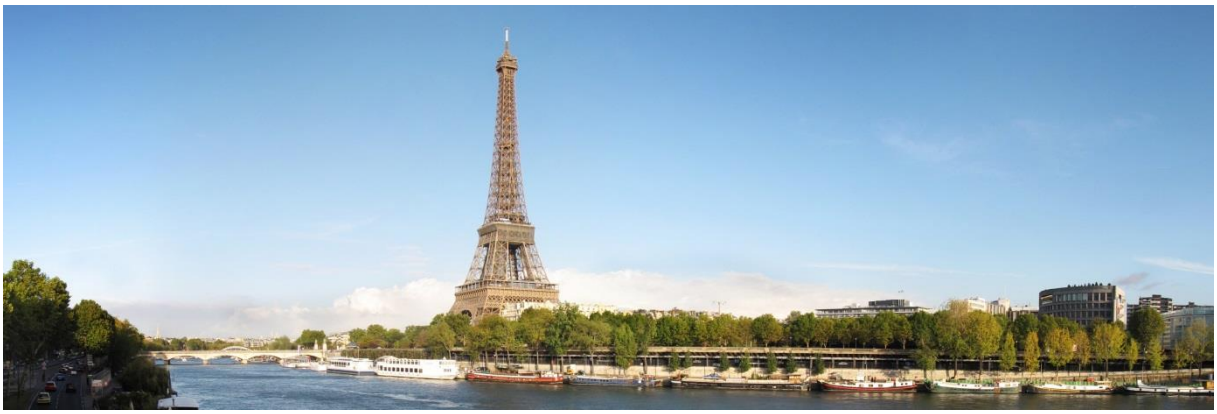
50 YEARS INTERNATIONAL ACADEMY OF WOOD SCIENCE 1966-2016

-Program and Abstracts-



-WOOD SCIENCE FOR THE FUTURE-

PARIS, 1-3 JUNE 2016

ORGANIZING COMMITTEE

Xavier DEGLISE / France

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Location:

Academie d' Agriculture de France
18 rue de Bellechasse
75007 Paris (France)

CONFERENCE PROGRAM

Day 1 / 1 June

16:00-17:45	Executive Committee Meeting
18:00-21:00	***Cheese and Wine***

Day 2 / 2 June

08:00-08:45	Registration
08:45-09:15	Opening **Uwe Schmitt**/President IAWS **Patrick Ollivier**/Permanent Treasurer French Academy of Agriculture **Xavier Deglise**/Past President IAWS
09:15-10:00	Academy Lecture **Gerd Wegener**: 1966 – 2016: Science and Use of Wood in a Changing World
10:00-10:15	Distinguished Service Award **Frank Beall**
10:15-10:45	***Coffee***
10:45-12:25	Session 1 – Chemical Biology / Chair: ***Yoon Soo Kim*** **Koch G, Schmitt U**: Review of 25 Years Research on the Topochemical Distribution of Lignin and Phenolic Extractives in Wood Cell Walls by Using UV Microspectrophotometry (UMSP) **Gray DG**: Chiral Structures in Wood **Bonnet M, Caré S, Courtier-Muras D, Bornert M, Faure P, Aimedieu P, Rodts S:** Multi-Scale Investigation of Sorption Mechanisms and Swelling Behaviour of Early- and Latewood through 1H NMR Relaxation and X-Ray Tomography Methods **Wanschura R, Windeisen E, Richter K**: Screening of Bioactive Extracts of Selected Wood Species and Identification of Leading Substances **Cetera P, Milella L, Todaro L, Russo D**: New Insight and Evaluation of the Extractives from Thermo-Treated Woods
12:25-13:30	***Lunch***
13:30-15:10	Session 2/1 – Wood Technology / Chair: ***Klaus Richter*** **Rindler A, Müller U:** Shape Stability of Multi-Layered Panels – A Review **Gong M, Li L, Tu D, Chui JH:** Effect of Specimen Size on Planar Shear Properties of Cross Layer in Cross Laminated Timber **Herzele S, Gindl-Altmutter W, Van Herwijnen H, Konnerth J:** Local Adhesion Testing on Lignocellulosic Fibers with Nanoindentation - A Sample Preparation Technique **Meints T, Lovaglio T, Platzer L, Hansmann C, Gindl-Altmutter W:** Solid Wood Surface Hydrophobising by AKD Application **Wang S, Wang X, Deng Y, Li Y:** Nanoscale Chemical-Mechanical Characterization of Wood-Adhesives Bondline
15:10-15:30	***Coffee***

15:30-16:30	Session2/2 – Wood Technology / Chair: ***Xavier Deglise*** **Gril J, Uzielli L:** Contribution of wood scientists to the preventive conservation of Mona Lisa **Niemz P, Amman S:** Mechanical Performance of Glue Joints in Structural Hardwood Elements **Doungpet M:** The Effects of Phenol Formaldehyde Impregnation and Hot Compression on Strength Property of Oil Palm Trunk and Rubber Wood
16:30-18:00	Business Meeting of IAWS Fellows
20:00	***Conference Dinner***

