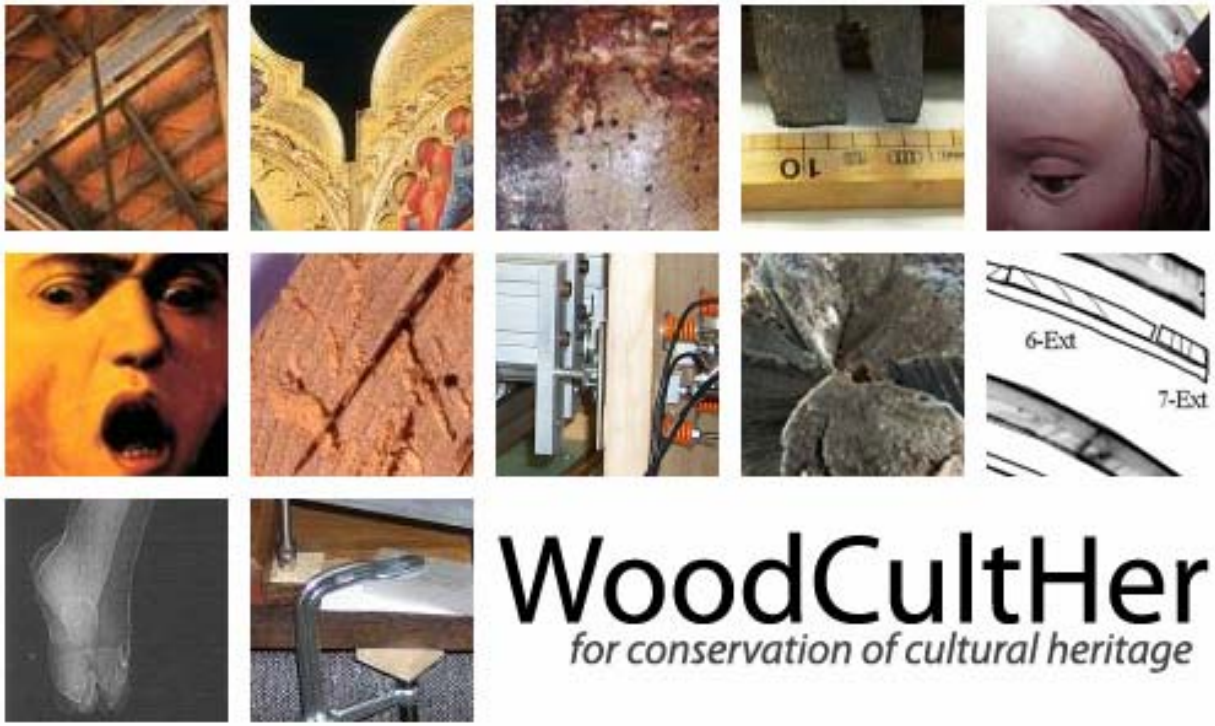

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EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

COST Action IE0601
Wood Science for Conservation
of Cultural Heritage

WoodCultHer
for conservation of cultural heritage

vTI
Johann Heinrich
von Thünen-Institut

UH

International Conference on Wooden Cultural Heritage:
Evaluation of Deterioration and Management of Change

October 7-10, 2009

Institute of Wood Technology and Wood Biology (HTB), Johann Heinrich von Thünen-Institute (vTI) / Federal Research Institute for Rural Areas, Forestry and Fisheries, Hamburg/Germany; Main Building

Organiser: Dr. Uwe Noldt

Abstract Booklet

Dear participants of the COST action meeting „Wood Science for Conservation of Cultural Heritage“!

I’d like to welcome you to this international conference in Hamburg, hosted by the Johann Heinrich von Thünen Institute (vTI) and the University of Hamburg. As one out of four Federal Research Institutes overseen by the Federal Ministry of Food, Agriculture and Consumer Protection, the vTI drafts scientific basics as decision-making helps for the policy of the German Government. We conduct application oriented, interdisciplinary research, targeted at the sustained development of agricultural, forestry and wood production as well as fisheries. The work encompasses economic, ecologic and technologic aspects.

As the Johann Heinrich von Thünen Institute was founded at the beginning of 2008, the name may sound quite new for many of you. But as a successor of three renowned Federal Research Centres we can draw upon a 60-year history in research.

The Institute of Wood Technology and Wood Biology as part of the vTI works on the entire life cycle of wood and timber. Research activities encompass the expansion of the technological capabilities for the increase of wood use as well as the material use of lignocellulosics. Another important topic is the quality assurance of wood products with respect to consumer protection. In this context, research on wood pests and their control has a long tradition in this institute.

As an institute acting in national and international networks, we are pleased to serve as a platform for communication and exchange of ideas within this COST Action. After Braga, Portugal, in 2008, Hamburg, the city with a long tradition of shipping and international trade, seems to be a very suitable location for a conference on conserving the Wooden Cultural Heritage. The current conference cumulates more than 100 experts from about 30 countries. Let me wish you a successful meeting with interesting lectures and fruitful discussions. Enjoy your stay in the vTI and in Hamburg.

Prof. Dr. Folkhard Isermeyer
President

Andrea Niemeyer

Bernd Ixmeyer

Maik Gruhlich

Thomas Schwarz

Elisabeth Nimz

Susanne Dencker

Annika Rauh

Lidia Waal

Sarah Beyer

Kerri Hagemann

Dr. Guna Noldt

Dr. Uwe Noldt

COST Action IE0601 "Wood Science for Conservation of Cultural Heritage"
Final Programme of International Conference on *Wooden Cultural Heritage: Evaluation of Deterioration and Management of Change*
Hamburg/Germany; October 7-10, 2009;

Wednesday October 7th, 2009				**Chairperson**
13:00	**Registration desk open**			
14:00-15:30		***MC meeting part 1***		**Uzielli L**
15:45-16:00	**Opening of the Conference**			
16:00-17:30	**Session 1**	**Keynote presentations**		
		Koch G, Richter H-G	MacroHOLZdata wood ID Innovative digital tools for macroscopic wood identification and information retrieval for educational facilities and professionals in wood utilization	
		Singh A	Role of electron microscopy in understanding deterioration of wooden objects of cultural heritage	
17:30-17.45	Short break			
17:45-19:30		**Short orals / posters**		**Nilsson T**
20:00-22:00	informal get together	„Alt-Lohbrügger Hof" with „Skittling"(Kegeln)		
Thursday October 8th, 2009				
09:00-10:15	**Session 2**	**Presentation and discussion of summaries from Focused meetings and Training School**		**Gril J**
		Kozlowski R	Diagnosis and conservation of wooden cultural heritage : necessary European standardisation within CEN TC 346 'Conservation of Cultural Heritage' ; Krakow, 2-3.4.09	
		Kucerova I / Olstad TM	Consolidation, reinforcement and stabilisation of decorated wooden artefacts ; Prague, 30-31.3.09	
		Noldt U	Wood-destroying insects and decay fungi in and moulds on wooden cultural heritage objects and constructions (Training School; Hamburg, 16-20.3.09)	
		Fioravanti M	Structural typologies and conservation of roof timber structure; Florence, 20-23.5.09	
		Thickett D / Kozlowski R	Managing environmental risks to wooden interiors and collections in historic buildings and churches; Cambridge, 27-28.4.09	
10:15-10:45	Coffee break	(Posters)		

Thursday October 8th, 2009				**Chairperson**
10:45-12:50	**Session 3**	**Re-treatment**	**Oral presentations**	
		Christensen IV, Ottosen LM, Jensen P, Bojesen-Koefoed I, Kutzke H, Braovac S, Sandström T, Christensen M	The use of an electric field for the removal of alum from treated wooden objects	
		Christensen M, Hansen FK, Kutzke H	New materials used for the consolidation of archaeological wood – past attempts, present struggles, and future requirements	**Olstad TM**
		Jelen E, Wiedemann G, Püschner K	Laser cleaning of contaminated wooden objects	
		Mayer I, Hunger K, Wörle M, Hubert V, Arx U von	Destructive and non-destructive methods for the evaluation of pesticides concentration and emissions from wooden art objects	
		Sperantza Ch, Papadimitriou M, Pournou A	Risk management: a case study of the wooden collection held in storage at the folk art museum of athens	
13:00-14:25	Lunch break	(Posters; **Group Foto!!!**)		
14:25-16:30	**Session 4**	**Wood Science for conservation**	**Oral presentations**	
		Fioravanti M, Togni M, Bertolini C, Ceresa F, Ronzon L, Iezzi M.	How physical and mechanical damages might affect conservation of wooden ships in Museum environments: the case of Ebe schooner	
		Klaassen RKWM	Factors that influence the speed of bacterial wood degradation	
		Yokoyama M, Gril J, Matsuo M, Yano H, Sugiyama J, Clair B, Kubodera S, Mistutani T, Sakamoto M, Ozaki H, Imamura M, Kawai S	Mechanical characteristics of aged Hinoki (*Chamaecyparis obtusa* Endl.) wood from Japanese historical buildings - Comparative analyses with accelerated aging wood	**Jeronimidis G**
		Gereke T, Anheuser K, Lehmann E, Niemz P	Moisture behaviour of recent and naturally aged wood	
		Saft S, Kaliske M.	Numerical Simulation of Historical Pianoforte	
16:30-17:00	Coffee break	(Posters)		

Thursday October 8th, 2009				**Chairperson**
17:00-18:15	**Session 5**	**Assessment**	**Oral presentations**	**Cruz H**
		Touza Vazquez MC	Case study: assessment the mechanical properties from an old "pitch pine" timber structure	
		Uzielli L, DionisiVici P, Cocchi L, Zazzeri D, Scudieri M	Monitoring actual deformations of an original painted panel by Beato Angelico in the San Marco Museum, Florence	
		Sandak A, Sandak J, Zborowska M, Prądzyński Wlodzimierz, Negri M	Characterization of archeological oak (*Quercus* sp.) with mid and near infrared spectroscopy	
18:15-19:00	**STSM Reports**	De Ridder M; Feci E; Goli G et al.; Lukomski M		
20:00	Workshop dinner			

Friday October 9th, 2009				
8:45-09:50	**Session 6**	**Non-destructive Techniques**	**Oral presentations**	**Lehmann E**
		Michette A	X-Ray Spectromicroscopy of Wood Fibre Composites	
		Bielecki J	X-ray Computed MicroTomographysystems based on laboratory sources – possibilities and limitations	
09:50-11:00	**WG meetings**			
11:00-11:30	Coffee break	(Posters)		
11:30-12:15	**Session 7**	**Keynote presentation**		**Uzielli L**
		Wadum J	Structural Conservation of Panel Paintings: Tradition, Innovation, Initiatives	
12:15-13:00		**Plenary discussion**		
13:00	**End of Workshop**			**Uzielli L**
13:00-14:00	Lunch break			
14:00-16:00		***MC meeting part 2***		
14:00-16:00	Participants visits at VTI	Arboretum, timber collections, dendrochronology, timber physics (groups < 15)		
16:00-17:00	MC visits at VTI	Arboretum, insects, timber collections (groups < 15)		

Saturday October 10th, 2009				
08:30-11:00		**Visit to Hamburg harbour**		

Annex – List of Short Orals, Reports from STSMs, Posters

Short Orals (presenting Author is underlined)

1	Abdel Rahman Medhat; Yassien Zidan; Nesrin M.N. El Hadidi	Study on the use of polymers in the treatment and conservation of historical wood
2	Jiri Bláha, Kloiber, M., Frankl, J., Drdácký, M., Valach, J., Růžička, P	The Conservation of the Historic Timber Roof of the Royal Palace at the Tocnik Castle
3	Susan Braovac, Hartmut Kutzke	The Presence of Sulphuric Acid in Alum-conserved Wood – Origin and Consequences
4	Bogdan Constantinescu, Catalina Pauna, Daniela Stan	Authentication of ancient stringed musical instruments – the contribution of X-Ray Fluorescence analysis
5	Helena Cruz, Pedro Palma	Fire risk and protection of old timber roofs - need for focused meetings
6	Jana Gelbrich, Carsten Mai, Holger Militz	Evaluation of bacterial wood degradation by FTIR measurement
7	Boštjan Lesar, Franc Pohleven and Miha Humar	Use of boron compounds for treatment of wooden historical objects
8	Margarita Kisternaya, Valery Kozlov	Wood-science approach to the preservation of historic timber structures
9	Sandie Leconte, Matthieu Vion, Christopher Clarke	Attempt to find the ancient sound: from the modelisation to the reconstruction of the Erard Piano in Musée de la musique
10	Miyuki Matsuo, Misao Yokoyama, Kenji Umemurai, Junji Sugiyama, Shuichi Kawai, Joseph Gril, Ken'ichiro Yano, Shigeru Kubodera, Takumi Mistutani, Hiromasa Ozaki, Minoru Sakamoto, Mineo Imamura	Evaluation of the aging wood from historical buildings as compared with the accelerated aging wood and cellulose - Analysis of color properties.
11	G. Giachi, S. Bugani, J.J. Łucejko, F. Modugno, F. Tatti	Different techniques (SEM, DR-µCT,FIB/SEM) for the evaluation of the deposition of consolidants into waterlogged archaeological wood
12	Kalle Pilt, Vello Pallav, Matis Miljan, Jaan Miljan	Diagnosis of Timber Structures and Archaeological Wood of Cultural Heritage.
13	László Tolvaj	Monitoring of photodegradation for wood by infrared spectroscopy
14	Eleftheria Tsakanika-Theohari, George Pavlopoulos, Anastasia Pournou	Diagnosis of the preservation state of timber structural elements: A case study of a post-Byzantine mansion in Greece

