. We are particularly grateful to Mr. Gangxiang Zhao, for his endless supports, inputs and encouragements in this research. We are also grateful to the experts who offered us valuable advice at the IIWC Symposium in York in 2018.

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Heritage Craft Science

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Introduction

Cultural Heritage Management requires both broad and pointed expertise in different fields with distinctive and intersecting practices. Both within natural science, humanities and social sciences. However, the management also requires special competence in craft traditions, practices, methods, documentation, interpretation and analysis. Heritage Craft Science is a new field within the University and closely linked to practical, procedural knowledge-based understanding. The research focus is both in and on craft. The knowledge of how previous generations and man have handled nature, raw materials, resources, substances and objects through making and cultivating is crucial. In the field of craft research, the working processes are used as a crucial method of investigation. This paper will present some perspectives on Heritage Craft Science as a new field of education and training towards Heritage Studies.

Department of Conservation in Gothenburg

What is conservation? How does the department define it? In light of the changed global context for conservation, scientists widely acknowledge that we live in a world dominated by the humans, but that this reality is characterized by how people, things and surroundings reflect and mirror each other. Therefore, conservation science today incorporates conservation into a broader interdisciplinary field that explicitly recognizes the tight coupling of social and natural systems. Emerging priorities include pursuing conservation within gardens, landscapes, buildings, constructions or objects etc. We work with knowledge, questions and practices regarding craft, sustainability, heritage management or focusing on heritage and human rights and equity. We argue that in conservation; strategies must be promoted that simultaneously maximize the preservation of biodiversity and the improvement of nature and human well-being.

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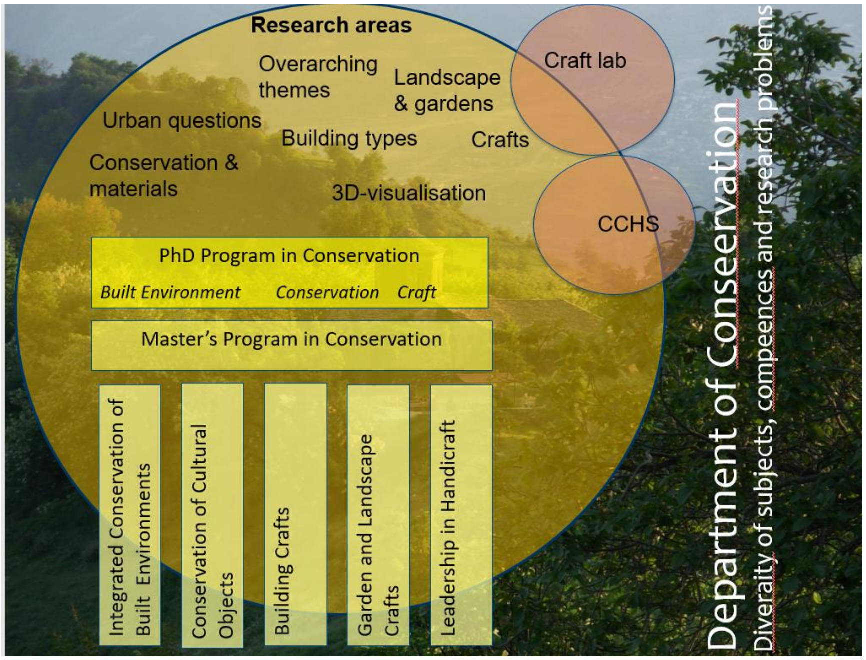

Fig. 2. Department of Conservation in Gothenburg

The term Conservation Science is also connected the UNESCOs definition of Heritage Science:

"[A]n interdisciplinary research domain bridging the humanities and sciences. It focuses on improving the understanding, care, use and management of both tangible and intangible heritage so it can enrich people's lives, both today and in the future"

Our department's intention is throughout practical- and scientific training and research projects to go deep into the heritage, both throughout surveys of intangible culture, material culture and the surroundings, but also how this factors interact with it each other and influence each other.

All this includes knowledge into methods and theories, such as examination and diagnosis, documentation, evaluation, planning and organization, implementation of actions, following-up and counseling.

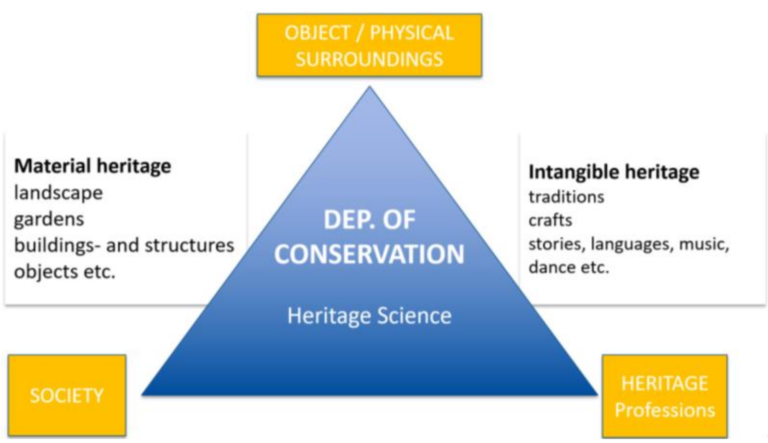

Fig. 3. Conservation Science and the departments "three corners"

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For our department conservation, science and heritage science consists of three corners. Junctions that we constantly alternates between; material and intangible culture, social context and ourselves; the skilled professionals. That means that we also are involved and engaged in society's development. Therefore, we believe in inter-disciplinary work but also the importance to work in the depth within each fields. Conservation Science and Heritage Science both needs humanists and social scientists, conservators, natural scientists, craft specialists or building antiquarians. However, we need a common understanding and a platform; we need a humble attitude and knowledge around each other professionalism.

Heritage Craft Science

Heritage Craft Science (HCS) is founded on hermeneutic and phenomenological practice and approach; the performer's surveys and investigating of certain phenomena. The craft researcher relate to something he/she are familiar with, but at the same time something that is distant and far-off for the agent. At the same time, the agent is dependent on his/hers skill, knowledge, experience and understanding. Recognition, mindfulness and empathy is crucial for HCS and within the heritage management protection. Our phenomenological approach is much about the process acting, doing, interpreting and explaining the phenomena that appears in the craft research process. The bodily and sensitivity from our inner perspective and subjective considerations.

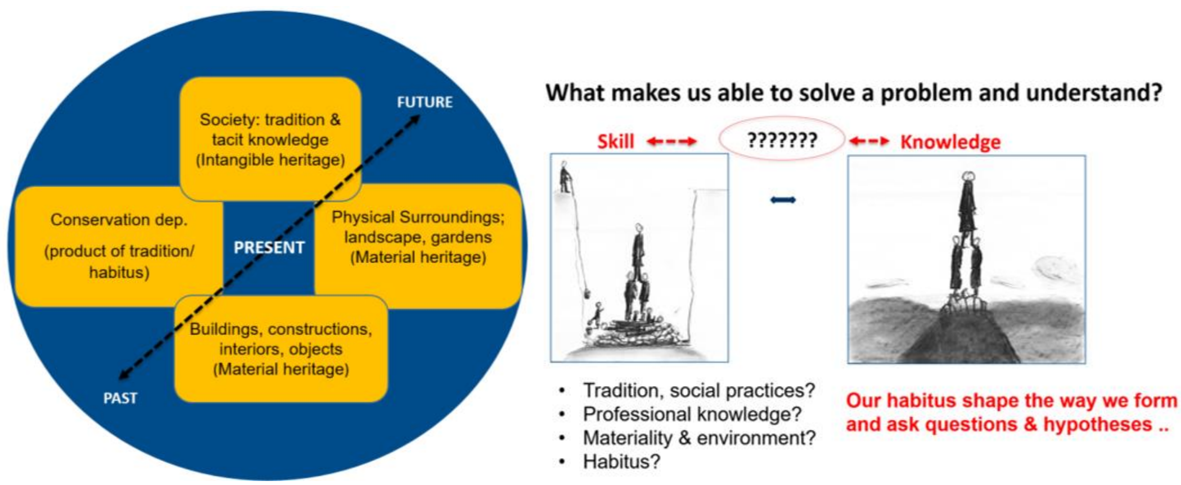

Fig. 4. The model to the left gives an impression of some important aspects of surveys and the relation past-present- and future. The model to the right demonstrates conditions that may affects us in the processes of awareness; the processes from action and skill to recognition (knowledge).

How are we able to ask questions, understand or problematize "time and being" - and the relation between past and present? Is there a definitive distinction or continuity? How do we deal with and investigate material and immaterial culture in this context? How are theory and science linked with crafts and know-how and vice-versa?

From a conservation point of view HCS is first and foremost a concern with things, and particularly with humble, everyday things, but in the same time on the people behind the artefacts. This interest rests on a consideration that this two, things and people, cannot be separated and are inextricably

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bounded. Heritage Craft Science are also concerned with the relation between past and present. How past lives in the present, and how it is mirrored through things but also in traditions and habits. However, in the same way, the existence of the past in the present is not always controlled by humans. Habitual actions is hardly possible without artifacts or surroundings and material culture is hardly possible without habitual actions. In this way, HCS is both connected to an ontology and epistemology based on a hermeneutic or phenomenology approach.

Heritage Craft Science is concerned about questions around knowledge and attitude, and are therefore concerned about how craft is connected and reflects our habitus and defines who we are.

The factors above in figure 3 is examples about what forms and affect our practices and should therefore be anchored on an epistemological and ontological platform that requires both distinct, divergent and complementary approaches based on practical, theoretical and methodological tools. Therefore, how can we use research strategies and scientific methods to better problematize, clarify and unfold what happens, in the so-called "black box" between skill and understanding? Sure, it is a complexity to explore past practice by using current knowledge, practices and traditions from present.

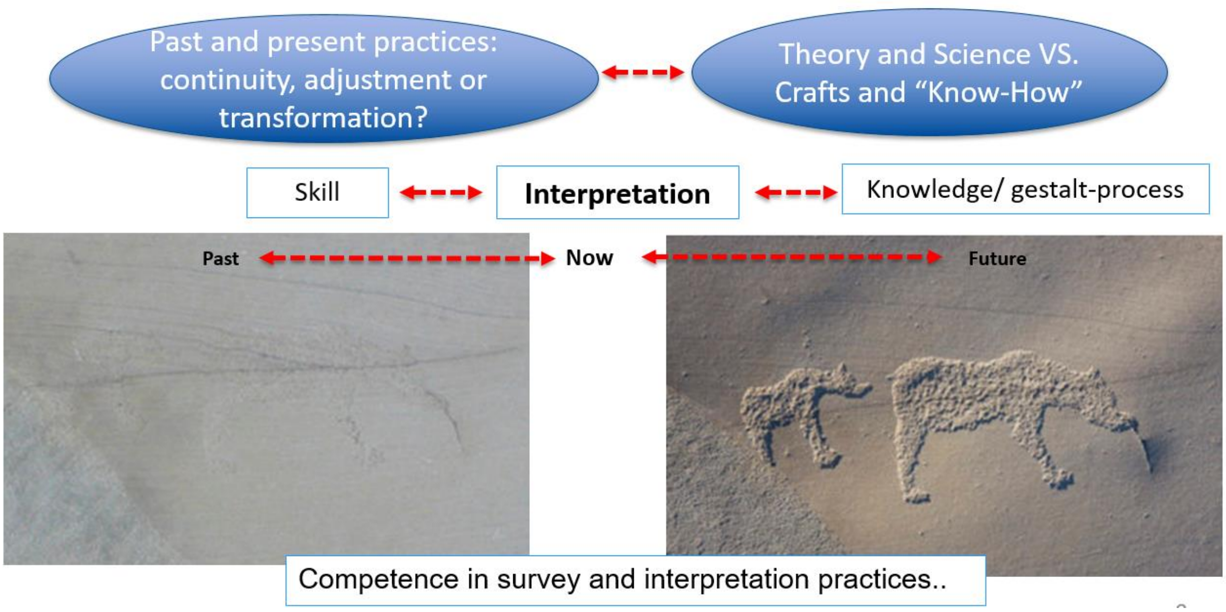

Fig. 5. some challenges in Heritage Craft Science; past and present – material culture – intangible culture.

The photo to the left in the figure above reveal how important light and technology is when we are doing a survey. In such examinations, we use both advanced technology, but also uncomplicated surveys. In HCS it is necessary to use advanced documentation methods, but even more crucial is his/ hers ability to analyze the know-how behind the object or the surroundings. HCS is dependent on both the antiquarian or conservation knowledge to do competent surveys, but first of all the craft knowledge. Heritage Craft Science are dependent on the connection between these disciplines.

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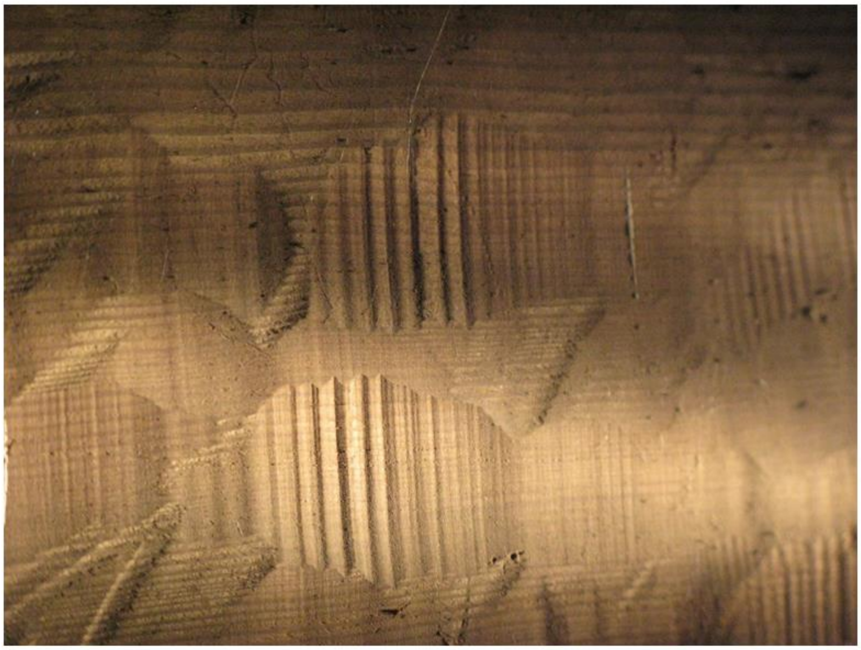

Fig. 6. Documentations of tool marks in timbers. Competence and knowledge about craft is crucial when surveys and documentation of craft is to be done.

The photo above (figure five) shows that it is also a good solution to use easier and not so complex technology when he/she are doing surveys. In that way, he/she knows how to focus, lens setting, but in the same way, it is also important to know how to use a camera; how right angel or lighting illuminate and clarify the traces of the construction or craftsmanship behind the product. The photo above visualize both tool marks in the surface and the inherent characteristics of the materiality itself, but also revealing stories about tools, techniques, procedures or choices of materials.

Education and research in Heritage Craft Science

Education in Heritage Craft Science at our department is off course about both problem-based learning, but also offers research preparative education:

In that sense, it is both important to learn methods and practices to do research IN traditional craft, but also how research strategies and scientific methods can help us to understand what makes us able to solve a problem or to understand.

Problem-based, skilled oriented learning and research

When it comes to problem-based learning oriented towards skill in the field of HCS it is necessary to focus on the craft itself, surveys, diagnosis, assessment of needs, choice of actions, planning/ organization and implementation of actions are all essential for good decision-making and a competent management of cultural heritage.

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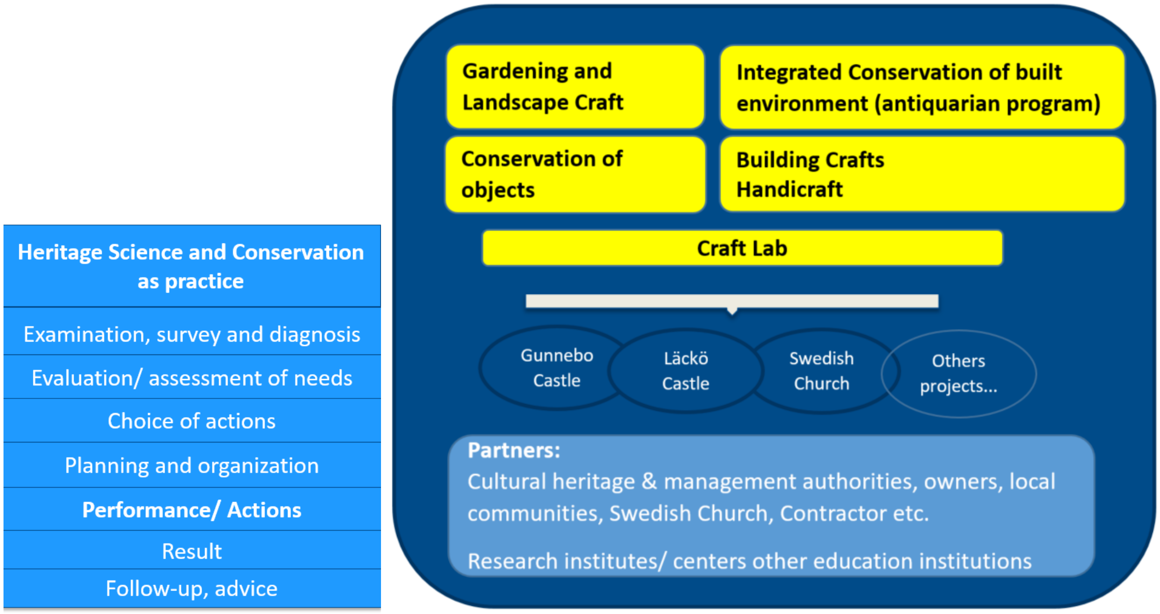

Fig. 7. Focus on problem-based, skilled oriented learning – and research infrastructure

In this way, HCS at our department is both research in and on/ about craft. Training in documentation, survey, analysis and interpretation are crucial – not only the skill to act itself. Training and research is oriented towards project-work preferably in smaller groups and interdisciplinary. A central objective of our education is that the students:

- Assess and form an opinion of certain situations and clarify concepts
- Train to examine, do surveys to identify and analyze problems and to make diagnosis and judgements (also to suggest possible causes and make hypotheses)
- Are able to evaluate and the assessment of needs
- Discuss the relationship between problem(s) and cause(s)
- Formulate the need for learning
- Obtain knowledge
- Are able to make choice of actions and use of knowledge
- Alter between practical work and reflection
- Supervising requires close contact between student and teacher

The objective is to:

- Achieve professional and academic competence
- Achieve skill and ability to go deeper into the practice
- Achieve collaboration abilities
- Ability to reflect in and about practice
- Ability to ethical reflection

The yellow boxes in fig. 7 demonstrates educational programs and research at the department. In the mid-section examples of research projects which our educations have possibilities to join. The

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main challenge with this model is to organize clusters of partners; both research institutes, specific competence centers outside the universities and local artisans.

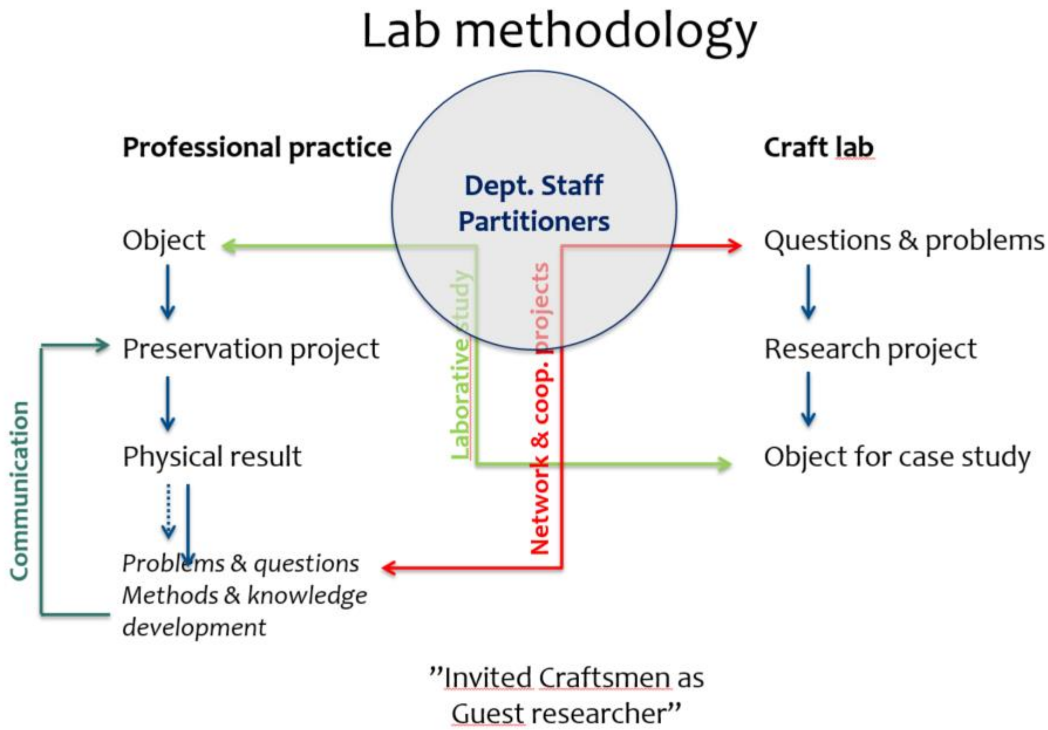

Fig. 8. In practice, knowledge works as a toolkit (Almevik 2011). Knowledge of traditional techniques and materials serves as a tool. In craft research, knowledge is the goal. In the craft laboratory, practice and theory are put into interaction in order to protect the heritage, both physical objects, surroundings and the craft knowledge behind it.

The research preparative education

An example of one specific research method is action research, so-called auto-ethnographic methods, and hypothetical deductive or inductive surveys. These methods is research and examinations in, about or through practice.

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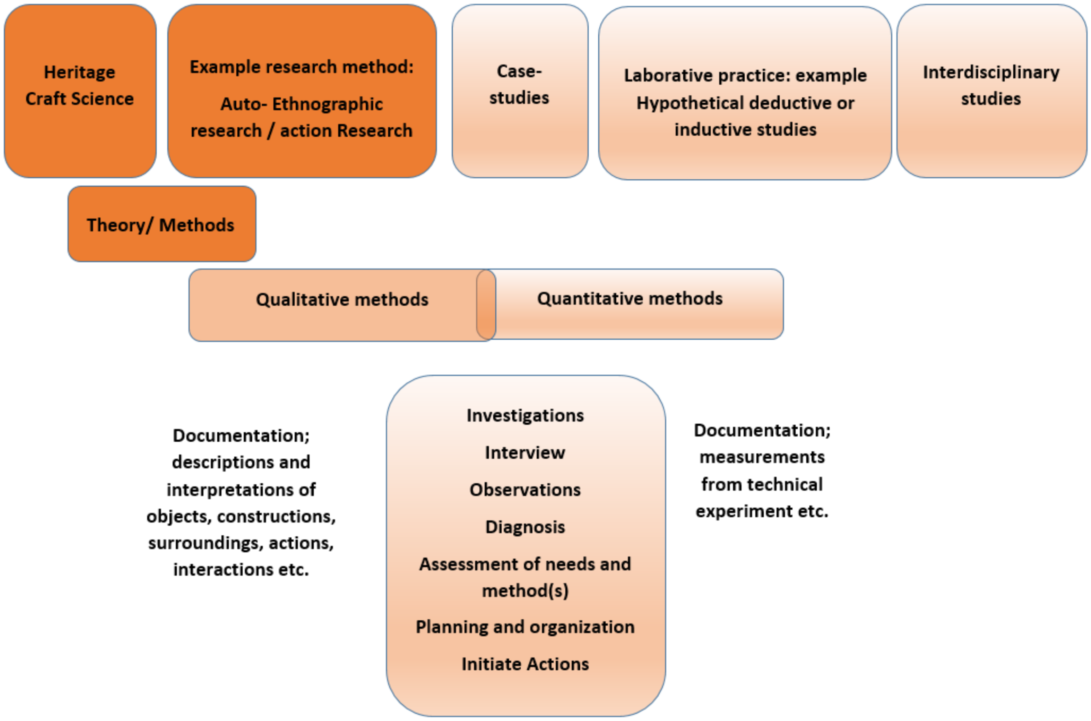

Fig. 9. Example of a research strategy and scientific methods in craft science

His/her practice controls and highlights the research process; it is the executive practitioner who is the examiner and the methods focuses on the craft. Practice led research can be done in different ways. One possible approach is when the executive practitioner do the survey, document the processes and in the same time are the observer. In the figure presented below we can see how the blacksmith analyses his own "step-by-step process" from intuition, action, survey and analyses:

Analytic steps:

Step 1: Initial phase (topic and questions, research-history, methods, source surveys)

Step 2: Prepare hypotheses

Step 3: Action phase 1. Reconstruction of hypotheses

Step 4: Action phase 2. Practical tests, documentation (film, photo, descriptions etc.). Testing and falsification

Step 5: Observation & analysis. Hypotheses, tests and results compares to original context/ objects .. The result translates to an academic format ..

The research structure are not linear..

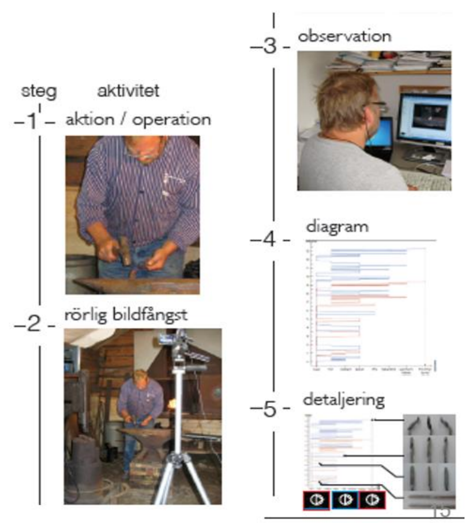

Fig. 10. Practice led research represented by the blacksmith and his "step-by-step process" from intuition, survey, to analysis.

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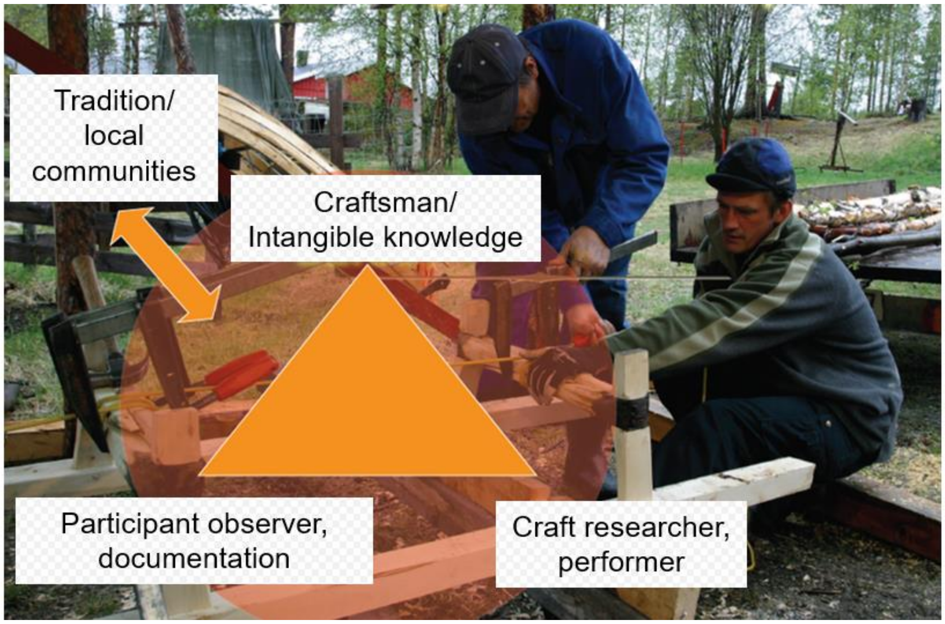
Another way doing approaches is surveys were the participant observer document the performer and craft researcher and the tradition bearer is the source:



Fig, 11. Methods documenting the relation between skill, knowledge and interpretations

The experienced craftsperson represent the tradition and the knowledge. The craft research here is done throughout the performer who participate but also the observer who does the survey. The two models above presented as fig. 10 and 11 illuminant the actor's perspective (intentional and subjective), but also the observers perspective (intentional, but more oriented towards the context; against the object, subject and surroundings).

In this way, empathy is crucial in practice led research. The Danish philosopher Kierkegaard describes it in this way:

"If One Is Truly to Succeed in Leading a Person to a Specific Place, One Must First and Foremost Take Care to Find Him Where He is and Begin There. This is the secret in the entire art of helping.. Anyone who cannot do this is himself under a delusion if he thinks he is able to help someone else. In order truly to help someone else, I must understand more than he–but certainly first and foremost understand what he understands.. If I do not do that, then my greater understanding does not help him at all. If I nevertheless want to assert my greater understanding, then it is because I am vain or proud, then basically instead of benefiting him I really want to be admired by him. But all true helping begins with a humbling.. The helper must first humble himself under the person he wants to help and thereby understand that to help is not to dominate but to serve, that to help is a not to be the most dominating but the most patient, that to help is a willingness for the time being to put up with being in the wrong and not understanding what the other understands".. (Søren Kierkegaard 1962-64)

In order to describe procedures and actions in craft it is always essential to understand the intentions and perceptions. To achieve this it is possible to use a participant observer who do the survey "in situ". In this way, the actions or procedures are documented, interpreted and explained

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based on the research topic in the approach. It is required that the observer has a basic understanding of craft practice and are able to accomplish a basic scientific method in the approach. This means that he/she are able to establish a continuity and correlation between practice situation (for example process and actions), survey and the analyses. The model below (fig. 12) demonstrates the inside and outside perspective in craft research.