Day 3 / 3 June

09:00-09:50	Session 3 – Pulp and Paper / Chair: ***Lennart Salmén*** **Colson J, Bauer W, Mayr M, Fischer W, Gindl-Altmutter W:** Nanocellulose Obtained from Mixtures of Pulp Fibres and Papermaking Fines: Rheological and Morphological Studies **Chirat C, Boucher J, Sanglard M, Lachenal D:** Lignocellulosic Biorefinery Integrated in a Pulp Mill: Extraction and Valorisation of Hemicelluloses, in Parallel to the Production of Cellulose
09:50-10:50	Session 4 – New Products / Chair: ***Lennart Salmén*** **Pizzi A:** Applications of Hard Plastics from Condensed Tannins **Merle J, Trinsoutrot P, Sénéchal P, Guerton F, Charrier-El Bouhtoury F:** Characterization of porous materials based on wood biomass and industrial waste **Hiziroglu S:** Manufacture of Value-Added Composite Panels from Under-Utilized Wood and Non-Wood Species
10:50-11:10	***Coffee***
11:10-13:10	Session 5 – Wood Biology and Wood Protection / Chair: ***Holger Militz*** **Funada R, Begum S, Kudo K, Rahman MH, Yamagishi Y, Nabeshima E, Nugroho WD, Nakaba W, Oribe Y:** Regulation of Wood Formation in Trees: The Role of Temperature in Cambial Activity **Grabner M, Mayer K, Wächter E, Nemestothy S, Klein A:** Characterization of Central European Tree- and Shrub Species - Analyses of Museum Objects, Historical Literature and Modern Testing **Gobakken LR, Thiis TK, Vestøl GI, Burud I, Lie SK, Høibø OA:** Towards Predicting and Visualizing Weathering and Mould Growth on Uncoated Wooden Façades **Humar M, Romagnoli M, de Angelis M, Kržišnik D, Thaler N, Lesar B:** Can *Pinus pinea* wood be used for outdoor applications? **Kržišnik D, Romagnoli M, Galotta G, Sidoti G, Humar M, Cufar K, Davidde B:** An Integrated Approach to Measure Wood Deterioration in Archaeological Wetwood in Lake of Bolsena **Thibaut B:** Tree biomechanics and the transition from juvenile to mature wood
13:10-14:00	***Lunch***

14:00-14:40	IAWS PhD Awards 2015 **Michaela Zauner** (co-author: Niemz P): In-situ SRμCT of Wood under Load **Muhammad Shabir Mahr** (co-authors: Hübner T, Militz H): Wood Modification with Silicon and Titanium Alkoxide Solutions
14:40-16:00	Session 6/1 – Future Aspects / Chair: ***Robert Evans*** **Deglise X, Donnot A:** Wood for Energy and Global Warming? **Buongiorno J:** Global Modeling to Predict Timber Production and Prices: The GFPM Approach **Rosen HN:** World Wood Day – Celebrating "Wood is Good" Through a Cultural Approach **Gorbacheva GA, Sanaev VG:** Wood Science for the Architecture: from Tradition to the Future
16:00-16:20	***Coffee***
16:20-17:40	Session 6/2 – Future Aspects / Chair: ***Howard Rosen*** **Risse M, Richter K:** Resource efficiency of cascading wood using a LCA-based exergy analysis **Gravitis J, Abolins J:** Next Generation Biorefineries and Forest Circular Bioeconomy – an Overview **Aldaeus F, Dedic D, Karpenja T, Magnusson M, Modorato-Rosta C, Rosén F, Sundin K, Lindström M, Lucisano M, Salmén L:** Towards a Cellulose-Based Society – Current Trends, Future Scenarios, and the Role of the Wood Biorefinery **Kim YS, Wong AH:** The Decline of Wood Science & Technology Education in the Times of High Edu-Business
17:40-18:00	Closing

ABSTRACTS

Academy Lecture 2016

IAWS - Abstract Paris 2016
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Title:

1966 - 2016: Science and Use of Wood in a Changing world

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Abstract:
Though fifty years are only a brief chapter in the long history of wood utilization, they represent a unique period. Franz Kollmann, the author of pioneering books on the technology of wood, initiated this era by founding the International Academy of Wood Science, the first global network in this field, along with a new, international journal Wood Science and Technology. The Academy is represented today by nearly 400 fellows worldwide who have published a number of outstanding books. The journal has published nearly 2,300 scholarly articles since 1966 chosen from manuscripts submitted from presently over 50 countries.
Global political and economic policy shifts along with eco-social and environmental conflicts and challenges form the background of the presentation. To mention but a few: Dynamic population growth and an exploding demand for energy and resources which is being increased further by digitalization and global markets; increasing urbanization and altered land use, including the destruction of tropical forests; and, overshadowing all these, climate change and moves towards an age of renewable resources.
Of course, the role of wood over this fifty-year period is illustrated here only through a small selection of issues. We start with the matter of changing forest resources and then discuss the current status of forests and the merits of wood in protecting our climate. This is followed by a look at some highlights in basic and applied material science, to demonstrate the unique role of wood in traditional and new applications as powerful symbols for a future worth living.

Session 1 – Chemical Biology

Chair: Yoon Soo Kim / Korea

IAWS - Abstract Paris 2016
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Title:

Review of 25 years research on the topochemical distribution of ligin and phenolic extractives in wood cell walls by using UV microspectrophotometry (UMSP)

Authors:
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Abstract:
Scanning UV-microspectrophotometry (UMSP) has been established as an excellent technique for the topochemical detection of lignin and phenolic extractives in the various layers of wood cell walls. The technique is based on the ultraviolet illumination of semi-thin transverse sections which can be scanned with a high resolution of 0.25 µm x 0.25 µm. The present review summarizes the successful and manifold application of UV-microspectrophotometry for the topochemical analyses of

- lignin distribution in individual cell wall layers during wood formation,
- lignification of bamboo tissue and vascular bundles of coconut wood,
- lignification of transgenic trees,
- topochemistry of waterlogged archaeological wood,
- characterization of wound reaction compounds in the xylem of trees,
- deterioration of lignin during fungal wood decay,
- removal of lignin during pulping processes,
- characterization of hydrothermally and chemically modified wood,
- etc.

during 25 years research in Hamburg.