Reports from STSMs

1	Maaike De Ridder, Jan van den Bulcke., Kristof Haneca, Hans Beeckman, Eberhard Lehmann, Eberhard, Joris van Acker	Changes in density and moisture content of archaeological waterlogged wood
2	Elisabetta Feci	Termites on old timber structures: diagnosis, identification and control. An essay with sol-gel treatments as prevention method
3	Michal Lukomski	Implementation of a portable ESPI to the characterization of damaged areas in painted wood
4	George Stoppani, Eric Fouilhé, Giacomo Goli, Anne Houssay	Modal analysis and vibrational behaviour of tailpieces in stringed instruments

Posters

1	Livia Bucsa, Corneliu Bucsa	The Study of Biological Decay with Church Icons on Wooden Support from Romania
2	Pruna Mariana, Ileana Chirtea	Monitoring Xylophages Insects in the Outdoor Section of “Dumbrava Sibiu”, NMC (the national museum center), ASTRA
3	Michael Formosa	On 18th and 19th Century Sacristy Furniture in the Maltese Islands: Preservation
4	Eric Fouilhé, Giacomo Goli, Anne Houssay, George Stoppani	Preliminary study on the vibrational behaviour of tailpieces in stringed instruments
5	Dulce Franco Henriques, Lina Nunes, Jorge de Brito	Preliminary testing of timber consolidants applied by impregnation
6	Erich Jelen	3D-confocal-microscopy: New advantages for non destructive measurements
7	J.J. Łucejko, F. Modugno, E. Ribechini, M. Zborowska, M.P. Colombini	Characterisation of archaeological waterlogged wood by pyrolytic and mass spectrometric techniques
8	Ladislav Reinprecht, Miloš Pánek, Ján Sikely	Detection of rot in wood beams by ultrasound method – model and practical studies
9	Misao Yokoyama, Shuichi Kawai, Junji Sugiyama	Making of the wood collection from historical buildings in Japanese context
10	Magdalena Zborowska, Anna Sandak, Jakub Sandak, Sławomir Borysiak, Wlodzimierz Prądzyński	Characterization of archaeological wood degradation with selected nondestructive methods
11	Flavio Ruffinatto, Nicola Macchioni, Guido Boetto, Roberto Zanuttini	Potential of reflected light microscopy as a non-invasive identification tool on wooden cultural artefactsMariapaola Riggio, Maurizio Piazza
12	A. Baldit, David Dureisseix, F. Morestin, H. Maigre	Follow-up of a panel restoration procedure through image correlation and finite elements modelling
13	Julien Colmars, Bertrand Marcon, Emmanuel Maurin,Fabrice Morestin, Paola Mozzanti, Romain Remond, Joseph Gril	Hygromechanical response of a painted panel in a church: monitoring and computer modelling
14	Artur Feio, Helena Cruz	Inspection Techniques and Rehabilitation Solutions for Ancient Wooden Structures: some Portuguese Case Studies
15	Paola Mazzanti, Luca Uzielli	Time to reach the equilibrium moisture content: laboratory tests on Poplar (*Populus alba L.*) mock-up panels
16	Frederico Henriques, Alexandre Gonçalves, Ana Calvo, Ana Bailão	Application of spatial analysis operations for the characterization of wood painting features
17	Ana Calvo, Joana Salgueiro, Salomé de Carvalho	The wooden supports in Portugal: the Pentecost in different altarpiece structures
18	Jan Bosselaers, Alex Valcke	From wood protection to preservation of historic monuments: the commitment of Janssen PMP to cultural heritage conservation
19	Aleksandra Hola	An artwork: alterable – unalterable A critical analysis of the restoration process as a creative factor within an artwork’s new structure

MacroHOLZdata wood ID Innovative digital tools for macroscopic wood identification and information retrieval for educational facilities and professionals in wood utilization

KOCH, Gerald; RICHTER, Hans-Georg

Institute of Wood Technology and Wood Biology (HTB), Johann Heinrich von Thünen-Institute (vTI) / Federal Research Institute for Rural Areas, Forestry and Fisheries, Hamburg, DE

Abstract

The knowledge about recognition and utilization of commercial timbers is of prime importance to timber trade and wood processing and as well as wood conservation. The reliable identification of wood based on microscopic wood structure requires considerable professional expertise, a rather sophisticated infrastructure, and a reference wood collection for comparison. A "first aid" for computer-assisted wood identification based on macroscopic features is already available from the databases ***macroHOLZdata*** and **CITES*wood*ID**. The databases enables the user to identify trade timbers by means of macroscopic wood structural features (characters). Macroscopic structural features are those which can be observed with the unaided eye or with the help of a magnifying lens (about 6x to 12x). In addition to computer-aided identification this digital learning tool allows access to a data-pool with timber specific information on properties, utilization, and other relevant characteristics of the timbers integrated in the database, i.e., data on biological, physical and mechanical properties, wood machining, wood processing, and appropriate end uses. The software **CITES*wood*ID** serves as a visual (illustrations) and textual (descriptions) identification aid to all institutions and persons involved in controlling the import as well as export of wood and wood products under particular consideration of CITES regulations.

Role of electron microscopy in understanding deterioration of wooden objects of cultural heritage

SINGH, Adya P.

Scion, Private Bag 3020, Rotorua, NZ

Abstract

Major wooden objects of cultural heritage have been found to suffer to varying degrees from microbial deterioration, resulting mainly from attack by bacteria that cause erosion and tunnelling of cell walls and fungi causing soft rot of wood. Investigations based on the use of electron microscopy as a major tool have provided wealth of information on the fine texture of the degraded wood tissues at the level of cell wall, which is proving helpful in developing appropriate methods for conserving these valuable wooden artefacts. The brief overview presented describes the different microbial decay patterns commonly associated with historically important archaeological wood.

Short Oral 1

Study on the use of polymers in the treatment and conservation of historical wood

MEDHAT, Abdel Rahman; ZIDAN, Yassien; EL HADIDI, Nesrin M.N.

Cairo University, Faculty of Archaeology, Conservation Department, Cairo, EG

Abstract

Repair and rehabilitation of monuments has increased in Egypt during the past decades, therefore it has become essential to develop techniques for restoration of historical timber and try to overcome the current methodology which involves total replacement of historical timber instead of its treatment and conservation. This work arises from the urgent need to study and develop important techniques that could be used in the treatment and conservation of historical wood in Egypt. The current restoration technique in many cases of historical structures usually involves total replacement of damaged timber by similar elements of new wood instead of treatment or conservation of deteriorated wood. The use of polymers for treatment and conservation of historical wood *in situ* may be difficult due to working conditions, especially during the summer months, and this research aims to put the main guidelines for choosing and applying polymers on historical wood. Two polymers were chosen for this study; epoxy and polyurethane; because of their ability to enhance wood due to their physical and chemical properties. There are many uses of epoxy and polyurethane in archaeological wood; but the main focus in our study is their use as adhesives, gap fillers and coating materials, putting into consideration the least loss of historical material during present and future repairs. Old and new wood samples will be treated with polymers available in the Egyptian market, and mechanical and chemical properties of all samples will be compared for the evaluation of these polymers after their application.

The conservation of the historic timber roof of the Royal Palace at the Tocnik Castle

[1]BLÁHA, Jiří; [1]FRANKL, Jiří; [1,2]KLOIBER, Michal

[1]Institute of Theoretical and Applied Mechanics, v. v. i., Academy of Sciences of the Czech Republic, Prague, CZ
[2]Mendel University of Agriculture and Forestry in Brno, Faculty of Forestry and Wood Technology, Department of Wood Science, Brno, CZ

Abstract

Tocnik Castle is situated in central Bohemia cca 40 km SW from Prague. Some serious failures and deformations have appeared on the roof timber frame of the Royal Palace. Then the task arose how to repair the structure on site preserving the most of the original substance.
Structural design solution finally offered that insufficient queen-post frame nearly two hundred years old should be replaced with another construction system of the period having short principals and king-posts in main trusses. The all-wood joints were designed to extend the rotten ends of some trusses. High quality of new inserted timber has been reached thanks to traditional techniques as hewing and hand sawing. Because of inaccessible terrain in the vicinity of the castle the replica of the medieval tread-wheel crane was used for vertical transportation of new timbers. The man-powered wooden machine proved its worth on adverse conditions and appears to be a good solution. Its appropriate working capacity was sufficient in desired labour schedule and brought even cost efficiency comparing to hire a truck crane with extremely long arm for the longer time. Conventional tubular scaffolding inside the building was replaced by adjustable and sliding one made from timber. Choosing the traditional "soft" methods of manipulation and woodworking finally brought good results.
The most interesting results of the survey research executed before the conservation works are described. Various up-to-date diagnostic methods had been used including ultrasonic detection, X-Ray screening as well like resistance drilling. The testing and evaluation focused to localization of fungal decay and other hidden imperfections expected mostly in spots damaged yet before by intruding water from precipitations. The outputs of the NDT were visually verified during the first stages of the repair works, calibrated and used for later improvement to better anticipate the hidden failures. All applied NDT methods were mutually corresponding, and all of them allowed us to identify the hidden defects in satisfactory way.

The presence of sulphuric acid in alum-conserved wood – Origin and consequences

BRAOVAC, Susan; KUTZKE, Hartmut

University of Oslo, Museum of Cultural History, Oslo, NO

Abstract

Art objects and archaeological finds have undergone restoration and conservation treatments in the past ca two hundred years. One does not need to be a prophet to forecast that historical conservation and restoration treatments and their consequences will be an issue that conservators and conservation scientists will meet with increasing frequency. Among wooden objects, conservation using alum salts has played and still plays an outstanding role: it was widely used in Scandinavia, but also worldwide. Today many objects are damaged or threatened by the consequences of this treatment. The objects are brittle and have a tendency to disintegrate.
It is assumed that the presence of sulfuric acid plays a central role in the still active deterioration process.

The alum-conservation method

An understanding of the observed deterioration of the alum-treated finds from Oseberg is the subject of investigations presented in this paper. These finds represent the world's richest collection of wooden objects from the Viking Age. The objects, found in a grave mound on the 'Oseberg farm' near Tønsberg, Norway, were part of a burial ritual in 834 AD for two women of high standing. In 1904, the objects were recovered in a highly fragmented and waterlogged state. Many of the wooden artifacts were conserved using the alum-conservation method and they are now threatened by a slow, active deterioration caused by the method originally used to preserve them.
The treatment used for the Oseberg find is described in excavation publications as well as in archival material. The artefacts were treated as follows:
The fragments were immersed in large tanks of concentrated alum solution, heated to ca 90° C. The solution penetrated the wood, the alum salts recrystallized and supported the structure, allowing the artefacts to be dried with minimal dimensional change. Maintaining the fragment's dimensions allowed the pieces to be fitted together. The fragments were then impregnated with linseed oil and reconstructed using metal screws, pins, fills and modern wood. The reconstructed object was finally lacquered. Objects treated in this way include the three sleds, and wagon now displayed at the Viking Ship Museum in Oslo, in addition to hundreds of smaller finds.

The role of sulfuric acid

Recent collections surveys indicate the wood is highly acidic (pH 1) and mechanically weak, due to the formation of new cracks and extension of existing cracks formed during drying. It is

thought that the low pH value of alum-treated wood is the main cause of active deterioration of the remaining wood polymers.
Experiments reproducing the Oseberg treatment were applied to freshly excavated archaeological poplar, fresh poplar, cellulose paper and lignin. FTIR analysis demonstrated that the alum treatment affects all samples at both RT and 90°C, with more degradation at 90°C. Aluminum ions, released from the alum salt upon dissolution, react with water to form various soluble and insoluble aluminum hydroxide species. This reaction is enhanced at higher temperatures, which explains the higher acidity obtained in alum solutions after heating (pH 0-2,5) than unheated solutions (pH 3,5-4). Precipitates formed in alum solutions heated to 90°C were identified by XRD to be aluminum hydroxide-salts, demonstrating the potential for mixtures of salts to also have been precipitated inside the Oseberg wood. Decomposition of alum in solution was compared with its decomposition/dehydration in solid form when heated. The present contribution discusses the immediate effects of high acidity on newly alum-treated archaeological wood analyzed by FTIR, and compares it with Oseberg wood treated with alum 100 years ago. It also suggests a possible mechanism of acid formation. This knowlegde will aid in designing preservation and re-treatment strategies.

Short Oral 4

Authentication of ancient stringed musical instruments – the contribution of X-Ray fluorescence analysis

CONSTANTINESCU, Bogdan; PAUNA, Catalina; STAN; Daniela

National Institute of Nuclear Physics and Engineering POB MG-6, Bucharest, RO

Abstract

The varnish from a supposed Stradivarius violin, recovered by Romanian Authorities in March 2009 was analyzed using X-Ray Fluorescence. Results were compared with the ones from literature, in order to try to authenticate the violin. Direct analysis was performed on the varnish instrument non-destructively, without any sampling - due its possible value. Analytical results obtained on violin varnish are discussed.