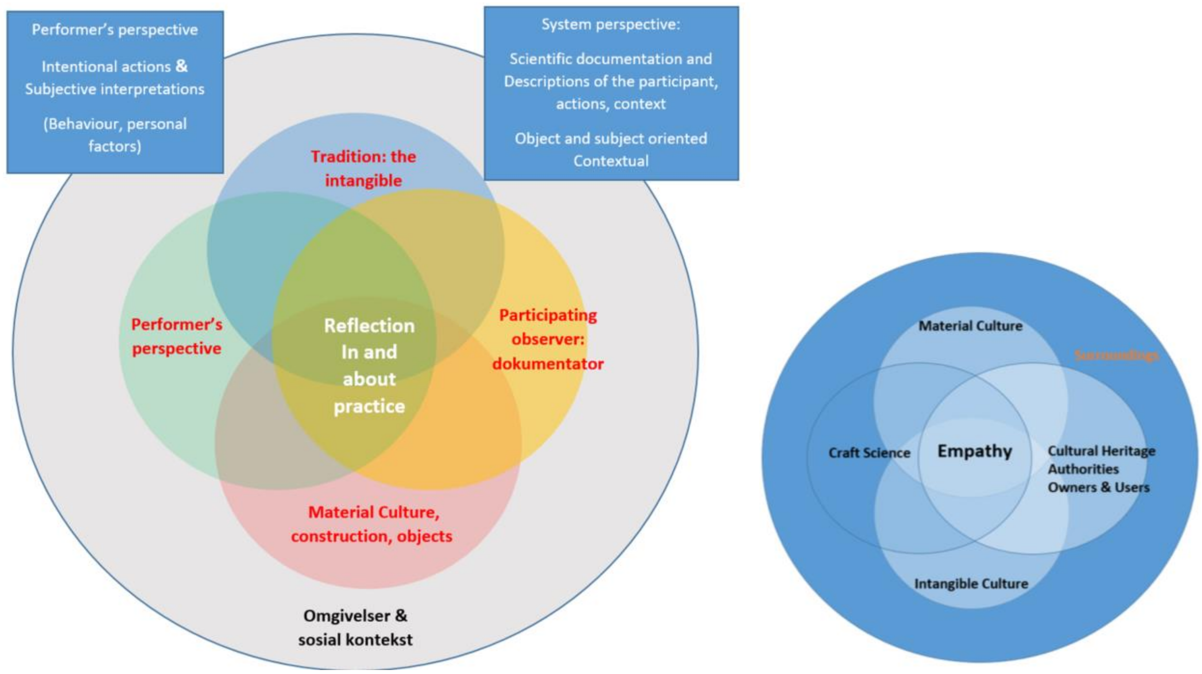

Fig. 12. Reflection in and on practice (skill – interpretation - understanding). The figure to the left summarize the role of empathy in approaches were the connections between things (material culture), traditions and practice (intangible culture), and surroundings are examined.

The figure below summarizes empathy first of all as an qualitative method in a hermeneuetic or phenomeneologic research tradition. It demonstrates the relation between natural- and human science. Heritage Craft Science are somewere between those traditions.

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Natural Science Research tradition	Human Science Research tradition
Positivism	Hermeneutics / phenomenology
Qualitative / Quantitative research	Qualitative / Quantitative research
Objectivity	Degrees of Subjectivity
Explanations	Understanding, empathy
Cause - Effect	Cause – Effect

Empathy as qualitative method

Recognize, immerse, identify, sensitivity as basis for:

- Analysis of intangible / material aspects
- Action, reflection and analysis
- Language, communication
- Interviewing
- Interactions
- Preliminary studies, fieldwork, observation, surveys (alternate between closeness/ distance)

Fig. 13. Empathy as qualitative method

So, what does this mean for practice led research in Heritage Craft Science? Why is this relevant? Empathy as qualitative method is first of all important because it brings us closer the material or the knowledge (craft person) behind it. Empathy in HCS is how the agent/ craft researcher are living himself/ herself into another craft person, a living tradition or something physical; for example an object. Empathy is the capacity to understand or feel what another person is experiencing from within his/ her frame of reference, or to go into something physical or material. It is the researcher capacity to place him/ herself into another`s position. Empathy is also the ability to recognize, immerse, identify or to use characteristics like sensitivity.

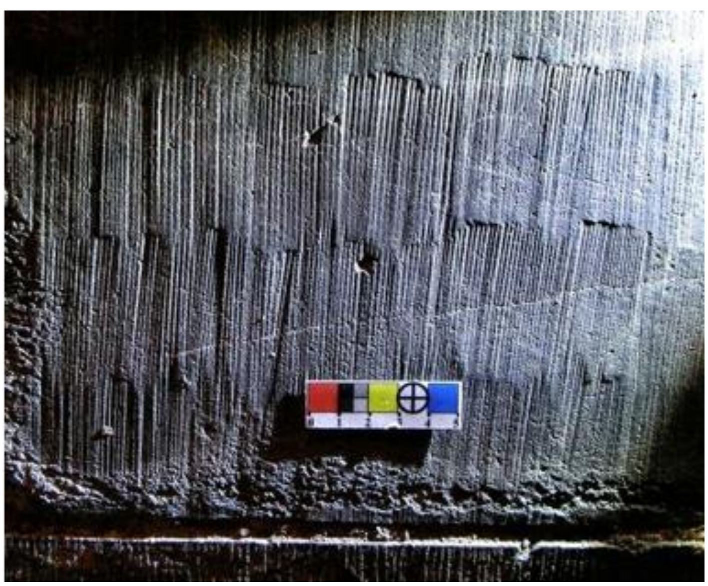

Fig. 14. Tool marks in soapstone. Surveys and documentation of craft were the capacity to understand craft in an object and living traditions from empathy and sensitivity.

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Empathy is a necessarily tool when intangible or material aspects, actions, dialogs and reflections throughout language and communication, interactions, interviews or fieldwork are performed. As a craft researcher it is neceserly to reconstruct and deconstruct the object, material, toolmarks and context before analyzing it.

An ontological and epistemological approach in craft is therefor to exploit empathy to observe the connections and contextual relationship between materiality, bodily expressions, cognitive aspects and surroundings.

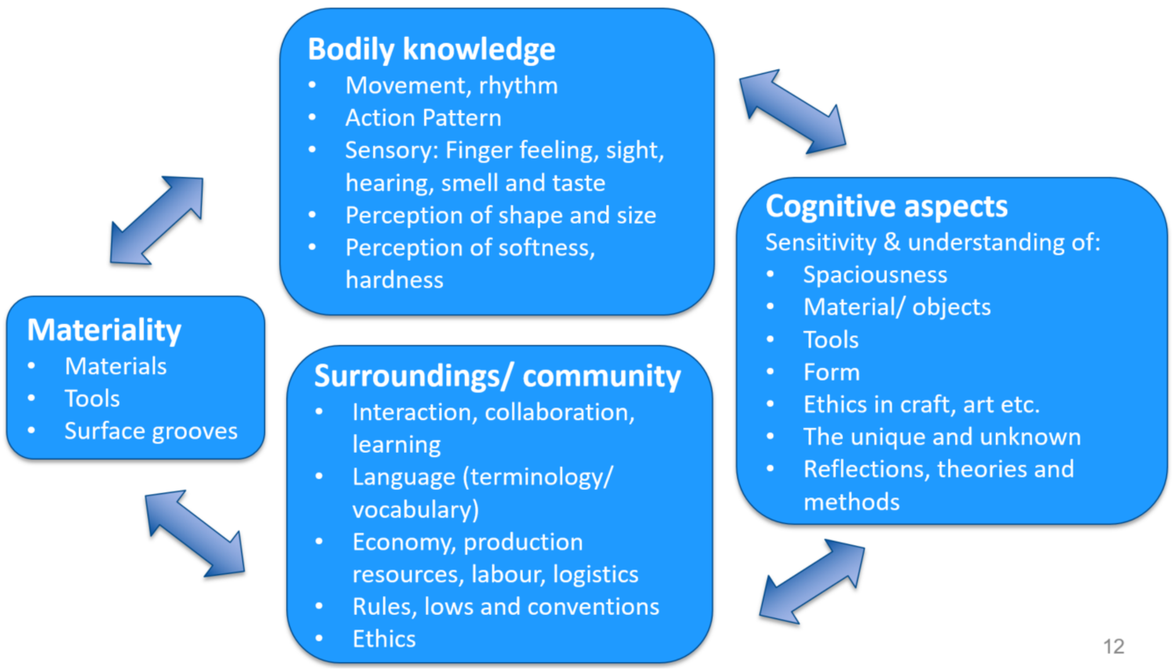

Fig. 15. Contextual relations between materiality, body, cognition and surroundings

Why do surveys and convey craft into a scientific format?

The Norwegian crafts researcher, Jon Bojer Godal, has focused on how vulnerable and exposed the living tradition of crafts is in modern society in light of its rapid technological innovations (Godal 1996). According to Godal, craft knowledge as tradition and cultural history, is about to die and the challenge is therefore primarily to transmit this action-oriented knowledge to new generations through transmission of action, knowledge and practice, and make it literally available. In craft research we often alternate between objects, surveys and performing - and the analytic and reflected situation after were the researcher are more distanced to the practical situation.

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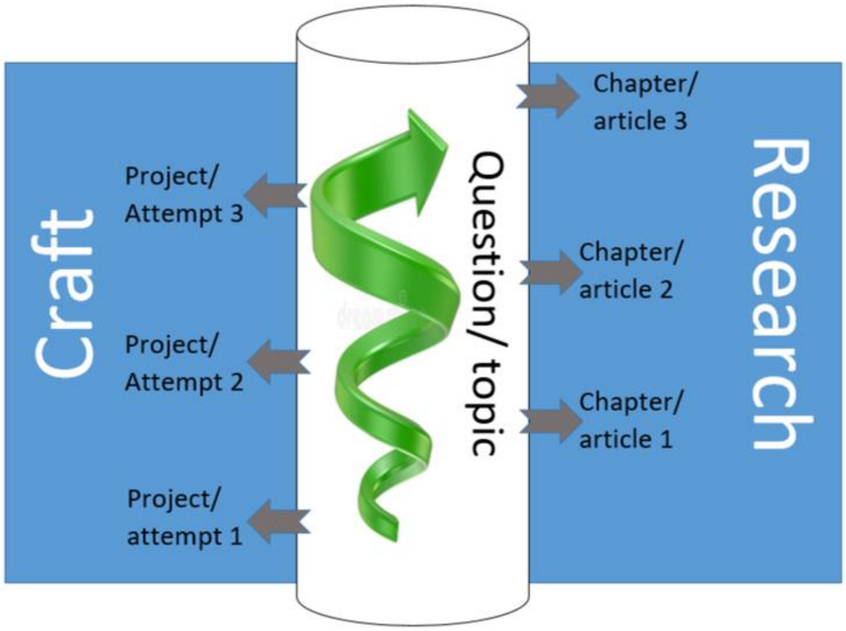

Fig. 16. The process of doing craft research into a scientific (academic) format. The figure demonstrates possible research steps and a possible way to present such research literary.

Ending

Heritage Craft Science explore and analyze the traditions, craft products and knowledge by means of step-by-step research stages. In this way craft science is required for skillful surveys, diagnosis, assessment of needs and choice of actions. All this, together with planning, organization and implementation of actions are essential for good decision making- and a competent management of our cultural heritage.

The ontological foundation of action- or practice led research is to master and understand objects, things and material culture and the knowledge behind them; the craft and craft traditions. The research is a movable process were the performer- and researcher throughout practice focuses on methods and results. To be able to document, interpret and explain the approach and exercise (the practice situation), it is a required that the observer has a basic understanding of practice and basic methodological, empathic approach. Continuity and correlation between situation, process and actions, surveys, documentation and analyses are necessary for a scientific interpretation processes. The practice is based on continuous assessments along the way. The research process continues when the video documentation is analyzed and transferred into a notation system where the actor is analyzing and explaining his actions.

The gradual process of practicing / exercising, interpreting, explaining and understanding the craftsmanship's insight is done by turning the knowledge process into concepts, action chains and theories. This by transcribing and transforming actions designing a physical form, throughout concrete physical tools, techniques and procedures into an academic format. Epistemological research within HCS is more about describing the knowledge processes, than the objects and things it selves. This means an emphasis were the researcher focuses more on finding conditions for

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knowledge and science. Epistemological studies focus mostly on methods, theories and the relevance or validity of knowledge. In short, the craft analysis is purely ontological when he/ she are focusing on research in craft, while it has an epistemological attention when the approach is about the reflections afterwards; i.e. research on crafts.

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Carpenters' Joints

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Abstract
A critique on the existing classification of carpenters' joints and a proposal for a new approach from a carpenters' perspective. The underlying logic of this methodology is focused on which timbers are cut and the arrangement of these timbers to each other. The proposed new classes are individually introduced and are then summarised in a decision tree that illustrates the questions to be asked and dependent on the answer gives the resulting class of structural timber joint.

Introduction

I am a carpenter, and I define my work as *"the craft of jointing timbers together to provide a load bearing structure".* To a carpenter a timber structure can be thought of as a three dimensional arrangement of joints separated by timbers. This emphasises the point that cutting joints is where most of the carpenters' time is spent and time equals money. So, an understanding of the variety of joints and the ways to line out, cut and assemble them is fundamental to a carpenter's efficiency and efficacy.

It is possible for a carpenter by study and experience to "know" what joint to use where. There are many textbooks, to help with this quest, mainly from the nineteenth and twentieth centuries that show joints in detail, e.g. *Modern Practical Carpentry* by George Ellis, 1908.

There is also a wealth of books that describe timber frame buildings and discuss some of the joints that are used to construct them. The all begs the question of why do we need a new classification, if the ground has already been covered? For many years I agreed with this but over the last decade or so I have become increasingly concerned with this orthodoxy. The reason being that when I show and discuss with students, aspects of traditional timber frame buildings and the joints used, there is often no agreed name or sometimes even no published name for the connection in question. This of course is less than ideal as when appraising and conserving timber structures *"This should be accompanied by an understanding and analysis of the construction and structural system,…"* [xxvi]

The types of joints that I was struggling to find a name for, were not always rare or restricted to a narrow date range, but often quite ubiquitous or long standing. The names applied to them often differed from carpenter to carpenter and these names were often applied by other carpenters to other different joints; a less than ideal situation.

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Alongside this challenge of ambiguous and incomplete nomenclature is the fact that timber structures can be looked at either in terms of their common features or their differences. Both perspectives enable greater understanding of timber structures both regionally and chronologically. By having an agreed and comprehensive classification then timber structures from all regions and all periods can be usefully compared and contrasted.

My draft classification, based on the definition of a carpenters' joint as connecting two timbers that transmit a structural load, starts with a simple question; *"How many of the two timbers are cut?"*

There are three possible answers; none, one or two. If no timbers are cut then I term this a "*passing joint"*. If only one timber is cut then it could be a "*butt joint or a notched joint"*. Whilst if both timbers are cut then it is either a "*scarf or a mortice & tenon or a lap joint"*. This approach yields six classes of joints.

Passing joints, where neither timber is cut to form a joint, but are secured with a fixing (timber, metal, fibre) occur in a wide variety of carpentry situations, both permanent and temporary. Examples are common rafters fixed to a side purlin using a trenail (a square peg hammered into a round hole), floorboards nailed to joists, and timber scaffolding lashed together with ropes.

If one of the two timbers is cut, then a second question is required to distinguish between a "*butt joint* and a *notched joint"*; this query relates to where the cut is made.

"Is it at the end of the timber?"

If the answer is yes, then I call this a *"butt joint"*. Again, these rely on a fixing (timber or metal) to secure the joint and transfer the load. Examples of butt joints are found at the heads of jack rafters (short rafters that do not reach to the apex of a roof), the feet of rafters that do not have a tail (an overhang) and at the ends of collars fitted in-between side purlins. In contrast the "notched joint" occurs where one timber is not cut at its end but is cut along its length. Examples of notched joints are where common rafters are trenched over the back of a side purlin, or at the feet of common rafters that do have a tail (or overhang).

Finally, when both timbers are cut, a second question is required to distinguish between some of the three possible options. This relates to the arrangement of the two timbers.

"Are the two timbers in-line?

If the answer is yes, then I classify this as a *"scarf joint"*. These are used to connect timbers lengthwise when a single timber is not long enough, typically found in cills and wall plates. The scarf joints being secured with either timber and/or metal fixings

If both timbers are cut but are not in-line then a third and final question is needed to distinguish between the "*mortice & tenon joint*" and the "*lap joint*".

"Does one timber have a mortice?"

A mortice being a slot parallel to the grain and so therefore having timber on both sides of it (rather than a housing which is not a slot and does not have timber on both sides). It can be cut either partially or all the way through the thickness of the timber and may be either at the end or along the length of the timber. If one timber does have a mortice then this is an example of a *"mortice*

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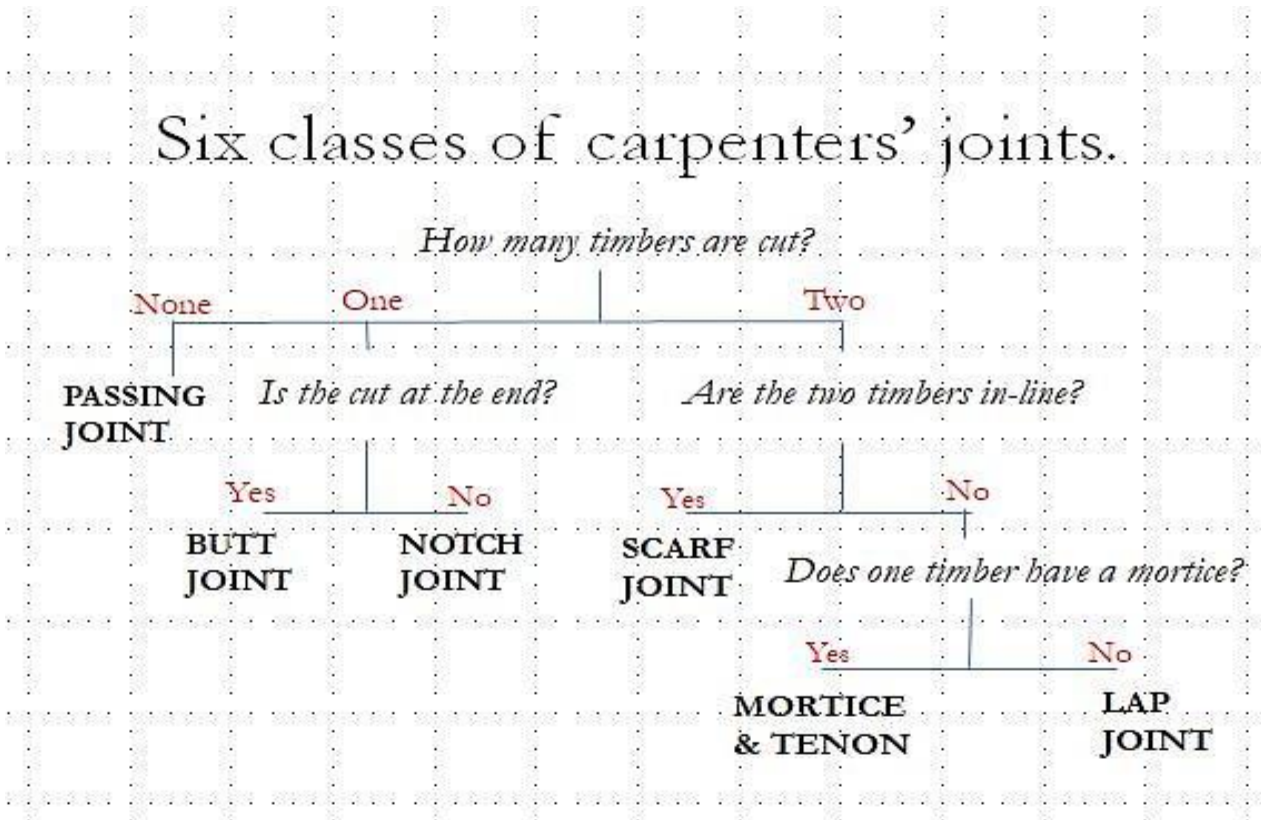
and tenon" joint. The tenon being a projection at the end of the other timber that enters into the mortice.

If one timber does not have a mortice then it is a *"lap"* joint. Here one timber has a housing, either at the end or along its length, the other timber then being cut to fit into the housing, the cut part being either at the end or along the length. Lap joints can be secured with a timber square peg (trenail) but in many cases no fixing is used.

The designation of the class of joint can be summarised in the decision tree below.



The benefits of having a comprehensive classification of structural timber joints are that it allows a better understanding of the structure, through observation and analysis of the connections. It would then allow further comparison between structures either chronologically or regionally. Following on from the classification would be a glossary relating to the many variations that exist within the six classes. Time does not permit a discussion here of the many descriptive and varied terms in use but this is a necessary corollary once the debate on classification is settled.

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Rescue wooden structures through the transfer to an open air museum (Rural heritage museum of Gilan -Iran)

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Abstract

Nowadays, the values of architecture and habitats of the native and their protection are becoming increasingly important and for this reason, the Idea of creation open air museum is extending in the world Now. Despite the variety of subjects, these museums have a Point of subscription, and that is, the transfer of wooden structures from the main place to the museum's location. These structures are usually related to the contemporary, and their age is less than a century, but all of them Are responsibility to familiarize and reconciliation people with the lives of their ancestors. At more open-air museums, the transfer of architectural effects is based on standardized principles and procedures and a similar process. Usually the main material is wood. In this paper, the origin was investigated, the foundations, and the evolution process of open-air museum, then was reviewed the role of open-air museums in the physical conservation of wooden heritage. These questions were answered that what is the cause of creating an open-air museum and does it not lead to harmful effects if was isolated these buildings from its original premises or transferring these houses to another location? What is the damage to the Authenticity of the building? This article is done by descriptive-analytical method with documentary and field instruments and experiences from the Gilan rural heritage museum. Considering the importance of protecting wooden structures, it is a fundamental - applied essay. The results indicated that despite the damage to the originality of the work, transfer to different locations can be the last way to save and conserve them.

Keywords: Rural heritage museum of Gilan, Wooden structures, Authenticity, Conservation.

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Introduction

Heritage is an evolving phenomenon, and as the community changes its heritage, this concept is also evolving. When the rural community, which was in its old form, was destroyed in the 1970s, the old farm also vanished. Was assumed that objects as a part of the heritage (1).

The science of museums entered a new stage in the nineteenth century, expanding concepts and classifications simultaneously. Nowadays, the duty of museums is not restricted by conservation and restoration a collection of often unique objects that forms the core of its activities for exhibitions, education, research, etc. Such museums over time and in different places have different names such as the Museum of Neighborhood, Natural Parks, or Open-air Museum; today, was called them Eco-museum (2).

In the lexical definition, Eco-museum is referred to museums that are formed in a broad and real-world context. An Eco-museum is based on a community agreement. The Eco-museum takes place in nature and adds nothing to it. It only indicates the area where was should conserved the nature.

In the opinion of the association of leaders of open air museums in Europe (AEOM), open air museums are defined as "scientific collections in the open air of various types of structures, which as constructional and functional entities, illustrate settlement patterns, dwellings, economy, and technology. The duties of Open Air Museum include (a) transfer historical monuments, (b) rearrange them in order to move to the desired place, (c) conservate, (d) maintain and equip these buildings. These buildings consist of buildings that are demolished in terms of appearance, lifestyle, housing conditions, cultural activities, agriculture, and craft. Rural heritage museums are a special type of open air museums, which their task is to preserve and display the rural heritages.

In this article, we review the roots and causes of the creation of open air museums, then we examine the role of open air museums in the physical conservation of wooden heritage. Finally, we address the questions; How much effect in conservation demontage and transfer the wooden houses and montage in site museum. And in this regard, how is damage to building Authenticity?

The research method in this paper is a descriptive-analytical method and with documentary and field tools and experiences from the Guilan rural heritage museum. Due to the importance of the theme of the protection of wooden structures, this is an applied article.

Literature Review

The aim of conservation and saving values is supporting of its material nature and safeguarding its coherence for future generations. The concept of supporting is not limited conservation of their habits and traditions and recognizing them which only led to maintain the physical elements and present the spiritual elements in the present (3). Here, the main concern is protecting the monument for the current generation and future generations (4).

Authenticity is the aspect of created or invented works as being new or novel, and thus distinguishable from reproductions, clones, forgeries, or derivative works. An original work is one not did not receive from others nor one copied from or based upon the work of others. It is a work created with a unique style and substance.

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From the Charter of Venice (1964) to the Charter of Burra (1999), the focus of the process has increased with a completely physical appearance on the situation.

The purpose of creating the new museums is to preserve the entire connection or relationship between man and the environment, nature and culture, in the sense of ecosystem. Unlike the museums, what is preserved in the Ecomuseum is not a specific object; it covers all aspects of people's lives (2).

Dejong (1992) declared that moving and rebuilding the structures is not done by accident; however, it was a real initiative where the structures have transferred to museums to protect them and display the pre-industrialization culture of rural society before the advent of the Industrial Revolution, which occurred from 1750 to 1850 (5).

Open air museum, like other museums, is a nonprofit institution for the public. It helps to develop society and its purpose is to collect, maintain, research, introduce and educate the intangible documents of people in a region and its environment (1).

In 4th General Conference (Geneva 1956) ICOM recommends that “whereas open-air museums select, dismantle, transport, reconstruct and maintain an appropriate site and with their original equipment, authentic architectural groups or elements, which are characteristic of types of life, of dwellings, of agricultural activities, of crafts, etc., of disappearing cultures” (6).

Rural museums are a subset of open air museums which indicate the resplendency of natural environment and civilization of rural culture. Rural museums are constructed with the transfer of real-scale works which take place in the same context as the initial situation (7). Rural Heritage museums are a special type of museum where a rural has been created by gathering different type of architecture from different locations. Usually, people have no idea about the origin of rural or house. Conservation, preservation and display the material and spiritual heritage of rural life are the main task of Rural Heritage Museums.

In this paper, was studied the stages of the transfer of the structure to the new ecosystem and also, was investigated these stages in terms of statements and the concept of authenticity.

The history of Open Air Museums

Karl Victor Vom Bonstetten (1745-1832) has a special place in the history of open air museums. In his imagination, he paid attention to some important points which later, these points became very important for open air museums, like arranging houses in open air along with their equipment, and most importantly, the possibility of comparisons between them (6). According to a number of experts such as Mark Maure, there was the collection of the Oscar II in Oslo, ten years before the Skansen open air museum. Maure believes that Norway is "the best place for the development of open air Museum (8).

Skansen was founded in 1891 and its primary aim was to show how different parts of rural Sweden lived before the emergence of an industrialized society. The Nordic Museum was also founded by Artur Hazelius and opened in 1907. The Old Town (The 'Den Gamle By' in Danish) with a collection of 75 historical buildings gathered from 20 locations in all parts of the country is another example of the open air museums. The Netherlands Open Air Museum in Arnhem features eighty

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historic houses, farms and windmills. The museum has been designed to create a highly realistic impression of daily life for the average Dutchman over the past few centuries. It has 9 rustic museums with a well-preserved and compact traditional structure (9).

The first open-air museums were focused on buildings and rural culture. But gradually, since 1909, the theme of urban culture, and since the 1960s, the theme of industrial prospects has been added to the concept. Today, there are many open-air museums in many European countries, as well as in North America, Japan, Australia and other countries.

In North America, the Association for Living History, Farm and Agricultural Museums (ALHFAM) serves those involved in living historical farms, agricultural museums and outdoor museums of history and folk-life. Since its founding in 1970, ALHFAM has been at the forefront of the growth and professionalization of the use of living history techniques in museum programs. ALHFAM members and member institutions can be found across the United States and Canada and in many other countries (10).

Since 1971, the idea of creation the Museum of Anthropology as an outdoor museum introducing the various cultural areas of Iran, was a major task for the Ministry of Culture and Arts in Iran. The idea came to practice phase in 1974. A plan was prepared in this area and the Chitgar Forest Park was proposed on the Tehran-Karaj road. Afterwards, various exhibitions of have held in 1976, 1977 and 1978 and again, the idea of the transfer of samples from rural and nomadic homes was pursued. Several mansions houses were purchased from different regions of Gilan and Mazandaran. The research group of Iran's Anthropology Center put numbers on structure component and then separated the building blocks from the origin place, in cooperation with the local professors. They took them to the place in Isfahan by truck, but unfortunately, today there are no pieces of construction (1).

After the earthquake in Gilan province (1990), the idea of creating the open-air museum was re-formed. The first Iranian Open air Museum - the Rural Heritage Museum of Gilan – officially opened in 2005. This museum is in Saravan forest park in Rasht, Gilan Province, Iran and have 263 hectares area and 80 buildings of 9 provincial cultural areas. In Figure1 the process of rebuilding the Tarbi home is simulated in the sample, and images 1-8 of the separation and reconstruction steps, as well as photographs before and after the separation of houses in the Gilan rural heritage museum, are used as examples (Figure1 and images 1-8).

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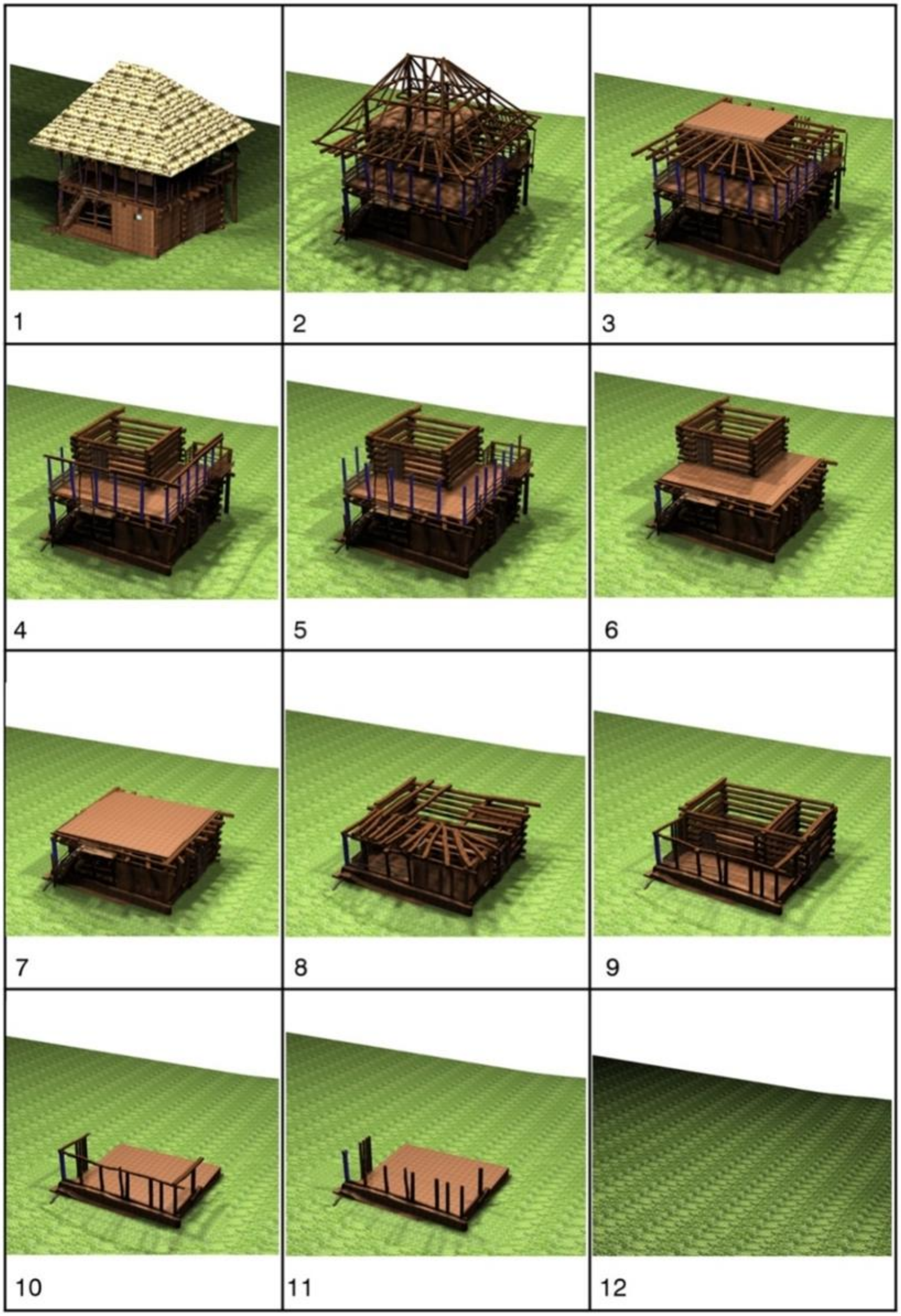

Fig.1. Rebuilding process of the Mr.Tarbi house are simulated in the sample (14)

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Images 1-2. Mr.Mir Sayyar's house, before (left) and after (right) rebuilding, in Gilan Rural Heritage Museum (15).