IAWS - Abstract Paris 2016
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Title:

Chiral structures in wood

Authors:

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Abstract:
Expressions of chirality in wood include spiral grain in lumber, the fibril angle in the S2 layer of wood cell walls and the twist reported for crystalline cellulose I fibrils. The molecular structures of cellulose and the hemicelluloses are intrinsically chiral, but how this relates to the chiral structures observed at longer length scales is poorly understood. Recently, helical coiled structures have been isolated from leaf petioles, and helical thickenings are often observed in plant vascular structures, starting with the earliest land plants (Cellulose, 2014, 21(5), 3181-3191). An attempt will be made to summarize the handedness of the chiral structures at observed to date, and to relate the structures to possible functions. The in vitro chiral properties of cellulose nanocrystal suspensions and films may provide a clue as to the source of the chirality in wood structures, but any connection remains speculative.

IAWS - Abstract Paris 2016
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Title:

Multi-scale investigation of sorption mechanisms and swelling behaviour of early- and latewood through 1H NMR relaxation and X-Ray tomography methods

Authors:

Marie Bonnet, Sabine Caré, Denis Courtier-Muras, Michel Bornert, Paméla Faure, Patrick Aimedieu, Stéphane Rodts

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Abstract:
The aim of this work is to investigate in the hygroscopic domain (a) the hygro-mechanical behaviour of early- and latewood using non-invasive methods and (b) the relationships between sorption mechanisms and swelling deformations taking into account their intra-cellular and cellular features. Experiments are carried out on specimens of Douglas-fir species. The samples of about 3x10x8mm3 are cut along the directions of anisotropy. The sorption isotherms and the swelling strains are macroscopically determined.

A Bruker Minispec MQ20, with a 0.5T magnetic field operating at 1H resonance frequency of 20MHz was used for NMR measurements. Determination of one-dimensional T1 and T2 relaxation time distributions or two-dimensional T1-T2 relaxation spectra allows having access to the local environment of water in wood (content, mobility and exchange of water). The results show that the sorption curves are quite similar for both early- and latewood. Identification of the different environments of water and relationships between moisture content and relaxation times are given related to microstructural features.

X-Ray microtomography images are performed with an Ultratom apparatus from RX-Solutions leading to a voxel size of 8µm. The tomographic data is analysed for the determination of the cellular structure and the local and global swelling strains with the volumetric digital image correlation method. The results show that early- and latewood samples exhibit respectively anisotropic and isotropic mechanical behaviours under relative humidity variations. Relationships between the swelling strains and the cellular features of the samples are discussed taking into account the content and the local environment of water.

IAWS – Abstract Paris 2016
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Title:

Screening of bioactive extracts of selected wood species and identification of leading substances

Authors:

Regina Wanschura, Elisabeth Windeisen, Klaus Richter

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Abstract:
The use of most tropical wood species is appreciated due to the durability against wood destroying fungi and insects. To understand the variations in durability against wood degrading organisms, the chemistry of the extractives needs to be known. The extractives of these species consist of a great variety of bioactive components, of which only some are identified in regards to their effectiveness. For example, tectoquinone in teak (Tectona grandis) is known to be one of the major components responsible for its natural durability (Schwager et al. 1998).
In the presented study tropical hardwoods, European wood species and modified timbers are extracted with organic solvents (successively with petrol ether, acetone and methanol) and are screened against Postia placenta (a brown rot fungi) and Trametes versicolor (a white rot fungi) with an agar disk diffusion assay. Several of the tested extracts show a distinct activity against both fungi while the major part is only effective against one.
The extracts which show an activity in the first screening test, are separated by flash chromatography and the obtained fractions are tested again against the two fungi species. The components of the active fractions are identified by means of e.g. GC/MS. This might allow identifying the effective substances responsible for the biological resistance of the wood species.

IAWS - Abstract Paris 2016
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Title:

New insight and evaluation of the extractives from thermo-treated woods

Authors:
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Abstract:
Several studies reported changes in physical and mechanical wood characteristics due to thermo-treatment but the information on the considerable significance and industrial potential of the role of extractives are underevaluted. The heat treatment modifies the chemical composition of the wood organic compounds and consequently its secondary metabolites content. The differences of the chemical composition and the antioxidant activity of the native extracts of a species and the extracts obtained from thermo-treated wood is poorly investigated. In this preliminary study the extraction of secondary metabolites from thermo-treated (at temperature between 170-220 °C for 3 hours) and untreated wood of several species was carried out and the content of polyphenols, tannins and flavonoids and the antioxidant activity of the extractives were also evaluated. The heat treatment clearly increased the extract yield in some investigated wood species, whereas in others the extractive yields
were
almost unchanged. The content of polyphenols, tannins and flavonoids was also higher in some species after the thermal treatment compared with other species. All samples, heat treated and untreated, exhibited antioxidant activity by DPPH assay. This activity increases with the content of secondary metabolites of the extracts, but not always the highest activity was exhibited by the heat treated extract. These differences were originated from intrinsic properties of lignin and other wood components and they are specific for each species. Further investigations will be focused on the identification of the compounds in untreated and heat treated samples and to deepen the biological activity of the extracts.

Session 2/1 – Wood Technology

Chair: Klaus Richter / Germany

IAWS - Abstract Paris 2016
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Title:

Shape stability of multi-layered panels – A review

Authors:
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Abstract:
The deformation of wood due to hygroscopically induced movement of its cell walls is still a challenge in engineering shape stable multi-layer wood based panels. To overcome this problem and accelerate the developing time of new wood based panels, numerically based simulation schemes, as used for composite materials, could be consulted in future. Therefore, relevant influencing factors on the hygro-thermal deformation behaviour of wood need to be considered. These factors are collected and described in this work. An overview of empirical and numerical approaches from wood science and numerical models based on micromechanical theories, which were generated to compute the hygro-thermal deformation of composite materials (classical lamination theory, composite theories, etc.) are presented. Micromechanical approaches from composite mechanics applied on wood and wood based materials at different scale levels are examined and compared. Problems that exist when using micromechanica
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approaches to calculate the hygroscopic deformation of wood based materials are outlined. Approaches that seem to be applicable for multi-layered wood based panels in future, in order to predict the deformation behaviour due to changes in the ambient climate, are discussed. Further essential mechanical properties which are necessary to describe the hygroscopic deformation behaviour of multi-layered panels, but still need to be described for wood, are defined.