Short Oral 5

Fire risk and protection of old timber roofs

CRUZ, Helena; PALMA, Pedro

Laboratório Nacional de Engenharia Civil, Lisbon, PT

Abstract

Timber combustibility is often mistaken with low fire resistance of timber structures. This often restrains the choice of timber as a structural material in new constructions, despite its many technical, architectural and environmental advantages.

Fire risk considerations may also be a strong draw-back to the safeguarding of old common or historical timber structures, even when they meet structural safety requirements, due to the fact that most practitioners and building owners have insufficient knowledge on this subject.

Real life has often shown that timber structures may present very good fire endurance, especially in the case of massive timber constructions, composed by large elements, with low cross section perimeter/area ratios.

However, not only old timber structures are not always made of large cross sections, but also specific joints detailing, timber surface conditions, building geometry and use, presence of special equipment or stored products may increase the risk of fire to a significant level and require the employment of special protection measures.

This paper focuses the fire performance of timber and timber structures and discusses possible approaches to mitigate the risk of fire in timber buildings, with special relevance to the case of timber roofs.

Short Oral 6

Evaluation of bacterial wood degradation by Fourier-Transform-Infrared (FTIR) measurements

[1]GELBRICH, Jana; [2]MAI, Carsten; [2]MILITZ, Holger

[1]German Maritime Museum, Wet wood laboratory, Bremerhaven, DE
[2]University of Göttingen, Department of Wood Biology and Wood Products, Goettingen, DE

Abstract

Awareness of the potential role of bacterial decay of wood in water-saturated environments is relatively recent, but has led to great concern that foundation poles under historical buildings in Europe as well as waterlogged archaeological remains are under serious bacterial threat. The evaluation of the degree of degradation is essential in developing stabilisation and/or conservation strategies. Most evaluations of wood degraded by bacteria are based on physical characterization [1, 2] or microscopic observations [3-5]. The chemical composition, especially lignin content, is also a good indicator for degree of degradation [6]. These methods are known as destructive analyses and are very time and material consuming. The present study correlated changes in chemistry with the degree of microscopically detectable degradation in order to find new ways in evaluating the degree of bacterial wood degradation.

The characterization of waterlogged softwood samples by means of infrared spectroscopy reflects results of chemical analyses but a direct quantitative analysis of wood compounds by FTIR is problematic. Due the linear regression between lignin content which was determined chemically and that which was based on absorbance values of lignin in FTIR spectra a calibration curve could be drawn up. Reversed on this database it was shown that FTIR measurements are practical in evaluating the degree of bacterial degradation in softwood with the advantage of smallest amounts of sample material required, the enhanced rapidity and simplicity of this method.

Short Oral 7

Use of boron compounds for treatment of wooden historical objects

LESAR, Boštjan; POHLEVEN, Franc; HUMAR, Miha

University of Ljubljana, Biotechnical faculty, Department of Wood Science and Technology, Ljubljana, SI

Abstract

Boron compounds are still one of the most important active ingredients used for wood preservation. They are applied as fungicides as well as insecticides. However, most of efficacy data reported for boron efficacy are rather old, and thus in contradiction with new reports. Therefore, minimal inhibitory concentrations for boron were re-evaluated. Tests were on three brown (*Gloeophyllum trabeum, Serpula lacrymans* and *Antrodia vaillantii*) and three white rot (*Trametes versicolor, Pleurotus ostreatus* and *Hypoxylon fragiforme*) fungi. To inhibit growth of wood decay fungi, lower minimal effective retentions were determined than reported in previous publications. Furthermore, minimal remedial boron fungicidal concentration is comparable to the preventive minimal inhibitory concentration.

Short Oral 8

Wood science approach for the preservation of historic timber structures

[1]KISTERNAYA, Margarita; [2]KOZLOV, Valery

[1]"Kizhi" State Open-Air Museum of Architecture, History and Ethnography, Petrozavodsk, RU
[2]Forest Research Institute, Karelian Research Centre RAS, Petrozavodsk, RU

Abstract

Authenticity of wooden architectural monuments is determined by original building material – timber.

The report presents the results of the investigation of XVIII cc. historic timber structures in the Republic of Karelia carried out in 1998-2008. The data obtained indicate that the chemical composition of Scots pine (*Pinus sylvestris* (L)) changes as the timber ages. Cellulose molecules are destroyed and water-soluble extractives – acids, sugars, appear. Nevertheless, the timber not damaged by biological agents preserves its strength properties. Biological agents – brown rot fungi (*Serpula lacrimans* (L.), *Coniophora puteana* (Fr.), *Coriolellus sinuosus* (Fr.), *Fibuloporia vaillantii* (Fr.), *Paxillus panuoides (*Fr), soft rot, and wood borers (*Hadrobregmus pertinax* (L.), *Anobium confuses (Fr.)*) are the most common destructors of historic timber in this region.

The proposed coherent strategy of regular monitoring aims to prevent biodeterioration of timber structures. It consists of several related levels and includes regular inspections; temperature and air humidity measurements, as well as control of wood moisture content, fungal and insect activity.

The procedure of historic structure inspection is described. It includes: visual inspection of structural elements to reveal the zones with high wood moisture content and those damaged by fungi and insects; sampling for mycological analysis in the zones damaged by fungi and insects; detection of wood-destroying insects and investigation of timber integrity using special equipment.

The main efforts are focused on detection the zones where the fungi and insects are active. At the first stage the fungal activity is predicted by wood moisture content. Continuous measurements allowed determining saprogenic zones. At the second stage small wooden samples (30-40 mm long, 5 mm in diameter, referred to below as "witness" samples) are exposed in the zones under investigation for estimation of fungal activity *in situ*. Their weight loss is considered an indicator of fungal activity.

Detecting wood- destroying insects includes light traps monitoring, visual inspections and acoustic detection. Audio sensors used by the authors proved to be quite efficient in detecting insects even if visual signs – flight holes, were not obvious. The best periods for the detection of *Anobiidae* are May-June and September.

The system of monitoring biodeterioration has been established in the State Open-Air Museum "Kizhi" since 1998. As a result, zones damaged by wood-destroying fungi and insects were

revealed, their activity was assessed: microclimate of the structure was studied, and the sources and distribution of moisture within timber were determined. The results were used as the basis for timely maintenance of the monuments.
As a result roof leakages were located and eliminated, although it was a rather difficult task given the complicated structure of the multi-domed churches. It decreased wood moisture content considerably, and the fungi development ceased. The absence of fungal activity was proved by experiments with “witness”-samples.
Disinfection is more problematic than control of the activity of wood-destroying fungi: the pests develop at relatively low wood moisture content and nearly all stages in their life are hidden inside the timber.
The report presents the technique for eradication of wood-destroying insects by means of local-scope microwave treatment developed by the authors and protected by Russian Federation copyright law. The obtained within the framework of the research temperatures and the exposure times lethal for the insects and larvae of borers are discussed. It is shown that the heating modes with slow increase in temperature at low wood moisture content provide the low temperature gradient and preserve the integrity of the timber.
The “Kizhi” museum experience proved the idea that preventive conservation principles can be applied to historic timber structures. Regular monitoring, integrated pest management, in-time maintenance are the best approaches for preservation of wooden monument. The proposed monitoring system can be easily adapted to a wide spectrum of historic timber structures. In the long term, it would increase the service life of the wooden architectural monuments preserving their authenticity.

Attempt to find the ancient sound: from the modelisation to the reconstruction of the Erard Piano in Musée de la musique

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Abstract

In addition to the fact that musical instruments are cultural heritage objects, there are also objects with a sound function. The preservation of these musical instruments is also the preservation of their sound function. But, in the collection of the Musée de la musique, only few of them are kept in a playable state. So when the musical instrument is too fragile to be played (mechanical risk du to the string tension) the Musée orders a fac-simile. The fac-simile is a copy of the original musical instrument, done with the same tools and methods. Of course, it's impossible to find the same wood used for the structure of the musical instrument and more particularly for the soundboard. Indeed, this part is one of the most important elements of the string instruments in the sound production. This is why in the laboratory we develop numerical simulation of the soundboard mechanical behaviour and study the influence of the material properties, thickness and preload on the structure dynamical response. First of all, the technical drawing has been done by the piano maker using numerical tool. This plane will be use by the piano maker and for the numerical simulation.

The main difficulty in this step is to take into account or not the deformation of some wooden element (few mm) due to the stress tension. For this expertise we use the piano maker knowledge.

The second step is to simplify this drawing to realize the meshing of the geometry. After, the string tension is calculated and added as an external force to the structure. Finally, the code can calculate the deformation, the static load, and the dynamical response.

Since the piano maker is doing the musical instrument in the same time, it's easy to collect some wood sample to measure its mechanical properties and insert them in the model.

Evaluation of the aging wood from historical buildings as compared with the accelerated aging wood and cellulose – Analysis of color properties

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Abstract

Color changes of wood during natural aging and during heat treatment were elucidated to determine whether they could be explained as the result of a mild thermal oxidation process at ambient temperatures. The results of kinetic analysis employing the time-temperature superposition method showed that the color changes during natural aging were mainly the result of an oxidation process. Color changes of heat-treated cellulose were also compared with that of wood and indicated that cellulose is responsible for the color changes of wood during natural aging and during heat treatment.

Short Oral 11

Different techniques (SR-µCT, SEM, FIB/SEM) for the evaluation of the deposition of impregnating substances into waterlogged archaeological wood

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Abstract

Conservation treatments of archaeological waterlogged wood artefacts often involve the replacement of water with impregnating substances which fill the cavities of wood, preventing drastic dimensional changes due to collapse and shrinkage of weakened cell walls during drying. The effectiveness of these treatments strongly depends on the chemical and physical behaviour of adopted substances and, moreover, on their degree of filling or bulking, penetration depth and distribution in the wood structure. This work investigates the deposition and penetration of impregnating substances into archaeological waterlogged wood structure by means of 2D/3D imaging techniques at micro- and submicron-level. Non-destructive techniques, namely Synchrotron Radiation X-ray Microtomography (SR-□CT), Scanning Electron Microscope (SEM) and Focused Ion Beam/Scanning Electron Microscope (FIB/SEM), were used to examine samples of pine and elm treated with a mixture of PEG 400/4000 and with colophony.

Short Oral 12

Diagnosis of timber structures and archaeological wood of cultural heritage

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Abstract

The aim of the present paper is to analyze usage the resistograph as a non-destructive method in diagnosing the mechanical and physical properties of existing timber structures and archaeological wood of cultural heritage.

There are several non-destructive methods for diagnosing mechanical properties of wood. The authors of this paper prefer mechanical methods as ecologically and economically suitable.

Test specimens are sawn from 15 beams of different age. Felling time of the trees was dendro-chronologicaly dated.

Regression analyses are carried out in order to obtain correlations between mechanical properties and density and non-destructive methods. Mechanical properties measured with a resistograph and using standardized laboratory methods. In order to get more reliable results, the experiments were carried out on archaeological wood (basements and foundations) as well as on load bearing timber structures.

Short Oral 13

Monitoring of photodegradation for wood by infrared spectroscopy

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Abstract

The infrared (IR) spectroscopy is a good analytical tool to determine the chemical changes of photodegradation caused by sunlight exposure. Wood is an excellent light absorber material, so the diffuse reflectance technique can only be applied. This technique gives information from the same surface layer which is affected by photodegradation. The IR spectroscopy is a nondestructive method. This paper presents the main chemical changes caused by light irradiation. The time dependence of these changes is displayed as well. Well presented that the rain leaches out the photodegradation products from the surface of outdoor wooden construction giving place for further degradations. The earlywood and latewood have different sensitivity to photodegradation; the earlywood suffers much more degradation than latewood. Lasers are special light sources emitting only one wavelength. The wavelength dependence of photodegradation is investigated applying lasers.

Short Oral 14

Non destructive diagnosis of the preservation state of timber structural elements: A case study of a post-byzantine mansion in Athens, Greece.

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Abstract

This work presents the diagnostic procedure that was implemented by a team of conservators/restorers and engineers, in order to provide the necessary documentation for the structural timbers of a post-byzantine mansion. The methods used were mainly non destructive and permitted reliable determination of the preservation state of the original small section timbers. The procedure followed, gave the opportunity to save structural members that otherwise would be replaced.

Oral presentation 2/1

Diagnosis and conservation of wooden cultural heritage: necessary European standardisation within CEN Technical Committee 346 'Conservation of cultural heritage' – a report from the focussed meeting organised on April 2-3, 2009 in Krakow, Poland

KOZLOWSKI, Roman

Polish Academy of Sciences, Institute of Catalysis and Surface Chemistry, Crakow, PL

Abstract

The meeting has considered the activities and work programme of CEN TC346 and has identified Working Group 2 'Materials constituting cultural property' as the key area of interest to the COST Action IE0601. The Action is deeply interested in providing support to the development of the European standards for the wood conservation field. It was agreed to start the preparatory work on two items: 'Waterlogged wood: characterisation, managing the sites, planning the recovery and conservation' and 'Guidelines for the on-site assessment of historic timber structures'. A crucial task is to establish contacts and identify experts from various European countries as a Europe-wide perspective and consensus is a vital condition of producing a successful standard

Consolidation, reinforcement & stabilisation of decorated wooden artefacts – a report from the Focused Meeting organised on March 30-31, 2009 in Institute of Chemical Technology Prague, Czech Republic.