Thinking in the philosophy of creating open air museums, was found that the philosophy behind the creation of these museums has been one of the following reasons: a)Protecting endangered architectural species with awareness, attention and education of people, b)Preserving and reviving the history and forgotten national heritage of material and spiritual, c)conservation of old traditions in the face of growing concerns about the industrialization, d)The desire to understand the heritage in its most comprehensive concept and for different generations, e)conserving the stuff of ordinary people and displaying them, f) conservation of culture, customs, and architecture, and etc. against malicious factors

Transfer and the concept of authenticity

Do we have the right to separate these elements of houses from their original context? Does the transfer of these houses does not cause harm to the authenticity of the buildings? Looking at the status of these buildings in the area, was found out why these homes cannot be displayed at their original location. These reasons include:

a) Geographical distribution

b) Architectural diversity

c) Aging and damage due to lack of proper repair as a result of its abandonment

d) Change in performance and inappropriate use of the building

e) Make changes in buildings to meet their needs

f) Drastic changes in rural buildings have led to the complete loss of buildings

g) Unwillingness of villagers to live in old buildings

h) Build a new home and abandon old buildings.

Old buildings, even in rural environments, are at risk. People make changes in buildings to meet their needs. Therefore, often the originality and historical nature of buildings are lost. Open-air

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museum buildings will be rebuilt in the same original form. Transferring of these buildings can help their physical protection.

It is usually possible to conserve works by registering monuments or objects on the national monuments list and their periodic control in order to identify the damaging factors. In this kind of open-air museum, the buildings have been rebuilt with moving different types of architecture to a different location which is similar to the original location. In rural heritage museums, the visitors have no idea about the origin place of the village or houses but was could conserve these buildings by transferring them to a new manageable complex. It was impossible to conserve the buildings in their original location due to the geographical extent and unknown architecture for ordinary people.

Brandy believes that the memories and the environment that surrounds it are living together and therefore, they are inseparable. He believes that moving and building a memorial in another place by imitation of its own structure is so worthless that it is even less than the value of a mummified body compared to a living person (11).

In assessing values attributed to cultural works, the authenticity of this trend, as endorsed in the Charter, is a fundamental factor. The assessment of the cultural heritage's authenticity depends on the richness and scope of information resources related to the effect; it depends on the nature, the context and the course of their evolution over time. These resources can include various materials such as design, shape, materials, combinations, usage and function, traditions and techniques, location and components, the spirit of the effect and feelings associated with it, and other related internal and external factors (12).

Images 3-4. Mr.Mahmudi's house, before (left) and after (right) rebuilding, in Gilan Rural Heritage Museum (15)

The concept of authenticity in the restoration of historical monuments will be taken into account. The restorer must ensure the continuation of the life of the work with a comprehensive approach. Was should respected to structural materials, signs and manufacturing technology and none of these elements should be damaged (12).

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Images 5-6. Mr.Behzadi's house, before (left) and after (right) rebuilding, in Gilan Rural Heritage Museum (15)

 

Images 7-8. Mr. Rostamie's house, before (left) and after (right) rebuilding, in Gilan Rural Heritage Museum (15)

From theoretical doctrines and practical protection records, was found that the seven basic criteria of originality include: a) physical integrity, b) form integrity, c) application continuity, d) the permanent symbolic value, e) reproduction or desire to keep the buildings fresh, f) continuing environmental action, g) the continuation of production techniques h). Meanwhile, "continuing environmental action" emphasizes respect for the environment and "the continuation of production techniques" emphasizes the integration between human beings, the environment and the preservation of the skills and knowledge associated with the emergence of the work. In all of them, emphasis is placed on the need to pay attention to the indigenous values set forth in the works (13).

Article 9 of Burra Charter stated that "The physical location of a place is part of its cultural significance. A building, work or other component of a place should remain in its historical location. Relocation is generally unacceptable unless this is the sole practical means of ensuring

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its survival." Article 10 of Burra Charter suggested that "Contents, fixtures and objects which contribute to the cultural significance of a place should be retained at that place. Their removal is unacceptable unless it is: the sole means of ensuring their security and preservation; " Article 22 of the Burra Charter states: "New work such as additions to the place may be acceptable where it does not distort or obscure the cultural significance of the place, or detract from its interpretation and appreciation". New work may be sympathetic if its siting, bulk, form, scale, character, color, texture and material are similar to the existing fabric, but imitation should be avoided.

Conclusion

The purpose of open air museums is not just the displacement of the building, but their use in the past or now is also important. Usually nobody resides in these houses, and their patrons are museum staff. Places of cultural significance enrich people's lives, often providing a deep and inspirational sense of connection to community and landscape, to the past and to lived experiences. Protecting endangered architectural species with awareness, attention and education of people, Preserving and reviving the history and forgotten national heritage of material and spiritual, conservation of old traditions in the face of growing concerns about the industrialization, The desire to understand the heritage in its most comprehensive concept and for different generations, Conserving the stuff of ordinary people and displaying them, conservation of culture, customs, and architecture, and etc. against malicious factors are the positive points the creation of open air museums. But with these positive points there are reasons to deny the creation of these museums.

It can be said that transfer monuments to museums and registering them on the national and global list of revivals and revitalization of native culture will lead to the protection of material and spiritual heritage, through proper residence and planning. This can be an important justification for transferring houses as the last solution to save them for future.

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Wood science in the educational programs for carpenters, restorers and conservators

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Abstract

The paper presents the wood-science course worked out for the educational center which was established in the “Kizhi” open-air museum in 2015. The training programs are aimed at both professionals and at beginners. The wood-science course concentrates on practical issues like parameters required for the selection of timber (wood species, wood property and quality), monitoring of biodeterioration. The lectures present the traditional ways for timber selection for peasant houses and big parish churches. The data was obtained during 20-years long research in the Republic of Karelia and Novgorod region. Special attention is paid to technologies used for provision of longevity of wooden monuments.

Key words: wood science, education, selection of timber, biodeteriotation, monitoring

Introduction

Wood has been the main building material in the northern part of Europe since prehistoric times. Its workability and versatility as well as exceptional impact strength, effective thermal insulating properties are well known. Wooden structures - houses, threshing barns, mills, churches and chapels are the essential part of the landscape in the Republic of Karelia (Russian Federation). The Republic is located in the north-west of Russia close to the Finnish border (fig. 1).

Fig. 1. Location of the Republic of Karelia (marked red).

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Carpentry traditions arrived in this region in the 14th century – with the Novgorodian (primarily Slavic) colonization of northern territories. Carpenters in Karelia have created wooden architecture masterpieces such as the Dormition Cathedral in Kem’ and the Church of the Dormition in Kondopoga (fig. 2-3). The oldest wooden structure in the region is the Lasarus Church built in 15th cc in Murom monastery (fig. 4).

Fig. 2. The Church of Assumption in Kondopoga. 1774-2018.

Fig. 3. The Assumption Cathedral in Kem’ 1711-1717

Fig. 4. The Lasarus Church from Murom monastery. XV c. Moved to the “Kizhi” museum in 1960’s

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The most famous timber structures in Karelia and in Russia are the Kizhi Pogost monuments included in the UNESCO World Heritage List (fig. 5). The Churches are an illustration of a carpenter pushing a technique to its furthest limits and they are masterpieces of log engineering. Their history is described in (Miltchik, 2000). The history of the restoration of the main Church of the Transfiguration is presented in (Piskunov, 2000) and the up-dated information can be found at the Kizhi museum site (*http://kizhi.karelia.ru/info/about/restoration-of-the-transfiguration-church*).

Fig. 5. The UNESCO site - Kizhi pogost. It is an example of traditional Northern Russian ternary group of buildings where a bell tower is located between the summer and winter churches. It includes: the Church of the Transfiguration (the summer church, 1714), the Church of the Intercession (the winter church, 1695-1764) and the Bell Tower (1863-1774) surrounded by the log wall (1950).

The Kizhi architectural ensemble and the Lasarus Church are in the day-to-day management of the “Kizhi” State Open-Air Museum. The museum was founded in 1966 and now it has a collection of 80 historic timber structures transferred from different regions of the Republic of Karelia (UUUU). Nowadays the Kizhi museum is one of the leading restoration and conservation centers. Educational and training programs have been organized for carpenters, restorers, conservators and architects since 2015. In 2017 the 1st ICCROM course “Wooden architecture restoration and conservation” was held in the museum.

Students study traditional carpentry technologies and tools, history of wooden architecture, design, international charters and principles for preservation of historic timber structures. They have lectures, workshop, practical lessons and educational tours.

Wood science is one of the main topics in the educational programs. Our experience showed that the wood science course should be very practical and three main topics should be highlighted in

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it. They are: selection of timber, properties and biodeterioration of wood. Quality of timber in a great degree influences the longevity of the structures. The biological origin of this building material determines special approaches for the structures maintenance. The conservators have to determine the main biological agents destroying the structure.

One of the most common tasks for the restorers and carpenters is the selection of a proper timber for a new building or the replacement of decayed or destroyed structural members or parts.
According to the ICOMOS "Principles for the Conservation of Wooden Built Heritage" approved by the 19th ICOMOS General Assembly: "Any replacement timber should preferably:
a be of the same species as the original;
b match the original in moisture content;
c have similar characteristics of grain where it will be visible;
d be worked using similar craft methods and tools as the original".

That's why a special attention is paid to wood species and their identification. We concentrate on macroscopic and minute characteristics of wood which help students in identification of main wood species. After the lectures and workshops the students are not confused with terms "sapwood/heartwood", "tree rings", "fibers", "vessels", "tracheids", "resin canals" and they are able to identify main wood species used for building purposes in our region. Traditionally in the north of Europe the most durable species were selected for the structures (Larsen, Marstein, 2000) . Scots pine (*Pinus sylvestris* L.) was preferred to spruce (*Picea abies* Kr.), whereas larch (*Larix sibirica* Ledeb.) was rare and more highly valued than Scots pine. In the Archangelsk Region (Russia) larch was used for the lower timber sets carrying higher loads, and pine was used for the rest of the house.

Traditionally visual grading played an important role in the selection of timber for buildings, especially for huge cathedrals and churches. Very simple parameters like density and tree ring width were used for it. In old times it was recommended to select pine trees in mature stands growing on sand or rock. In Finland old building guidelines determined the appropriate age of trees as 140-200 years (Kaila, 1997). Our research showed that the majority of religious buildings in the Republic of Karelia were built of 200-300 year old Scots timber. At the same time, its density and annual ring width varied widely (400-600 kg/m^3, 0.01-0.2 cm) (Kisternaya, Kozlov, 2006).
For small chapels the age of logged trees was 100-150 years and the proportion of young trees was quite high. As opposed to huge parish churches the only criterion for the selection of timber for small chapels in Russian villages was visual appearance of the structure. Namely the correlation was found between the height of the structure and an average diameter of its logs. Tiny chapels made of small-diameter logs looked more majestic and sublime (Kisternaya et.al., 2016).
Timber of different quality can be used for different parts of the buildings. In the 37-meters high Transfiguration Cathedral, narrow-ringed wood was used for lower timber sets of the structure. Upper parts were mostly built of wide-ringed wood with lower density. Thus, stronger logs were used in the load-carrying parts of the structure, and the weight of the structure was reduced using looser timber for the upper part (Kozlov et.al., 2000).
The obtained results show that timber should be specially selected for every structure and the restorers should pay attention to this fact.

The next topic is wood properties. Familiarity with physical properties is important because they can significantly influence the performance and strength of wood used in structural applications. Students learn the directional properties (parallel to grain (longitudinal) and perpendicular to grain (radial or tangential)), wood moisture content and density. Special attention is paid to the

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variability of the wood quality parameters in different growing conditions and the factors - anatomical, environmental, rate and duration of load affecting properties of wood.
Biodeterioration, along with fire, plays a dominant role in decreasing the service life of timber structures that's why main wood-destroying fungi and insects are in focus of our course. Students are able to distinguish mold and rot fungi, find an appropriate strategy for conservation of the structure. They also are getting acquainted with the developed in the Kizhi museum system of biological control of timber structures (Kisternaya, Kozlov, 2012). The proposed monitoring system enables determination of the zones damaged by fungi and insects, assessment of the activity of a wide range of biological agents at initial stages, environmental control of biodeterioration. The results are used as the basis for timely maintenance of the monuments. In the long term, it would increase the service life of the wooden architectural monuments preserving their authenticity.

The book "Wood science for restorers in brief" which summarized the theoretical and practical issues of the course was published in 2016 (Kisternaya, 2014).
I do believe that knowledge of wood and its properties will help our students – restorers, conservators, architects utilize this natural resource closer to its full potential and rejuvenate the wooden architecture in Russian North.

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CONSERVATION MODEL FOR WOODEN MOSQUES IN TURKEY: CASE STUDY OF BEYSEHİR ESREFOGLU MOSQUE

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Abstract

In current heritage conservation thinking, increasing attention has been focused on respect for cultural and heritage diversity. The IIWC principles aim to respect cultural diversity in the preservation of cultural heritage by promoting traditional conservation methods in which the culture of the wooden built heritage was shaped. The majority of the research on this subject is focused on two main themes as European aspect and Asian aspect. Located between Europe and Asia, because of proximity and interaction with the west, the applications in Turkey are mostly considered as European case. However, the style and technique of the wooden built heritage in Turkey show an amazing variety. The wooden columned mosque tradition in Turkey which dates back to the 13th century and mostly located in Central Anatolia Region, do not get the attention it deserves, although the examples of this style have great importance for Turkish architectural history.

In this context, Beysehir Esrefoglu Mosque which is regarded as the oldest and biggest wooden columned mosque in Turkey will be the case study. The mosque, which was built in the late 13th century, survived, almost intact, thanks to both the details of the construction technique and the repair works implemented during its long history. In this paper, firstly the material selection and construction techniques will be briefly introduced, and then the repair works which have been executed in different periods will be explained in detail. It is interesting to note that the repair history also helps to trace the changing perceptions and attitudes on conservation approaches. After the evaluation of repairs in consideration of the IIWC principles, an in-situ assessment model, and a conservation model which show the particular requirements will be proposed to form the basic principles for the conservation of other wooden columned mosques.

Keywords: Wooden mosques, conservation model, Turkey, IIWC Principles

Introduction

The style and technique of the wooden built heritage in Turkey show an amazing variety. While only vernacular wooden houses in Istanbul, Safranbolu, and Cumalızık are represented as the wooden cultural heritage of Turkey in World Heritage List, five wooden pillar mosques were added to the tentative list in May 2018. These five mosques are the earliest, most significant and

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truly authentic examples of this style. Other than these, there are more than two hundred wooden pillar mosques existing in different regions of Turkey (*Figure 1*).

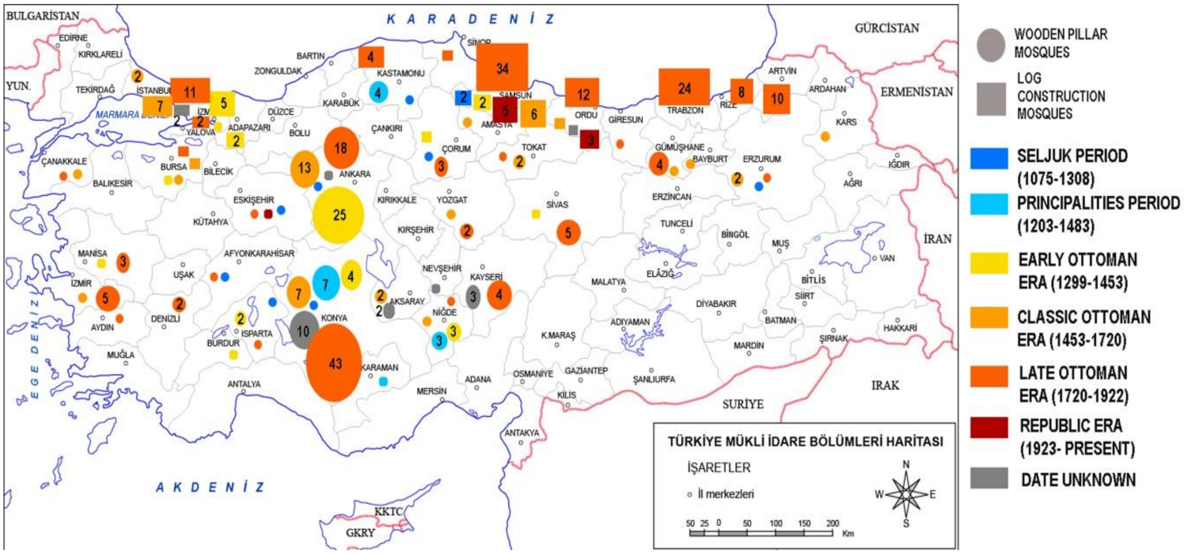

Fig. 1. Wooden mosques in Turkey

Beysehir Esrefoglu Mosque which is regarded as the oldest and biggest wooden columned mosque in Turkey is the case study of this paper. The mosque, which was built in the late 13th century, survived, almost intact, thanks to both the details of the construction technique and the repair works implemented during its long history. Esrefoglu Suleyman Bey Mosque, bearing the name of its constructor, was built in 1296 in Beysehir 100 m north of the Lake Beysehir in southwest Turkey. It was a part of the complex (*kulliye*) with hammam and Bezzaziye Khan. The open tomb, the covered bazaar, and the madrasah are additions of later periods. Due to the form of the main road, the portal wall of the mosque is chamfered (Erdemir, 1999). After the portal, there is the last prayer hall which is an early example. This hall is separated from the main prayer area by masonry entrance wall and five double pillars connected with fences. In the main prayer area, the roof is carried by 39 pillars which form 7 naves. In front of the mihrab, there is the maqsure (elevated lodge) dome. Maqsure dome and roof structure do not have an organic connection. Other than the portal there are two more entrances in the east and west sides; the west door is used by the sultan to reach the sultan tribune safely (Çaycı, 2008). In the center of the mosque, there is a snow pit above which is placed a lighting well. Originally the roof was flat, and lighting well was open. During winter, the snow in the roof was put with shovels to the snow pit; straw was put over it. During summer, after the night prayer, the straw is opened and let the snow melt slowly. It is believed that this system helps to keep the moisture balance of the wooden elements. The mausoleum was added in 1301, and the muezzin tribune in 1571 (*Figure 2*).

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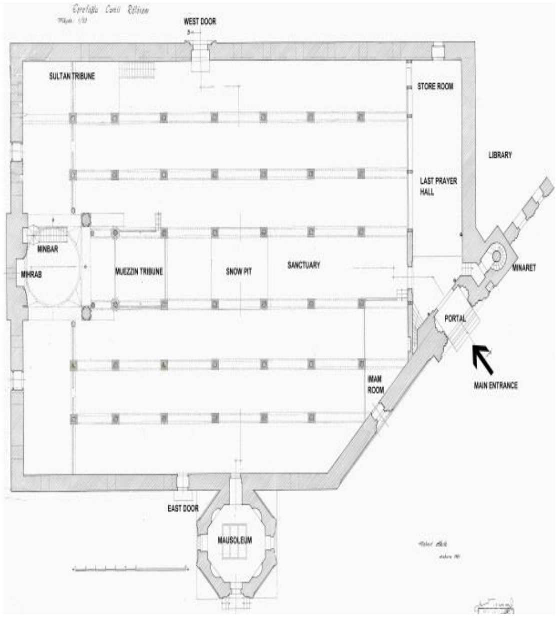

Fig. 2. The plan of Esrefoglu Mosque

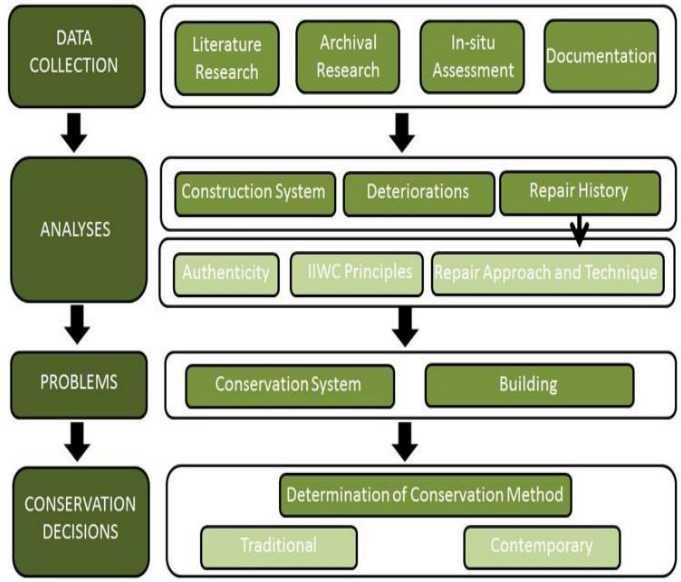

Fig. 3. The Conservation Model

The suggested conservation model (*Figure 3*) starts with the re-evaluation of all the components. It starts with data collection. Although how to make documentation, how to collect data is written in many charters and laws, the implementation and results of it depend on the country. Moreover, in Turkey, there are some problems in archives and literature resources which lead us to suspect all the data we collect. The lack and confusion of data lead us to make an in-situ assessment with the adaptation of the COST Action FP1101 Assessment, Reinforcement and Monitoring of Timber structures project (Serafini and others, 2017) to wooden mosques in Turkey.

After collecting of all data, the analyses of the construction system, deteriorations and repair history start. All information is cross-checked with other data to find the correct information. Construction system shows the original design and deteriorations show the problems that still couldn't be solved. In between, repair history is evaluated in three stages. First, the repair year and repair approach-method evaluation; second, according to authenticity criteria the determination of authenticity percentage; and lastly the evaluation of previous implementations according to IIWC 2017 principles. With all these steps, the second stage of the model is completed which give us the data about the problems of system and building, also the methods that work for wooden mosques and the methods on the contrary that harm the mosques. The last stage of the model is the determination of which conservation model is appropriate for the mosque. Each mosque has different features and different repair history. According to obtained data from analyses and evaluations, which implementation in which parts should do for each traditional approach and contemporary approach will be explained.

The documentation was made with the help of 3d laser scanner which documents each member with all its features together like size, color, deterioration, and so on. After the literature and archival research, there is still much missing information. Because of the difficulty of taking permission for collecting of samples from the mosque and lack of research budget, it leads us to develop an in-situ assessment method. In the first part, the identity of the building is determined with the help of archival documents and literature, a general description of the building is made

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on site. General description of the overall load-bearing system is made with the focus on structural units, material, size and connection details (*Figure 4*). Firstly, each member is numbered, and from base to roof tile, all measurements, traces, details are noted. This helps to see the construction details, deteriorations and the traces of the repairs.

Identity of the building	
Building name	Esrefoglu Suleyman Bey Mosque
Address/Geographical location	İçeri şehir Mahallesi, Kale Sok. No:21, 42700 Beyşehir/Konya
Period of construction/dating (identified by)	1296-99 (Inscriptions)
The Constructor	Eşrefoğlu Süleyman Bey
Name of the architect, engineer, carpenter etc.	Carpenter Isa (for the door and the minbar)
Affiliated Foundations	Eşrefoğlu Camii (Eşraf zade, İmam Camii), Eşrefoğlu Camii Vakfı (Beyşehir), Eşref-i Rumi Camii, Eşref zade Camii Vakfı (Beyşehir)
Use (original/new)	Mosque/Mosque
The owner name	The General Directorate of Foundations (Konya Regional Directorate)
Year/period of previous interventions	1500, 1522, 1571, 1846-48, 1860s, 1912, 1933-1941, 1960-1970, 1994-1998, 1998-2008, 2017
General description of the building	
Average floor area (mq)	1400
Number of floors above the ground	One floor
Average height for each level/floor (m)	7.50
Seismic zone	3. degree
Snow load zone	2
Plan features (style)	
Façade features (Material, style)	
General description of the overall load bearing system	
Vertical load bearing systems	Masonry structures and wooden pillars
Horizontal load bearing systems	Timber beams with double-layer boards
Roofs	Pitched (Originally flat)
Details of Structural Unit	
Base (Material, size, connection details)	Stone, approx. 70x70 cm
Pillar (Material, size, connection details and traces)	Toros cedar, approx. 42 cm in diameter
Capital (Material, size, connection details)	5 different styles
Beam (Material, size, connection details)	Toros cedar, pine

Fig. 4. In-situ Assessment Model

During its history Beysehir experienced many disasters; earthquakes and flooding occasionally damaged the mosque, as well. To understand the repair approach and method, building element-based evaluation is done for the maqsure dome, roof system, and lighting well, central nave, facades, ground, snow pit and wooden elements.

In the maqsure dome, due to lack of connection between the dome and wooden roof system, the wooden roof exerted pressure on masonry walls of the dome, so in Ottoman Classical Era, four pillars were added to support the roof in order to release the pressure on the dome. In the 1900s there were big earthquakes in this region and the dome was about to collapse and around 1912, wooden supports were added to prevent demolition. Later in 1950s repair, the stone pillars were dismantled and reassembled, and the dome was strengthened with reinforced concrete. Also, the

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wooden beams were changed with reinforced concrete beams and covered with wood to be seen as a wooden beam.

The roof system was the flat earthen roof, and the protection was provided by regular maintenance of the Waqf system until the end of the Ottoman Era. Due to war and adverse economic conditions of the early 20th century, the building gradually fell into disrepair. During 1933-1941 repairs, the roof system was changed into the hipped tiled roof, and the lighting well was closed. The roof cover is first changed to copper sheet in 1960, replaced later in 2004 by lead sheet. The closed lighting well is extended during 1950 repair; in 1960 the initially open part is closed with glass. Also, in 2004 the glass is changed to the polycarbonate with metal structure.

The original foundation with wooden beams was changed into reinforced concrete frame basement in 1996 repair. In the same repair, the closed snow pit during 1965 repair was reopened in smaller size.

Until the 1950s repair, there was only limited intervention made on facades. However, in the late 1950s, the cement as a modern material started to be used in the facades; the changes in the walling, size and connection of the stones and wooden girders are spectacular. From 2014, it is suggested to clean cement and use traditional mortar (*Figure 5*).

Fig. 5. Repair of façades (VGM Archive)

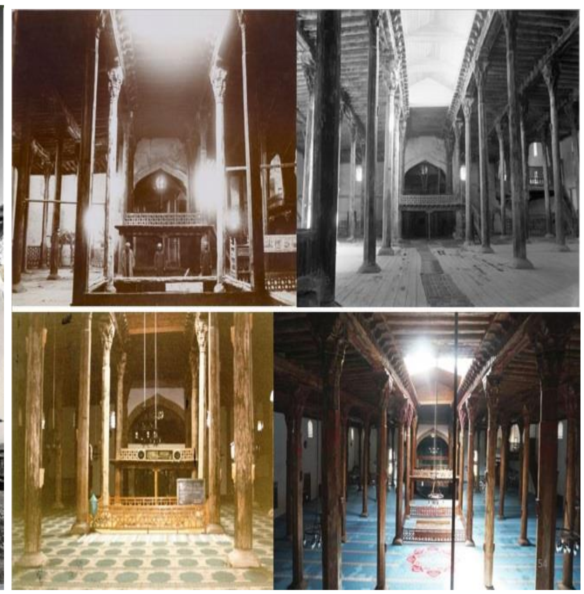

Fig. 6. Repair of inner space (VGM Archive)

Until 2003, there is no direct intervention to the wooden elements, especially to the pillars. However, during the change of the roof system, roofing boards are completely renewed, and some of the beams are changed, as well (*Figure 6*). The windows and doors are reproduced in different years. There was a severe water problem in the structure which caused damage to walls and wooden elements, probably due to the partial collapse of the roof.

A legend was prepared to show mostly used implementations, like dismantling and rebuilding, the change of the form, removal and additions, reinforcement, replacement and reproduction according to the usage of same or different kind of materials and techniques. This legend allowed evaluating repairs according to repair years and repair approach and methods (*Figure 7*).

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- In Ottoman Classical Era, four pillars were added for structural reasons, and muezzin tribune was also added for the necessity of the time. In Late Ottoman Era, due to collapse risk of the dome, temporary supports were added, and the mosque was separated with wooden mihrab and fences from the snow pit level for safety reasons (*Figure 7*).
- In 1950-1970 repairs, the dome was strengthened with concrete, stone pillars dismantled and reassembled, temporary supports and separation fences were removed, snow pit was closed. The wooden mihrab was moved to the last prayer hall, drainage was added. Wooden fences next to mihrab were repaired (*Figure 7*).
- In 1985-2003 repairs, ground reinforcement is done, snow pit is reopened. Imam room and the store are added. Drainage is renewed. Wooden windows are reconstructed (*Figure 7*).
- In 2003-2018 repairs, the focus was given to the wooden pillars, impregnation, cleaning and lacquering was done. The library section was reconstructed (*Figure 7*).