IAWS - Abstract Paris 2016
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Title:

Effect of specimen size on planar shear properties of cross layer in cross laminated timber

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Abstract:
The planar shear modulus (G) and strength (τ) in cross laminated timber (CLT) have been identified as key issues that may control the design and performance of CLT floor or roof systems. The experience on testing the planar shear properties of structural composite lumber using two metal plates following ASTM D2718 showed that the maximum load to fail a full size specimen could surpass 200kN, the capacity of most mechanical testing machines. Researchers have explored to directly test 3-layer wood-wood-wood (WWW) specimens cut from a CLT panel. However, the inclination of a full size specimen was quite small, causing some difficulties in preparation and testing. Therefore, reduction in dimensions and increase in angle are of interest if the WWW assembly is adopted. This study was aimed at examining the influence of the length and width of a 3-layer WWW specimen on G and τ of the cross layer in CLT. Commercial 5-layer CLT panels were cut and trimmed to 3-layer specimens. Six g
roups
were prepared, which had lengths from 152mm to 106mm with an interval of 51mm. Another two groups were also made, which had widths of 51mm and 102mm. Based on the test results and statistical analysis, it was found that (1) there was not a statistically significant difference in both G and τ when the specimen length was more than 203 mm; and (2) the specimen width did not have a meaningful impact on G and τ.

IAWS - Abstract Paris 2016
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Title:

Local adhesion testing on lignocellulosic fibers with nanoindentation, A Sample preparation technique

Authors:
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Abstract:
The performance in a wood adhesive bond is determined by many factors, among others, the adhesion between adherent and adhesive. The adhesion between adherent and adhesive at the interface can be determined by means of nanoindentation at the microscopic scale. Nanoindentation is a micromechanical testing method enabling the calculation of mechanical values such as modulus, hardness, or deformation energy from a load-displacement curve recorded during a local indentation.
To characterize the behaviour of various available interface types between single lignocellulosic fiber (MDF, single wood fibers, pulp fibers) surfaces (S2, S3, ML) and different adhesives (UF, PUR), an experimental setup needs to be developed to be able to gain comparable testing conditions for all different interface types within one single specimen which will be presented in this talk.
With the help of the newly developed specimen preparation technique we aim for analysing the effects of varying surface conditions (originated by cell wall anatomy or fibre pre-treatment) in combination with different adhesives on adhesion performance.

IAWS - Abstract Paris 2016
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Title:

Solid wood surface hydrophobising by AKD application

Authors:
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Teresa Lovaglio: University of Basilicata in Italy, Dep. Agriculture, Forestry and Food Science
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Abstract:
In order to protect wood surfaces from water penetration and the resulting swelling, AKD (alkyl ketene dimer) was used to hydrophobise spruce wood surfaces. AKD is a common sizing agent in the paper industry and is able to react with the hydroxyl groups of the wood cell wall polymers. The AKD was solved in different solutions and was applied by spraying. To investigate the amount of applied AKD, FTIR-spectroscopy was carried out. Contact angle measurements confirmed the quality of the hydrophobising depending on the AKD concentration. Already very small quantities of AKD on the wood surface resulted in high hydrophobic properties with water contact angles of over 110° after 120 seconds. Additionally the resistance of the AKD applied on wood against UV irradiation and water storage was investigated. Over all, AKD is promising modification agent for wood surfaces for hydrophobising or primer use.

IAWS - Abstract Paris 2016
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Title:

Nanoscale chemical-mechanical characterization of wood-adhesives bondline

Authors:

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Abstract:
Understanding and controlling the chemical and mechanical properties of wood-adhesives bondline at sub-micrometer spatial resolutions are critical to accelerate the development of high-quality wood-based composites. In this presentation, we will discuss our recent efforts to investigate the interactions between wood cell-wall materials and adhesives, mechanical durability of the bondline, and potential modification methods for the bondline. First of all, we have combined atomic force microscope infrared spectroscopy (AFM-IR) and nanoindentation measurements to identify the specific molecular-scale interactions between phenol-formaldehyde resin (PF) and wood cell wall on the bondline for the first time. PF resin molecules not only simply dispersed within the cell wall but also reacted with cell-wall materials, resulting in the increase in the mechanics of wood cell wall. The nanoscale mechanical interlocks formed between resin and wood cell wall might be beneficial to adhesion
performance of wood-based composites. Second, we have attempted a combined technique of in-situ heating and nanoindentation to investigate the mechanical behavior of each phase on the bondline including cell walls and adhesives at elevated temperature. Results indicated that the wood-PF bondline showed a strong dependence on elevated temperatures. Third, cellulose nanofibrils and cellulose nanocrystals were applied as reinforcing materials to modify PF resin. Results showed that the nano-materials mostly accumulate on the bondline have a positive impact on interlocking formation between woods. Furthermore, cellulose nano-materials can improve the mechanical properties of both adhesives and the cell wall. Fourth, we will discuss potential applications in wood science field through our recent developments.