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[2]Institute of Chemical Technology Prague, Prague, CZ

Abstract

The meeting was focused on consolidation and stabilisation of decorated wooden artefacts and it dealt with non-archaeological wood. The aim of the meeting was to share problems, research-results and knowledge on how to consolidate the wood and to discuss techniques and materials, the criteria and methods applied for evaluating a treatment.

The first lecture gave a survey on wood consolidation treatments, the composition of the used consolidants and the damages they have caused. Different ways of consolidants extracting from the consolidated wood were presented, too. The second lecture provided information about The Panel Paintings Initiative - a multi year collaborative project initiated by the Getty Conservation Institute. The third lecture introduced research results dealing with study of consolidant penetration into wood and its distribution in wood: The results of Neutron radiography and Raman spectroscopy were showed. The following lecture showed the conservation and reconstruction of a painted wooden tomb chamber dating from 480 BC. The next oral presentation discussed many current problems and questions. Some of them were:

- consolidation of wood is based on experience more than research based knowledge,
- where consolidants go – how deep into the wood structure it penetrates,
- internal tensions,
- drying time and solvents retention,
- discoloration of the wood,
- wood "plasticification" after its consolidation.

Then research results on wood consolidation by acrylates were presented. The following lecture was focused on a barrier effect to water vapour of consolidants on tempera and oil paints on wood. Research results, how consolidation of a painted wooden surface influences the water vapour transport, were showed. A method for evaluating the efficiency of consolidants for decorated wooden artifacts based on mechanical properties analysis were introduced during following presentation. Thereafter, lectures deal with practical experiences of Academy of fine art, Poland and of private conservator from Netherlands were presented. Later part of the meeting was concerned with non-destructive evaluation of decorated wooden artefacts by active infrared thermography and with a method on electrochemical in situ wood impregnation with copper. Practical experiences and problems were discussed during poster session again and research results how liquid surface tension influences consolidant solution penetration into wood were showed.

Oral presentation 2/3

Wood-destroying insects and decay fungi in and moulds on wooden cultural heritage objects and constructions (Training School; Hamburg, 16-20.3.09

NOLDT, Uwe

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Abstract

The training school which was carried out as a COST Outreach Activity focussed on the important wood-destroying organisms, both insects and fungi which damage wooden cultural heritage, artworks and timber constructions. The training school fulfilled the initial objectives and intentions regarding most fields of the Conservation of Wooden Cultural Heritage. Thirteen courses and presentations were conducted by 9 lecturers from 6 countries(DE, LV, MK, PT, RO). New techniques and methods were taught and discussed (e.g., monitoring and control measures for insects, molecular methods for fungi, detection methods for moulds). New contacts between trainees from 21 countries (AT, BE, CH, CZ, EE, FI, DE, FR, GR, IT, LV, MK, NL, NO, PL, PT, RO, SE, SI, SK) and lecturers were made, especially with reference to the different fields of work of the participants. There is demand for a repetition of this training school on the basis of the reactions of the participants as well as by the response during the application period.

Structural typologies and conservation of roof timber structure - Short scientific report on Focused Meeting of COST Action IE0601 and CULTURA Project "Les Toits de l'Europe II"joint meeting Florence (May 21-22, 2009)

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Abstract

The meeting, organised by DISTAF (a Department of Florence University), was structured according to three presentation sections (Structural typologies, dating and intervention techniques) and visits to important timber structures of the City. In two days, about 20 presentations (orals and posters) have been given by Delegates. At the end of the meeting, during a plenary discussion, the following major outcomes and addressing remarks have been settled:

1) Ancient timber structures are not only a static problem to be managed in order to guarantee structural safety, but they also must be considered as depositaries of many further and important cultural values. As consequence, when historic timber structures, whether buildings or parts of a building, or their components or members, are being assessed in connection with a project of development or modification, there is a risk that after the assessment, and perhaps as a result of it, the structures or components will be destroyed or significantly modified. It is therefore essential that the assessment include an archaeological record of the structures or components, and of their context, and including both photographs and measured drawings with scales, and if relevant, video material, all clearly dated and labeled.

2) Within technical information to be recorded, structure dating is a very important issue, both for the indication of building construction phases and for information that could be contained in old timber element (i.e. climatology and ecology).

3) Assessment of both structure and members is another key aspect for structures conservation and safety. Visual inspection is emerged as a fundamental step of the processes (both for assessment of biological and physical/mechanical damages). Of course the inspection effectiveness can be significantly improved by means of different non-destructive techniques (i.e. ultrasound, stress waves, sonic tomography, drilling devices) and especially from combination of two or more of them. Determination of both MOE of the whole structural elements, and identification of residual cross section of the beams, are two aims satisfactorily achieved by current knowledge, while still open, and necessary of further research work, are:
Assessment of actual residual strength of old timber;
Identification of classes of damage;
Determination of strength classes for old timber (even if it is really possible).

4) The necessity of developing a data base of experimental results, and to set material banks in which collect old timber elements, have been highlighted as two of the most important needs for development of future research works.

5) A brief summary of the most important outcomes of the focused meeting on standards for wooden cultural heritage, held in Krakow on April 2-3, 2009, has been presented by H. Cruz. The need of developing Guidelines and Standards for assessment and conservation of historical timber structure has been confirmed as a priority task to be developed in this field.

Oral presentation 2/5

Managing environmental risks to wooden interiors and collections in historic buildings and churches – a report from the focussed meeting organised on April 27-28, 2009, Cambridge, UK

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Abstract

The initial session focussed on the problems of environment in historic houses and churches and well established mitigation methods such as humidistatic 'conservation' heating, panel painting frames and limiting access. The use of an intermediate building simulation software package WUFI+ was of particular interest and appeared to generate reasonable simulations with much less input than packages such as Energy plus.

The second session concentrated on new heating approaches to balancing the needs of wooden artefacts and visitors/staff and the concept of historic climate to determine tolerable RH conditions, based on survival of material. Vertical profile measurements were particularly enlightening and a novel ceiling heating system was described to prevent from condensation events.

A third session continued the theme of heating and church environments. Work on in situ monitoring appeared to provide a viable route to understanding tolerable RH conditions. The combination of acoustic emission and electronic speckle interferometry to localise the 'damage' detected by acoustic emission was very impressive.

The fourth session was focussed on bio deterioration, which is a high risk in historic properties because of frequent water ingress, sometimes high humidities and many refuges for insect pests. Critical mould growth conditions were presented along with improved models to determine the mould risk from T and RH data. Approaches to preventing mould growth in organs were assessed from a series of case studies or particular interest was the increase in risk associated with conservation heating and increased evaporation of moisture from materials under this method. A very wide range of treatment options for insect pests were compared presenting the most comprehensive data set yet published.

The final technical session concentrated on allowable fluctuations from modelling and measurement studies. An excellent approach for export-ware lacquer objects was developed, refuting some common misunderstandings about the durability of this material. The effect of reduced water permeability through paint and gesso layers was quantified. A challenging technical issue with aged materials and the impossibility of large scale sampling from precious art works.

The use of an electric field for the removal of alum from treated wooden objects

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Abstract

In this paper the removal of sulfate and aluminum ions from waterlogged alum treated wood with the use of an applied electric field is in focus. Removal of alum is seen as the first step towards re-conservation of the wood with e.g. PEG. Alum treated wood samples from the Hjortspring finds (app. 350 BC) was used in this investigation and a total of five experiments are presented here. An electric DC field was applied across the wood for 4-20 days. A constant current of 1-3 mA was applied and the corresponding voltage drop was low, often below 10 V. At the end of the experiments sulfate has moved as expected towards the positively charged electrode (anode) and after 20 days 76% of the sulfate was removed from the wood with the use of the electric field. Aluminum tended to be removed more slowly and even after 20 days only minor amounts of aluminum was removed from the wood, however there was a tendency of redistribution in the wood that implied aluminum being transported as expected towards the negatively charged electrode (cathode). The power consumption was low, only 1.6 Wh after 20 days. Even if total removal was not obtained in the experiments reported here, the high conductivity and the transport of the measured ions due to the electric field indicates that an applied electric field as a method for removal of alum and other unwanted ions from treated objects should be further investigated. Research is ongoing and distribution of potassium after treatment will be measured in the near future.

Oral presentation 3/2

New materials used for the consolidation of archaeological wood – past attempts, present struggles, and future requirements

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Abstract

Given the perilous state of the Oseberg find from Norway, the University of Oslo is looking into new methods for treating waterlogged wood. While numerous polymers have been previously tested, most do not stabilise the wood sufficiently, penetrate far enough, or remain stable without degassing toxic fumes. A few of the more common examples are: Alum salt, $KAl(SO_4)_2 \cdot 12H_2O$, which was used for treatment earlier but does not penetrate well and leaves the wood very acidic. After WW2, conservators began using poly(ethylene glycol) (PEG) but this material degrades over time and thus cannot support the finds for very long. Melamine-formaldehyde (Kauramin) has also been used and while it is fairly stable, it also fills the wood enough to turn it into a 'block' of plastic. It is proposed that the single most vital requirement for a stabilising agent is to leave an airy structure in order to allow re-treatment in the future. This might be accomplished by foaming a polymer, or by combining nanoparticles with a polymer 'spider web' network to keep them in place. It may also be possible to construct a frame using biomimetic materials (an 'artificial lignin' either alone or as a polymer component) or through biomineralisation (an inorganic 'skeleton'). In any case, the recent advances in materials science must be considered and implemented if we are to develop new, airy, re-treatable, durable consolidants for archaeological wood.

Oral presentation 3/3

Laser cleaning of contaminated wooden objects

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Abstract

Starting in the 1940s, chemical wood protectives based on dichlordiphenyltrichlorethane (DDT), γ- hexachlorcyclohexane (γ-HCH, lindane) and pentachlorophenol (PCP) were used to save wooden objects of art and to protect them from insect attack and wood-destroying fungi. These formulations have an insecticide effect. They act as contact and stomach insecticides (DDT), contact and respiratory toxicant (PCP) or fungicides, respectively. However, these safety measures have additional long-term effects: DDT, PCP and Lindane may outgas from the objects and even crystallize out onto the surface of the wood as "typical white needles".
Different treatments were tested in the past to clean or decontaminate the artworks. All these processes have their assets and drawbacks, and no single process solves all problems. They can be distinguished by two criteria: movable and non-movable objects, and with or without polychrome paintings. So there are dry mechanical treatments like brushing or blowing off, and wet processes like the so called vacuum-washing-method. A nearly new process for cleaning of cultural heritage is the decontamination with supercritical carbon dioxide. With this method also a cleaning of the inner-sphere of the wooden objects is possible. This process can also be used for other materials or objects like ethnological ones, too.
In the context of cleaning objects of art or cultural heritage the laser is well known for the cleaning of dirty surfaces. But the laser cleaning can also be used for decontamination of the surface. Within the project there were three kinds of experiments. The first was lasing the pure substances DDT, Lindane and PCP in an extractor hood and to look how the absorption of the white powder is. The second was to clean specimens which contamination were already known from former investigations on supercritical carbon dioxide by chemical analysis, and the third the cleaning of the bottom of a virginal piano from Ignaz Hill made in 1812. The laser exhaust steam was adsorbed on PU-foams regarding to a German VDI guideline and ASTM rules. These adsorption foams were analyzed at the Fraunhofer UMSICHT laboratory. For comparison the surface of the virginal piano was analysed by a portable μ-XRF (X-ray fluorescence spectroscopy) once. These method should give a hint for the decontamination rate directly.
It was found out that the absorption of the laser for the cleaning of the white powders is to weak to crack the pure substances. Even if dirt is present on the surface, the absorption seems to be strong enough to have an impact on the contaminants. In many cases a real clean surface was generated. But sometimes, the whitish bloom on the surface of the specimens is only broken up to characteristic needles. The chemical analysis of the specimens show a decontamination rate of 50 % regarding to the whole sample and 80 % regarding to the surface of the sample measured with μ-XRF. One of the results within the presented project is that DDT was detected in the exhaust system while laser cleaning. Another result of the project is that the extraction system for the laser steam has to be upgraded and the restorer has to use a personal particulate filter respirator. The laser system, the measurement equipment and the chemical analysis will be also described.

Funding of the Deutsche Bundesstiftung Umwelt (DBU) is gratefully acknowledged.

Oral presentation 3/4

Destructive and non-destructive methods for the evaluation of pesticides concentration and emissions from wooden art objects

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Abstract

Liquid solvent extraction with dichloromethane combined with liquid injection gas chromatography-mass spectrometry (GC-MS) is a well suited method for determination and quantification of chlorinated pesticides in wood tissue. By scaling down the extraction step to micro level, concentration profiles of the pesticides in the wood tissue can be acquired. For this, wood tissue sections with a thickness of 50 µm are prepared with a sliding microtome. The sections are extracted in GC vials with dichloromethane and further analyzed by GC-MS. Chlorinated pesticides can be detected and semi quantified non-destructively on wood surfaces by µ-X-ray fluorescence (µ-XRF). Emissions of pesticides from contaminated art objects can be measured by emission chamber experiments followed by thermal desorption GC-MS analysis of the sampled volatiles. However emission chamber experiments are often difficult to realize, as they are cost intensive, time consuming and the objects need to be transported to the emission chamber. Passive sampling with polydimethylsiloxane (PDMS) can be used alternatively for easy-to-do on-site sampling of pesticide emissions from art objects to further qualify and quantify the emissions by thermal desorption GC-MS.