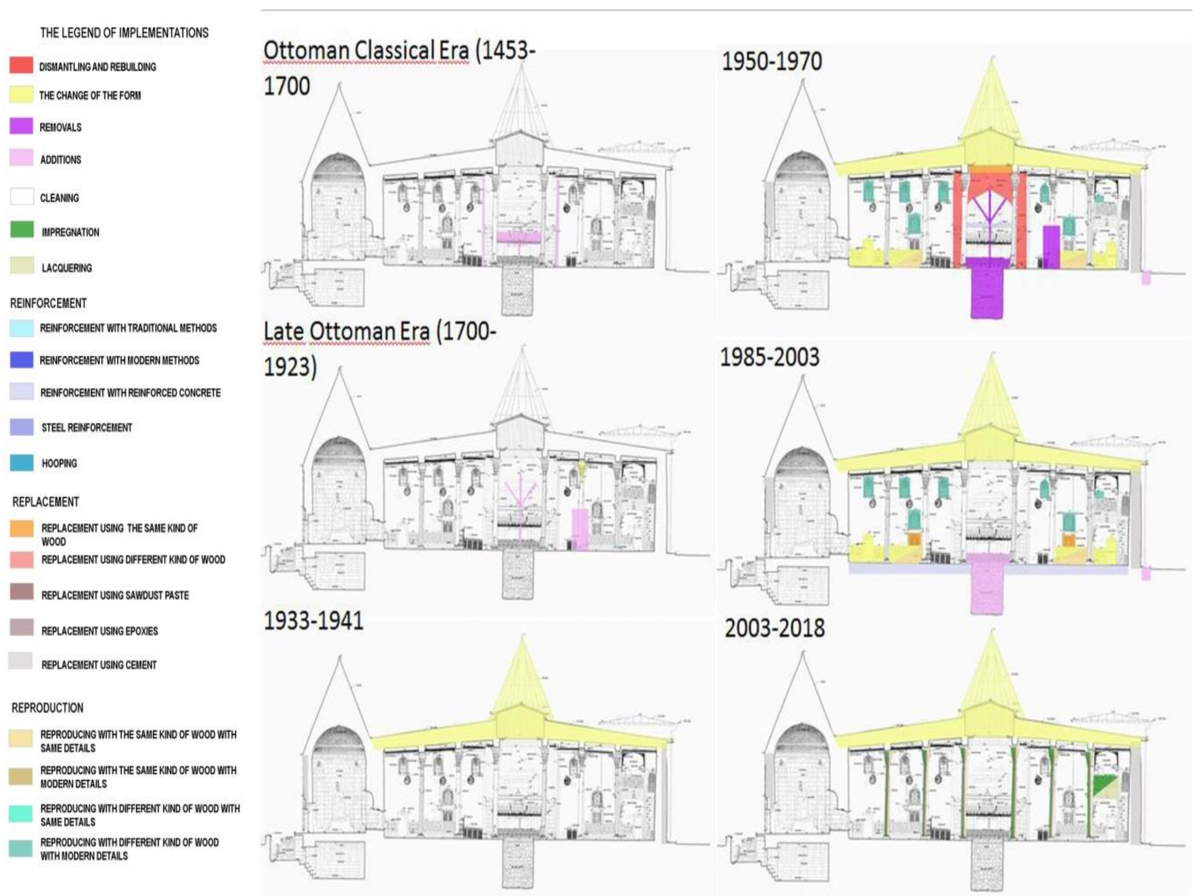

Fig. 7. The evaluation of repairs according to repair year and repair method

According to this analysis, in Ottoman Classical Era, the repairs were compatible with original construction and made for the maintenance and provide the needs of the era. In the Late Ottoman Era, the repairs were made on emergency measures. In 1933-1941, simple repairs were made, and rotted members were renewed. From the 1950s, modern materials and techniques were started to be used in repairs. After 1996, reinforcement became the main concern and extensive repairs took

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place. After 2003, the mistakes and problems of previous repairs were tried to be solved, there is a return to traditional repair methods.

It is important to determine the authentic material and technique to be able to make an evaluation of authenticity. The pillars show the same characteristics, so all of them are considered authentic. In case of beams, three different size, color, and texture beams were determined. The darkest and thickest one is around 35 cm in diameter, the second one is around 25 cm in diameter and the third one is less than 20 cm in diameter. The beams in the center nave are less than 20 cm in diameter; these probably were changed during 1950s repair when the lighting well was extended. The rest blue color shows the second ones which changed during repairs earlier than 1950, but the exact date is unknown. The white ones are 35 cm in diameter which is the same size as original ones which mean that even if they were changed, the technique was preserved (*Figure 8*). When it comes to ornamentations, there are three different colorings which show the technical differences. Yellowish ones are considered as original, brownish ones are in between, and red ones are made after 2003 repair. The yellowish and brownish ones are shown as original in the map with red color (*Figure 9*). It is evident that at least the technique was preserved.

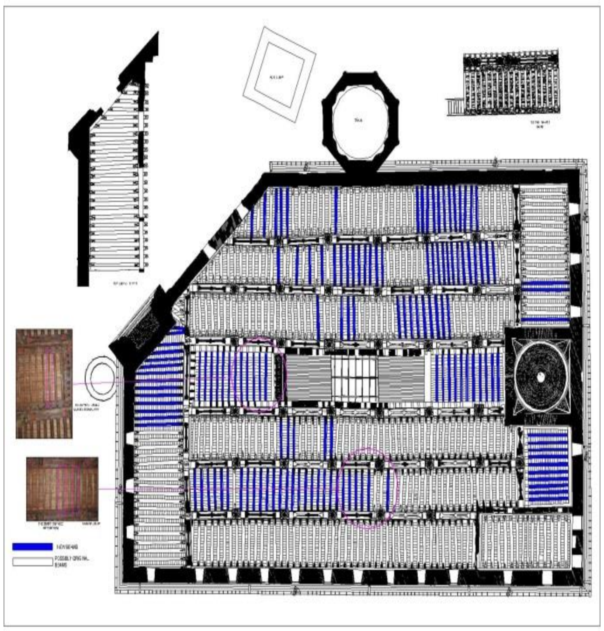

Fig. 8. Authenticity of the beams

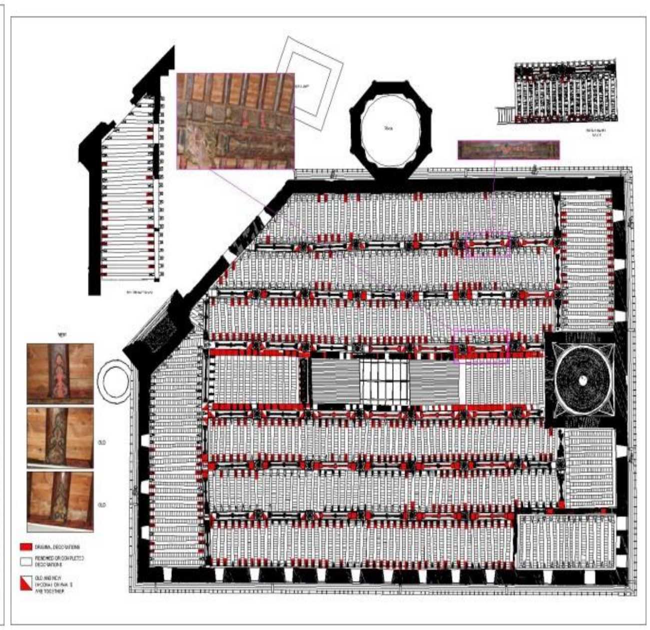

Fig. 9. Authenticity of the ornamentations

Regarding location, function, the spirit of the place and design, Esrefoglu Mosque keeps its authenticity, but concerning material and technique, the percentage is not the same. Pillars 100%, beams approx. 69%, ornamentations on beams approx. 47% (Ornamentations show the technical authenticity), covering board ornamentations on double beams approx. 42%, elbows approx. 41%, panels between elbows approx. 51% are authentic. As for the flooring elements, roof boards and bonding timber on facades, these are completely lost or renewed. This data shows the authenticity percentage for wooden materials. Regarding the masonry part of the mosque, original material and mortar were already lost in previous repairs. It means that in this type of mosques, the outer walls take the protection task for wooden members.

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The repairs in different periods are evaluated according to IIWC 2017 principles (*Figure 10*), like the minimum intervention, reversibility, and so on. The implementations during the Late Ottoman Era were successful regarding the authenticity of material and technique, reversibility, minimum intervention, compatibility of new members with old one, the consideration of environmental conditions and structural needs. The success comes from the regular maintenance culture of the Waqf System.

IIWC 2017 Principles	Late Ottoman Era (The 1900s)	1923-1950	1950-1970	1980- 2000	2000- 2018
the strengthening of the structure using traditional or compatible materials and techniques	O	-	X	X	X
Minimum intervention	O	X	X	X	X
follow traditional practices	O	O	X	X	O
be reversible	O	O	X	X	X
not prejudice or impede future conservation work	O	O	X	X	X
not hinder the possibility of later access to evidence exposed and incorporated in the construction	O	O	X	X	X
Take environmental conditions into account	O	X	X	X	X
Any replacement timber should preferably: a be of the same species as the original; b match the original in moisture content; c have similar characteristics of grain where it will be visible; d be worked using similar craft methods and tools as the original	O	X	X	X	X
Meet the requirements of modern building codes	-	-	X	X	O
All interventions must be justified based upon sound structural principles and usage.	O	O	O	O	O
Installations should be designed so as not to cause changes to significant environmental conditions, such as temperature and humidity	-	X	X	X	X

Fig. 10. The Evaluation of repairs according to IIWC Principles

The implementation of the Republican Era showed an increasing interest in modern materials and reinforcement, especially after the 1950s. However, regarding the principle of compatibility of the modern material with the old ones, the needs of the structural system, reversibility and misguiding of the users, the implementations do not follow the IIWC principles.

The evaluation of wood construction techniques shows that;

- The repairs from the Ottoman Era to the present time reveal inefficiency on the technical aspects and loss of original details

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- The wooden elements are kept intact during the first period of the Republican era
- After the 1950s complete renewal and reproduction approach is increased
- In the 2000s minimum intervention becomes the main purpose, only preventing repairs are made for insects and the cracks on wooden elements. However, the details of changing members are disappointing and far from the original details.

From the obtained data, in the conservation system of Turkey;

- There is a lack of systematic archive and inventory.
- When compared with other examples which had a repair in the same periods, it seems that instead of case by case approach, standard projects are used as a conservation model
- In the project budget, there is very little, or no part is spared for material laboratory analyses
- Mostly for important monumental buildings, scientific committees are established during repair to follow and guide the process and findings. It should be expanded
- Moreover, in the case of wood, lack of carpenters who know traditional techniques is another problem
- Wood species used in buildings vary, but in today's system only oak and pine has a place in the bill of quantities, special forests should be established for restoration works, and precaution should be taken for the endangered wood species
- Lastly, there is not enough laboratory infrastructure for wooden research in Turkey

The problems unique to this mosque are:

- The loss of natural ventilation due to the closing of the lighting well and snow pit
- The use of hazardous substances on human health for impregnation of wooden elements
- Incompatible fillings made on pillars
- Poor quality connection details of wooden members during repair
- Due to sander and painting, loss of traces
- The irreversible change of the structural system with reinforcement in the ground, facades, and dome by introducing reinforced concrete

The problems related to the system should be solved with the holistic project, involving the participation of different stakeholders. But the building related problems can be solved by this model.

Before determination of the conservation model (*Figure 3*), firstly determination of what to conserve is needed; the original features and members, additions of later periods, structural needs and so on. In the case of the Esrefoglu Mosque, wooden members are more advantageous than masonry parts, as they mostly could conserve their authenticity in material and technical aspect.

The second is to determine how to preserve. Not in all parts of the mosque neither traditional nor contemporary methods can be used. So, we suggest using traditional methods for the members which still protect their authenticity, which means wooden elements. To not forget and to learn the traditional techniques, we suggest making 1 to 1 scale models for the details like capitals and fences. This was tried by Istanbul KUDEB timber workshop but in 1/20 scale. The problem is that it was made with contemporary approach, and the pillar and capital were prepared separately and

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connected with glue. However, in the original one, the pillar was a single piece, and the muqarnas elements were nailed over it. So, 1/1 scale is essential.

Contemporary methods should be used in the analyses of the current structural situation. Some parts of the mosque already lost their authenticity, try to make it as original will lead to reconstruction, so to keep intervention in minimum level, contemporary methods should be used as the mark of today's approach. For example, the roof structure is believed to be heavy for the pillars; to make it with lighter materials could help.

Also, contemporary methods can be used for natural ventilation. Even if the lighting well is opened, rammed earth roof should be made again which needs regular maintenance every year. The climate has changed; it does not snow like before. So, the need of elements should be determined and provided with contemporary methods.

The difference of this model is the evaluation of each member in detail, in-situ assessment and development of observation methods according to size, color, and texture of the wood, the emphasis on repair history and authenticity of material and technique and the determination of the usage of traditional and contemporary methods in conservation in certain areas. It is expected that the implementation of this model will help more accurate decision taking on conservation by using the efficiency of previous implementations.

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Mutual development of base to ridge post structure and shaft/roof frame structure - Examination from linguistic expressions targeting architecture

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Abstract
Wooden buildings are one of the ancient architectural styles among various architectural styles. They are valuable as one of architectural styles seen today. It is especially meaningful to focus on various types of wooden structures developed with wooden architecture. Among various types of wooden structures, if horizontally stacked lumber is regarded as a log house structure, vertically aligned lumber can be regarded as a post structure. Both structures have been seen since ancient times up until today. This paper focuses on the post structure of these two types and surveys their development.

Post structures can be roughly categorized into base-to-ridge post structures and the shaft/roof frame structures (Fig.1). These two types display opposite styles. In base-to-ridge post structures, the post extending from the ground directly supports the ridge beam, while shaft/roof frame structures have short posts, and other materials on top of the posts support the ridge beam. This paper regards the simultaneous development of base-to-ridge post structures and shaft/roof frame structures as general architectural history and as the history of Japanese architecture focusing on ancient and medieval Japan. Among periods from which there are few wooden architectural relics available, this paper focuses on the plan description method based on the number of lengthwise bays and that of open aisles kenmen-kihou, the linguistic expression (Fig.2), as architectural references which can be used for observation.

Base-to-ridge post structures such as the architecture of Ise Shrine and the shaft/roof frame structure as seen in Horyuji Temple are architectural relics which have been passed on through sustainable development since ancient times. This paper discusses that they have mutually developed as a pair that has continued complementing each other rather than through independent and separate processes.

Keywords: Wooden post, base-to-ridge post, plan description method based on the number of lengthwise bays and that of open aisles, ancient and medieval Japan

Introduction

This study concludes that the kenmenkihou *間面記法* method (plan description method based on the number of lengthwise bays and that of open aisles) did not exclude plans for munamochibashira (base-to-ridge post) *棟持柱* structures from the verbal description.

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The kenmenkihou method is a method of describing plans for traditional wooden Japanese buildings, and the method was used in Japan from the Nara period to the Nanboku-cho period. Wooden Japanese buildings from the relevant periods are mainly accounted for by those built with posts. Among the surviving wooden buildings from the Nara period is the Shōsō-in *正倉院* treasure house. This storage facility includes parts built in the so-called azekura-zukuri *校倉造* construction style by laying only horizontal members one on top of another without using any posts. The treasure house, however, also includes a part built with posts. Many of the other architectural remains of the Shōsō-in treasure house are structures built with posts as vertical members in combination with horizontal members. In addition to posts, short vertical members, such as struts are also found in the Shōsō-in treasure house. The horizontal members include ridge beams, moyageta *母屋桁* purins (ridge purlins), purlins, and beams.

Included among the architectural structural concepts that allow broad classification of those wooden buildings built with the heavy use of posts is the concept of munamochibashira posts. Munamochibashira posts have the greatest height among posts, which are vertical members, and extend directly from the foundation ground to the ridge beam. The ground is the lowest part in a building structure and is in contact with the feet of the posts. The ridge beam is the horizontal member installed on the highest part of a wooden building. Munamochibashira posts are tallest in the sense that they are vertical members extending from the ground, the lowest part, to the ridge beam, the highest part.

A building structure featuring such munamochibashira posts is called a munamochibashira structure. Where munamochibashira posts are used, no vertical discontinuities are found between vertical members. In contrast, where no munamochibashira posts are used, discontinuities are found between the areas above and below the posts. In other words, where beams rest on top of posts, followed by struts on top of beams and then by ridge beams on struts, the posts terminate below the beams and hence are not munamochibashira posts. In the absence of munamochibashira posts, posts serve as vertical members on top of which horizontal members, such as beams or purlins, rest. The part thus built is called jikubu *軸部*. On top of this jikubu is a roof-slope support structure or roof truss called koyagumi *小屋組*. In other words, a building structure with no munamochibashira posts has a jikubu and a koyagumi separated from each other. In this sense, a building structure with its jikubu and koyagumi separated from each other is called a jikubu-koyagumi structure *軸部・小屋組構造*.

From the above, wooden building structures are largely classified as munamochibashira structures or jikubu-koyagumi structures according to the ridge beam support method. Meanwhile, as is typical with building structures with a hougyo*宝形* roof (tented roof) or single-pitch roof, some building structures have no ridge beam in the first place. Let us call these building structures intermediate structures because they are neither munamochibashira structures nor jikubu-koyagumi structures.

The above definitions allow us to classify building structures largely as follows: ridge beam-less building structures, such as structures featuring a hougyo-styled roof, fall into the category of intermediate structures, while building structures with ridge beams are classified as either

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munamochibashira structures or jikubu-koyagumi structures.

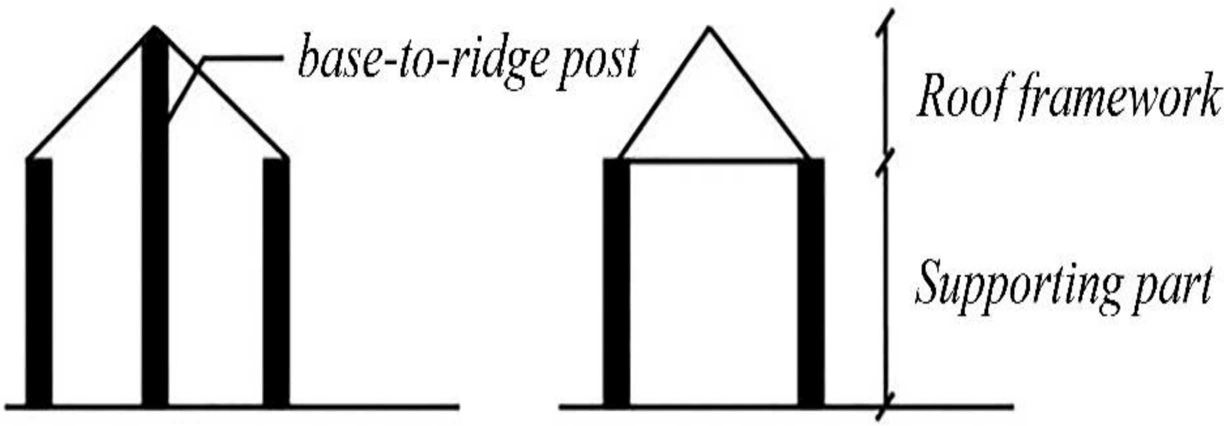

Fig. 1. Post structures categorized into base-to-ridge post structures and the shaft/roof frame structures

Fig. 2. Plan description method based on the number of lengthwise bays and that of open aisles kenmen-kihou, the linguistic expression

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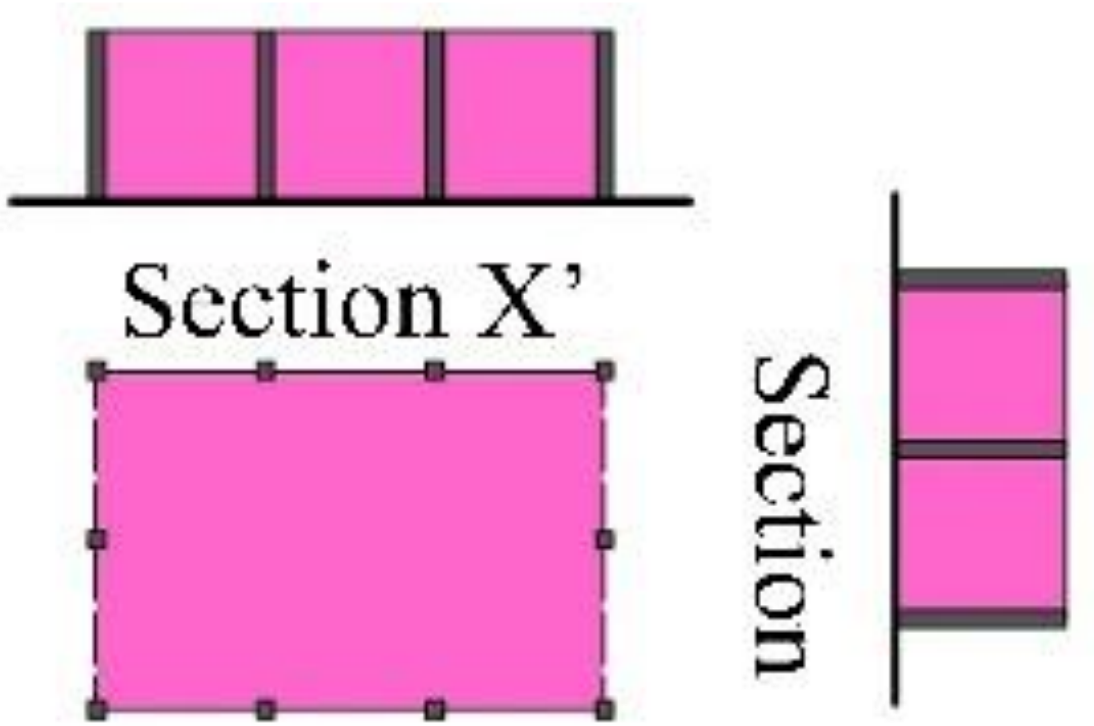

Fig. 3. "Bays" in the sense of the kenmenkihou method: intercolumnar spaces, the numbers of which are used to describe dimensions parallel to the ridge beam.

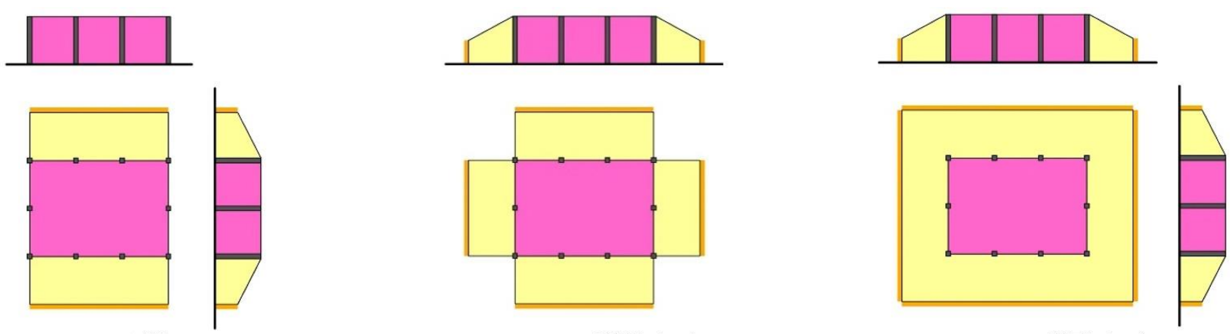

Fig:4-1 三間二面 *Fig:4-2(a) 三間四面(a)* *Fig:4-2(b) 三間四面(b)*

The three bays and two sides *The three bays and four sides (a)* *The three bays and four sides (b)*

Fig. 4. "Sides" in the sense of the kenmenkihoumethod: equally heighted posts smaller in height than posts constituting a moya are arranged in rows around the moya to add hisashi aisles to the outside of the moya

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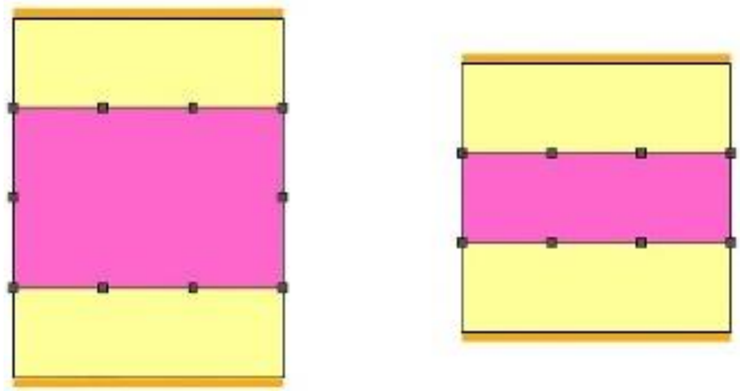

Fig. 5. The kenmenkihou method recorded only dimensions parallel to the ridge beam, for example, as three bays and two sides, with dimensions at right angles to the ridge beam left unknown

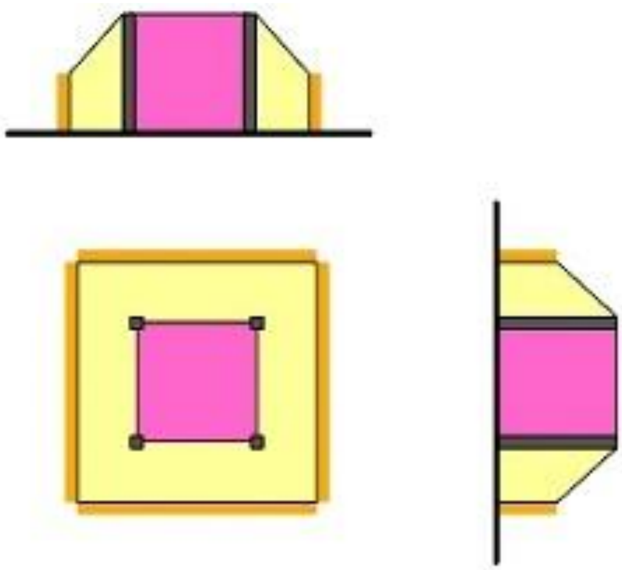

Fig. 6. One bay and four sides

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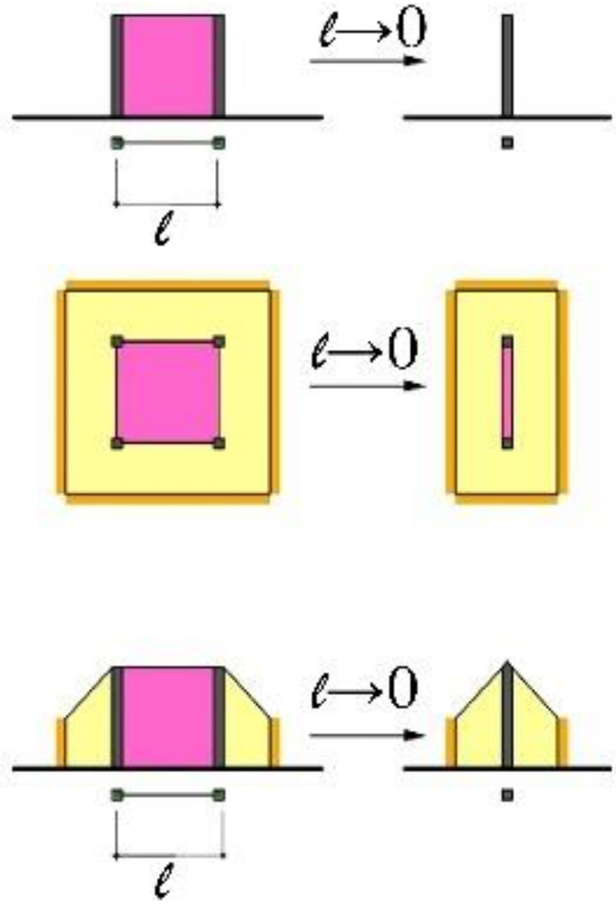

Fig. 7. Zero bays: The value “zero bays” is the infinitesimal size of intercolumnar space and is a value resulting from the merge of two posts into one

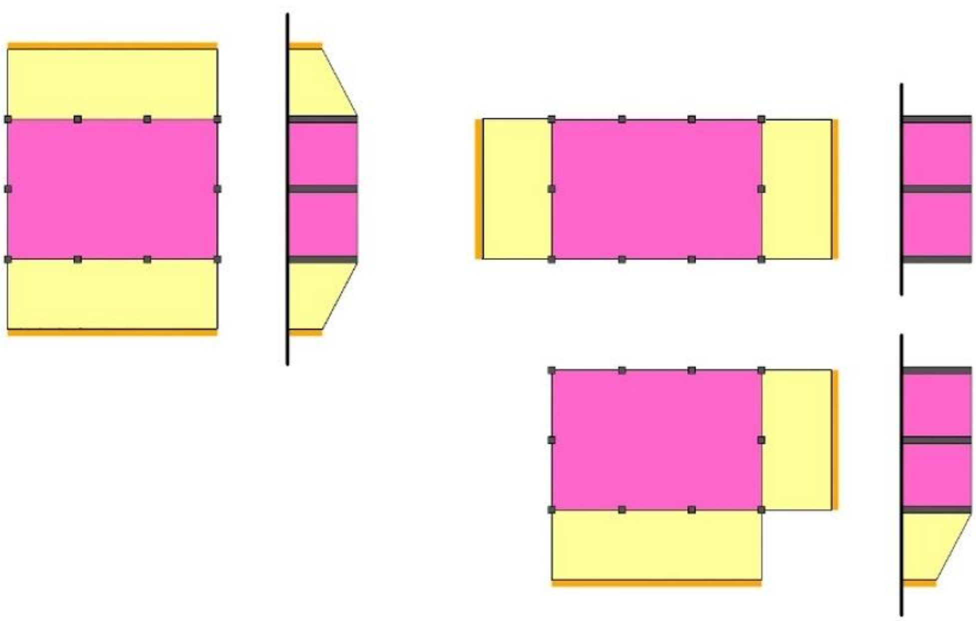

Fig. 8. Three bays and two sides (jikubu-koyagumi structure)

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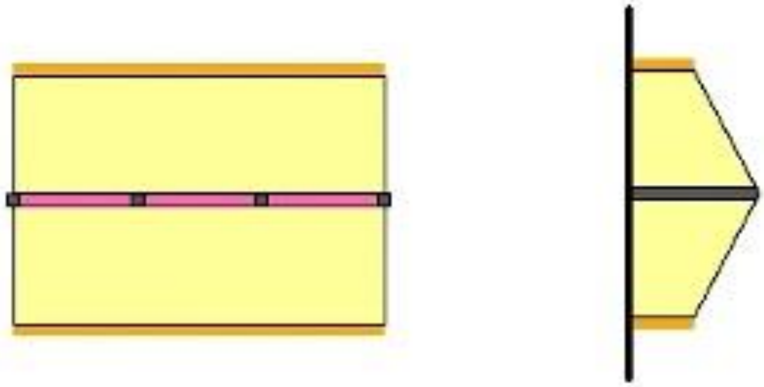

Fig. 9. Three bays and two sides (munamochibashira structure)

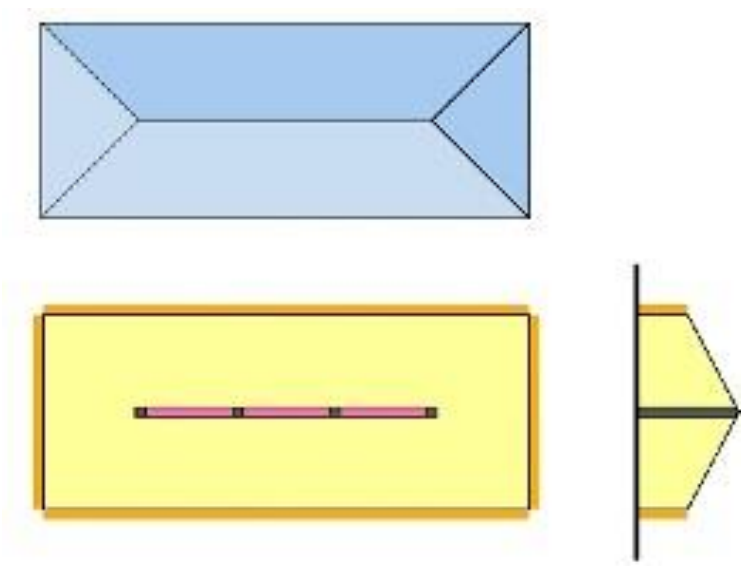

Fig. 10. Three bays and four sides (munamochibashira structure)

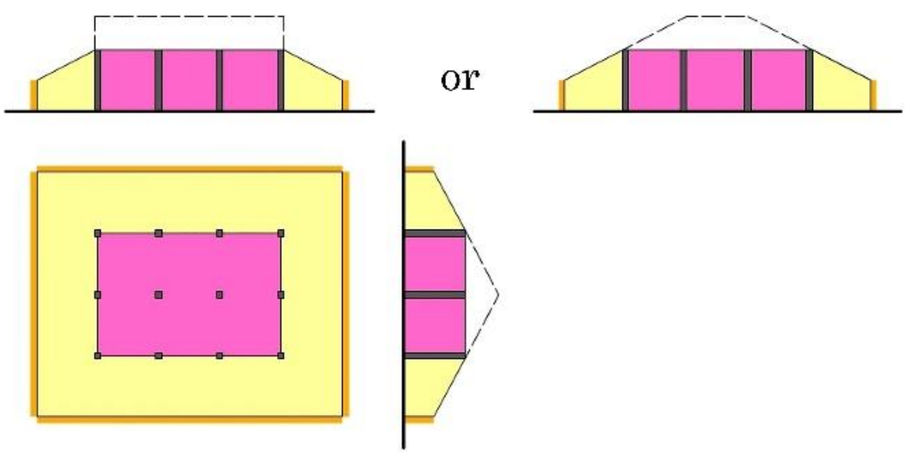

Fig. 11. Three bays and four sides (jikubu-koyagumi structure)

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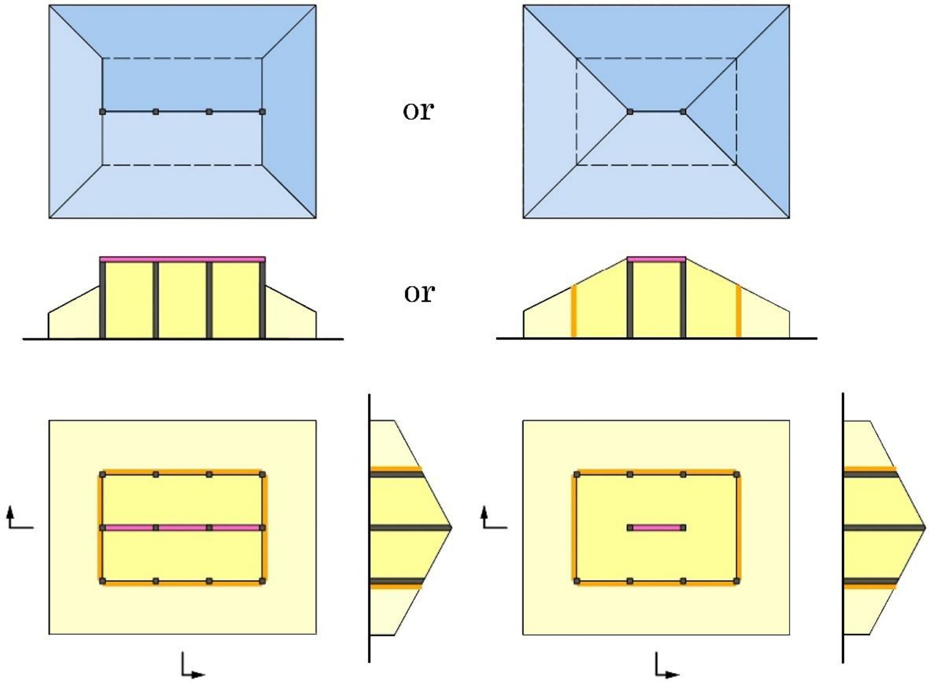

Fig. 12. The kenmenkihou method with the inclusion of zero bays can verbally describe plans for munamochibashira

Then, how were these building structures handled in the kenmenkihou method when it was used to verbally describe plans for wooden buildings? The conclusion reached by this study is that the kenmenkihou method did not exclude plans for intermediate structures, jikubu-koyagumi structure, or munamochibashira structures from the verbal descriptions.