Session 2/2 – Wood Technology

Chair: Xavier Deglise / France

IAWS - Abstract Paris 2016
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Title:

Contribution of wood scientists to the preventive conservation of Mona Lisa

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Abstract:
Since 2004 an international research group of wood technologists has been given by the Louvre museum the task of analysing the mechanical situation of the wooden support Mona Lisa, the world famous poplar panel painted early 16th century by Leonardo da Vinci. The general purpose of such study was to evaluate the influences that could possibly derive from environmental fluctuations in the showcase where the painting is exhibited as well as outside the showcase for occasional checks, and develop measurements and models to improve its conservation conditions. To acquire data on the mechanical behaviour of the panel, and to feed and calibrate appropriate simulation models, the team has set up a continuous monitoring by means of automatic equipment, completed by occasional measurement of the panel shape by optical methods. The results from the measurements are being processed to be included into a 3D numerical finite elements model to simulate the panel behaviour under environmental fluctuations.

IAWS - Abstract Paris 2016
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Title:

Mechanical Performance of Glue Joints in Structural Hardwood Elements

Authors:

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Abstract:
Adhesive bonding is an essential task in modern timber engineering. The spruce is since 100 years and more Europe's most important wood resource for timber engineering. Consequently, the testing standards focus mainly on this wood species. A transfer of these standards onto other wood species is, due to the material's complexity, only of limited application. New approaches have thus to be employed to verify the load bearing capacity of glue joints in other wood species.
The European beech (Fagus silvatica L.) is the most common broad-leafed tree species in Switzerland. It has good mechanical properties of which the timber engineering can combined. The focus of this presentation therefore was on the failure mechanisms of glue joints in beech wood, realized with different, commercially available adhesive systems. The fracture toughness of cracks within the bond line, crack propagation at the glue joint and wood fibre and adhesive bridging after failure were investigated. Joints of phenol resorcinol formaldehyde (PRF) showed constantly good results, the determined characteristics generally lay in the same range.
Mechanical Performance of Glue Joints in Structural Hardwood Elements as those for solid beech wood, wherein also the crack propagation takes place. It can be concluded that such joints have the necessary strength to be used in timber constructions.

IAWS - Abstract Paris 2016
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Title:

The effects of phenol formaldehyde impregnation and hot compression on strength property of oil palm trunk and rubber wood

Authors:

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Abstract:
The oil palm trunk (Elaeis guineensis) was studied to increase strength and hardness properties by phenol formaldehyde resin (PF). The trunk samples were 25-years old according to a rotation of planting schedule. After removing of the bark, the trunk was cut into 2 centimeter (cm.) by 2 cm. with 30 cm. in length for static bending test and 5 cm. by 5 cm. with 5cm. in length for hardness test. Samples were collected from near bark region, middle region and inner region of the trunk. There were 30 samples from each region to treat with PF resin as well as 30 rubber wood (Hevea brasiliensis) samples. Hardness test was measured from other 14 samples which sampling from different three regions. The control samples were untreated with PF resin. The samples were impregnated with 10 percent PF resin (by weight) by vacuum-pressure method. Physical and mechanical properties of impregnated and hot compressed samples were analyzed. Modification strength of three different regions of oil
palm trunk were discussed and compared to rubber wood samples.

Session 3 – Pulp and Paper

Chair: Lennart Salmén / Sweden

IAWS - Abstract Paris 2016
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Title:

Nanocellulose obtained from mixtures of pulp fibres and papermaking fines: rheological and morphological studies

Authors:

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Abstract:
The hierarchical structure of wood allows it to be used for numerous purposes. After the development of nanocellulose in the past decades, its utilisation extended even to the nanometer scale. Pulp and paper industry is an important supplier of raw material for the production of nanocellulose, which can be produced in several ways. High-pressure homogenisation is one of the best known and most well established mechanical processes. A critical parameter of nanocellulose suspensions is viscosity, which has to be adapted to the intended application. In this talk, the influence of fibre length and degree of homogenisation on the rheological behaviour of fibre suspensions will be presented. Long fibres, short fibres (“fines”) and mixtures of both will be compared. The differences in rheological behaviour between the samples will be discussed and put in relation with results obtained from morphological characterization methods.

IAWS - Abstract Paris 2016
==========
Title:

Lignocellulosic biorefinery integrated in a pulp mill : extraction and valorisation of hemicelluloses, in parallel to the production of cellulose

Authors:
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Abstract:
Wood is the main raw material used to produce cellulosic fibers. Worldwide, their production is about 150 million tons, using 310 millions tons of wood. Mills producing cellulosic fibers look very much like a “biorefinery” : the cellulose is isolated almost pure, and then valorised principally as paper, whereas the hemicelluloses and the lignin are degraded and solubilised. This liquor is burnt in a recovery boiler, which covers very largely the energetic needs of the mill.
One way to improve this biorefinery would be to extract and valorise hemicelluloses, instead of burning them. This can be done by submitting the wood chips to a hot water extraction process prior to the cooking stage. Given the fact that the hemicelluloses' calorific value is much lower than that of lignin, this would not affect the energy balance of the mill, which would continue to produce cellulose, in parallel to the valorisation of hemicelluloses.
The presentation will first deal with the optimisation of the extraction process of hemicelluloses regarding the quantity of hemicelluloses extracted, their nature (sugar composition, molecular weight, degree of acetylation, ratio oligomers/monomers), and the presence of contaminants, for both hardwood and softwood species. The second part will deal with the effect of the hemicelluloses extraction process on the delignification ability of the wood chips in kraft or soda cooking. Finally the third part will present two different ways of valorisation of the hemicelluloses: fermentation into alcohol and transformation into surface active agents (alkylpolyglucosides).