Oral presentation 3/5

Risk management: a case study of the wooden collection held in storage at the Folk Art Museum of Athens, Greece

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Abstract

This work deals with the implementation of a risk management (RM) methodology that was undertaken in 2008, for the wooden collection held in storage at the Folk Art Museum of Athens (M.E.L.T.), Greece. The goal of the RM at MELT was to establish the context, identify, analyze and evaluate the risks to the wooden collection, in order to propose a plan of action and communicate the results to the stakeholders. The results of the RM showed that the risk with the greatest magnitude and the most catastrophic impact to the wooden collection was *fire*, and that the measures to reduce this risk were easy to apply and of relatively low cost. Recommendations for a Fire Prevention Program were proposed, that can easily be adopted by the museum management and staff of M.E.L.T. The risk of fire was followed by the risks of *dissociation* and some scenarios of *physical forces*, while the lowest risks appeared to be the action of *criminals / vandals* and *water*. Based on the results obtained, it appears that wood properties, such as hygroscopicity, flammability, biodegradability and so on, will affect the magnitude of each risk and the priority of actions that need to be followed. However, in a RM, the site, building, room, fittings and the support and packaging of the wooden artifacts would determine the actual risk and the measures that need to be taken. Finally, it appears that RM for wooden artifact collections is imperative as it can describe equally the gradual and cumulative damage to the collection, quantify all possible risks and determine the most cost-effective means to reduce them.

Oral presentation 4/1

How physical and mechanical damages might affect conservation of wooden ships in Museum environments: the case of Ebe schooner

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[3]Museum Of Science and Technology L. da Vinci of Milan, Milan, IT

Abstract

In the present paper are reported the main results of a project focused on the study of the conservation state of the Ebe ship, a schooner 40 metres in length, built at the beginning of the XX century, for many decades training ship of the Italian Army, and conserved in the Museum Of Science and Technology Leonardo da Vinci of Milan since the early 60'. In order to make possible its transportation from the arbour to the Museum, the ship was fractioned in about 90 different pieces by cutting the hull in transversal and longitudinal directions. The ship was reassembled in the museum during the building of the exposition pavilion, with the contribution of museum workers and that of specialised ship makers. During over 40 years of permanence inside the museum only some minor restoration works have been carried out, and the ship has started to evidence some deformations that could be considered as first signals of deterioration of the structural safety of the boat. The most important outcomes of the research project carried out for assessing and monitoring the state of conservation of the Schooner have been the following:

1) Biological damage has interested very smoothly the timber members of the ship. Some evidenced of House beetles attach were recorded in the sapwood of new Pine timber elements introduced at the time of reassembling in the museum, as well as some brown decay occurred on two beams interested by water infiltration from the ceiling of the building.
2) The moisture content of wooden component of the ship would be quite high at the time of its entrance in the museum, as well as the big masts, completely re-made using new fresh wood during the reassembling in the museum. During the following years the moisture content of wood has progressively decrease up to the 10% of this years, value that is resulted to be dependent by artificial heating of the environment in winter time. Big drying cracks and deformation occurred on several elements. The main mast, heavily checked, has been object of a restoration intervention that is a paradigm of the worst practice to be applied in such situation (Crack filled with resin and wooden edges and the mast plate with iron belts).
3) The most important damages that have seriously affected the safety of the ship are of mechanical origin. A first problem evidenced by the study has been the alteration of the loading condition: the timber members of the ship, originally designed for contrasting the

hydrostatic pressure of the water during navigation, were suppose to work in compression.

The consequence of the lack of water pressure, does not counterbalanced by an actual supporting structure, has determined a loading on the timber framework because of the self-weight of the ship (a total weight of approximately 70 Tons has been estimated). The wooden members are now subjected to bending and tension loads (several fracture in bending were recorded in some structural element of the second order bridge).

The total weight of the ship (including the two big masts and the sails) has been mostly burdened on the wooden keel; with a minor contribute of few lateral supports. The lower stiffness of the material to compression transversal to grain, in combination with its visco-elastic behaviour, have determined important transversal deformation of the timber elements that were assembled for composing the length of the keel.

In particular the stem and the stern of the ship are in overhang for about 10 metres respect to the two edges of the keel, and their weight act as load concentration at the two extremities of the keel. These points have acted as centres of rotation for the two extremities of the ship that are letting down with deformation in the order of several centimetres.

Oral presentation 4/2

Factors that influence the speed of bacterial wood degradation

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SHR Timber Research, Wageningen, NL

Abstract

Bacterial wood decay is a serious threat to the many wooden foundation piles in the Netherlands. In order to learn more about the factors that influence the process of decay app. 2000 wood samples taken from Amsterdam piles were analysed on type and degree of decay. Although large scale differences in soil constitution (between cities) are a factor in the process of wood decay, on micro scale (within Amsterdam), no influence is found that explains the variety in degree of decay. Differences in wood quality (growth rate, origin, process of harvesting) are regarded as more important in causing the variety in degree of degradation in piles of a same location.

Oral presentation 4/3

Mechanical characteristics of aged Hinoki (*Chamaecyparis obtusa* Endl.) wood from Japanese historical buildings - Comparative analyses with accelerated aging wood

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Abstract

Wood is present in many cultural heritage objects thanks to its capacity to resist odvantage of the Japanese context where building traditions have been maintained for centuries. The paper deals with mechanical characteristics of aged hinoki (*Chamaecyparis obtusa* Endl.) wood of Japanese historical buildings especially their Young's modulus and rapture energy. Besides, the paper deals with mechanical properties of accelerated hinoki wood by thermally treated (90,120,150,180□) for comparison of naturally aged hinoki wood.

3 points bending test were performed in longitudinal (L) and radial (R) directions on small clear wood specimens cut from 8 historical samples and one modern reference considered of high quality by craftsmen. Although aged wood appeared more rigid and stronger than recent wood, after density and humidity corrections were applied no significant variation of L and R rigidity or L strength was observed. The post-linear behaviour, however, was drastically influenced by wood age especially in R direction where the strength and rupture energy decreased markedly with the time elapsed since the wood was processed: aged wood can be considered as safe as long as it is not loaded perpendicular to grain.

Similar phenomena were observed on thermally treated wood, quantitative differences are likely to be observed between the various kinds of modifications induced by age.

Oral presentation 4/4

Moisture behaviour of recent and naturally aged wood

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Abstract

Furniture and other wooden objects in historic buildings which for a variety of reasons cannot be climate controlled, are often exposed to important variations of relative humidity. Degradation effects resulting from cyclic or irreversible swelling and shrinkage of wood (cracks, warping, deteriorating physical properties, delamination of painted surfaces) are well known and pose an important threat to the preservation of our cultural heritage. At the Musées d'art et d'histoire (Geneva, Switzerland) seasonal fluctuations of relative humidity between 15 and 65 % were measured. There were also important short term fluctuations over 2-4 days depending on weather conditions, as well as day-night cycles. These fluctuations are typical for real museum conditions to which cultural objects are regularly exposed in many institutions. This paper reports first results from studies at ETH Zürich investigating differences in behaviour between recent and naturally aged European oak (*Quercus robur*), Norway spruce (*Picea abies*) and Silver fir (*Abies alba*), using material from beams, window frames and floorboards of 16th to 19th century buildings. Sorption hysteresis measurements were carried out at room temperature. The response of wood to moisture variations, i.e. swelling and shrinkage, was tested in different steps of relative humidity simulating realistic conditions. Additionally, Young's and shear moduli were calculated from ultrasound velocity measurements on historic and recent timber. The results demonstrate little if any difference between the two groups, indicating that conclusions drawn from the study of modern wood are also valid for historic wood in good condition. Finite element modelling of the deformation of wooden panels subjected to environmental changes demonstrates that works of art coated with a layer of reduced permeability on one side (varnish, paint layer) are more at risk from mechanical damage through deformation than objects without coating.

Oral presentation 4/5

Supporting the restoration of historical pianofortes by numerical simulation

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Abstract

Historical music instruments belong to the great achievements of culture. Next to the conservation of the original substance, their restoration is often aimed at the maintenance of the original usage. Instruments that are kept in playable state often show large deformations and considerable damages. The reason can be found in loading by the tensioned strings enforced by climatic fluctuations. Furthermore, the influence of long-term effects has to be taken into account. Therefore, a time-dependent, coupled material model is required for the realistic description of the structural behaviour of historical pianofortes.

The basis for the development of restoration concepts and the decision, if or on which conditions a keyboard instrument can be playably restored and in the long term be used in concerts, is the knowledge about its load bearing behaviour. Therefore, the analysis of the structural behaviour of historical keyboard instruments is carried out within the outlined project using the Finite Element Method. After the characterisation of the basic systems, the conclusions will be applied for the restoration of a particular pianoforte.

Before the numerical simulation can be performed, a 3-D geometric volume model of the structure is created and in the course of meshing transferred to a FE-platform. Due to the complex structure, a simplification of the model is not possible, which leads to a large number of nodes and elements. A further difficulty is the identification of the material parameters of the used wood types. The amount of independent references for the material parameters of hardwood, which is frequently used in instrument making, is limited. Besides, one has to consider the age of the employed material and the necessity of information on the dependence of mechanical properties on the moisture content.

For the numerical simulation of wood, appropriate material models are required. First, three models for the characterization of the mechanical behaviour are introduced. At this, elastic, brittle and ductile properties are considered. Furthermore, the modelling of moisture diffusion in wood is explained. Based on these models, the coupling of linear elastic anisotropic mechanics and anisotropic moisture transport (steady state form) is carried out. The dependence of the elastic material parameters on moisture content is considered, whereas every component of the elasticity tensor is characterized by a sine function approximation of experimental results. The coupling of mechanics and moisture is completed by the extension of the internal nodal forces by swelling and shrinkage. The nonlinearity of the formulation is taken into account.

In order to illustrate the effects of using the coupled formulation, an example is shown, comparing the deformations of a particular part of the piano due to different load cases. It is pointed out, that the negligence of the dependence of the elastic parameters on moisture leads to inaccurate deformations. Beyond, it is shown that due to the nonlinear character of the studied feature, the superposition of two load scenarios does not lead to appropriate results for the combined case. Furthermore, the consideration of moisture dependencies influences the failure behaviour.

Finally, an outlook of the next steps within the project is given.

Case study: Assessment of the mechanical properties of an old "pitch pine" timber structure

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Abstract

The accurate assessment of the mechanical properties of old timber structures is still a great source of conflicts among architects, engineers and constructors. Even nowadays and with the exception of a minor amount of historically important buildings, this situation is commonly used as a justification for the integral replacement of all the timber structural components [1].

This paper presents a case study detailing the procedure followed to assess the mechanical properties of old timber beams made up of "pitch pine" employed as structural floors in a 19th century building. After many years abandoned, it was decided to transform the building into a public museum.

A priori, the assessment of the timber mechanical properties appears to be particularly difficult because there are not any grading rules for old "pitch pine" beams and even in the case they have existed, several beams had been hidden inside artistic covers or over suspended decorative ceilings.

Under these conditions it was planned a two-step inspection. In the first step, the biological degradation of the timber would be assessed employing the resistograph and, during the second step, six load tests would be carried out on individual members in order to assess the mechanical behaviour of the timber beams.

All the necessary work was carried out in few days with a reduced budget and the museum was inaugurated in 2007 preserving (with a minimum reinforcement of some elements) all the existing timber floor beams.

Oral presentation 5/2

Monitoring actual deformations of an original painted panel by Beato Angelico in the San Marco Museum, Florence

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Abstract

This paper reports about the results of approximately one year's monitoring, performed with three "Deformometric Kits" fixed on the rear face of the wooden support of Beato Angelico's "Trittico di San Pietro Martire", while it is being exhibited in its usual museum location. Details are given about the geometry and functionality of the measuring apparatus.
The following main results are presented:
a) The instrumentation shows good performance, and measures correctly the deformation of the wooden support, together with the climatic parameters of the surrounding air.
b) After processing, the recorded data provide good indication about the dynamic deformation of the wooden support (cupping of the boards, shrinkage/swelling of the painted face) in the locations where the three Deformometric Kits have been placed, i.e.:

- DK1: central location of a board, showing no singularities
- DK2: on the same board, but near a cross-beam
- DK3: across the edge joint between two adjacent boards.

c) The permanent deformations developed along the centuries are here disregarded, since in this case they can be considered as the initial status of the short term monitoring (just one year…) performed.
d) The dynamic deformations caused by the climatic variations (especially by RH variations) are correctly shown and quantified. Different behaviors in different periods of the year can be clearly identified: larger variations during the summer season, where external climatic conditions tend to prevail (due to the frequent opening of doors and windows), smaller variations during winter season, where the influence of the heating plant mainly prevails.
e) Disregarding some occasional anomalous behaviors shown in the locations of DK2 and DK3 (very likely related to the presence of the cross-beam and of the connection between the boards), the measured deformations are in this case quite limited: cupping variations are not larger than +/- 1° (one sexagesimal degree), swelling/shrinkage of the painted surface, perpendicular to grain, are of the order of 0.01 % (one hundredth of one percent).
f) The measured deformations are clearly related to the environmental variations; however, some lag is shown, depending on the "history" (and especially on the rate) of the climatic variations.