The kenmenkihou method was used from the Nara period to the Nanboku-cho period as a method of verbally describing the plans for wooden buildings built with posts. In buildings of the relevant periods, the moya*母屋* (core of a building) was surrounded by peripheral hisashi*庇* aisles. Let us assume, for example, that a building with a ridge beam has dimensions of three bays and four sides. Then, two rows of posts parallel to the ridge beam run three bays lengthwise over which the moya is built with four hisashi aisles added around the four sides. Such an empirical interpretation of the kenmenkihou method was presented by Kō Adachi *足立康*, an architectural historian (1898–1941) to demonstrate the correspondence between verbal descriptions by the kenmenkihou method and actual plans for architectural remains (Reference 5). Kō Adachi, however, fell short of answering the biggest mystery about verbal descriptions of moya by the kenmenkihou method, namely, why the kenmenkihou method was used to record dimensions parallel to the ridge beam in terms of the number of intercolumnar spaces (for example, as three bays) but none at right angles to the ridge beam.

Under such circumstances, it has been assumed, from the days of Kō Adachi until today, that the kenmenkihou method was intended to describe the plans for jikubu-koyagumi structures or intermediate structures. At the same time, it has been tacitly taken for granted that the

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kenmenkihou method was not intended to describe the plans for munamochibashira structures. More importantly, it has been tacitly taken for granted that, except for the buildings with munamochibashira posts in Ise Jingu Shrine, wooden buildings of the relevant periods were ones without munamochibashira posts. In other words, it has been assumed that the kenmenkihou method was seen to emerge in the Nara period, when munamochibashira structures were no longer built, and to survive until the Nanboku-cho period, when structural configurations consisting of a moya and hisashi aisles were still in use.

Through architectural historical investigation, however, this study discovered that the kenmenkihou method did not exclude plans for munamochibashira structures from the verbal description. This agrees with our previously reached conclusion (Reference 1,3) that a pictorial representation method called fukinuki yatai*吹抜屋台* (oblique see-through bird's eye view) did not exclude plans for munamochibashira structures.

Paying particular attention to the fact that the kenmenkihou method did not exclude plans for munamochibashira structures from the verbal description, this study concludes that building structures constituting munamochibashira structures actually existed from the Nara period to the Nanboku-cho period when the kenmenkihou method was used. The following presents evidence that allows us to conclude that the kenmenkihou method did not exclude plans for munamochibashira structures.

First, in the kenmenkihou method, dimensions parallel to the ridge beam were recorded in terms of the number of bays or intercolumnar spaces. Individual posts giving such intercolumnar spaces were equal in height. For instance, in the case of three bays, two rows of four posts equal in height ran straight in line and were topped with horizontal members such as purlins (Fig.3).

Then, on the sides of the moya in the sense of the kenmenkihou method, equally heighted posts lower in height than those constituting the moya were erected in rows to add aisle-like spaces called hisashi to the outside of the moya. For example, in the case of three bays and two sides, a row of four equally tall posts lower in height than the moya ran along each of the front and rear sides of the moya. In the case of three bays and four sides, posts of the same height were erected in rows along the left and right sides and the front and rear sides to surround all four sides (Fig. 4).

As in the cases of three bays and two sides or three bays and four sides, however, the kenmenkihou method recorded only the dimensions parallel to the ridge beam with dimensions at right angles to the ridge beam left unknown (Fig. 5). In spite of this, it has been uncritically accepted that the dimension at right angles to the ridge beam was also defined by vertical members equal in height to the dimension parallel to the ridge beam.

Before examining this point, let us consider a building recorded as one bay and four sides (Fig. 6). The one bay in one bay and four sides is the minimum number of intercolumnar spaces; therefore, the moya is assumed to be sized as one by one bay. In reality, this assumption agrees with the actual architectural remains. With the moya sized as one by one bay surrounded on four sides by four hisashi aisles, a building sized as three by three bays is obtained. This building is an

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intermediate structure because it features a square floor plan and a hougyo tented roof with no ridge beam; thus, it follows that the kenmenkihou method did not exclude plans for intermediate structures. In contrast, a building featuring a ridge beam and a square floor plan is classified as either a munamochibashira structure or a jikubu-koyagumi structure. According to the conventionally accepted view, the kenmenkihou method was only intended to describe plans for jikubu-koyagumi structures, excluding those of munamochibashira structures.

Then, did the kenmenkihou method really exclude munamochibashira structures? Now to clarify this point, let us include the number zero in the set of natural numbers. The concept of zero was not known in the relevant periods, and there was no notation for the number zero back then. We can, however, consider zero bays by expanding the set of natural numbers into a set of non-negative integers including 0. Assuming that zero bays can be obtained when the dimension of one-bay intercolumnar space is reduced to an infinitesimal, we can define zero bays as a value resulting from the merging of two posts into one. This allows us to understand that the one bay defined by two posts has merged into one munamochibashira post (Fig. 7) in that the moya sized as one by one bay has merged into one post. In fact, it turns out that the dimension at right angles to the ridge beam can be described coherently by assuming a set of bays including the zero bays.

Let us take three bays and two sides as an example. While the dimensions of three bays and two sides recorded by the kenmenkihou method do not include the dimension at right angles to the ridge beam, it has been conventionally accepted that, in common building forms, the dimension in this direction is interpreted as two bays. According to this interpretation, the moya sized as three bays and two sides means that the number of intercolumnar spaces parallel to the ridge beam is three bays lengthwise, and the number of those at right angles to the ridge beam is two bays deep to the post. Then, on each of the front and rear sides of the moya sized as three by two bays, a three-bay long hisashi aisle is given between equally tall posts lower in height than those of the moya.

In this case, the posts constituting the moya sized as three by two bays are identical in height. The posts constituting the hisashi aisles are also posts of the same height (Fig. 8).

Then, the unknown dimension of intercolumnar space at right angles to the ridge beam can be rationally interpreted as one bay allowing us to draw a corresponding form. In addition, when the dimension of one-bay intercolumnar space is reduced to an infinitesimal, a zero-bay intercolumnar space is found. This corresponds to a single munamochibashira post. Let us reconsider the size of three bays and two sides according to this interpretation. Then, the moya parallel to the ridge beam is so formed as to have a four-post intercolumnar space sized three bays lengthwise, whereas the moya at right angles to the ridge beam is so formed as to have a single-post intercolumnar space sized zero bays deep. In this case, the moya equivalent is sized three by zero bays. This is a row of munamochibashira posts defining a four-post intercolumnar space sized three bays in length. Then, the two sides as three bays and two sides are added to the front and back of the row of munamochibashira posts defining the moya-equivalent four-post intercolumnar space sized three bays lengthwise. Consequently, equally heighted posts lower in height than the munamochibashira posts are arranged in rows along the front and back of the row of munamochibashira posts defining

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the four-post intercolumnar space sized three bays lengthwise. This building form constitutes a munamochibashira structure (Fig. 9).

Thus, when a moya size of three bays and two sides is taken as an example, followed by inclusion of a zero-bay intercolumnar space in the verbal description by the kenmenkihou method and then by definition of the building form corresponding thereto, a munamochibashira structure emerges. This is because such an intercolumnar space consists of a row of munamochibashira posts, especially when a zero-bay intercolumnar space is included in the dimension at right angles to the ridge beam.

The kenmenkihou method recorded no dimensions at right angles to the ridge beam at all. The first reason is that not only plans for intermediate structures and jikubu-koyagumi structures but also those of munamochibashira structures were included in the objects of verbal description by the kenmenkihou method. The second reason is that, when dimensions at right angles to the ridge beam are described as n bays, it follows by substitution of non-zero natural numbers, such as 1, 2, 3, and so on, that all moya dimensions at right angles to the ridge beam consist of posts of the same height. The forms thus obtained are either intermediate structures or jikubu-koyagumi structures.
If, however, the set of numbers to be substituted is expanded into a set of non-negative integers (0, 1, 2, 3 ...) and 0 is substituted, the row of posts under the ridge beam will be interpreted as zero bays deep. Then, it becomes possible to verbally describe plans for all buildings constituting munamochibashira structures when equally tall posts lower in height than the munamochibashira posts are added along the front and back of the row of munamochibashira posts interpreted as above.
In fact, when a moya sized three bays and four sides with the dimension at right angles to the ridge beam given as zero bays deep is surrounded on four sides by equally tall posts lower in height than the munamochibashira posts to add four hisashi aisles, a hip-roofed form of building sized as five by two bays as a whole will be obtained with the ridge beam supported by four munamochibashira posts (Fig. 10). By contrast, if the same moya sized three bays and four sides with the dimension at right angles to the ridge beam given as two bays deep is surrounded on four sides by equally tall posts lower in height than the moya to add four hisashi aisles, a hip-roofed form of building sized as five by four bays as a whole will be obtained. This is a jikubu-koyagumi structure (Fig. 11). Conventionally, this interpretation has been the only accepted interpretation of three bays and four sides. If, however, the dimension at right angles to the ridge beam is interpreted as zero bays deep, a munamochibashira structure will emerge. Consequently, we can conclude that the verbal description “three bays and four sides” does not exclude plans for munamochibashira structures but covers plans for both munamochibashira structures and jikubu-koyagumi structures.

As observed above, the kenmenkihou method with the inclusion of the verbal description “zero bays” and corresponding building forms can verbally describe plans for all munamochibashira structures (Fig. 12). From the Nara period to the Nanboku-cho period, the concept of zero did not exist in Japan in the first place. Much less is it likely that the concept of zero bays was discovered. The kenmenkihou method during the relevant periods did not verbally record dimensions at right angles to the ridge beam as n bays because plans for munamochibashira structures were included in the verbal description by the kenmenkihou method and because the concept of zero bays necessary to describe them specifically was not discovered.

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From the above considerations of the kenmenkihou method, this study concludes that building structures constituting munamochibashira structures actually existed from the Nara period to the Nanboku-cho period and that the kenmenkihou method recorded no dimensions at right angles to the ridge beam of such structures so that plans for munamochibashira structures would not be excluded from the verbal description.

This conclusion allows us to understand that munamochibashira structures were never replaced with jikubu-koyagumi structures during the relevant periods, with the exception of Ise Jingu Shrine, but co-existed and complementarily evolved with jikubu-koyagumi structures.

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PRESERVATION OF HISTORIC WOODEN BUILDINGS WITH TRADITIONAL SURFACE FINISHES

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Abstract

The legacy of century old wooden architecture has largely remained in the city landscapes in Estonia. Today, it is a challenge to renovate the historic dwellings with traditional materials and techniques due to the modern building regulations. Historically, the interior walls and ceilings were covered by clay and lime plasters. Today, these materials are largely superseded by new materials whereas one of the reasons is the lack of technical parameters for fire design. This paper provides an overview of the main retrofit measures, traditional building design and research results on the fire performance of traditional plasters that contribute to the authentic preservation of wooden buildings.

Keywords: Wooden buildings, historic structures, fire protection, clay plaster, lime plaster

Introduction and background

Wood has been the primary building material in the northern part of Europe throughout the centuries. Today, the legacy of the 19th and early 20th century architecture in Estonia stands out as the historic wooden buildings are still largely remained in the city landscapes. About a century ago the rapid industrialization resulted in a high demand for cheap tenant apartments that nowadays represent a unique part of local identity transmitting the society's level of development throughout decades [1]. Large wooden suburbs comprise more than 500 buildings that are designed by Estonian architects and present a distinctive characteristic of Tallinn. Currently, the wooden suburbs are listed as milieu valuable areas, yet majority of the dwellings are not under heritage protection. The dwellings are principally private properties.

Today, these buildings are subjected to various needs by the homeowners. In the course of time, the requirements of buildings have evolved and the dwellings are subjected to stringent building

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standards compared to the time they were initially erected. This has raised conflicts between different interest groups when finding solutions to provide sufficient thermal comfort, energy efficiency and fire safety. It is therefore a challenge to maintain the original structure and fabric of the buildings, especially to preserve traditional materials and building techniques.

The energy efficiency of old buildings has largely been discussed due to the environmental impact of buildings. Analysis has shown that these buildings have an energy saving potential up to 63 % [2]. A typical retrofit measure is the addition of external thermal insulation. However, such a solution may jeopardize the architectural appearance of the facades. Hence, an assessment method has been developed [3] that prefers a whole building renovation over a single insulation measure as the energy savings and the overall influence on the external appearance of the buildings is the smallest.

On the other hand, an internal insulation is a possible solution when the existing façade is of high value whereas this approach may result in mould growth and poor indoor climate. Studies have shown that a 50 mm thick interior insulation on a log wall presents a high risk to fail regarding the climate conditions in Estonia [4]. As a result, the insulation measures should be considered as a combination with functioning ventilation and heating systems.

The upgrading of historic buildings should comprise traditional materials and technology while not diminishing today's living standards. In contrast to the achievements on the preservation of the architectural appearance of the buildings, far less attention has been paid to the interiors. Herein, one of the main factors that hinders the use of traditional surface finish materials is the lack of technical information. Technical design parameters are necessary in order to prove the design solutions to the building officials and meet the current building regulations such as fire and sound performance. Lack of performance data derives the concerns and risks on the use of traditional linings such as plasters. As a result, new materials are incorporated in the old buildings that provide well-known technical performance.

Fire safety has always been one of the main concerns when a wooden building is being renovated. Timber is a combustible material and therefore the primary protection against charring is provided by a protection material. Today, the design guidelines and standards lack the fire performance data of plasters despite their historic use as a primary fire protection for timber structures. Current fire design standard EN 1995-1-2 [5] does not consider traditional plasters as fire protection materials for timber. Hence, gypsum plasterboards are extensively used as the most popular material, especially when the attics are upgraded as living places and higher fire requirements must be achieved.

In the following, an overview of traditional building designs and recent fire experimental studies on the wooden structures with plasters is presented. The aim is to provide new knowledge on the fire performance of plasters that contribute to an increased, trustworthy and fire safe use of these materials in the future.

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Fig. 1. Front façade of ‘Lenderi maja’. Photo: Endrik Arumägi

Fig. 2. Three-storey dwelling named ‘Tallinna maja’. Photo: Madis Ahman

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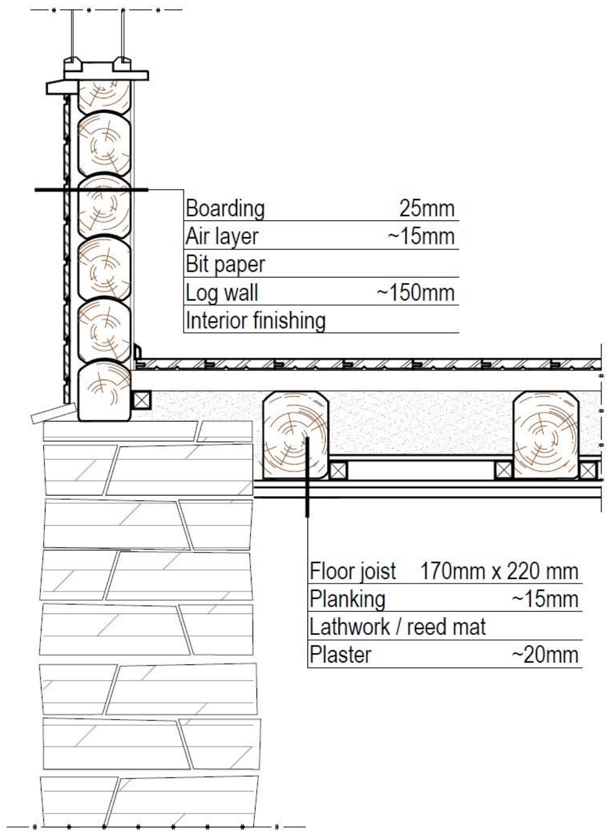

Fig. 3. Structural design of log walls and timber floor partitions.

Fig. 4. Layers of clay plaster applied with a reed mat on a log wall. Photo: Indrek Kerbo

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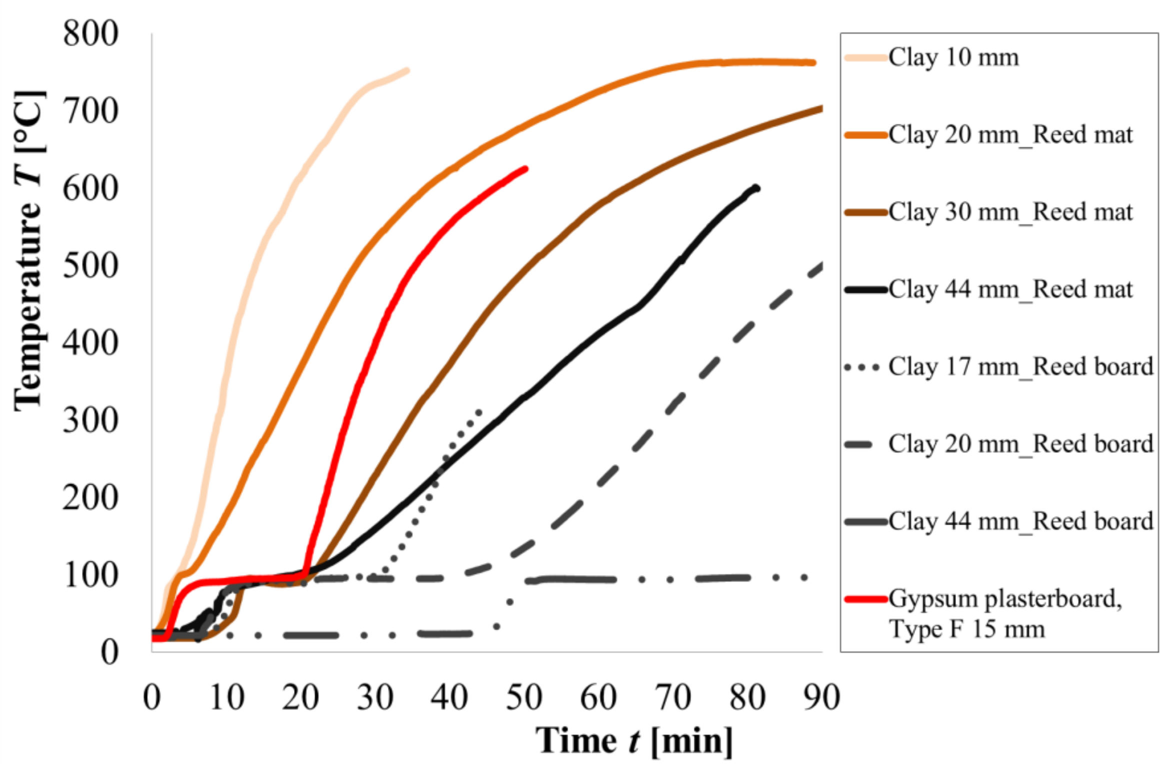

Fig. 5. Temperature measurements recorded on timber behind the protection materials [14].

Wooden buildings

There are two main types of apartment buildings built before the World War II in Tallinn named as “Lenderi maja” and “Tallinna maja” [1]. The standard dwellings are constructed of two symmetrical wooden wings separated by a stone or a wooden central staircase. The “Lenderi maja” is a two-storey building with wooden staircases, see fig. 1. Similar types of buildings can also be found in other cities in Estonia. From late 1920s up to three-storey wooden buildings were permitted with a central stone staircase that is a distinctive characteristic for a house type called “Tallinna maja” (see fig. 2).

Building structures

For a long time, buildings were erected as a horizontal-log construction; see fig. 3. The external walls are typically 120 mm - 160 mm thick without additional insulation. From the 20th century vertical double-plank walls as a novel framework was introduced that increased the mass construction of these houses [1]. Wooden planks are positioned in two rows with an overlap to provide better air tightness. The exterior walls, regardless of the wall structure, are mainly cladded with a wooden boarding or plaster. Additionally, reed boards were used to increase the thermal insulation of walls. The inner walls were mainly finished with locally available surface finish materials - clay and lime plasters that were sometimes painted or covered with wallpapers.

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The intermediate floors are constructed of wooden joists 170 mm x 220 mm, placed approx. 600 mm apart. The space between the load-bearing floor beams are mainly filled with sand and clay that provided the sound insulation and fire safety required during that time. Wooden floor boards were nailed on the top of the joists. The ceilings are covered by lathwork and plaster.

Surface finish materials

The interior walls and ceilings were mainly covered by plasters to provide air tightness and hide the rough qualities of wooden surfaces for a pleasing interior. The material properties of plasters also contribute to the preservation of timber since they derive the excess water out which protects timber from mould growth and fungus. In the past, lime and clay plaster provided the primary fire protection for timber since they are non-combustible materials. The use of these plasters as the main interior surface finish materials continued until they were superseded by modern materials that came to the market during the 20th century.

Lime and clay plaster differ from their respective binding agent. Clay plaster is more versatile and eco-friendly since it does not need any specific processing and remains re-workable even after application. It comprises clay, sand, silt and some form of natural fibres. Water activates the binding forces of clay. Clay plaster differs from other types of plaster as the hardening process is not a product of a chemical curing [6]. In contrast, traditional lime plaster that is a combination of lime and sand sets slowly by absorbing carbon dioxide from the air. Therefore, lime plaster performs well in tough weather conditions whereas clay plaster acts as a passive regulator of indoor climate.

During the course of time the mixtures of plasters have varied in their components and ratios of ingredients. Historical plasters are frequently site specific and no recipe is known. Different properties of each plaster mixture have made them suitable for certain applications. Today, there is no product standard for clay plaster at European level. The first product standard for clay plaster DIN 18947 [7] has been published in Germany 2013. For the lime plaster EN 998-1 [8] should be applied to ensure sufficient quality and endurance. Types of plaster are distinguished according to their function and granularity. In general, plaster is applied in two or three layers to obtain required surface qualities. Plasters can benefit from additional stabilisation through the embedding of reinforcement mesh across the entire surface such as flax, jute, glass-fibre fabric or plastic [6]. Traditionally, a jute fabric has been used in clay plaster. For lime plaster, plastic mesh is suggested to be used.

The adherence of the plaster to the wood surfaces is practically non-existent. This means that plaster requires a support system (substrate) when applied on wooden surfaces to achieve a good mechanical bond. One of the oldest techniques was to treat the wooden surface with an axe to achieve a rough surface for a better adhesion. In the buildings of interest in this paper, a wooden lath or a reed mat was used as a substrate for plaster, see fig. 4. The main key is formed by the plaster being squeezed between the laths or reed mat. During the 20th century modern materials such as metal and plastic meshes were also introduced.

Fire performance of plasters

In the following, a general fire concept is introduced and recent research results are presented. There are two different stages of a fire scenario to be considered in the fire safety of buildings in

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relation to building materials and structures – the reaction to fire and the fire resistance. The reaction to fire concerns the initial stage of fire development that happens before flashover and is closely related to the fire behaviour of a building material. The resistance to fire relates to the fully developed fire conditions and concerns the structural elements.

With regards to the fire behaviour of a material, plasters without any fibrous additives or their proportion of homogeneously distributed organic material constitutes no more than 1 % of the mass or volume (whichever is larger) are generally regarded as non-combustible. Plasters with greater proportion of organic fibre are classified according to EN 13501-1 [9]. The combustibility of clay mixtures is given in *Lehmbau Regeln* [10] that is mainly the same for lime plaster.

The main objective of the structural measures is to restrict the spread of fire from the room of origin and guarantee the load-bearing capacity for a certain time period. Here, the technical parameters of materials enable to design the primary fire protection for timber structures. Until today, plasters have hardly been examined in terms of their fire protection ability to fulfil the European K classification system [11]. The structural fire design of timber structures is described in EN 1995-1-2 that does not consider traditional plasters as fire protection materials for timber structures.

Fire design of timber structures

The verification of fire resistance of timber elements with protection materials is usually based on large-scale fire tests or on calculations according to EN 1995-1-2 with respect to national application documents. Until today, limited data is known about large-scale tests with timber elements and plaster. However, a number of straw-bale tests have shown encouraging results on the fire performance of different plasters as the whole structures have reached fire resistance up to 2 hours [12].

According to EN 1995-1-2 the resistance to fire concerns structural elements which must withstand a fully developed fire that is described by the standard temperature-time curve. Charring is generally the dominating effect influencing the mechanical resistance of timber structures since the cross-section of a timber member is reduced by fire. Therefore, the primary protection for timber in fire is provided by an additional material. Important design parameters for different protection materials are the start time of charring of timber, charring rate at the protected charring phase, the post-protection charring phase and the failure time of the protection. EN 1995-1-2 specifies that the temperature value of 300˚C is agreed to be taken as the start time of charring.

Research studies

One of the first comprehensive studies on the fire performance of lime and clay plasters has been made by Küppers (ne Watchling) et al [11]. The objective was to reach the fire resistance of 60 minutes for building elements and meet the classified fire protection coating $K_2$60 under standard fire conditions. Different plasters and set-ups of materials were tested in small and model-scale furnaces. Results indicated that thick plaster coats provide sufficient fire protection.

In recent years, an investigation on timber structures protected by clay plaster has been carried out by Liblik and Just [13]. As there is limited available data and large-scale fire tests are expensive and time consuming, bench-scale fire tests have provided a simple alternative to determine the basic fire performance of various types, thicknesses and compositions of plasters. The cone heater of a cone calorimeter was used to get an indication of the fire technical properties and to prepare

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the larger-scale fire tests in furnace. Undercoat plasters with a density of 1600 kg/m³ - 2000 kg/m³ have been of main interest due to their extensive use on timber in practice. Traditional plaster substrates such as a thin reed mat and a reed board of 50 mm thickness were used.

A number of model-scale furnace tests have been carried out to confirm the results gained in small-scale and to determine the fall-off time of clay plaster [14]. The protection ability of plasters was determined by using thermocouples that recorded the temperature rise on timber behind the respective plaster system throughout a fire test. Fig. 5 illustrates some main test results where the average temperature measurements recorded behind plaster systems are presented. Lower temperatures indicate better protection ability for plaster systems. For reference, the performance of 15 mm thick gypsum plasterboard Type F (GtF) is presented. Results indicate that the same start time of charring of timber behind GtF is achievable with thicker plasters.

Different studies agree that the most significant parameter to influence the fire protection ability of traditional plasters (without special additives) is the thickness. The charring rate of protected timber is slowed down by thicker coats of plaster. The fall-off time of plaster is mainly dependable on the respective substrate, e. g. plaster falls-off when the charring depth of timber has reached the length of the fixed staples of a reed mat. The addition of special additives in plasters shows enhanced fire performance [11]. Based on the test analysis, a design model for clay plaster has been developed that could be extended to lime plaster [14]. This is proved by the results from the furnace tests with lime plaster on straw bale as well as small scale tests that indicate better fire protection for lime plasters. Further studies should comprise furnace tests with lime plaster on timber. In the future, numerical simulations should follow that enable a flexible way to analyse various combinations of plaster systems on timber.