Session 4 – New Products

Chair: Lennart Salmén / Sweden

IAWS - Abstract Paris 2016
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Title:

Applications of Hard Plastics from condensed Tannins

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Abstract:
Biosourced thermosetting hard plastics based on condensed tannins and furfuryl alcohol were developed and used and tested for a number of new applications: (1) as a resin matrix for solid grinding wheels for angle grinders; (2) for unscratchable surface finishes for glass and metal surfaces; (3) as flexible films, and (4) as resin matrix for automotive brake pads. The manufacturing procedures developed is particularly easy. Cutting and grinding discs mechanical resistance was found to be comparable to that of commercial grinding discs bonded with synthetic phenolic resins. They tolerated well the severe stresses induced by the 11000 revolutions per minute (rpm) by operation in an angle grinder when grinding or cutting steel. Equally the brake pads developed outperformed the commercial ones prepared with synthetic phenolic resins.

IAWS - Abstract Paris 2016
==========
Title:

Characterization of porous materials based on wood biomass and industrial waste

Authors:

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Abstract:
With the need to promote biomass and waste industry against the use of petrochemistry, we developed an insulating material with natural polyphenols. The foams are formed with condensed and hydrolysable tannins, from wood biomass and lignosulfonate, from paper industry. The formulations were presented in a previous article of the laboratory [1] and demonstrated interesting morphological and mechanical properties.
The foams were characterized through techniques such as Scanning Electron Microscopy (SEM) and mercury porosimetry and one specimen was characterized with a X-ray microtomography (from micronic to submicronic resolution).
This non-destructive technique allows us to handle a numerical reconstruction of the sample in 3 dimensions. Thus it is possible to estimate various parameters of the foam such as the shape and the size distribution of the cells, the total porosity of the material, its anisotropy... These data are confronted with the results obtained from SEM and mercury porosimeter.
Those open cell porous materials were obtained through a simple and green process. They were also characterized through thermal conductivity and acoustical absorption, in the range of medium to high frequencies (1000-4000Hz) but also in terms of water absorption and the volume change after immersion.

[1] J. Merle, M. Birot, H. Deleuze, C. Mitterer, H. Carré, F.Charrier.-El Bouhtoury, New biobased foams from wood byproducts, Materials & Design, 91: 186–192. doi:10.1016/j.matdes.2015.11.076.

IAWS - Abstract Paris 2016
==========
Title:

Manufacture of Value-Added Composite Panels from Under-Utilized Wood and Non-Wood Species

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Abstract:
Abstract

The manufacture of value-added composite panels from under-utilized wood and non-wood species is getting more popular in many countries. Most of the developing countries are rich in agricultural products which create large amount of waste fiber. Rice straw, jute, coconut fiber, oil palm, bagasse are only some of the resources that can be used to produce different types of value-added composite panels including particleboard and medium density fiberboard (MDF). In addition to agricultural waste fibers bamboo is also getting more attention from composite panels manufacturers in Asian countries as an alternative raw material. Invasive species such as Eastern redcedar (Juniperus virginiana) in South Western states in the USA would also be considered as viable raw material to manufacture above products. This presentation will review some of the findings of ongoing and past research projects related to experimental particleboard, fiberboard and strand type panels manufactured from
underutilized invasive species and non-wood materials. Eastern redcedar, bamboo, and rice straw were used to manufacture experimental panels. Basic properties of samples including modulus of elasticity, modulus of rupture, internal bond strength, thickness swelling, water absorption, screw holding strength, density profiles and surface quality of such panels will be reviewed.

Session 5 – Wood Biology and Wood Protection

Chair: Holger Militz / Germany

IAWS - Abstract Paris 2016
==========
Title:

Regulation of wood formation in trees: the role of temperature in cambial activity

Authors:
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Abstract:
Wood has been used for thousands of years as a raw material for timber, furniture, pulp and paper, chemicals and fuels. Wood is produced by cell division of vascular cambium (cambium) of stems of trees. Cambial cells differentiate into secondary xylem cells through a process of cell expansion or elongation, cell wall thickening, cell wall sculpturing, lignification, and cell death. Although wood is of great economical importance as renewable bio-materials and bio-energies, the precise process of its formation is not yet fully understood. Therefore, in order to create “new woods” with desirable qualities, more detailed information is needed on the cellular and molecular aspects of cambial activity.
In temperate and cool zones, the cambium of trees undergoes seasonal cycles of activity and dormancy. This periodicity plays a critical role in the control of both the quantity and the quality of wood. In addition, seasonal variations in cambial activity play an important role in the environmental adaptivity of trees. In this paper, we will show our recent data concerning the process of the start of first cambial cell divisions from late winter to early spring using the model system of localized-heating induced cambial reactivation. Moreover, we will show the effects of low temperature on cambial activity and xylem differentiation using localized cooling in stems. Our results show that cambium can respond directly to changes in temperature and that changes in the temperature of the stem might be the critical factor in the control of seasonal changes in cambial activity.

IAWS - Abstract Paris 2016
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Title:

Characterization of Central European Tree- and Shrub species - Analyses of museum objects, historical literature and modern testing

Authors:

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Abstract:
Wood was the most frequently used raw-material in former times. It was handled with great wisdom which was gathered over centuries. Selection of a wood species for each application was well considered.

To rediscover this knowledge, which was lost partially within the last decades, several possibilities to characterize various wood species were used:
1) Historical wooden goods (e.g. buildings, tools) were analyzed. Beside the identification of wood species, the loads of all different parts were described (e.g.: a spoke of a wheel was associated with dynamic loads).
2) In total, 121 historical books dating back to the year 1690, describing trees, shrubs and the utilization of their wood were analyzed.
3) Extensive sampling of shrubs and small trees ended in several thousands of test specimens. Beside characterization according to standards (like wood density, bending strength) new testing procedures were developed.

Due to the results of point 1 and 2, it was obvious, that not all applications can be described using standard tests. For example, friction bearings were often made of pear- or apple wood, which cannot be described by wood density alone. The suitability of different wood species for tool handles is not only related to mechanical strength, but is also associated to tactile properties. For these two cases, different testing methods for static and dynamic friction were set up and performed. The results are mainly confirming the analyses of the museum objects.
An overview of various properties of 60 different Central European shrub- and tree species will be given.