Oral presentation 5/3

Characterization of archeological oak (*Quercus* sp.) with mid and near infrared spectroscopy

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Abstract

Archeological wood, as most of natural materials, is slowly decomposing on the archeological site due to various biological factors. In a consequence of such degradation significant changes within physical, mechanical and chemical properties are occurring. Rapid and accurate estimation of the degradation level is extremely important as it influences the selection of optimal restoration and conservation procedures.

The goal of this research was to verify the usefulness of infrared (FT-ATR and FT-NIR) techniques for monitoring of the ageing process in archeological wood. The important advantage of the infrared spectroscopy is its accuracy, simplicity, and ability of performing very high number of tests without needs of any destruction to the workpiece. The methods explored in this research might be a novel tool assisting experts in evaluation of the degradation state of archeological and historical wooden materials. Examples of infrared application in to qualitative and quantitative evaluation have been presented. By linking both infrared techniques with novel signal processing methods it is possible to improve the knowledge and interpretation of spectra.

Oral presentation 6/1

X-Ray Microscopy of wood based products

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Abstract

A preliminary study has been carried out to determine if the x-ray spectromicroscopic technique can be used to determine spatial distributions and chemical details of isocyanate-wood composites. When a material is probed by a focused x-ray beam, and the transmitted x-rays are detected, then a spatially resolved map of the chemical distribution can be obtained. Current x-ray optics, based on diffraction, can provide focal spot sizes of around 30nm and it is this which limits the spatial resolution of the technique. In x-ray spectromicroscopy, a specimen is scanned raster fashion across the focal spot and the transmitted x-rays are detected. Repeating this at a series of energies in the region of an absorption edge allows the chemical state distribution to be determined. In the preliminary study described in detail in the main report, observations close to the absorption edge of carbon were used to determine the distributions of different wood components and resins in wood fibre composites. By comparing spectra obtained from different image points with those of pure samples, it was possible to determine the percentages of each component at each point. A significant conclusion is that the percentages of isocyanate resin in the cell walls and in cellular pits were constant at around 4% and 6% respectively, irrespective of the overall glue loading of the sample between 2% and 6%.

X-ray spectromicroscopy can currently only be done using a synchrotron source, because of the required high brightness and energy tuneability. Various data acquisition protocols were employed (individual point spectra, stacked images) to study the isocyanate-wood samples. However, due to limited acquisition times and the employment of non-ideal samples, chemical features could not be completely identified with sufficient precision. The experimental deficiencies of these approaches will be addressed in future work, which will also involve the use of other absorption edges (nitrogen and oxygen) to give more detailed information.

The preliminary results show that with refined sample preparation techniques and improved data acquisition methodologies, based on the experiences of the preliminary studies, it is anticipated that detailed assessments of the chemistry of interactions and spatial distributions of resins in various cured chemical forms will be realised.

Oral presentation 6/2

X-ray Computed MicroTomography systems based on laboratory sources – possibilities and limitations.

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Abstract

In this paper possibilities and limitations of microtomographic systems based on laboratory sources are discussed. Examples of application in wood science are presented. The special emphasis has been put on microtomographic system which has been recently constructed and developed at Institute of Nuclear Physics, Polish Academy of Sciences, Krakow. Technical details such as: evaluation of the line spread function and the modulation transfer function, resolution assessment, detector linearity evaluation and others have been presented.
The system consists of a microfocus x-ray source, a precise object manipulator and a high resolution CCD camera. As the source of radiation an X-ray tube (Hamamatsu L9191) with focal spot of about 4μm and transmission exchangeable targets (Ti, Mo, W, and Ag) is used. The X-ray detector consists of a high resolution CCD chip (4000x 2670) connected with scintillator by tapered fiber-optic. Image reconstruction is performed with a use of the Feldkamp algorithm. Tomographic artefacts which can be misleading in wood analysis are discussed. Details of the facility construction with its hardware description are presented as well.

Short oral presentation STSM 1

Changes in density and moisture content of archaeological waterlogged wood

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Abstract

Within the framework of this action, a STSM was undertaken to investigate the behavior of archaeological wood and more specifically waterlogged archaeological oak. Neutron scanning was performed at the Paul Scherrer Institute on oak samples of different eras: subfossil, roman, medieval and contemporary. In this small scale study, a small but significant loss of density was noticed through time. Still, further research is necessary due to the use of samples that were air-dried and still contained some water, causing unwanted absorption of the neutron beam.
On the other hand, variations in the attenuation coefficient on the neutron beam and tree ring boundaries often corresponded quite well. Analysis of the graphs leads to a set of factors that might influence the correspondence: dry, rather contemporary and fast-grown wood showed the best results. The interpretation of these structural alterations leads to a better understanding of the behavior of archaeological wood, knowledge that can also be useful to conservators, dealing with the conservation of WCH objects.

Termites on old timber structures: diagnosis, identification and control. An essay with sol-gel treatments as prevention method

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Abstract

Wood modification by sol-gel treatments shows many positive features, like antimicrobial properties. Wood was also successfully modified with alkoxysilanes enhancing its resistance against soil micro-organisms. Silver, copper, zinc compounds, boric acid or organic biocides such as alkylammonium compounds may be added to the sol-gel to enhance its biocidal properties. Nevertheless, if some of these active ingredients and compounds are not fixed into wood by chemical reactions, they can be easily leached out by water. To overcome this limitation, a system based on silica sol-gel material starting from alkoxysilanes has been functionalized with organic groups having copper linking function. Sol-gel was also coupled with boric acid. As preliminary tests against the brown rot agent *Coniophora puteana* (Schumacher ex Fries) gave good results, the sol-gel formulations were also tested for their efficacy against subterranean termites. A no-choice test was set up, in two different time scales. Results show that though the sol-gel treatments act in very different ways, all of them are efficacy against subterranean termites. The total mortality occurred in the longer test suggested that active ingredients may be added in lower quantity.

Short oral presentation STSM 3

Implementation of a portable ESPI to the characterization of damaged areas in painted wood

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Abstract

Electronic Speckle Pattern Interferometry (ESPI) and Speckle Decorrelation were used in condition surveys of wooden altarpiece in the church of Hedalen, Norway. Two surveys were conducted before and after the heating season in the church to trace a possible development of damage in the paint layer caused by relative humidity variations induced by the heating system. The measurements demonstrated that the speckle techniques can greatly contribute to detecting problematic areas on the paint surface and thus guide a subsequent traditional conservation survey, or the use of further microscopic or analytical techniques

Parallel to the interferometric study Acoustic Emission (AE) monitoring of the wooden altar was performed. Portable acoustic emission system was successfully used in the church to trace the fracture intensity of the wood in selected parts of the altarpiece. Correlation between measured signals and the microclimate variations caused by the heating system performance was established.

Structural conservation of panel paintings: Tradition, innovation, initiatives.

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Abstract

This paper describes briefly the making of panels for panel paintings, primarily in the 16th to 18th century Flanders and Northern Netherlands. The wood species used will be mentioned and also the wood trade in the period, their obstacles and the consequences.

Examinations of the wooden support of panel paintings have revealed that not only were strict rules inaugurated for panel makers as how to construct the panels, but also that these regulations often were not followed. The consequence could be wood panels more vulnerable to climate changes than most average panel paintings.

Throughout history keepers of collections, private or established museums have carried out consolidation or conservation treatments in order to keep the panels form deterioration. A variety of methods have been employed over time, and mane of the methods gained recognition and were thus employed in a rather epidemic way. Although some of these were in their time innovative but were they always adequate? Whatever the treatment method was they were done in the best intention but with hindsight we can easily conclude that many of the attempts have had a rather negative effect on the art work. The thinning of panels in order to apply cradles often caused the wood structure to partly collapse and forms a so-called washboard-appearance. Attempts to impregnate the wood panels from the reverse in order to establish a moisture buffer often caused more damage rather than long-term protection of the objects.

A new programme for understanding panel paintings was initiated by the Getty and called the Panel Paintings Initiative (PPI). This multi-year project is a collaboration of the Getty Conservation Institute, the Getty Foundation, and the J. Paul Getty Museum. The Panel Paintings Initiative is a response to the growing recognition that significant collections of paintings on wood panels may be at risk in coming decades due to the waning numbers of conservators and craftspeople with the highly specialized skills required for the conservation of these complex works of art. The aim of the Panel Paintings Initiative is to increase specialized training in the structural conservation of panel paintings and to advance the treatment of these works in collections in Europe (including Eastern Europe and Russia) and North America. The initiative will also raise general awareness of panel painting conservation among painting and wood conservators, curators and scientists. Specialization within this field is important to ensure that structural issues of paintings on wooden supports are treated in accordance with current best practices.

The survey for the field of panel paintings conservation in Europe and in the United States is being carried out under the supervision of the National gallery of Denmark in close collaboration with the Royal Academy of Fine Arts School of Conservation, both in Copenhagen, Denmark. Members of the PPI Advisory Group and other experts conduct a survey of major art collections and training programs, which is undertaken through personal interviews and questionnaires. The survey is being carried out by collecting factual information about the collections in Europe and in the United States that hold significant collections of panel paintings. Existing conservation training institutions are also being surveyed with regard to the past and/or current training efforts of this discipline and related fields, such as for example, historic interiors, musical instruments and furniture. As part of the Needs Assessment Survey a literature bibliography is being developed that includes published and unpublished literature on structural treatment of panel paintings and related subjects.

Selected literature and web-links:

Dardes, Kathleen, and Andrea Rothe, eds. *The Structural Conservation of Panel Paintings: Proceedings of a Symposium at the J. Paul Getty Museum, April 1995.* Los Angeles: The Getty Conservation Institute, 1998.
Downloadable in four separate sections. A bound copy is available for purchase at the Getty Bookstore

T. Grøntoft, E. Dahlin, M. Odlyha, M. Scharff, G. Andrade, P. Mottner, J. Czop, P. Colombini, S. Hackney, J. Wadum: "Improved protection of paintings during exhibition, storage and transit – PROPAINT (EU project FP6, 044254)", in *"Museums microclimates. Abstracts of posters at the conference in Copenhagen 19 - 23 November 2007"*, 30.

J. Wadum, „Mikroklimavitrinen ohne Feuchtigkeitspuffer. Für Feuchtigkeitsempfindliche Holztafeln und leimdoublierte Gemälde", in *Restauro* 2. München (2000) 96-100.

J. Wadum,"Microclimate-Boxes for Panel Paintings", in *Die Kunst zu verpacken…, 2e Symposium Bundesverband Deutscher Diplom-RestauratorInnen 19. November 1994 Köln*, ed. U.H. Vielhaber, Cologne (1998) 22-24.

J. Wadum,"Historical Overview of Panel-Making Techniques in the Northern Countries", in *The Structural Conservation of Panel Paintings. Proceedings of a Symposium at the J. Paul Getty Museum, 24-28 April 1995*, eds. K. Dardes & A. Rothe. Los Angeles (1998) 149-177.
"Microclimate Boxes for Panel Paintings", in *The Structural Conservation of Panel Paintings. Proceedings of a Symposium at the J. Paul Getty Museum*, April 1995, eds. K. Dardes & A. Rothe. Los Angeles (1998) 497-524.

Panel Paintings Initiative
http://www.getty.edu/conservation/education/panelpaintings/index.html

Related articles in ***Conservation, the GCI Newsletter***
Cracked, Warped, and Cradled! Training in the Structural Conservation of Panel Paintings (Spring 2009)

Poster 1

The study of biological decay with church icons on wooden support in Romania

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Abstract

The icons on wooden support are widely spread in Romania. In our research we analysed a number of 200 icons from museum, church and private collections and presented the type of wood and their biological decay. The types of wood identified with the supports studied are: fir, spruce, lime, evergreen oak, beech, maple.
The biological attack with the most widespread occurrence is that of the insects *Anobium punctatum*.
The occurrence of fungi attacks is reduced and we identified only *Coniophora puteana, Antrodia sp., Coprinus sp.*

Poster 2

Monitoring xylophages in the open-air section of the ASTRA Museum in Dumbrava Sibiului

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Abstract

The present paper handles the observations made as a result of monitoring xylophages in the open-air section of the ASTRA Museum in Dumbrava Sibiului. This process is of great scientific importance, because it has led to the accurate recording of the bio-noxious bugs existing in the units and of the results to insecticide treatments.
Within the monitoring process of xylophages in the open-air section of the ASTRA Museum in Dumbrava Sibiului, the predominant species of xylophages have been identified, as well as the secondary existing ones.
The effect of the insecticide Per Xil 10 has been studied. It is an insecticide with generally persistent remanence, this remanence being influenced by the location of the unit in the field, by increased humidity and shade.
It was noted that June was generally a month of hatching for all the species of caries under observation, fact shown by the evident increase in the number of individuals.
The treatment of the units located in shady places with high humidity (near a source of water - lake, river) is more difficult to carry out because this is a beneficial microclimate for the development of xylophages. The treatment with insecticides in this case needs three successive stages to decimate the population of individuals.
Generally speaking, during the year 2008, the attacks of xylophages had a lower intensity, as it was a warm year, with lower rainfall and more frequent high temperature phases. These characteristics have led to active attacks reduced in intensity, attacks which have been rather insularly than massive. The lack of humidity plays an important role in decreasing the active attacks of xylophages.
INSECTICIDE TREATMENTS WITH Per Xil 10 GAVE GOOD RESULTS, BEING MADE CYCLICALY BY INJECTION. The remanence of this insecticide is obvious, and so the active attacks of this year have been visibly reduced.