Conclusion

The wooden suburbs in Estonian cities present a unique part of the national cultural heritage. Today, the dwellings undergo renovation to comply with modern building requirements. The preservation of traditional building techniques and materials are in jeopardy since majority of the century old buildings are not under heritage protection. Research studies on the energy efficiency provide sufficient solutions for renovation. However, traditional surface finish materials – clay and lime plaster – are often superseded by modern lining materials such as gypsum plasterboards. One of the reasons is the lack of fire performance data that could ensure the required fire protection for timber walls and ceilings. Recent studies present new knowledge on the fire protection ability of plasters, also a design model for lime and clay plaster has been developed. This provides scientific basis to the evaluation of fire performance of traditional plasters. Design models enable an assessment method for existing plasters and can therefore minimize the alterations to the original building fabric. Further research is necessary to incorporate traditional plasters to the technical guidelines and design standards. Studies on the fire technical data of plasters contributes to their wider use together with traditional building techniques in existing buildings. Increasing the knowledge on the technical performance of traditional materials supports the authentic preservation of buildings.

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THE HANDING DOWN OF TRADITIONAL CARPENTRY TECHNIQUES IN JAPAN

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Abstract

With the enactment of the *Law for the Protection of Cultural Properties* in 1950, Japan became the first country to take legal measures for the protection of intangible cultural heritage. In 1975, a further step was taken with the introduction of the concept of "Selected Conservation Techniques". Under this system, techniques necessary for the conservation of cultural properties are officially recognized, and individuals or organizations who have achieved mastery of these techniques are certified as "holders".

Traditional carpentry is one of these "Selected Conservation Techniques". Carpentry techniques were historically handed down from one generation to the next inside carpenter's families. However, during the 20th century the knowledge and skill to manipulate traditional tools and make complex woodwork joints was gradually being lost. In order to avoid the further loss of this technique, two organizations are currently entrusted with holding specialized training programs for carpenters.

One special scribing technique employed to design the eaves of the roofs of religious buildings, known as *kiku*, is studied by carpenters during these programs. The knowledge of the *kiku* technique had to be relearned through research of old treatises and buildings. Carpenter Takeo Mochida is currently the only person designated as "holder" of the technique and works as instructor in order to pass his knowledge to the next generation.

Key words: intangible heritage, Japanese architecture, carpenter's square, scribing

Introduction

Wood was historically the main building material in Japan, and highly sophisticated techniques to build with this material were developed throughout time. Such techniques form a valuable body of knowledge, which gives us a deeper understanding of heritage buildings and can be applied to repair them. However, especially from the 20th century, this knowledge started to be gradually lost.

This paper examines the measures implemented in Japan for the handing down of techniques associated to building with wood. First, the legal framework of this measures and its background will be discussed. Then, different traditional techniques related to wooden buildings and their mutual relationships will be introduced. Finally, the case of the *kiku* technique will be studied as an example of how this knowledge is being currently handed down in Japan.

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The legal framework for the conservation of traditional techniques in Japan

Japan was one of the first countries to establish a legal framework for the protection of its cultural heritage. The political reforms of the Meiji Restoration, starting from 1868, resulted in a fast modernization of the country; but at the same time brought along a period of unrest. One of the consequences of this social climate was a reaction against Buddhism (*haibutsu kishaku*), which resulted in a widespread destruction of temple buildings.

The newly established Meiji Government, however, soon recognized the importance of these buildings as part of the country's cultural heritage. As a result, the *Law for the Conservation of Ancient Shrines and Temples* was enacted in 1897. As its name indicates, the scope of this law was limited to religious buildings. It would be necessary to wait until 1929 for the inclusion of other kinds of buildings (such as private residences and castles) with the enactment of the *Law for the Conservation of National Treasures*.

Finally, the currently in force *Law for the Protection of Cultural Properties* was enacted in 1950. This law merged previous independent acts for the protection of buildings, historic sites and art objects. However, its most innovative aspect was the introduction of a new category, "Intangible Cultural Properties", which included performing arts (such as different forms of traditional theatre and dance) and craft techniques (such as lacquerware or ceramics). This was the first time that any country recognized and protected intangible cultural heritage in its legislation.

Several amendments of this law have enlarged the scope of protected heritage. Shortly after its adoption, the new category of "Folk Cultural Properties" (both tangible and intangible) was added. In 1975, "Groups of Traditional Buildings" and "Selected Conservation Techniques" were included. The most recent additions include "Cultural Landscapes" and "Buried Cultural Properties".

Thus, according to the current legal framework, intangible cultural heritage in Japan is protected under three different categories:

- "Intangible Cultural Properties", which include performing arts and craft techniques. The persons or organizations who have achieved mastery of these arts and techniques and are engaged in activities to bequeath them to the next generation are officially certified as "holders" (popularly known as "Living National Treasures"). These "holders" can receive subsidies to carry out training and documentation activities aimed at conserving and handing down their knowledge.
- "Folk Intangible Cultural Properties", which include festivals and dances generally associated to a particular region and rooted in the local communities.
- "Selected Conservation Techniques", which are defined as techniques required to conserve other tangible or intangible cultural properties. These techniques include, for example, the manufacturing of Japanese *washi* paper required to repair paintings, or the hairstyling technique required to style the wigs employed in *kabuki* theatre. There are currently 75 of these techniques, which are protected in a similar way to the "Intangible Cultural Properties": officially certified "holders" of the technique are entrusted the task of handing it down to the

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next generation.

The early recognition by the Japanese legislation of the importance of intangible cultural heritage and the development of this protection framework is probably the result of the character of Japanese cultural manifestations, which in many cases employ fragile and perishable materials. In such cases, not only the physical object itself, but the techniques involved in their creation and maintenance are an integral part of the cultural heritage. This framework has since served as a reference for the establishment of legislation protecting intangible cultural heritage in other countries. Japanese experts were also actively involved in the creation of the UNESCO Convention for the Safeguarding of Intangible Cultural Heritage in 2003.

Techniques related to the conservation of wooden buildings

Under the above described legal framework, techniques related to the conservation of wooden built heritage are classified under the category of "Selected Conservation Techniques".

Although traditional carpentry is perhaps the most cited technique in this context, there are many other techniques involved in the conservation of wooden buildings. In fact, out of the 75 "Selected Conservation Techniques", around one third are related to the process of building and repairing traditional wooden buildings. These techniques include every stage of the building process, from collection of raw materials (such as reed for thatched roofs) and the manufacture of building parts (such as *tatami* mats) to roofing and finishing techniques (such as traditional plastering and painting). Many of these techniques are deeply interrelated, and in order to keep the building cycle it becomes necessary to conserve them as a whole.

An example of mutually interrelated techniques can be seen in the creation of a cypress bark roof. In Japanese architecture, thin shingles of cypress bark (*hiwada*) are commonly employed as roofing material. These lightweight and flexible shingles make possible to have roofs with complex curved designs and a light and elegant appearance. However, in the humid Japanese climate, these shingles decay and need to be replaced every 20-30 years. The replacement of a cypress bark roof is a process that involves three different traditional techniques: collection of cypress bark, roofing, and manufacturing of bamboo nails.

The cypress bark is collected from live Japanese *hinoki* cypress trees (*Chamaecyparis obtusa*), which have to be between 80 and 100 years old. The collecting technique involves climbing to the tree (sometimes up to 20 m) without damaging it, using hemp ropes. The outer layer of bark is then peeled using a wooden spatula. If the collection is done properly, the tree will regenerate the bark in around 10 years, when it will be possible to collect it again. Collected bark is then cut to measure and tied in bundles that are sent to the building site. Currently, there is only one individual certified as "holder" of this technique. Collection of bark is a heavy and risky task; in addition, it cannot be performed during the bark forming season between April and July. These factors make it difficult to secure the next generation of craftspersons.

Once the cypress bark shingles arrive to the site, a different type of craftspersons lay them on the roof. Shingles are laid with great precision, adapting to the complex shapes of the roof, and fixed

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with bamboo nails. The roofers put a handful of these nails in their mouth, and then fix them one by one using a small hammer (fig. 1).

Fig. 1. Roofing with cypress bark shingles (hiwada)

The third technique involved in the process is the manufacturing of the bamboo nails (fig. 2). These nails have to be cut to the same shape and size, polished, and heated to give them strength. The quality of these nails is very important for the roofing craftspersons, not only as a work tool, but as a product that they put in their mouth every day. However, the only certified "holder" of the technique for manufacturing bamboo nails passed away in 2004, and although nails are still being produced, the conservation of the technique is in a critical situation.

Fig. 2. Bamboo nails used to roof with cypress bark shingles

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Regarding the repair of the main structural framework of a wooden building, traditional carpentry is the most relevant technique. In the Japanese approach to the conservation of wooden buildings, the basic methodology is repairing decayed members using timber repairs: the decayed part is cut and substituted by new timber, and woodwork joints are employed to connect the old part with the new one (fig. 3). Sometimes these woodwork joints can be very complex; in addition, new timbers are usually processed with traditional tools in order to match the finishing of the original members (fig. 4). Carpenters working on conservation have to go through specialized training programs to master these techniques.

Fig. 3. Repair of pillars with woodwork joints

Fig. 4. Finishing with an adze

Currently, two organizations are certified as "holders" of the traditional carpentry technique and hold training programs: The Japanese association for conservation of Architectural monuments (JACAM), which is mostly an architect's association, and the Japanese Association for Conservation of Traditional Architecture, which is a carpenter's organization.

JACAM, for example, organizes two levels of courses: the "regular course" and the "advanced course", each one for 10 trainees per year. To qualify for the regular course, trainees need to have 6 years of experience (at least 3 of them in conservation work) and be under 40 years of age. The course is organized in 2 terms of one week, totaling 104 hours. Trainees of the advanced course must have graduated from the regular course, acquired 6 more years of work experience, and be between 40 and 60 years of age. The duration of the advanced course is a single term of one week, for a total of 56 hours.

As the demanding requirements to be admitted to these courses and the small number of trainees per year suggest, the content of these programs is highly specific, and focused on a few advanced techniques which a carpenter would find difficult to master otherwise. One of these advanced techniques is the *kiku* technique.

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Fig. 5. Model of the corner of the roof eaves

Handing down the *kiku* technique

The *kiku* technique is a scribing technique which employs the carpenter's square to make three-dimensional geometric calculations and shape timber members.

The carpenter's square is employed all over the world; however, the Japanese version of this tool (known as *sashigane*) has some unique features. The most important one is the use of two different scales on each side of the long arm of the square. The front side has a regular scale (*omote*), while on the back side the units equal those of the front side multiplied by the square root of 2. This allows for faster calculations.

The *kiku* technique originated around the 13th-14th century. Its main application is the design of the corners of the eaves of religious buildings. The roof of these buildings generally has a two-layer structure: the roofing material is laid on an upper set of rafters, while a lower set of rafters functions as a ceiling. The actual members carrying the load of the roof (beams, purlins and struts) remain hidden between these two sets of rafters. Roofs are usually hipped or hipped-and-gabled; the rafters from each side of the building meet at the corners.

Fig. 6. Handing down the kiku technique

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From a strictly structural point of view, it is not necessary that the rafters fit perfectly at the corners, and buildings until the 13th century did not have perfectly fitting corners. However, at a certain point around the 13th-14th century, making the ceiling rafters fit neatly and seamlessly at the corners started to be perceived as increasingly important from an aesthetic point of view. These rafters have to be evenly spaced and their shape must follow the eaves, which are curved in two directions. As a result, each rafter has a slightly different shape depending on its position. Making the complex calculations required to make all these members fit perfectly is the objective of the *kiku* technique.

Knowledge of the *kiku* technique was traditionally handed down inside carpenter's families. In addition, around the 19th century some treatises describing this technique started to appear. The most important one was *Hitorikeiko Sumikane Hinagata*, written in 1854 by a carpenter named Kobayashi Genzo. In the mid-20th century, this treatise was translated into modern Japanese and reinterpreted by another carpenter, Ageta Torasuke. In addition, Ageta gave a scientific basis for several calculation procedures that were unexplained in the original texts (Hattori, Ageta, 1948). Ageta was the first person certified as "holder" of the early modern *kiku* technique, from 1979 until he passed away in 1984. His successor, carpenter Mochida Takeo, has continued his task, teaching the *kiku* technique at the specialized training programs, and publishing several textbooks on the subject (Mochida, 2014 and Mochida, 2017). Mochida has been certified as "holder" since 1992.
During the regular course organized by JACAM, carpenters make a scale model of the corner of a temple roof, combining the two major ways of laying the ceiling rafters: radially (fig. 5, left side) and parallel to each other (fig. 5, right side). During the first week of the course, the trainees prepare a 1:1 drawing on a plywood board. During the second week, they divide in two groups of five and complete the model. Mochida Takeo (fig. 6, to the right) and his disciple Aoki Koji (fig. 6, in the middle) give guidance to the trainees at every stage.

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HERITAGE EDUCATION SYSTEM IN THE CONSERVATION AND REGENERATION PLAN OF TSUMAGO-JUKU IN JAPAN

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Abstract

Number 11 of the United Nations' Sustainable Development Goals asserts that the principle of equity in sustainable urban development necessitates the recognition of cultural rights; the right to a "sense of belonging" for all citizens as "tangible" and "intangible" heritage. The significance of the subjectivity of inhabitants in the regeneration of rural districts is reflected in the conservation and regeneration plan of *Tsumago-juku* in Japan. Since the 1950s, *Tsumago* has epitomized a nationwide democratic movement in the country. The Tsumago Citizen Center, which was built in 1948 by local inhabitants, established the *Noh* Drama Research Society. Such popular *Noh* dramas as "The King and the Prophet" interpreted the relationship between the public and those in power, where the wisdom of the former was recognized by the latter. The rules of conservation of rural districts and vernacular architecture subsequently prepared inhabitants for future district regeneration movements, which echo public wisdom. The three principles of the Tsumago Citizens' Charters, which was formulated in 1971 by another non-governmental organization Caring Tsumago Society, of "no selling, no renting, and no dismantling[19]" was in resistance against vulgarization and external capital flow. The community gradually developed a unique heritage education system as well as a heritage stewardship system in the 1960s. By focusing on community building and public participation, and analyzing the stakeholders in local society, this paper proposes heritage education system as a motivator for the conservation of vernacular architectural heritage to propose a means of protecting local identity in a neo-liberal context.

Keywords: built vernacular heritage heritage education system *Tsumago-juku*

Introduction

In the 1920s, Le Corbusier, the high priest of modern architecture, wrote that "a house is a machine for living in," in his famous *Toward an Architecture*, and homogenized houses and city residences as industrial products spread through modern Japan. This gradually resulted in a deep nostalgia for the hometown, a traditionally built environment all over the country. Reflections by Japanese academia consisting of planners, architects, and conservationists appeared to resist the worldwide forces of economic, cultural, and architectural homogenization such as *Nishikawakoji*'s well-known proposal of a "Plan on Preservation and Restoration of Landscape Heritage" (*hozonshiukekekaku*)[20], suggesting that all historic areas should be preserved as cultural relics to preserve the traditional environment for future generations. This view was endorsed 26 years later in the "Charter on the Built Vernacular Heritage," ratified by the 12th General Assembly of ICOMOS (International Council on Monuments and Sites) in Mexico in October 1999. The text

[19] Koji,1973.
[20] *Nishikawakoji*, 1973.

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of the charter summarized the value of built vernacular heritage.[21] Before international principles for the care and protection of built vernacular heritage were established in the 1970s, vernacular houses of *Shirakawa* village in Japan, featuring thatched roofs built in the *Gassho* structure, were restored spontaneously under strict principles

Fig. 1. Townscape of Tsumago-juku. Photo by author.

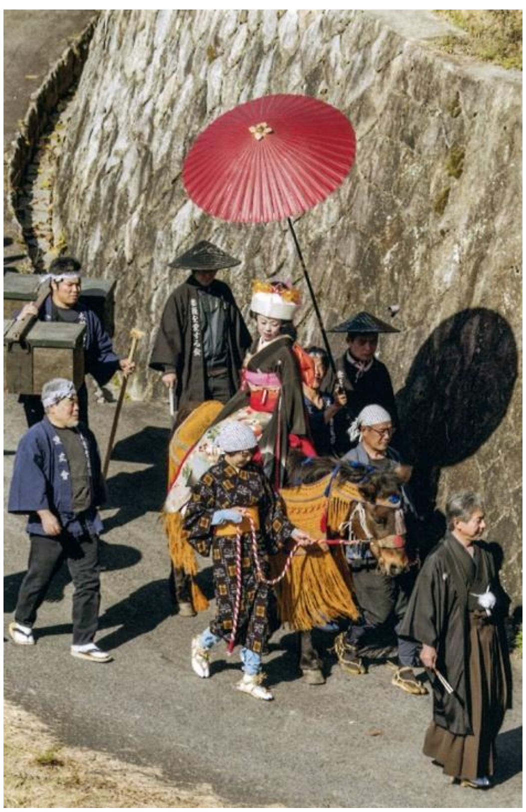

Fig. 2. 'Bunka-Bunsei period folk picture scroll' on Tsumago-juku streets every November.

[21] ICOMOS, 1999.

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Tsumago-juku is an ancient *Edo shukuba*(accommodation) building cluster found in *Nakisomachi* in *Nagano*, Japan, and dates to the *shogunate* period (Fig. 1, Fig.2). As an excellent case in the history of timber village heritage conservation, it took 15 years for the implementation of a conservation and regeneration plan for it.

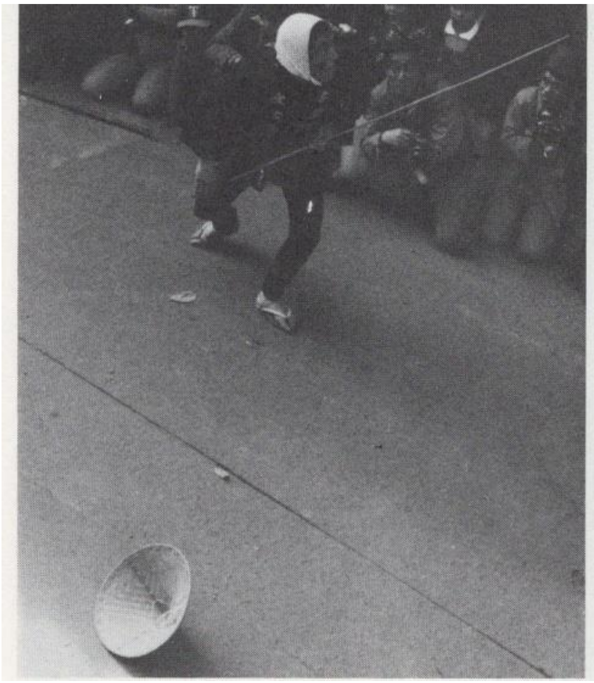

Fig. 3. Noh drama actor in Tsumago-juku.

In tracing *Tsumago-juku*'s odyssey of conservation, the significance of heritage education system is noticeable. The outcome of heritage education system was a heritage self-stewardship mechanism supported by the local inhabitants that is still in effect today. It grew spontaneously from the local society, whose members were successfully inculcated with communal consciousness: in other words, believing in equity in sustainable urban development, the right to a "sense of belonging" for all citizens for both "tangible" and "intangible" heritage. By detailing on community formation, public participation, and stakeholders in local society, heritage education system is proposed as a motivator in the conservation of vernacular timber heritage to seek local identity in a neo-liberal context, as articulated in the "new horizons" in the conservation of wooden built heritage embraced in the new ICOMOS(International Council on Monuments and Sites) 'Principles for the Conservation of the Wooden Built Heritage' adopted in Delhi in 2017[22].

Beginning of heritage education system and implementation of democracy in post-war Japan in *Tsumago-juku*

Since the 1950s, the Japanese government's policy of economic stimulus has had a significant effect on rural areas. *Tsumago* came to epitomize a nationwide democratic movement. The

[22] ICOMOS, 2017.

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Tsumago community was not borne of resistance against rural depopulation, but widespread love for Japan's *Noh* drama. In two decades, two remarkable documents were formulated: the *Tsumago* Citizens' Charters and the *Tsumago* Mutual Supporting Principles. The relationship between the implementation of democracy in post-war Japan, *Noh* theatre, and methodologies of conservation was deep as the people participating in *Noh* theater were those who first propagated the idea of the village conservation. Without these "*Noh* fanatics," the 15-year plan would have been impossible.

In 1948, *Tsumago*'s citizen center established the *Noh* Drama Research Society, whose members were mainly young people. The object was to educate them to establish subjectivity and self-esteem in a democratic society. Popular *Noh* dramas, such as "The King and the Prophet" (Fig. 3), interpreted the relationship between the people and those in power. Plebeian's wisdom was recognized by the patricians. Rules of conversation formulated in this backdrop mentally prepared inhabitants as citizens conscientious of future conservation, which echoed the people's wisdom and self-esteem.

In 1960, the liberation of the imperial forest zone of *Kisomachi* accelerated local economic revival. The primary tea industry and agriculture improved *Tsumago*'s economic conditions, while administrative consolidation of the villages had the opposite effect. In 1966, national road no. 19 became operative, and *Tsumago* gradually experienced depopulation. In 1964, activists in the *Tsumago* citizen center began collecting vernacular archives and established the Association of *Tsumago-juku* Archives in 1965.

Fig. 4. Okutani Waki Hongjin building (Nagano heritage). By 'www.tsumago.jp'

The text of the association's meeting in 1965 contained the following:
"In *Tsumago*, every family inherited some precious folk archives and cultural heritage from its ancestors, which lose value in daily life. In order to protect them, we have established the Association of *Tsumago-juku* Archives. This association is run as one part of *Tsumago* citizen

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center's organization to discover, preserve, and collate *Tsumago-juku* archives. In future, we will establish museums for for students, tourists, and scholars"[23]

The Association of *Tsumago-juku* Archives absorbed members of such local organizations as Women's Society and the Young Men's Association. Its first achievement was the successful preservation of the *Okutani Waki Hongjin* building, which was the *daimyo*'s former residence (Fig. 4). The members agreed that the relics of *Edo shukuba* buildings could motivate local revival. They formed a non-government organization (NGO) called Caring *Tsumago* Society in 1968, which passed the *Tsumago* Citizens' Charter and invited all residents to participate in the 15-year conservation and regeneration movement of *Tsumago-juku*.

Fig. 5. Restoration of Edo vernacular building details in Tsumago-juku. Photo by author.

The *Tsumago* citizen center was the first local organization to educate the inhabitants as a community in the post-war period. The *Noh* Drama Research Society, the Association of *Tsumago-juku* Archives, Caring *Tsumago* Society, and Caring Friendship Society continued to further educate citizens. As expressed in the following, the aims of *Tsumago*'s community participation departed from regional egoism and highlighted the theme of subjectivity and self-esteem in conservation under contemporary Japanese urban and rural contexts:

"With the pressure of economic development taking precedence, Japanese people felt depressed when they mentioned their hometowns. In the 1970s, the local conservation movement brought great benefits to nationwide development. The value of *Tsumago*'s case has been fully recognized,

[23] Nagano, 1972: 831-833

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but it doesn't mean the essence is regional egoism. It is a creation from the perspectives of history and society, starting from the rural place and spreading all over Japan"[24]

Self-educating as methodology of conservation in *Tsumago-juku* community

The heritage education system consisting of the *Tsumago* citizen center, the *Noh* Drama Research Society, the Association of *Tsumago-juku* Archives, and the Caring *Tsumago* Society was built before the conservation and regeneration plan of *Tsumago-juku* began. In 1961, the Association of *Nakisomachi* Tourism was established by *Akiyoshi Katayama* to prepare for a rise in tourism, along with the Association of *Tsumago-juku* Archives and the Caring *Tsumago* Society.

Fig. 6. Townscape of Tsumago-juku after 15-year conservation plan. Photo by author.

Three years after its establishment, the Caring *Tsumago* Society absorbed all the inhabitants in *Tsumago* as members. The activity was described in regulations of the society as follows:

1. Fixing up the cultural heritage of *Tsumago* area (tangible, intangible, folk archives, monuments);
2. preservation of *Tsumago-juku*'s buildings;
3. conservation of other vernacular elements;
4. education of members (lectures, exhibitions, investigation tours to learn from others);
5. other necessary enterprises.

All members agreed on the *Tsumago* Citizens' Charter in 1971.[25]
In 1967, *ōta Hirotaro* proposed that *Tsumago shukuba* buildings be entitled to protection. The regional heritage of *Nakisomachi* covered a total of 1,245 km^2 at the time.[26] The conservation and regeneration plan took 15 years to complete. The first part started in 1968, last five years, and cost 36 million yen. A total of 26 *Edo shukuba* buildings in *Terashita* were preserved and restored in

[24]Nakisomachi, 1989: 154
[25] Nakisomachi,　1989：163
[26] Hirotaro,1969.1984.

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this phase. In the next plan in 1971–72, 58 *Edo shukuba* buildings in *Koino*, *Kamimachi*, *Nakamachi*, and *Shitamachi* areas of *Tsumago* were restored, and included renovations to municipal facilities. In 1975, national legislation was passed to stimulate conservation, and national traditional building clusters were added to the list of historic monuments, with financial aid earmarked for them. *Tsumago-juku* was included in the list of historic monuments as a national traditional building cluster, and a plan for its conservation and regeneration was executed, in the course of which 57 *shukuba* buildings were restored (Fig. 5 and Fig. 6).

Evaluation of the *Tsumago-juku* plan and its adaptation to other communities

During its conservation, *Tsumago-juku*'s came to be known worldwide. The conservation and regeneration plan was awarded prizes by the Architectural Institute of Japan as well as the Japan Design Association. The comments of the panel of judges of the former summarized the creative contributions as follows:

"Succeeding as an enterprise by the local community, the cooperation of the inhabitants, and the endeavor of experts, *Tsumago-juku* resolved long-standing conflicts between conservation and tourism. Not limited to a single building, the integrity of the enterprise included expansive natural areas."[27]

As concluded above, the success of the conservation and regeneration plan of *Tsumago-juku* depended on execution by the community and experts' adherence to a scientific methodology for conservation. The media and national policy were important as well. The conservation and regeneration of *Tsumago-juku* was implemented from bottom to top to reflect the people's wisdom, as they gathered as trusted guardians of the tangible and intangible heritage of *Tsumago*. The conservation enthusiast *Obayashi Toshihiko*'s remarks expressed the balance among the stakeholders as follows:

"The two organizations—the Association of *Nakisomachi* Tourism and Caring *Tsumago* Society—pursued economic profit and public interest differently: The latter prevented decisions guided by economic reasons while fundraising was assumed by the former. As a result, it is believed that conservation could be harmonized with tourism when there are proper organizations, and different value-seeking stakeholders counterbalance each other in this system designed beforehand"[28]

Democratic development brought about a heritage stewardship system as well as a sustainable motivator in local community revival. Starting in 1970, the number of tourists kept increasing: 390,000 in 1971, 540,000 in 1972, and more than 600,000 on average from then on every year. [29]*Tsumago-juku* eradicated poverty. The Caring *Tsumago* Society then held winter seminars in 1977 centered on solutions to these problems and continued this discussion once a year. The new principles of *Tsumago-juku*'s conservation and regeneration were formulated as follows:

"Maintaining the principle of preservation as a priority under regional revival without forgetting the initial intention, abiding by the *Tsumago* Citizens' Charter and the preservation regulations of

[27] Nagano, 1972: 831-833
[28]Nagano, 1998: 4-8
[29] Akira, 2009

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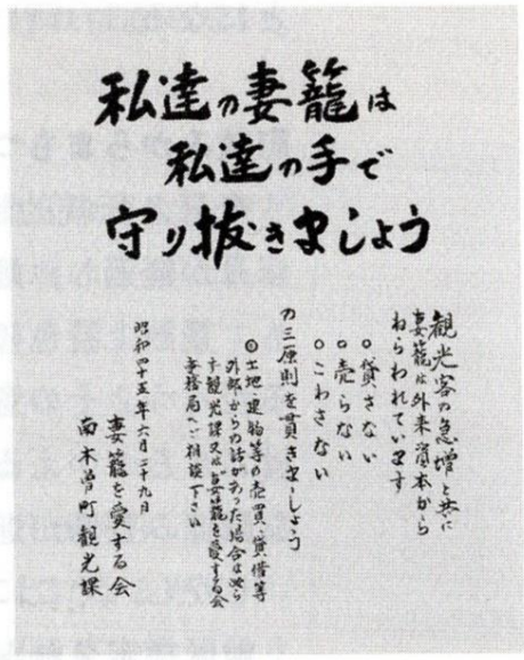
Tsumago-juku; respecting the local character, preserving the built environment and living states as representative of integrity since the natural and historical environments belong to all inhabitants in *Tsumago*; maintaining the trinity conservation mode of inhabitants, government, and scholars. "[30]



私達の妻籠は
私達の手で
守り抜きましょう

観光客の急増と共に
妻籠は外来資本から
ねらわれています
○貸さない
○売らない
○こわさない
の三原則を貫きましょう
◎土地・建物等の売買・貸借等
外部からの話があった場合は必ら
ず観光課又は妻籠を愛する会
事務局へご相談下さい

昭和四十五年六月二十九日
妻籠を愛する会
南木曽町観光課

Fig. 7. Text of 'no selling, no renting, no dismantling'on pamphlet of Tsumago Citizen Charters drew up in 1971.

Conclusion

As is embraced in the new ICOMOSʹPrinciples for the Conservation of the Wooden Built Heritageʹ adopted in Delhi in 2017. The text of the principles summarized the significance of community participation in built vernacular heritage conservation as follows:
Recognize and respect the importance of the wooden built heritage,... its relation with social and environmental transformations, and its role in sustainable development.[31]

Vernacular architecture is the traditional and native way in which communities build houses. The conservation and regeneration plan for *Tsumago-juku* is an ongoing process, with continual adaptation a response by local people to social and environmental constraints. Compared with others, most timber heritage in villages belongs to people in rural districts who are still living in these buildings. The heritage education system built by the local community to build cooperation among stakeholders in the community is important for built vernacular heritage, especially timber buildings. The conservation and regeneration plan of *Tsumago-juku* highlights the potential of heritage education system. It is worth noting that the basis of all impulses concerning the conservation of the local townscape derived from *Noh* fanatics, where the popular drama "The King and the Prophet" helped local youth impart civic sense among citizens.