IAWS - Abstract Paris 2016
==========
Title:

Towards predicting and visualizing weathering and mould growth on uncoated wooden façades

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Abstract:
The use of uncoated wood in building façades has increased during the last years. It is therefore relevant to understand and control the aesthetical character and appearance of wood materials used outdoors. By predicting the aesthetical service life and the visual appearance of a wooden façade over time, we can accommodate some of the end-user expectations, perception, values and aesthetical preferences. The spatial variation of climate on a façade is large, and estimation of the weathering process and mould growth on outdoor exposed wood should be based on the actual surface climate rather than data from meteorological stations. A first version of a simulation model that aims to predict and visualize future aesthetical appearance of wooden façades has been developed. The model is based on existing mould growth models and on a new model that aim account for the surface meteorological condition (RH, temperature and UV). On-set of mould growth on selected wood materials (pine, spruce, larch, oak, aspen, thermally treated pine) have been studied in 8 different controlled climate conditions, where two levels of surface condensation regimes have been mimicked to capture time-of-wetness. Wood samples in conditions with high RH (85%) and longest time-of-wetness had the earliest on-set of mould growth, and under these conditions temperature (25°C/10°C) had no significant impact. Aspen had the earliest on-set of mould growth and thermally treated pine the latest. Data on on-set of mould growth will be incorporated in the simulation model to enable a knowledge-based decision tool regarding design and material selection.

IAWS - Abstract Paris 2016
==========
Title:

Can *Pinus pinea* wood be used for outdoor applications?

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Abstract:
Pinus pinea tree is quite common species, both in Europe and North America. However, in the Mediterranean area it obtains its highest importance. P. pinea is often called the 'Stone Pine' and sometimes the 'Umbrella Nut'. This tree species is planted in parks and for production of pine nuts. Despite of the fact that there is quite some P. pinea wood available, there are not many data available about performance of this wood in outdoor application. In present research durability of sapwood and heartwood against four key wood decay fungi was determined. In parallel sorption properties, water uptake, extractive contents, presence of tannins, dimensional stability… were determined. Additionally, possibilities to use this wood for impregnation with water soluble and solvent based preservatives were determined as well. In parallel, P. pinea wood was thermally modified as well. The results showed, that sapwood of P. pinea fits to durability class 5 (very susceptible wood), while heartwood meet requirements of the durability class 2 (durable wood). Predominately heartwood contains a lot of extractives, up to 15 % of resin. This makes heartwood very hydrophobic. However, due to high resin content wood is very challenging to modify. Thermal modification is possible, but resin makes a lot of problem on hardware. Similarly, sapwood is permeable and easily to impregnate, while more durable heartwood exhibits low permeability. We believe that P. pinea wood can be used for outdoor application where high resin content does not bother. However, sapwood has to be properly treated if used outdoor.

IAWS - Abstract Paris 2016
==========
Title:

An integrated approach to measure wood deterioration in archaeological wetwood in lake of Bolsena

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Abstract:
Wood degradation in wetwood has been studied with many methods and techniques. The assessment of the state of degradation is very important because it affects the methods of restoration to be chosen and the type of consolidant which can be applied.
The most part of the research on this field is on wetwood from sea locations, not so much can be found in bibliography as regards the effects of deterioration in lake sediments. Different techniques have proved to be suitable for such kind of investigations chemical (lignin content, FTIR etc.), physical (RDC and LWS) and microscopic. Some efforts have been done in order to assess the relationships between the different techniques but no references deal with the method of TGA, physical properties and mechanical performances. The paper deals with the combination of this techniques on archaeological Quercus wetwood of iron age sampled in Bolsena Lake, Italy. The results are compared with the references of sea wetwood samples. Sapwood and heartwood behaviour is considered.

IAWS - Abstract Paris 2016
==========
Title:

Tree biomechanics and the transition from juvenile to mature wood

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Abstract:
Juvenility in xylem formation can be looked as a mere biological ageing process. It can be also the result of biomechanical adaption to growing conditions different in the young ages.
The field of structural mechanics regards resistance to external forces and posture control in long lasting progressive loading, according to external conditions as wind action or light availability. Many adaptive parameters are involved: inertia of the stem section, slenderness of this stem, position and weight of crown, basic wood density, grain angle, MFA, chemical composition of fibre wall affecting resistance to bending, elastic buckling or genesis of regulating forces (growth stresses).
Besides the well known typical radial pattern of variation (TRP) in juvenile wood: decrease of ring width and MFA, increase in basic density with the distance to pith, there are other typical patterns associated to juvenile growth regarding pertinent mechanical parameters, common in primary or secondary tropical forests. One is the exact reverse of TRP for semi-tolerant emerging trees.
Examples of typical transition from juvenile to mature xylem mechanical strategies are described with their implication for wood properties.

IAWS PhD Awards
2015

IAWS - Abstract Paris 2016
==========
Title:

In-situ SRµCT of wood under load

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Abstract:
Although the structure of wood is well known, the relationship between different wood structures and properties is not yet fully understood. Various techniques can be used to observe samples non-destructively during load: X-ray and synchrotron radiation micro-CT (SRµCT) can be used to record the complete 3D-structure of wood in-situ. Acoustic emission monitoring, on the other hand, allows an estimation of failure processes.
The reaction of wood to mechanical load was observed with both techniques. To realize this, a mechanical test device was constructed and samples produced from beech, fir and spruce and beech were loaded in-situ and recorded at consecutive load steps at the TOMCAT beamline at the Swiss Light Source of the Paul Scherrer Institute (Villigen, Switzerland).
The reconstructed 3-dimensional data allowed the investigation of the original structure and the subsequent development of failure regions in the samples. The dependency of the initiation, type and subsequent development of failure (e.g. buckling) on the structure could be shown for structures under longitudinal compression. Additionally, to illustrate the deformation mechanisms, the initiation and further progression of deformation was investigated on wood structures (like vessel and tracheid) isolated from the recordings.
Furthermore, in-situ acoustic emission monitoring of wood was successfully combined with tensile load and SRµCT. The acoustic emission signals won in the experiments, compliment the structural information found in the recorded CT-Data.
Overall, the techniques used enable an observation of the development of failure mechanisms in the complete sample for different loading types and directions.