Poster 3

On 18th and 19th century sacristy furniture in the Maltese Islands: Preservation

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University of Malta, Institute of Conservation and Management of Cultural Heritage, Msida, MT

Abstract

Very few studies have been devoted to Maltese sacristy furniture. Some sacristy furniture presents excellent examples of grand style artefacts and such important items ought to be preserved for future generations. Unfortunately, due to constant use, adverse environmental conditions, and in some cases neglect, sacristy furniture is continuously subject to irreversible damage. In this study, monitoring of relative humidity (RH), temperature (T) and light levels was carried out in two Maltese sacristies in order to investigate any adverse conditions that may be affecting sacristy furniture. A computer software routine was applied in order to predict the reaction of wood in two different pieces of furniture which, due to the type of construction, restrict expansion and contraction. Environmental monitoring results indicated that RH and T were in line with past records. In the two sacristies that were monitored, there was a relatively constant environment which fluctuated gradually throughout the seasons. The computer software predictions showed a low risk of physical damage, except in cases where the furniture was subjected to very humid environments. Under such conditions, the furniture was also prone to fast insect and mould activity development. Light measurement in both sacristies was above the safety levels recommended for highly sensitive materials and such materials, such as textiles, were being exposed to rapid deterioration conditions. The most damaging factors were found to be wear and tear, misuse and neglect. Old and recent restoration treatments had unfortunately not been carried out using sound ethical principles and historical information and materials were permanently lost.

Poster 4

Preliminary study on the vibrational behaviour of tailpieces in stringed instruments

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Abstract

Modal analysis is a way of understanding vibrational behaviour of objects. The understanding of this behaviour becomes a fundamental task in musical instruments making. Even if many studies have been conducted in this specific field, the influence of tailpieces on sound genesis still needs to be studied and understood. In this background the STSM at George Stoppani's workshop have been requested and a work on a matal tailpiece behaviour mounted on a high quality violoncello have been conducted. Some preliminary results are presentea and discussed.

Poster 5

Preliminary testing of timber consolidants applied by impregnation

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Abstract

This paper presents the initial laboratory work developed with the aim of consolidating timber that has been subjected to the action of rot fungi, by impregnation with polymeric products. This technique has been largely used in restoration of works of art but not so much in civil engineering.

Indeed, structural wooden elements in buildings are often subjected to degradation by rot fungi due to the accidental presence of water from various causes such as deficiencies in plumbing, broken tiles, clogging of guttering or degradation of exterior masonry. In these situations the question arises about which repair action to take: replace the whole element? Replace only the damaged part by inserting prosthesis? Maintain the damaged element, strengthening or consolidating it? The option of maintaining in the building the original (even though deteriorated) timber has been gaining more and more importance, because the loss of the element contributes to the loss of its historical identity. Consolidation by impregnation falls within this context, thus justifying deeper studies.

The laboratorial work, developed using degraded maritime pine (*Pinus pinaster*) specimens, is presented. The test-specimens were prepared in the laboratory, to reach different decay levels by varying the exposure time to brown-rot fungi (*Coniophora puteana*). Three commercial low-viscosity products, specific for the impregnation of timber deteriorated by rot fungi, were tested: two epoxy-based and one acrylic. The efficiency of these products was assessed through compression tests parallel to the grain and hardness tests, involving both impregnated and non impregnated wood. Their influence, when applied to degraded timber, on its water absorption behavior was also tested.

Poster 6

3D-confocal-microscopy: New advantages for non destructive measurements

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Abstract

Using confocal microscopy was driven by the attempt to characterize the surface of wooden objects after decontamination with supercritical carbon dioxide or laser cleaning. The question was, is there any impact of the surface using this cleaning methods. REM could give good answers, but the specimens are damaged and can not be used for further chemical or spectroscopically analysis.

The 3d-confocal microscopy is an optical instrument for measuring and analysing surfaces. It can be used for DIN EN ISO compliant roughness determination, analyses of 3D structures,layer thickness and measurement of geometry in the micrometer and nanometer range. A wide range of materials from polymers to metals through to composite materials, all surfaces can be transformed into precise measurement data. The advantage of this kind of microscopy is that no sample preparation is required for measurement.

Basically, the method works on the principle of focusing a standard light microscope. As the microscope "scans" the surface, it moves the objective lens up and down to keep the surface in focus. This up-and-down movement is the change in height of the surface, the roughness, which is then automatically stored. All height data are summed up and put together to create an error free 3D-picture of the sample. Within one measurement all data for creating different analysis are stored:

- height
- reflection
- roughness
- profile
- three dimensional picture.
-

All reporting can be done ad any time after the original measurement because all data are stored within the measurement.

Within the projects lots of different surfaces and varnishes were studied: for example composition gold, shellack, different glues etc. Also the characterization of the characteristically needles of DDT after laser cleaning was carried out with the described microscope. Another interesting point was the detection and characterization of damaged and degraded wood. In some cases the question was the identification of the used carving tools. This very promising analysis tool for non destructive measurements can be used for different investigations on materials besides from wood.

For the detection of impacts on the surfaces of works of art or cultural heritage a optical 3D measurement system *µsurf explorer* (nanofocus, Oberhausen, Germany) as a compact system for the measurement and analysis of surfaces was used.

Poster 7

Characterization of archaeological waterlogged wood by pyrolytic and mass spectrometric techniques

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Abstract

Two analytical approaches based on analytical pyrolysis and mass spectrometry were used for the chemical study of archaeological waterlogged wood: direct exposure- mass spectrometry (DE-MS) and pyrolysis-gas chromatography/mass spectrometry Py-GC/MS with in situ thermally assisted silylation of pyrolysis products using hexamethyldisilazane (HMDS). The wood remains derived from Polish early-Mediaeval settlement in Żółte (Cental Maritine Province, Poland). The data were compared to those relative to native sound wood of the same species alder (*Alnus glutinosa* Geartn.), oak (*Quercus robur* L.), beech (*Fagus sylvatica* L.). The potentials of the adopted mass spectrometric techniques were compared. Both of them achieved semi-quantitative results on the content of lignin and polysaccharides in degraded wood, on syringyl vs. guaiacyl ratio, and on the chemical structure of lignin, avoiding the long wet-chemical procedures that are commonly used in wood analysis, and allowing us to use a minimal sample size.

Poster 8

Detection of rot in wood beams by ultrasound method – model and practical studies

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Abstract

Speed propagation of ultrasound waves in spruce (*Picea abies* Karst. L.) beams with transversal dimensions (80x80 mm; 120x120 mm; 150x150 mm), having various types of model internal rot achieved by their mechanical working – applying cuts of various widths (from 5 mm to 100 mm) into one-half of their heights and then by filling of these cuts with sawdust was measured in selected positions of these beams.

The speed of ultrasonic waves through the model damaged beams was statistically significantly influenced by the position of ultrasonic probes. In the 1st position of measuring, if the probes were located between cut or filled parts of beams (there between probes was model rot), the speeds were evidently lower obviously from 450 to 700 m/s while in the original ones they were from 1550 to 2200 m/s. On the other hand, in the 2nd and 3rd positions of measuring, if the probes were located either between the partially damaged or between the undamaged parts of beams, the speeds were quite similar in the original, cut and filled beams.

The speed of ultrasonic waves was partly influenced also by the width of cuts (by the model internal rot) in beams, however only in the 1st position of measuring.. For beams of the A. type (cross-section 80x80 mm), presence of cuts with a smaller width of 5-30 mm caused drop of the speed by about 35.4 %. For beams of the B. and C. types (cross-sections 120x120 mm, or 150x150 mm), presence of cuts with a larger width of 40-100 mm caused a more significant drop of the speed by about 72.7 % (type B) or 71.5 % (type C).

A positive effect of the additional filling of the damaged parts of beams with spruce sawdust on the propagation of ultrasonic waves was not statistically confirmed. This result signifies indirectly that the ultrasonic waves are spread mainly in the solid part of wood. Their spreading in empty parts – cavities filled either with air or with mixture of small wooden elements (sawdust) is evidently lower, and mutually comparable. For propagation of ultrasonic waves, the adjoining healthy parts of the beam are in this case very significant, although here they are spread through a longer way.

Achieved results from model studies correspond well with various practical "*in situ*" measurements.

Poster 9

Making of the aged wood collection from historical buildings in Japanese context

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Abstract

Wood is a material designed by nature to last, unless it is free from biodeterioration. It can support trees for centuries, and as an engineering material it can again sustain loads for considerable periods. It is, as a consequence, a major component of the cultural heritages of many civilizations and the assessment of wood properties from ancient artifacts and constructions is of fundamental and practical interest.

One major difficulty for such research is to make a suitable collection from assured origin, together with certified dating and permission of publication by conservation administration. The Japanese context, where traditional uses of wood have been maintained for more than 1600 years, offers a unique opportunity to address the question of wood aging. Wood has always played a major role in Japanese culture and is used in more than 90% of buildings listed as a National property or Important cultural property of Japan. The ancient capitals Kyoto and Nara have many traditional wooden buildings, some of which are also listed as a World Cultural Heritage of the UNESCO.

Since 2004, a project making a unique collection of wood that has been sustaining various temples and other historical building at our Research Institute for Sustainable Humanosphere, Kyoto University, Japan. The paper deals with the Japanese traditional ideas and dedication of wood selections transfer of the technology of construction and maintenance, and how wood identification can contribute in restoration of historical buildings in modern Japanese contexts.

Poster 10

Characterization of archaeological wood degradation with selected nondestructive methods

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Abstract

Estimation of the degradation state is a first and fundamental phase of archaeological wood conservatory process. A full set of information regarding all the workpiece properties allows selection of the most suitable conservation process. Various analytical methods might be employed for determination of physical properties, chemical composition or microscopic structure in conservation laboratories. However, most of the state-of-the-art techniques require sampling of objects, and therefore these are more or less destructive.
The goal of this research was to investigate applicability of some non-destructive methods into evaluation of the degradation state of archaeological wood and confront to the reference data produced on the basis of "standard" procedures of classical analysis. Each investigated method provided supplementary information enriching the knowledge on the archeological woods researched. The quality of information was especially superior in a case of FT-NIR spectroscopy. The results show close correlation with the reference data obtained by standard analytical methods. Special focus has been taken to estimate a change of the archeological wood properties along the radial direction, very often observed on the archeological objects. Both, chemical changes (measured by means of FT-NIR) and density variations (scrutinized with x-ray and resistograph) are very much related to the degradation state and are important for the proper conservation. Ultrasonic technique investigated might be useful for rapid (and non destructive) estimation of the strength of wood and to detect non-visible internal defects such as root, cracks or voids. Measurement of color, even if on a very limited scale, can be also applied to monitoring of the degradation state of the archeological wood and to evaluation of the conservation progress.

Poster 11

Potential of reflected light microscopy as a non-invasive identification tool on wooden cultural artefacts – preliminary results

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Abstract

Species determination is a crucial step in wooden cultural artefacts diagnostic process. Not only it actually represents the key to physical and mechanical properties of a wooden object, but a precious instrument for its cultural understanding too. Scientific wood identification by microscopic analysis currently represents the most reliable and practicable technique. Since both this method is affected by biological limitations and most of the artefacts present sampling limitations, it is however impossible to predict end result accuracy and hence survey usefulness. Non-invasive alternatives to the common sampling procedure are hence preferable, when not necessary in the case of objects that do not permit sampling at all. Objective of this paper is to present some preliminary results of a study held in order to evaluate the usefulness of reflected light microscopy as a non-invasive identification tool.

Different surfacing and finishing treatments with reference to typical ancient manufacturing methods were reproduced on selected species. The visibility of anatomical features was then evaluated on the basis of a four level scale. Two indexes were created to evaluate both differences between treatments effects and single anatomical feature hardness of identification. Surfacing affected anatomical features visibility at different degrees of severity depending both on adopted technique and species, while finishes partially improved or worsened it. Each anatomical feature demonstrated to have different susceptibility towards treatments, showing distinct identification hardness. For an evaluation of the reflected light microscopy potential as a non-invasive identification tool, a further study aimed to evaluate the efficacy of polarized and narrow-band filters has been fixed up.