[30]Nakisomachi, 1989: 9-22

[31]ICOMOS, 2017

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In conclusion, heritage education system can be a sustainable motivator of the conservation of vernacular timber heritage in rural districts in countries including China. Conservation in China is nowadays related to issues like development, social well-being, cultural expression, discrimination, and immigration, which indicates a shift to an urbanistic conservation practice. The community-as-heritage stewardship system implemented in the conservation and regeneration plan of *Tsumago-juku* was a coordinated and structured operation of heritage conservation with the broader purpose of protecting the significance of the place according to criteria defined by the government and other stakeholders, with the legitimate interests of stakeholders considered.

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Conservation of wooden buildings complex of Kiashahr port fishery area

(with emphasis on conserving of heritage values)

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Abstract

The heritage site of Kiashahr port fisheries is an example of the heritage of contemporary Iranian architecture. The history of the first period of its construction of wooden structures dates back to the Qajar era (second half of the 19th century until 1921 AD), and according to the values of this complex, it has been registered in Iran's national monuments list in 2007. The site is one of the main centers for fishing, harvesting, processing and selling aquaculture, especially caviar. Despite the abandonment of the complex, the location of its construction as well as the existence of advanced fisheries facilities along with wooden buildings architectural value structures that are a combination of Russian-Iranian architecture, this complex has been distinguished in terms of cultural, historical and architectural style in the region. Nowadays, this valuable area is almost deserted and its life has been facing serious challenges. The research addresses the question of how identifying architectural - legacy values of a historical site conservation? In this regard, data have been collected based on library and field studies and a combination of historical and descriptive research method has been used based on the nature of the research. This paper seeks to achieve the strategy of architectural conservation within the studied area by identifying the architectural - legacy values of wooden buildings in the site. In order to achieve this goal, the heritage values of the set have been identified and categorized in order to make informed decisions based on purpose and value-based measures. These classifications have for the first time resulted in recognition of different architectural periods. Finally, the idea of conserving the Kiashahr port fishery Complex with the aim of improving the quality of physical architecture, revitalizing the socio-cultural structure, conserving green infrastructure, as well as recognizing and strengthening the historical identity of the study area was presented.

Keywords: Kiashahr port fishery area, Heritage values, Wooden buildings, Architectural conservation strategy.

Introduction

Kiashahr port fishery complex with advanced facilities and structures with architectural value has been built for harvesting the highest quality resources of Persian caviar and aquatic organisms and transfer them to Russia. Even the materials required for constructing the complex, such as timber, raw materials used for producing brick and cement have been imported from Russia (Issawi, 1971, p. 256).

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Overharvesting of the aquatic resources in the Caspian Sea by Russians over the past century, as well as the implementation of improper programs in the management of fishery resources in the recent decades, have led to a reduction in production and, consequently, slackened Kiashahr port fishery complex.

Continuation of this issue has led to the gradual abandonment of the complex and therefore, destruction of its architectural and heritage values. Identifying and highlighting the heritage values of the wooden structures in Kiashahr port fishery area, the current research attempts to clarify its conservation importance, suggesting an idea.

1- How will identification of the architectural values in a heritage site result in encouraging its conservation?
2- Which values do affect the architectural conservation of the wooden structures in Kiashahr port fishery heritage area?

To advance the research forward, the data was gathered in two parts, including the library studies and field investigations of the wooden building complexes in Kiashahr port fishery heritage area; in such a way that, the data has been collected from historical resources, books, documents and plans utilizing the library method, and physical presence for direct observation and connection to the fabric was performed by imaging, documentation, and data extraction using the field method. The information of the research data includes all physical, functional, and cultural values of the wooden building complexes constructed in Kiashahr port fishery heritage area. The data was analyzed and Codify qualitatively applying the graphics software by the authors. It should be noted that the research method is functional in terms of its objective, and it is historical-descriptive in terms of its nature.

The wooden structure complexes in Kiashahr port fishery heritage area lack any comprehensive and reliable study and research records. In 2007, some studies have been carried out for the first time by Gilan’s Cultural Heritage, Handicrafts and Tourism Organization, in line with documentation of the registered records of this organization, only to record buildings with heritage values. It should be noted that the primary research in this regard was conducted in 2017 by the authors in the format of a Master’s thesis entitled “conservation of Kiashahr port fishery heritage area with change use approach” which has been mostly with urban conservation approach. However, no studies have been conducted yet, in particular, on the conservation of the wooden structures in this heritage area.

Publication of the Venice Charter indicating on historical values, as well as, the guidelines of the World Heritage Convention in 1972 with an emphasis on the global leading values, are accounted as the first compiled documents on conservation of the cultural heritage on the basis of the value recognition (Nasrollahi, 2016, p. 28). In the Nara Document, it has been indicated that the values are approximate, and there is emphasize on inspecting the values in relation to their authenticity and quality in heritage (Habibi & Maghsoudi, 2012, p. 150). Also, the Burra Charter is the first international document that divided and classified the cultural heritage values into aesthetic, historical, scientific, and social values; these values are totally called “cultural significance” (Nasrollahi, 2016, p. 29).

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In the following, after understanding and analysis of the area under study, the intrinsic and innate values was explored and then the project entitled conservation of the wooden structures in Kiashahr fishery port was provided in line with the theoretical framework of the study.

Kiashahr port fishery heritage area

The area under study is located in Iran, Gilan province, Astaneh-ye Ashrafiyeh, and the old part of the city of Kiashahr Port (Pa'in Mahalleh). On the South, it is limited to Imam Street, on the West and the North to Kiashahr River, and on the East to a residential area and the Great Mosque in the city (fig. 1 & 2).

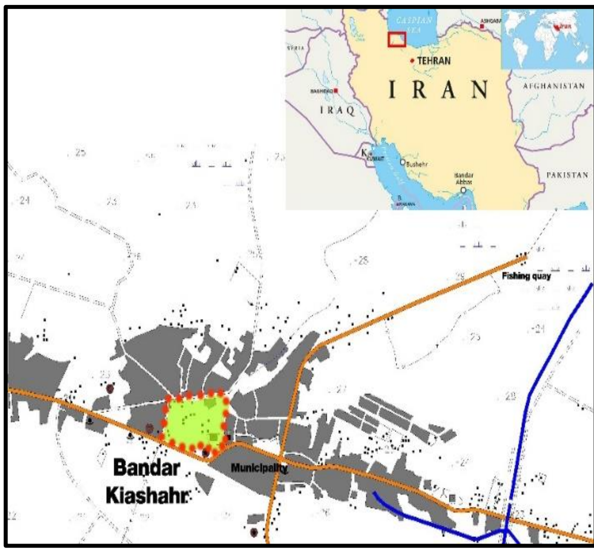

Fig. 1. The location of the area under study in

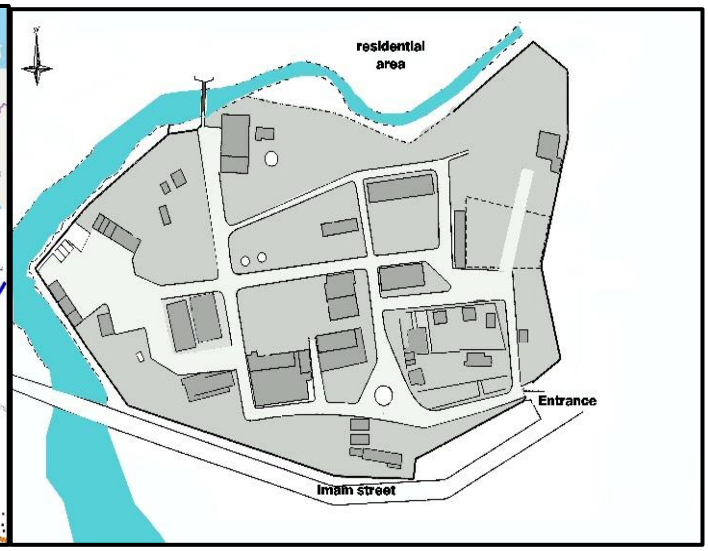

Fig. 2. The Limited of the area in town.

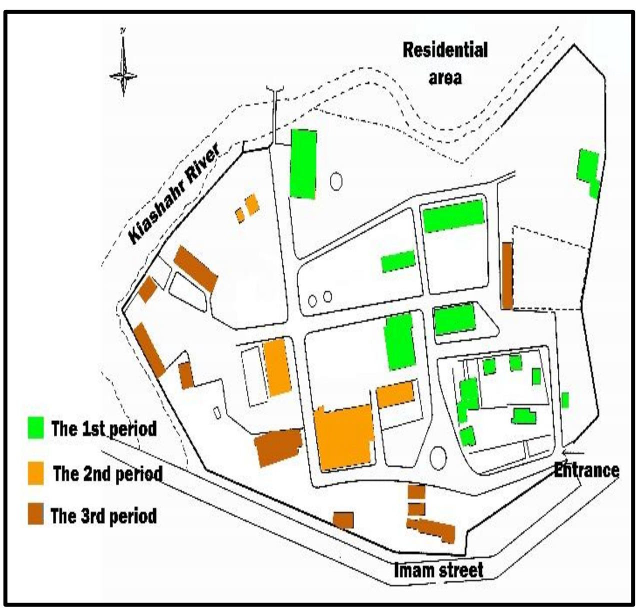

Fig. 3. Three architectural periods have known in the area.

Fig. 4. Sample of the building that constructed in the first architectural period

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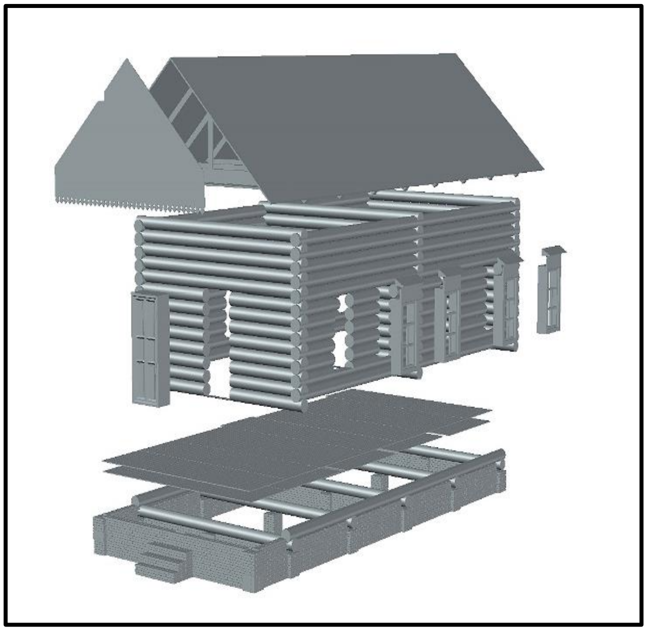


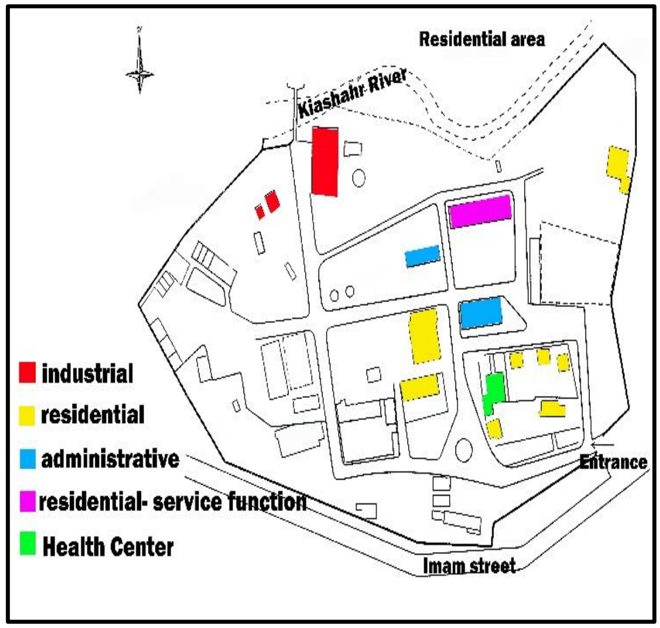
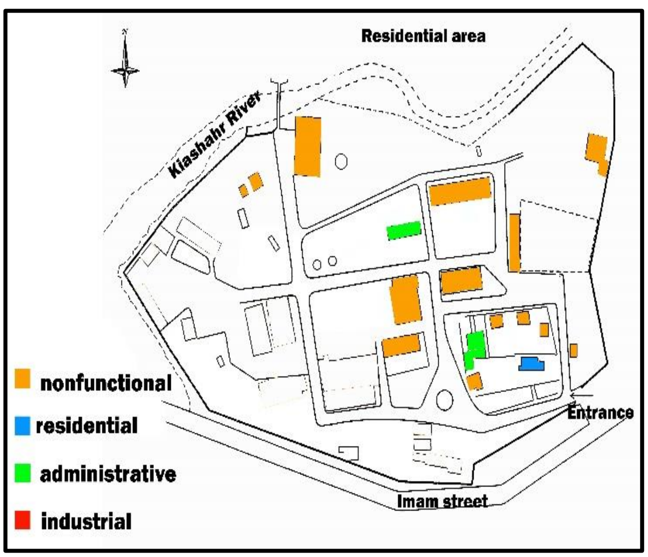


Fig. 5. The component and Construction materials that used in the wooden structure complex in Kiashahr port fishery heritage area

Fig. 6. The past functions of this complex.



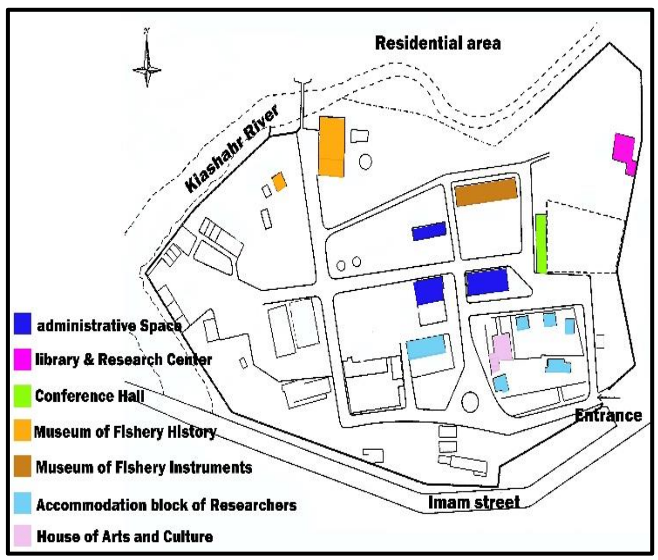


Fig. 7. The current functions of this complex.

Fig. 8. The idea of conserving (change use) the Kiashahr port fishery Complex.

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	Functions	previous function		Current function	
		Area (m²)	Percentage	Area (m²)	Percentage
1	Administrative	1819	22.8	452	5.67
2	Industrial	1827	22.9	0	0
3	Residential	1564	19.7	88	1.1
4	Services		25.4	0	0
5	Others	740.8	9.2	416	5.21
6	Nonfunctional	0	0	6464.8	81.3
7	whole of Area	7970.8			

Table 1. The Study of functions of the Kiashahr port fishery Complex.

Component	Huge target	Small targets
Structural forms	Promoting the structural qualities	1- Conserving the framework and morphology
		2- Conserving and promoting of the physical qualities
		3- Rehabilitation for promoting well known functional qualities in fabric
		4-conservation of the wooden structures with change use approach to Empowerment the fabric of complex
		5-exploration and conservation of Construction method
Social and cultural forms	Revitalizing the social and cultural structure	1-planning to the revitalization of economic, functional and cultural Interactions between this complex with the whole of the city
		2-invitation for social intercommunity to conserving the culture of fishery
		3-Increasing the tourist in the region with the goal of enchantment in the specific tourist
Environmental forms	Conservation of the green infrastructures	1-exploration, conservation and promoting of the environment capitation in site
		2-conservation of the green infrastructures in this area
Historical forms	Reinforcing the historical identity	1-Recognition and presentation of the sign of distinguished Identity
		2-Action toward promoting the sign of distinguished Identity

Table 2. The conservation plan of the Kiashahr port fishery Complex.

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Evaluating the values affecting the conservation of the wooden structures in the area under study

The significance of a historical fabric is created due to the value of the existed historical buildings and monuments and the relationship between them. Therefore, the value should be explored and investigated both in the whole and in every part of the fabric (Hanachi & Pourserajian, 2014, p. 11). Feilden & Jukka Jokilehto consider the conservation as a cultural issue which depends on having a proper understanding of the values existed in the heritage reserve (Jukka Jokilehto & Feilden, 2003, p. 33). In general, two types of values can be conceived for the monuments. Those values which are created by creation of a work and can be evaluated at the present time and involve all existence aspects such as, primary utilization, cultural and functional identity, construction technique, and so on, are regarded as intrinsic and innate values; those values which are acquired by the works during their lifetime including, the antiquity of the building, forming the collective memories, covering the important historical events, the relationship between the works and coordination with the environment are considered as acquired values.

A The intrinsic values of the site (architecture and construction): With regards to the materials used in construction, construction technique, and decorations utilized in buildings, we can divide the construction method in the fishery site into three architectural periods: Qajar period, first Pahlavi era, and second Pahlavi era up to the present (Mahjoub, 2017, p, 79). Considering the purpose of the current research based on conservation of the wooden structures of the fishery complex, and also due to the fact that most wooden structures existed have been built during the first period (Qajar period), in this paper, we have just explored and analyzed the first architectural period of the complex (fig. 3). This period begins with concluding a contract between Lianasov company and the Iranian Government in 1876 (Eslah Arbani, 1995, p. 284) and continued until the beginning of the first Pahlavi era (1921). The buildings and monuments remained from this period are generally distinguished from other buildings existed in the fishery complex by decorations, patterns, and simple geometric forms, extrovert buildings, and wooden materials used (fig. 4), including:

Construction materials: The structures in this period have been mostly constructed with woods imported from Russia to Iran. Such that the foundation beams are located on brick bases, 50 to 70 cm high from the floor. Then, the floor, walls, windows, pillars, stairs, ceilings (*Sarbandi*) and even the fences have been made of wood. The diameter of the wooden beams used in the buildings of this period is 35 to 40 cm, at a height of nearly 15 to 20 meters. Moreover, wood has been used as nail at the joints of the beams and timbers (fig.5). Brick is the second most widely used material after wood, in constructing the buildings during this period which is used in the bases and foundations, piers and pillars in two-story buildings, as well as fireplace wall in the main spaces. The bricks used in this period are red bricks with dimensions of 4×20×20 cm. Roof coating of the buildings constructed in this period has been made of tin or galvanized metal. However, the authenticity of these coatings has not been proved in the author's research process due to the periodic replacements and restorations. Lime has been used on the ground floors and even the foundation. Plaster has been used for coating the interior walls to create an insulation and flatten the interior surfaces.

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Simple form and plan: Using simple forms and plans involving square and rectangular or a combination of both in construction is one of the prominent features of this period. Using such simple geometric shapes and their extension at the east-west axis facilitated proper ventilation for the indoor humidity during the warm seasons.

Facade and its decorations: Despite this complex was established for industrial and commercial use, its builders have taken advantage of various decorations in the construction of the wooden buildings during this period which is mostly affected by Russian architecture. The wooden Decorations with outstanding edges, wood carving, abstract wooden reliefs, decorative grooves on external window sills, decorative motifs on stair railings, as well as the decorations on decorative fireplace dampers are among the decorations used in the buildings.

B The intrinsic values of the site (functional values):

It's been several years the heritage site of Kiashahr Port is not as prosperous and vivid as before, while extensive relations with different sections of the society such as, fishers, craftsmen and the Iranian fisheries specialists, organizational interactions with the neighboring cities, providing service and the important task of economic provision for the region had been taken into account as only a portion of the functional identity of this area. The activities and functions of this complex in the past amounted to twenty including, administrative, commercial, industrial, manufacturing, residential, welfare and service functions (Pedram, 2017). Today, over 80% of the various activities and previous utilization within the first architectural period of the complex has been abandoned, and few existed utilizations are not as prosperous and vivid as before (fig. 6 & 7) and (tab. 1).

Clarification of the conservation concept within the area under study

The major obsession in every single action towards conservation is the survival of conservation theme (historical work) for the current and future generations (Pedram et al., 2011, p. 2). This is important because the real security for a work will be created when its values are recognized and respected by the society (Hojat, 2001, p. 49). Also, executing conservation policies means integrating the heritage values with the planning process, which itself requires the people to be prepared for understanding such values (Nasrollahi, 2006, p. 31). Conventions and recommendations provided by UNESCO form the basis for establishing an international framework for identification and protection, conservation and restoration of the cultural heritage (Jokilehto, 1998, p. 124). According to the principles on the charter for the conservation of historic towns and urban areas, ICOMOS 1987 [adopted by the ICOMOS General Assembly in 1987], it is essential to conduct a series of studies utilizing different sciences prior to planning for conservation (Cheraghchi, 2000, p. 120). The term "conservation", conceptually, refers to a wide range of interventions and programs aimed at preserving cultural heritage; Of course, various measures are recommended related to the context and topic discussed (Heidari, 2009, p. 8). As regards to the above-mentioned, from the authors' viewpoint, conservation within the area under study involves a wide range of cognition, data analysis, project submission, restoration measures in line with the project submitted, as well as its maintenance by the users. In other words, the definition of the conservation here begins with the complete recognition of the complex in various aspects, while no conclusion can be conceived for it.

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On Venice Charter (1964) it is emphasized that conservation of the monuments is always possible by creating utilization for beneficial social purposes (Pedram, 2017, p. 14). In this regards, the utilization or a combination of the utilizations, or restraints on the utilizations which preserve the cultural status of a place need to be identified. The new utilization of a place should bring about the least changes for the framework and the important utilization, and it should respect for the connections and concepts (As same as 97).

Project entitled conservation of the wooden structures in Kiashahr fishery Port complex

Taking into account the primary objective of the current research, in order to achieve the principles for conservation of the heritage values of the wooden structures in the fishery site, we have proceeded with clarifying a functional strategy for architectural conservation in accordance with the laws and regulations of the Charters for conservation.

A- Objectives of the project on conservation of the wooden structures in Kiashahr port fishery heritage site: (tab. 2).

B- The application for the project on conservation of the wooden structures in Kiashahr fishery Port complex

- **Structural aspects:**

1- Conservation, strengthening and revitalizing the wooden structures with previous residential and administrative utilization, aiming at establishing specialized fishery libraries, generating research centers, establishing museums of fishing tools and equipment, specialized fisheries education center, establishing offices for culture and art, providing spaces for temporary settlement of the researchers, and finally, equipping and establishing administrative offices tailored to the requirements of the new fishery complex;

2- Conservation, strengthening and revitalizing the wooden structures with industrial utilization in the complex aiming at establishing museums of history and industry of the Persian caviar.

- **Social and cultural aspects:** Establishing research centers for scientific, historical and cultural studies; establishing fisheries museums; facilitating the social and cultural interactions of indigenous students with the fishery complex; to encourage participation of the Russian Embassy in understanding and introducing different cultural courses in the complex and playing the probable role in restoration and revitalization.
- **Environmental aspects:** Remove inappropriate views of the landscape and facade; revitalizing the private gardens in the complex; providing public green spaces; introducing and reinforcing the tree species existed within the complex.
- **Historical aspects:** Strengthening the typical heritage values in the complex through physical and meta-physical conservation (fig. 8).

Conclusion

Since there is no adequate evidence as for understanding and analysis of the area under study, there was an attempt to read-out for the first time its heritage values in different aspects including, the intrinsic and innate values. These values involve components such as, physical, functional, environmental, cultural, social and historical factors. After evaluating and analyzing the gathered

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data, the project entitled conservation of the wooden structures in Kiashahr fishery port was provided aiming at promoting the structural qualities, revitalizing the social and cultural structure, conservation of the green infrastructures as well as, reinforcing the historical identity of the area under study.

Imposing the conservation policies, i.e., integration of the heritage values with the planning process, which requires itself to recognize the values, can be effective for conservation of Kiashahr port fishery heritage site. However, the proposed topic is not necessity and sufficiency, and to achieve sustainable conservation of the complex required efficient and realistic projects to revitalize and rehabilitate the area under study, in addition to conducting interdisciplinary research in various fields including, social sciences and art.

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IN SEARCH FOR KNOWLEDGE ON SUSTAINABLITY:

FIELD STUDIES AND CONSERVATION OF OLD WOODEN BUILDINGS IN COASTAL ARCTIC CLIMATE

Arnstein Brekke

How could wooden buildings survive for 500 years in a coastal arctic climate? Could it be due to the duration of timber, the craftmanship, the architecture as such, or perhaps the culture and the people that built them and kept them? Can these old buildings teach us something about sustainability, and perhaps about climate? Are there other questions to be made?

This paper present preliminary results from the ongoing field studies and conservation in the Salten region, North Norway. Through the project 240 wooden buildings have been investigated, restored or conserved. The main purpose has been to build knowledge on the vernacular architecture in a region where little had been before. The project was initiated in the 1990`s, in somewhat early days of focus on sustainability, and this perspective have been a cornerstone in the work. More and more the changing climate has given impulses to secure buildings and to learn from the regions heritage.

Geography and climate

The Salten region, with Bodo town as the center, is located north of the northern Arctic Circle[32]. The region is situated around the Salten fiord, from small islands outside the coast to the deep valleys and steep mountains close to the border to Sweden. The climate in the Salten region variates from the warmer and somewhat rainy seaside at west to the mountains in the east, where its colder and little rainfall. June to August are the summer months. Normally only July are guaranteed free of frost in the east, but at seaside the average temperature in winter is around zero. The recent climate changes has given higher temperature, shorter and more unstable winters, more rainfall and more extreme wind.

[32] In this paper we refer to Arctic being north of the northern Arctic Circle.

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Fig. 1. The Ljones farm in Salten. All main buildings are orientated towards the predominant wind. From left the old living house built 1606, later used as smokehouse, a storhouse built 1589, the living house from mid 18th century and onwards. The living house has a timber frame «sval» in both ends of the building, which functions as an outhouse and climate zones, protecting the log construction. The «sval» can only be reached trough the door in the longwall, and there are no internal connection to the living rooms made in log construction. All Photographs by Author.

The fish farmer community

From the high and late middle-ages and until the dawn of the 20th century this was a fish farmer community. The women were the actual farmers. Men travelled half a year for seasonal fisheries, up to a thousand km north, and they sailed the fish carriers a thousand km south to the Hanseatic city of Bergen. Fishery gave income true exchange and sometimes money, and farming brought food on the table. All food needed to be conserved, due to adapt to the short seasons, and due to the need to working and harvesting together. Nothing was done without carefully planning, and with a distinct purpose. The fish farmers had a high competence in resource economics: To use as little manpower and material resources as needed. Nature lead to need of planning and discipline. Also their buildings, their architecture, are products of this.

In Salten region there is an old saying that when a building has "served its time" it should be taken down, and the materials reused. Not only is it possible to take it down, it's an obligation. The lifecycle of a building don't end; the materials are reused in new buildings. There were no sentimentality connected to this. Life was hard, and everything done for a purpose.

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"The lazy northern men"

The fish farmer community in the north and its cultural heritage was earlier given little attention. What was seen as the richer and older wooden architecture of the southeast played an important role in building a national identity from mid 19th century. The more impressing buildings, like the stave churches and decorated lofts, gave better grounds for connecting directly to the high middle age and possibly the Viking age.

The elites of the 18th and 19th century described how lazy the men in the north were, who preferred "the more leisurely life on the sea, imposing their women to run the farm by them self" [33]. The elites did perhaps not fully understand the fish farmer society. Their culture and their heritage became of little interest when building a national identity.

Since the older wooden architecture of the southeast came to play an important role in building a national identity, much of the research also focused on this. It can be argued that the richness and variations of the wooden architecture of Norway as a whole was not fully known and understood. It took time before a broader perspective developed. Norway is a little populated but wide country. There is a big variation in climate and resources, and there are distinct regional differences in the vernacular architecture.

Fig. 2. Perspective of the field studies in Salten

[33] The pastor and scientist Søren Chr. Sommerfelt, 1827. (the authours translation from norwegian).

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The field studies and conservation of old wooden buildings in the Salten region, was initiated in 1992[34]. Little had then been done in the region in this field. There was a lack of research[35], knowledge and awareness. But the area gave an instant impression of an interesting and well preserved vernacular architecture.

From the field studies and conservation in Salten was initiated buildings have been considered as the primarily source of knowledge. To discover and protect their source value have been crucial. Old craftsmen took part in teaching. Looking into the broader oral tradition, to understand the culture, also became important. Different issues as building methods, terminology, craftmanship, use of materials, technology, development of buildings, development of fireplaces and regional forest history have been investigated.

The perspective of the Norwegian architect Hans Jakob Hansteen[36] (born 1938) gave inspiration from the beginning: In his article from 1988, Protection of a building as document: Challenges and utopia building is a result of human motive and actions. This is a good platform for looking into vernacular buildings. When added the perspective of resource economics and sustainability the buildings could carry important knowledge of the culture in the context it belong.

It can also be said the building do not speak to you[37]. It's the way you formulate the questions that matter. Within your questions lies the possible answer[xxvii]. Your questions are influenced by your competence, and your purpose. In respect of the vernacular architecture there is a special challenge that common knowledge, "what everybody knows", are rarely or never spoken of. It is challenging to establish knowledge when you don't know what to ask about. To be present in the community trough many years gives better possibility to discover such common knowledge.

In early years focus was given to conserving and learning from the vernacular architecture as such. The buildings age was not an important issue. The oral tradition in Salten told about existing buildings from the 18th century. But no secure knowledge about this could be established. In North Norway no one had tried to reveal the age of the buildings using dendrochronology. It was seen as impossible to find old buildings in the north. It was not considered an issue.

After some years of field studies a suspicion grew that some of the buildings might could have an considerable age. Norwegian legislation on cultural heritage stated that buildings dated before 1537 ac are automatically protected by law due to their age. From 2001 a new regulation was added that buildings from before 1650 ac should be protected by law when they are identified. The project management in Salten now saw the possibility there could be buildings from before 1650. Since there are no oral tradition, and very few written sources, on the vernacular architecture as far back as the 16th and 17th century, the only way to establish secure knowledge is to use dendrochronology.

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[34] This ongoing work was initatied and are still lead be the author. Formally its organized under the Department of culture, Bodo town, in cooperation with the Nordland county and the Directorate for Cultural Heritage.

[35] An important exception must be made for the etnoholigist mrs Astri Riddervold (1925-2019) and her research about food culture, fireplaces and houses.

[36] Hansteen, Hans Jacob: **Vern av bygget form som dokument. Utfordring og utopi.** Dugnad nr. 3 - 1988.

[37] Liberly quoted from the Norwegian historian Jens A. Seip (1903-1992)

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Fig. 3. Examples from the dendrochronological analyzis of the Ljones storhouse, built 1589.

Using dendrochronology

Dendrochronology is the scientific method of dating tree rings to the exact year they were formed in order to analyze atmospheric conditions during different periods in history[xxviii][38]
In essence dendrochronology is the fingerprint of climate, materialized in the year rings.