Poster 12

Follow-up of a panel restoration procedure through image correlation and finite elements modelling

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Abstract

Conservation of paintings of Cultural Heritage on wood panels could gain from using tools of wood science and structural mechanics. Indeed, with a virtual model, prediction of an artwork behavior for various scenarii could help for decision on conservation or restoration acts.
Since each artwork is a particular case, it requires an identification step to nurture the model. In this article, we are concerned with a particular restoration act: the partial replacement of a cradle. This study couples an experimental approach (3D stereo-correlation) and a numerical approach (finite elements). The experimental part concerns an optical non-invasive form measurement with digital image correlation, using a projected speckle pattern on the painted panel, with luminance compensation. The numerical part concerns stress evaluation, once the model and the experiments are compared using a geometric mapping and a spatial projection of discrete fields.
Using modeling and identification, the simulation attempts to recover the residual stresses in the panel, and allows testing several restoration conditions.

Poster 13

Hygromechanical response of a painted panel in a church: monitoring and computer modelling

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Abstract

Painted wooden panel are commonly displayed in traditional churches, where they play to some degree a religious function in addition to their cultural value. They are subject to uncontrolled microclimatic variations that include weekly heating periods. The actual amount of these variations, as well as the consequence on the panel deformations, are insufficiently known. Such information is particularly required when a painted panel needs to be transported, either to be displayed in a different place like a museum or to a workshop for restoration, in order to assess the risk resulting from the change of ambient conditions and make the appropriate decision for their preventive conservation.

The panel called “Le Couronnement d’Epines”, about 500 years old, is made of 3 horizontal boards assembled through a pair of vertical crossbars. It is on display in the choir of Saint Didier church, Avignon, south of France, and presents a satisfactory conservation state. Our study focused on the upper board. The deflection of the back face and the surrounding environment were monitored for about 2 years, while the external shape was recorded at two occasions by an optical method based on 3D image correlation. The analysis of the shape, together with the observation of anatomical orientation of two wood samples, allowed estimating the board position in the stem. The deflection was simulated numerically using a 1D version of the code TransPore, which models the heat and mass transfer through the panel and the hygromechanical response of the wood.

The hygrothermal variations followed very slowly those of the external climate, and little perturbation resulted from the occasional heating. After adjustment of the permeability of the painted face, the observed deflection history was well predicted by the model, which could be used to predict the reaction of the panel to a different hygrothermal environment.

Poster 14

Inspection techniques and rehabilitation solutions for ancient wooden structures: some Portuguese case studies

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Abstract

Timber is one of the most used materials in the roofs and floors of monumental constructions in Portugal. The geometry is defined by elements that occupy a limited and well defined part of the tri-dimensional space, with a clear evidence of the hierarchy of the components. Timber elements are often visible, which allows easier conservation, identification of the wood species, characterization of details and evaluation of deterioration.

Complex timber structures, such as those belonging to the roofs of large monuments, are often not easy to understand in a expedite way. As the coverings of monuments as cathedrals, public buildings, mansions or villas show very complicate features, not easy to be understood during the first inspection. This is not only due to the fact that the system is very elaborate and to the large number of members but also due to continuous changes and repair past works, mostly with additional stiffening or propping. The typical result of the history of the construction is the increase in the number and the heterogeneity of the members, together with a multiplicity of connections and diversity of supports. This means that the original must be distinguished from the additions and the replacements. This complexity makes the field of conservation of historical timber structures not only a challenge but a field much in need of modern research.

Load bearing timber structures are exposed during their life to some degradation factors which lead, in the absence of appropriate maintenance interventions, to the loss of their structural integrity and serviceability. Carefully conservation or rehabilitation of existing constructions implies extensive knowledge about the constituent material from which the structure was made, both from the mechanical point of view and from the physical point of view.

In order to assess the safety of old structures and preserve their original essence as much as possible, a reliable, effective and economic, *in situ* inspection and evaluation of actual mechanical properties represent a first step towards diagnosis, structural analysis and the definition of possible remedial measures.

The objective of this paper is to present some of the Portuguese experience in this field, showing how the rehabilitation solutions can be supported by the inspection techniques. A number of case studies will be presented to illustrate common conservation problems, as well as the possibilities and limitations of several inspection techniques in the assessment of structural safety and to discuss the suitability of several intervention methods.

Poster 15

Time to reach the equilibrium moisture content: in laboratory tests on poplar (*Populus alba* L.) mock-up panels

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Abstract

At DISTAF laboratories many tests has been carried out on Poplar (*Populus alba* L.) mock-up panels to study their tensional and deformational behaviour. The main aim of these tests is improving the knowledge of their conservation and elaborating mathematical models to explain the behaviour itself.
In addition to tensional and deformational measurements, weighing is monitored to determine the equilibrium moisture content (EMC is the acronym) time for each tested panels. These marginal data are here collected.
Panels of various shapes and dimensions are tested:
-new wood big panels, not isolated;
-new wood big panel, isolated on the edges and one face;
-old and new wood small panels, isolated on the edges and one face;
-mock up Medusa shield, not isolated.
The panels are inside the DISTAF climatic chamber, where the environmental conditions cyclically vary. The environmental conditions set in the climatic chamber reproduce:
-dry climate: 42% RH and 30°C;
-humid climate: 85% RH and 30°C.
The adsorption, or desorption, process is monitored by periodic weightings. By the analysis of the weight data, the determination of the equilibrium moisture content time and the elaboration of the fitting curves for each of the tested panel are possible.

Poster 16

Application of spatial analysis operations for the characterization of wood painting features

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Abstract

This paper explores the use of spatial analysis functions and geographic information systems (GIS) on the characterization of wood painting features. The study evaluates the performance of neighbourhood functions and maximum likelihood classification of ancient wood painting pathologies and construction techniques. The paper demonstrates in four case studies the added value of GIS spatial analysis functions in the documenting process of wood pieces.

Poster 17

The wooden supports in Portugal: the Pentecost in different altarpiece structures

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Abstract

Wooden painting arose in monumental shape integrated in great altarpiece called "narrative" altarpieces which maintained a narrow symbolic relation with the buildings where they fit. In the 15th century the idea of "window over the world", brought technical and formal consequences in the production of these panels – the so-called "*pala*" structures, then gave place to independent paintings like diptychs or triptychs, which fit the private cult and were totally independent from architecture. However these wooden paintings and their production was dependent from workshops and gilds in which the Master had the most important role. In the Portuguese case we can stand that the transition from the 15th to the 16th centuries reflected a plentiful import and internal production of wood painting, from whom the five hundreds where the maximum exponent to the national creation. This reality translates itself in different production centres, being possible to distinguish three major panels constructive systems: a first one of technical and aesthetical Flemish influence and two others of national distinguishable characteristics, distributed by major schools, located in the urban and cultural centres (as the case of *Lisboa, Viseu, Coimbra, Porto* and *Évora*) and rural centres whose traces are concerned with higher economic difficulties which limit the field of technology and access to raw materials of quality. It is our purpose to the present study to compare technically and materially this three structural strands through the analysis of three wooden paintings, that share the same iconography (Pentecost) that illustrates not only the importance of worship of the Holy Spirit in Portugal, but also the importance of supports in a real technical knowledge of the practice of the five and six hundred paintings in national territory. Methodologically the achieved information comes through the direct exam *in situ* by radiological analysis.

Poster 18

From wood protection to preservation of historic monuments: the commitment of Janssen PMP to cultural heritage conservation

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Abstract

Janssen Preservation and Material Protection, a division of Janssen Pharmaceutica NV, successfully developed a number of new, environmentally benign fungicides suited for a wide range of applications. The cornerstone of this innovative antifungal portfolio is constituted by a number of sterol biosynthesis inhibiting azole fungicides, the most important of these being imazalil and propiconazole.

Initial applications of these molecules in cultural heritage related projects include antifungal treatment and protection of a full size, seaworthy replica of the Batavia, the flagship of the Dutch Oost Indische Companie, as well as the medieval village in the Open-air Museum of Bokrijk, Belgium.

Other interventions where the Janssen PMP material protection expertise and portfolio actively assisted in cultural heritage projects concerned important museum collection pieces threatened by superficial mould growth. An imazalil smoke generator could be used with excellent results in each of these cases.

Subsequent projects evolved into a collaboration with a broader perspective. The commitment of Janssen PMP in these projects was not limited to an *ad hoc* solution of the biodeterioration problem alone, but aimed for an integrated approach towards documentation, monitoring and conservation of selected sites.

Around the turn of the century, a cooperation agreement was signed between Janssen Pharmaceutica and the Museum of the Terracotta Warriors and Horses, encompassing the donation of specially formulated fungicide combinations to the Museum in order to treat the terracotta army, threatened by mould growth, the training of scientists from the Terracotta Museum at Janssen PMP in Beerse, as well as the equipment of a state of the art mycological laboratory in the Terracotta Museum itself.

A more recent collaboration between Janssen PMP and the Archeological Survey of India (ASI) on the preservation of monuments in Karnataka is based on the same broader, integrated approach towards cultural heritage preservation, in close collaboration with the UNESCO chair for Preventive Conservation, Monitoring and Maintenance of Monuments and Sites at K.U. Leuven, Belgium. Two sites were selected as pilot projects: the Tipu Sultan summer palace (Daria Daulat Bagh) in Srirangapatna, and the Hampi temple complex World Heritage Site.

Poster 19

An artwork: alterable – unalterable
A critical analysis of the restoration process as a creative factor within an artwork's new structure

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Abstract

Presentation discusses issues of analysis and evaluation of restoration interventions in the aesthetic grasp. The phenomenological approach allows for widening the range of conservation understating which is generally focused on material factors further, for defining new objectives and scope of possible interventions; finally, this approach revives the proper place for an artefact material aspect.

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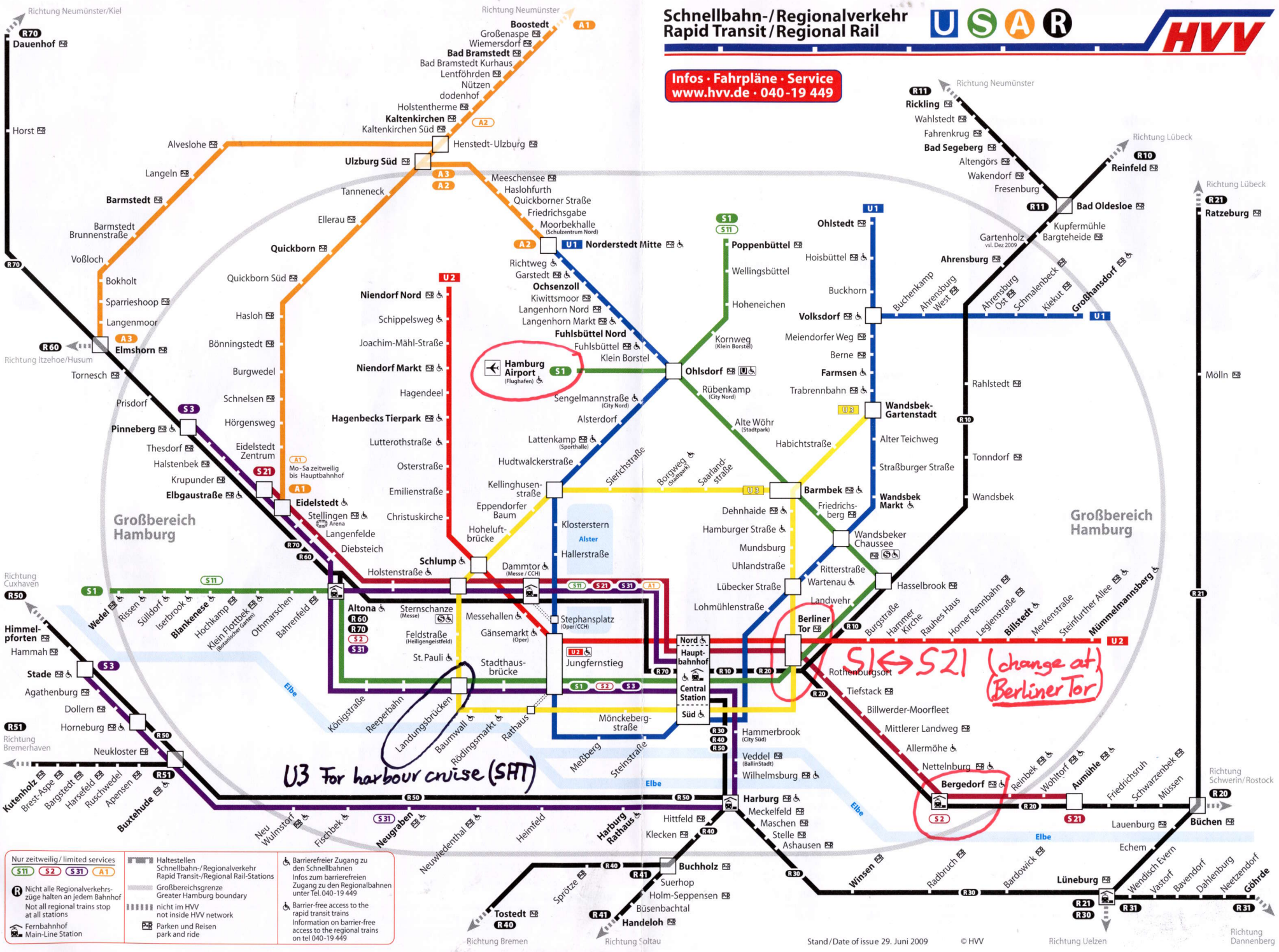
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