In 2004 the first 4 buildings in the Salten region was investigated. 4 of these 7 was possible to date. All 4 are from the 16^{th} century. The following 15 years a total of 75 buildings, 60 of them in a small area around the Salten fiord have been dated. So far 24 have been dated to be built before 1650. The oldest in 1510, including a part of the building from 1496. The samples from the buildings are taken by the craftsmen, and the project manager and craftsman do the analyzes. The dendrochronological analysis as such has been performed by the researcher Thomas Bartholin, and in cooperation with The Norwegian University of Science and Technology.

The Salten region is now the most carefully investigated region in Norway trough dendrochronology. It has been emphasized to build knowledge about the building as such, but also various types of buildings and building methods. The different building phases, and the different elements have been dated. By doing this it is possible to build knowledge about different aspects; the development of log hewings, use of tools, materials, type of building, plan, fireplaces etc.

[38] Wikipedia

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Fig. 4. The Ljoenes storhouse when conservation started, in 2006. Hard wind and rainfall from west had damaged the short wall.

Achievements so far:

- It framework for research about all aspects of the building traditions in the region
- the methods use in the project to build knowledge could possibly be an example for other regions
- It gives far better possibility to identify and to conserve the buildings source value
- Buildings in the same culture geographical context can now easily be evaluated just by visual inspection, to roughly identify the age of the building and the different elements.
- Buildings of national value has been identified. The Salten region is the only region in North Norway that has a significant number of buildings protected by law as being built before 1650.
- The many samples taken from one small region have given a contribution to the research on climate history

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Fig. 5. Details of the Ljones storhouse: The longwall with the log construction to the right and the lighter and more airy entrance and storage room to the left.

Databases on dendrochronology

The knowledge built in these regional field studies have recently been systematized in a database. The structure for the databases are developed by the University of Lund Sweden, and SEAD - the Strategic Environmental Archeological Database at the University of Umeå, in 2012[39].

The database combines the dendrochronological analysis, in 2019 ca 1450 samples, and the characteristics of the buildings and the different elements of the buildings. From the database it is possible to extract knowledge about for example the dendrochronology as such, about the origin of timber, the outspread of building methods and technology and when they have been introduced and used.

[39] The structuere for the database are developed by Katja Meissner, BYGGKULT AB, Sweden. She has also been providing the database for use in the Salten region.

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Fig. 6. The storhouse at Ljones was given a climate shell, to protect the damaged short wall against west. In 2017, ten years after the conservation and the boards was put up, the old wall was controlled and it was in a very good condition.

Sustainability and climate

What knowledge have been established trough the field studies in Salten?

The field studies have built a platform for research, and there is a need for continued research. Findings and conclusions must be seen as preliminary. In this paper the focus is on knowledge related to climate and sustainability.

A building is a climate shell, with an internal climate zone. The more hush the climate is the more demanding it is to build, and to maintenance. It can be interesting to build knowledge from how the buildings in question are constructed, and what has given them their long life. In the following some of the more important characteristics of the buildings in the Salten region are mentioned:

Orientation

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The buildings are normally orientated with the short side against the predominant wind. It reduces the climate effect on materials, and reduces energy loss. The buildings are even twisted a little so that “the wind breaks at the corner”, following the oral tradition in the region. It gives an airflow around the building. In general the two dominant wind direction are complementary: If the western winds are strong, so are the east. And this is of course an important factor in orientation of the building.

An interesting and practical observation - common knowledge, is that the wind lift the snow away from the building, which give easier access to the building.

In the older and more primitive houses the open fireplace and the smoke went was always placed a little to the side of the ridge, never in the middle of the roof. Later on the chimneys was placed the same way. The natural airflow was used to bring the smoke away.

Fig. 7. Typical log hewings from the 16th century in Salten, dated 1564 ac. These log hewings are closely related to the oldest known log hewings in southeast Norway, from before the Black Death.

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When windows got common, from the second half 18th century, they were always placed at the long walls, never at the short side. Note that the English word window comes from the Norse language and means the “wind eye”. Originally it means an opening in the long wall made to ventilate, and to make the fireplace function - together with the smoke vent. It makes an airflow, from the “wind eye”, trough the smoke went and the chimney. Other details are also important, like the exterior door always open inwards, never outwards. Originally it supported the ”wind eye”, to regulate the airflow to the fireplace.

It is obvious that in these traditional buildings there is a differential pressure over the building envelope.

Plan

The plan of these traditional buildings are also designed according to the climate, or more accurate to the predominant wind. For traditional living houses there are often a climate zone added to the log, the main construction. These climate zones are not made in a log construction but in a timber frame. The rooms made in timber frame are in general named a “sval”, a norse word meaning “cold”, hence a climate zone in opposite to the warmer living rooms built in log. These type of rooms added to a log construction can also be used for storage, it’s a easy way to make an extra room, and to reduce the use of materials. Most important it is a climate shell for the main or center part of building and its living rooms.

Fig. 8._Typical storhouse, dated 1637, with the short side orientated and twisted against the predominate wind. In the short wall against the soutwest there is a timber frame «sval».

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Storage houses for clothes and food are mainly built with primary room in log construction, and a smaller room (entrance) in a timber frame or stave construction, sometimes named "sval". The plan of the building and the lighter and more open entrance stave are made due to the need for a climate zone: Regulation of temperature and a more airy environment. These often small one floored storage houses are mainly orientated with the short side against the predominant wind. The entrance, with its more open construction, are orientated away from the wind that gives the most rainfall.

The materials

The materials of these buildings have in general a high quality. The traditional timber used in the Salten region is pine (Pinus sylvestris)[40]. It is mostly used slow grown pine with a high density. Pine develops heartwood during its lifetime. Most pine used here have around 80 or 90 % heartwood. In these cases the logs are normally shaped so that the sapwood are taken away, so only the heartwood are exposed. Using old pines has the advantage that the wood has less tensions, and the log hewings and the construction as such are more stable than if younger not mature trees were used.

The field studies and the dendrochronological analyses give many answers, but also many new questions, and potential for research. Some to be mentioned here:

[40] There are also traditions for use of hardwood, mostly birch (*Betula pubescens)* and aspen (*Populus tremula*), sometimes as main material, often as supplementary. Traditional methods to select and produce both birch and aspen that prolongs their lifetime as materials have been identified.

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Climate change from 16th to 19th century

Being the best investigated region in Norway, it has already given contribution to the research about climate change. This is due to the high number and distribution of the samples. There are potential for more research in this field.

Climate change and building operations

Our findings indicates there is a correlation between climate changes and building operations. For example are there few buildings from "the little ice age". This was a northern phenomenon. In this region the climate turned worse and colder from the 1630`s, and the next decades were difficult for the fish farmer community. Climate change had an impact on agriculture and fishery, the economy as whole. From around 1640 and up to around the 1710 some very few buildings are identified in the Salten region.

The reuse of buildings and materials

Reuse has been an important part of the culture. A great number of the 75 dated buildings, and of the rest of the investigated buildings, have a significant reuse of older sections or of single materials. Reuse seem to follow certain methods or patterns, and these should be further investigated.

Influence and distribution of building methods

The investigations as such and the database on dendrochronology give opportunities for systematization of knowledge.

Fig. 11. Fishermans cabin dated 1601, damaged by the sea in 2010, later restored. The Givaer Island, Bodo municipality.

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Fig. 10. Fish farmers from Salten at seasonal fisheries, early 20th century. Private archive.

Conclusions

The old wooden buildings that have been investigated are in general built from materials with high quality. They are built in excellent craftsmanship. These are both typical arguments about the old way of building, and they are mostly right. But it is also clear that these buildings would not have this long life without the knowledge of climate and of sustainability. The main common knowledge about orientation against the predominant wind is perhaps the most important example of this knowledge. Simple knowledge that will have an impact in northern and arctic climate. Up to know this has in fact been "common knowledge", meaning no one heard about it.

There are still much to be done in research on this building heritage. It is not obvious that this knowledge can help us in our struggle to build in better ways, in respect of climate and sustainability, our common challenge. The strongest lesson lies perhaps in the greatness of the fish farmer culture. The thinking, the methods, the knowledge and abilities in resource economics. A sustainable way of life, the reuse of resources. The culture and their methods needs research.

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Theoretical aspects of Dismantling-Temporary Architecture a look based on the Principles of Heritage Conservation built with wood and the Nara Charter

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Abstract

The new category of heritage built with wood called Temporary Architecture and which was incorporated into the Heritage Conservation Principles built with wood adopted on December 15, 2017 in the city of New Delhi India, has important theoretical implications that have not been discussed or presented in previous symposiums. Dismantling-Temporary Architecture can be observed and analyzed based on the aforementioned Principles as well as the Nara Charter and the proposals of conservation theorists and restoration of cultural heritage. This study presents the first direct observation of the bullring of the Petatera de Villa de Álvarez in Colima Mexico, analysis, based on the main postulates of the aforementioned Principles and the Nara Charter and Cesare Brandi postulates. The aspects of: its materiality, construction of the architecture, the author and the history are analyzed to visualize the attributes that characterize it.
The purpose is to contribute to the description of the theoretical essence of this type of architecture, recently *patrimonialized* in the Principles.

Background

The last update of the Principles of conservation of the heritage built with wood took five years until its adoption in the City of New Delhi on December 15, 2017. The updating works began in 2012 at the initiative of Gennaro Tampone in the Symposium held in Guadalajara Jalisco Mexico organized by María de Guadalupe Zepeda Martínez; then in 2013 at Himeji Japan organized by Dr. Nobuo Ito and Yasuhiro Watanabe. This process lasted until the year of 2016 with the symposium held in Falun Sweden, at the initiative of Tina Wik and then with the creation of a committee reviewing principles led by Mikel Landa who finished the review by email until its presentation in the Assembly of Advisers of Scientific Committees held in Istanbul in October 2016, attended by Ian Mc Gillivray and Mikel Landa.

The main purpose was then to update the document to the current conservation problem of the heritage built with wood. It was considered that new variables of use and deterioration affected the protection of this heritage, that the testimonies had new challenges to integrate into contemporary life, new treatments had to be considered within the intervention options of the monuments and even the technical terms of the document they had to be refined and redefined. In the 2012 review, there was little echo of the new holistic situation in which the heritage built with wood is produced and used and transmitted to the future. That is to say that many testimonies constructed with wood are due not only to the construction craftsmen, but to the tradition they reproduce and the woods

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they have available. It was also commented that the woods present in the monuments and that are located in present wooded areas could hold cultural values for that community.

In the 2013 revision, he was especially dedicated to the revision of the technical terminology, where the consolidation term was changed to the reinforcement term. At the same time they presented a series of traditional carpentry practices where the importance of the temporal architecture was based, in the following aspects: the removable, mountable architecture, which is the main characteristic of the temporal architecture that is also a periodic architectural expression.

In 2016 at the symposium held in Falun Sweden, the works of María de Guadalupe Zepeda Martínez, Christian Zamora Alvarado and Iris Marisol Ortiz Llerenas were presented on the La Petatera bullring in Villa de Alvarez, an example of Temporary architecture in Colima, Mexico. Three papers and a model of the bullring were presented.The first presentation presented the importance of the dismantling-temporary architecture of the bullring, and marked the articles for updates to the Principles that were related to it.

The second paper presented a complete description of the traditional construction technique based on the participation of planners and craftsmen-builders.The third paper presented a study of the timber species present in the construction of the Petatera and its cultural value as an endemic species of the area.

This example was illustrative to detect the category of Temporary Architecture. In the question session, it was commented that this type of architecture was also built in Greece, as examples of vernacular architecture and in Japan as an example of temporary architecture built with wood to store grains. Then the temporary architecture has been there all this time, and we had not considered it heritage to conserve it until then. Aspectos teóricos de la categoría de la denominación de Arquitectura Temporal

One of the modalities of the cultural production of the 21st century is patrimonialization[41], according to Marmol, Frigolé and Narotzky, "heritage is the result of a process of incorporation of value referred to the past. It is a process of reconfiguration of values and meanings referred to social, cultural or "natural" elements of the past.[42]

The case of the bullring of Petatera de Villa de Álvarez, is the example that gave rise to this new category proposed in 2016 in Falun Sweden; that is, a new category is patrimonialized that manages to represent them and take them to official and formal platforms for their protection towards the future. The new principles of Heritage Conservation built with wood officially adopted by ICOMOS International in the General Assembly of New Delhi on December 15, 2017, are the official regulatory platform on which it is possible to protect them internationally.

It is then necessary to develop the theoretical corpus of what defines the new category of Dismantling-Temporary Architecture in order to be able to identify it, and register in all those architectural examples that represent it. There are five aspects of the cultural property that are considered in this first study: the matter, the construction, the author, its conservation and its history.

[41] DEL MARMOL, FRIGOLÉ Y NAROTZKY eds. (2010) Los Lindes del Patrimonio.Icaria Intituto de Catalá d' Antropología pp. 9
[42] Ídem.

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Temporary architecture has been the oldest architectural expression of the human being. The first nomadic groups of the Paleolithic, and later in the Neolithic period, migrated constantly in search of better places to survive. These communities of the Neolithic are the creators of the disassembly wooden structures, and it is developed thanks to the intelligence and creativity of the human being influenced by its environment and the woods available.

Dismantling and assembling is the essential feature of this type of architecture and we can still find it in many parts of the world. The Nara Charter expresses that all cultures and societies are rooted in a particular way and have tangible and intangible means of expression that constitute their heritage and that must be respected.

The temporary-dismantable architecture constructed with wood is a product whose material presence is for a defined time, that is to say in periods. As its nature is periodic, its constructive anatomy is designed to be removable that is to say that it allows its removal and assembly without the impairment of the unit or the parts. This characteristic distinguishes it from the permanent architecture where the constructive solutions are designed to be fixed and immovable, solid and integrated to the unit.

The author of the temporary-dismantling architecture is a group of builders who know the traditional construction techniques and from their memory they build according to them, that is, they are the bearers of ancestral knowledge. Unlike with the permanent architecture, where the author is unique, owner of his project that is made to remain, the author can request changes during its construction, but once finished, it is not demolished and then rebuilt.

The assembly-disassembly process allows the preservation of the temporary architecture per se because it is a constant practice to reuse the construction elements of wood and to gradually replace the elements that are no longer having the properties required by the structure by the construction elements of new and strong wood.

For the observer, the constructed architecture has a value of 1 because it can be appreciated materially in all its spatial and architectural potential, value 1 of the unit it represents. But it also has another value; the architectural zero that is its value when its elements are disunited, or dismantled and where architecture does not exist, but only the parts of it that make it up: the architectural value 0 becomes an anthropological X value that represents the quantity X of the constituent elements manufactured by man, from the raw material to the constructive element-part of the temporal architecture. In both cases, this architecture has a cultural value that must be addressed and preserved in the future.

The permanent architecture does not have this potential, because it is built to reach its value 1 in a definitive and immovable way and when its parts are disunited, fractured or separated, it is not a state of the planned architecture, but a deterioration.

All value judgments attributed to cultural heritage, as well as the credibility of information sources can differ for each culture and even within the same culture. The respect due to all cultures requires that heritage properties be considered and judged in the cultural context to which they belong. (Nara,11)

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The bullring La Petatera de Villa de Alvarez, is located in the municipality of Villa de Alvarez (Colima) in the state of Colima. This square is built and rebuilt year after year in the month of February from materials such as wood, mat and ixtle and regional processes that have more than one hundred and sixty years of tradition in Colima.

Fig. 1. Petatera de Villa de Alvarez bullring (www.colimanoticia.com)

Fig. 2. Building process (www..ecosdelacosta.mx)

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It is structurally formed by a wooden framework of several types that occur in the region and according to the characteristics of the system, either to absorb tensile stress through poles and stringers, as to transmit compression forces to the ground through forks.

Fig. 3. Wood elements to build the bullring. (colima.quadratin.com.mx)

Fig. 4. Reused wood (www.mundotoro.com)

This structural system is joined to each other with rope and rope of ixtle. The work begins once the center of the land is located and the circle that defines the ring is drawn, which has a diameter of sixty meters and the constructed surface area of nearly three thousand square meters. The bleachers area, also built in wood, has an area of two thousand m2, which allows a quota of approximately five thousand spectators.

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These bleachers are divided into 70 sections or boards, which belong to 70 different dealers who store, build and later dismantle the structure.

The architectural complex of the bullring is complemented by the area of corrals, built with the same principles of the square. The shadows represent the complementary system of the square and consist of the roof that is prepared with otate cages, all with the same width but of different lengths, which are known as long shadows and short shadows. On these cages, the mats are sewn with rope and aria needles..

The covers are the cover of the square, which are made of mat and are placed in the lower part of the stands, as well as on the stairs of each of the stalls. To carry out this work, each flooring dealer contributes five horcones, five soleras, three long cans, three short ones, a dozen and a half tables for the stalls, the seats and stirrups, half a dozen bars for the arena, four dozen mats and six ropes to tie.

The master of the work defines if the condition of the materials is acceptable or not, otherwise he must provide them new. The concessionaire hires the tabladeros for a fixed amount that includes assembly, termination, maintenance during the holidays as well as the final dismantling, then picks up the material on the site to take it to the rest of the year and protect it in some corner of the their own house. It should be noted that the plaza, despite its construction has never collapsed.

Matter

The temporary-dismantling architecture built with wood is a product whose material presence is defined by time, that is to say in periods. As its nature is periodic, its constructive anatomy is designed to be removable that is to say that it allows its removal and assembly without the impairment of the unit or parts. This characteristic distinguishes it from the permanent architecture where the constructive solutions are designed to be fixed and immovable, solid and integrated to the unit

Author

The temporary architecture by its essence of removable and periodic, is associated with many human activities and its construction depends on the craftsman-builder to manufacture and disassemble it. This craftsman-builder is the main architect not only of its manufacture but of its conservation and its transmission to the future. The participation of the artisan-builder is group, where several are responsible for its construction or material consistency and its finishes or its image. The temporary architecture is a living heritage because it depends on the participation of the group of craftsmen-builders assemble and dismantle at the end of each period. When the temporal architecture does not have the artisan-builder that makes it, it will not have possibilities to exist.

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Fig. 5. Dismantling process by the craftman builders (www.villadealvarez.gob.mx)

Fig. 6. The artisan builder ancestral knowledge bearer (author: María de Guadalupe Zepeda Martinez)

The author of the temporal architecture is a group of builders who know the constructive techniques and from their memory they build according to them, that is to say that they are the bearers of the ancestral knowledge.The ancestral knowledge to survive is transmitted from generation to generation of the craft builders. That is, the author or group of authors instruct younger generations to preserve knowledge. Thus, the temporal architecture is preserved, through the transmission of ancestral knowledge and the authorship of the artisan builders. Thus the temporal architecture has authors for each generation and while the ancestral knowledge is transmitted it will still have authors that build it.

Unlike the permanent architecture, the author is unique, owner of his project that is made to remain, the author can request changes during its construction, but once finished, it is not torn down and then rebuilt.

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Conservation

"El proceso de conservación por excelencia de la arquitectura temporal es precisamente el proceso de montaje-desmontaje, referido esto en términos teóricos a los saberes ancestrales del montaje-desmontaje o sean las técnicas constructivas tradicionales y en términos físicos-materiales de la arquitectura en su unidad estructural y en sus partes."

The conservation process par excellence of the dismantling-temporary architecture is precisely the assembly-disassembly process, referred in theoretical terms to the ancestral knowledge of assembly-disassembly or be the traditional construction techniques and in physical-material terms of the architecture in its unit structural and in its parts.

The assembly-disassembly process is the preservation of the temporary architecture per se because it is a constant practice to reuse the wooden construction elements and to gradually replace the elements that are no longer having the properties required by the structure by the construction elements of new and strong wood. Thus the architectural unit is reinforced and its structural efficiency is assured, that is to say, its constructive structure is conserved from which the temporal architecture exists.

If the assembly process were ever to freeze over time, that is, the architecture was musealized and not dismantled, the temporal architecture would cease to be temporary and the remaining permanent testimony would be subject to traditional conservation treatments. The craftsman-builder would cease to be the conservator of temporal architecture and traditional construction techniques would fall into disuse, therefore ancestral heritage knowledge would be condemned to oblivion. The dismantling-temporal architecture would lose its essence and the cultural heritage would be lost.

This is the essence of the bullring of Petatera de Villa de Alvarez that are architecturally present for a period until the moment of dismantling, where the architecture disentangles its parts, and the architectural unit is no longer present, but the anthropological testimony survives when its elements are preserved, parts in the houses of the tabladeros of the community of Villa de Alvarez.

Cultural Value of the temporary structure

According Nara charter, number 9, **"**. Conservation of cultural heritage in all its forms and historical periods is rooted in the values attributed to the heritage. Our ability to understand these values depends, in part, on the degree to which information sources about these values may be understood as credible or 47 truthful. Knowledge and understanding of these sources of information, in relation to original and subsequent characteristics of the cultural heritage, and their meaning, is a requisite basis for assessing all aspects of authenticity.

Temporal architecture generates an additional value to the heritage that is to exist in its state of architecture built or manufactured to generate spaces useful to man and the value that its parts retain when the architecture is disassembled, that is to say, its parts are separated.

Temporary architecture exists in both circumstances. For the observer, the constructed architecture has a value of 1 because it can be appreciated materially in all its spatial and architectural potential, value 1 of the unit it represents. But it also has another value; the architectural zero that is its value when its elements are disunited, or dismantled and where architecture does not exist, but only the

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parts of it that make it up: the architectural value 0 becomes an anthropological X value that represents the quantity X of the constituent elements manufactured by man, from the raw material to the constructive element-part of the temporal architecture. In both cases, this architecture has a cultural value that must be addressed and preserved in the future

We could say that the temporal architecture offers us this possibility of heritage in its value 1, in its architectural value 0 or anthropological X value. To these values of the testimony, the temporal architecture can accredit historicities and patina.

The permanent architecture does not have this potential, because it is built to reach its value 1 in a definitive and immovable way and when its parts are disunited, fractured or separated, it is not a state of the planned architecture, but a deterioration .

As long as there is an artisan-builder integrated to the community who develops the traditional constructive techniques, one has at the disposition the own and traditional wood for the construction the heritage built with wood, the temporary architecture is conserved.

Conclusion

The study of the theoretical aspects of the architecture and the dismantlable-temporary structures build with wood showed us that this heritage represents the oldest timber structure that has existed: it dates from the Neolithic period. That being structures associated with daily life and survival, had been little valued structures, had not been sufficiently perceived or studied.

The yurts that are the mogolicas houses and the houses of the Tuareg desert nomadic communities are exquisite examples of dismantling and temporary architecture. So are some Buddhist temples that are periodically dismantled to keep them in good condition. La Patatera de Villa de Alvarez en Colima, México is representative o f this type of wooden architecture.

This heritage requires its own parameters to be observed and recognized, since it does not present the characteristics of the permanent and millenary architecture for which the guidelines for conservation and transmission to the future have been established.

The dismantling-temporal architecture represents and nevertheless communicates to us the essence of the human being that builds them and their immediate needs, creative potential and constructive talent. It is also a heritage that depends on the artisan-builder, who knows the ancestral knowledge of constructive techniques and is the mirror where the community looks at itself. It is also recognized that the craftsman builder must also transmit to the future generations the ancestral knowledge in order to guarantee the conservation

This study aims to detonate many other studies of surviving and current dismantlable-temporal studies in other regions and to observe how cultures, although diverse, observe common aspects such as the dismantling-temporal architecture.

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Abstracts

What lies beneath - the wooden built heritage under our feet

Michael Bamforth

Recent discoveries at the Early Mesolithic site of Star Carr, Yorkshire, have pushed back the date of the earliest wooden structures in the UK to 11,000 BP. There is a wealth of wooden built heritage beneath out feet, from the Bronze Age roundhouses of Must Farm in Cambridgeshire to the Viking buildings excavated beneath York. However, development, modern drainage regimes and climate change all pose risks to the delicate burial environments that have preserved such astonishing evidence of past wooden structures.

This presentation will consider some recent discoveries of Prehistoric wooden structures, the digital recording methods that have been employed to record them, and the burial environments that we must protect to ensure the survival of as yet undiscovered remains.

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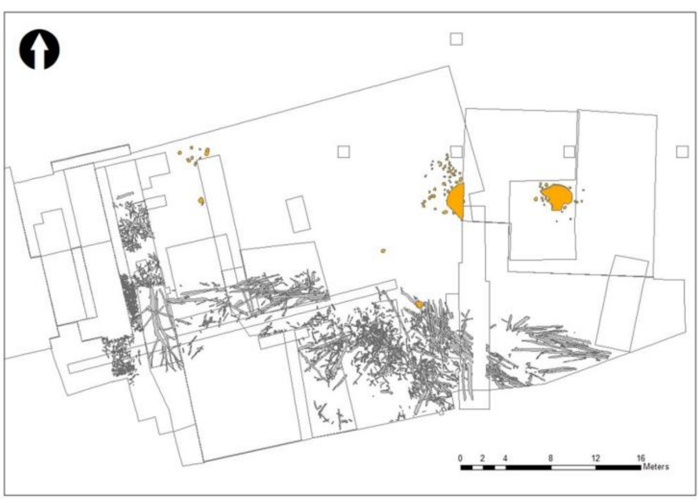

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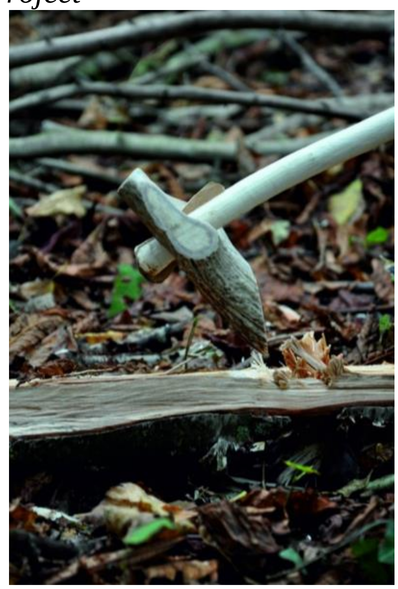

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From Trees and Timber to Shipwrightry and the Wooden Built Heritage: The Mary Rose

Christopher Dobbs

Head of Interpretation and Maritime Archaeology
Mary Rose Trust

The Mary Rose Museum, Portsmouth. Credit: Christopher Dobbs/ Mary Rose Trust

The Mary Rose was Henry VIII's warship that was built in 1510 and sank during the Battle of the Solent in 1545. It was successfully excavated and raised in 1982 and after a 34 year period of conservation, it is now the centrepiece of a stunning new museum that gives personal insights into the lives of the crew from the Tudor period.

There are a multitude of reasons why this project is of extraordinary significance, not least of which is the ship herself. As the only preserved sixteenth-century warship, she is a unique resource. Little is known about ship construction in that period and this example of a historic wooden structure - of the built wooden heritage - is a mine of knowledge. This presentation will delve into aspects as diverse as the ship's timbers and their conversion from forest to futtock, the wood fuel that powered the ship's ovens, dendrochronology, and evidence from tool-marks on objects and timbers.

But how do we or should we present these complex or specialist themes to the general public – to a 21st century visitor attraction audience? Interpretation is key to the new museum and the presentation will touch on the methods chosen to intrigue the visitor. Finally, we recognise that our Wooden Built Heritage has often lasted for hundreds or even thousands of years in some cases. Hence our heritage projects need to have the vision to prioritise their long term preservation, but acknowledge that long term projects may take a long time to achieve.

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Wood identifications of *London* wreck artefacts, using microscopy and X-ray micro-CT scanning

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The site of the *London* came to the attention of Historic England during a staged archaeological assessment which took place as part of the on-going mitigation for the London Gateway project. It was immediately apparent that the site was of high significance and so in 2008 it was designated under the Protection of Wrecks Act. It has been on the Heritage at Risk register since 2009. To mitigate this risk a programme of surface recovery (by the licensing team) and limited excavations (led by Cotswold Archaeology and funded by Historic England) took place from 2014–2016.

These works have resulted in a rich material archive, of which wooden remains were a substantial component – including elements of the ship's fixtures and fittings, armaments and domestic/personal effects. Wood identifications were carried out to investigate wood use and selection preferences, and where possible, other characteristics (eg wood maturity) were recorded. Close examination of the material also identified a possible running repair.

Complete artefacts were not sampled, and were examined using alternative methods; this included trialling X-ray micro-CT scanning as a non-destructive 3D volumetric analysis tool in order to establish a recommended methodology when dealing with waterlogged/conserved wood. Water is highly attenuating to X-ray photons, which results in a reduction in image contrast, making wood identifications from the reconstructed volume very challenging for the pre-conservation samples. Dry conserved specimens (using PEG) were scanned for comparison, and to assess using micro-CT for wood identification post-conservation.

Close co-operation of the specialists with the project's archaeological conservation team was vital, especially when formulating the sampling strategy, finalising methodologies and scheduling the work. This project highlights the positive outcomes achievable through such close collaborations; demonstrating the wealth of information that can be obtained from such material, and creating and strengthening links between heritage and research organisations.

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The Conservation of Wooden Built Heritage in a Post-Quake Climate: The former Community of the Scared Name Convent and Chapel, Christchurch New Zealand

William Fulton and Jenny May

Post the devastating cycle of earthquakes which began in Canterbury, New Zealand in 2010, and the subsequent loss of masonry heritage, the repair and conservation of our wooden built heritage became extraordinarily important. This paper will provide an overview of built timber heritage within this climate within Christchurch, the principal city of Canterbury NZ, and then focus on a case study.

While wooden buildings survived and performed relatively well in the seismic conditions, the task to bring them to 21st century building code requirements in a post-quake climate and still meet professional standards of heritage conservation had its challenges. This required close collaboration and thinking between a wide variety of professional disciplines such as engineering, geotechnical, architectural, heritage and local government. All standards had to be met and ethical dilemmas resolved to enable traditional and new methods to work hand in hand.

Generally, 19th century wooden built heritage performed well in the earthquake cycle tending to be rather forgiving in a sea of seismic activity ranging from moderate to serious levels of up to 7.8 on the Richter scale. Timber laths assisted in bracing internal walls, while timber framing and weatherboard construction generally proved a very ductile material that settled back into place.

The case study of this paper, the Community of the Sacred Name Convent and Chapel, was built between 1895 and 1900 in wood and corrugated iron and designed by New Zealand's foremost Victorian Gothic Revival architect Benjamin Mountfort. Post-quake the Sisters of the Community decided to pass the building to a community group who have raised the substantial capital to restore the building. To meet the requirements of a change of use and structural upgrade while retaining the full heritage values and aesthetic of this 19th century wooden building has required innovative thinking and solutions.

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Community of the Sacred Name Convent c1900. © Jenny May.

Community of the Sacred Name Convent Chapel. © Jenny May.

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Community of the Sacred Name Convent and Chapel. © William Fulton.

Reopening ceremony. © William Fulton.

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