IAWS - Abstract Paris 2016
==========
Title:

Wood Modification with Silicon and Titanium Alkoxide Solutions”

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Abstract:
Abstract
Sol-gel technology was successfully applied for wood modification. In practice, kiln dried Pine sapwood was vacuum impregnated by nano-scaled partially un-hydrolyzed precursor solutions derived from tetra-ethoxysilane (TEOS) and titanium(IV) isopropoxide (TIP). In subsequent curing step, impregnated wood was oven dried under defined conditions to transform the penetrating liquids into TiO2/SiO2 gel layers therein by sol-gel processing (in situ hydrolysis-condensation).
As a consequence of this treatment, natural color of wood was not altered and a number of physical properties of the modified wood namely water and moisture sorption capabilities, Anti-swelling-efficiency (ASE) and bending strength in terms of MOE were substantially improved when compared with untreated wood. In addition, sol-gel modified wood showed good resistance against leaching because of the insolubility of inorganic gels in water as well as demonstrated remarkable tendency to hold active agents like CuCl2 into the gel structure within treated wood. Sol-gel modified wood also exhibited excellent resistances against fire of different scenarios and against fungal attack. Due to easy handling, non-toxic nature of the precursors used and above mentioned improvements, titanium and silicon alkoxide based sol-gel wood modification treatment has a possibility to be commercialized in near future.

Session 6/1 – Future Aspects

Chair: Robert Evans / Australia

IAWS - Abstract Paris 2016
==========
Title:

Wood for energy and global warming?

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Abstract:
Increasing concentrations of greenhouse gases (GHG) are coming not only from burning of fossil fuels and deforestation, but probably from the increasing use of forests as a source of energy. Wood accounts for half of the renewable energy in Europe. There are actually different sources of wood for energy:
50% clean wood from stems,
50% residues from harvest operations, end of life wood coming from the cascaded use of wood (firstly wood-based products, secondly recovered and reused or recycled and finally used for energy).
Fuel wood is increasing very fast, namely with the conversion of coal fired power plants into biomass power plants. Drax in North Yorkshire and Gardanne in Provence, among a dozen of the largest power plants in the world, are the best examples.
Carbon neutrality refers to achieving net zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset.
It can refer to the practice of balancing carbon dioxide released into the atmosphere from burning fossil fuels, with renewable energy that creates a similar amount of useful energy, so that the carbon emissions are compensated....if renewable energy is produced without CO2 emission!
To have a real equilibrium the rate of combustion must be equivalent to the rate of photosynthesis. In fact the rate of combustion has an order of magnitude much more important than the rate of growing trees by photosynthesis.
This carbon neutrality fits much more when annual crops (Miscanthus, Switch grass….) are used as bio fuels!

IAWS - Abstract Paris 2016
==========
Title:

Global modeling to predict timber production and prices: The GFPM approach

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Abstract:
Timber production and prices are determined by the global demand for forest products, and the capability of producers from many countries to grow and harvest trees, transform them into products, and export. The Global Forest Products Model (GFPM) simulates how this global demand and supply of multiple products among many countries determines prices and attendant consumption, production and trade. This paper documents the methods, data, and computer software of the GFPM model, followed by examples of applications to forecasting, and for policy analysis of climate change and the consequences of offset payments for carbon sequestration.

IAWS - Abstract Paris 2016
==========
Title:

World Wood Day – Celebrating “Wood is Good” Through a Cultural Approach

Authors:

Howard N. Rosen

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Abstract:
Wood culture encompasses the human use of wood, and the value and the way people use wood in society. Wood culture includes activities with wood, human or societal attitudes toward wood, wood products and wood-related environments. The International Wood Culture Society (IWCS), a non-profit, non-governmental, global international network of wood professionals is dedicated to research, education and promotion of wood culture. The IWCS was founded in the United States in 2007, and strives toward the concept that 'Wood is Good' by enhancing society and culture. World Wood Day began on March 21, 2013 in Dar es Salaam, Tanzania to promote the ways that wood has enhanced and enriched societies around the world. That celebration included tree plantings, technical presentations, wood craft demonstrations, and youth programs.

World Wood Day (WWD) is held every year on March 21st. In 2014, WWD was celebrated in Xianyou County, Fujian Province, China with 313 wood artists, wood professionals and scholars from over 70 countries. Smaller regional programs were held in 4 other countries and several other locations in China. In 2015, WWD was held in Odunpazarı, Eskişehir, Turkey with 400 people from 93 countries with the theme “wood and humanity.” In 2016, WWD will be held in Katmandu, Nepal and will continue to highlight wood as an eco-friendly and renewable biomaterial and to raise awareness of the key role wood plays in a sustainable world through biodiversity and forest conservation. This unique celebration will continue to remind humans of the importance and value of wood.

IAWS - Abstract Paris 2016
==========
Title:

Wood science for the architecture: from tradition to the future

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Abstract:
The architecture aims to reflect ideas about the world. The last 20 years, the interest of architects focuses on computer technology, physical and biological processes. It led to emergence of new types of architecture, such as performative, responsive, dynamic, climate-responsive architecture, etc. Realization of these approaches, which became the main trends in modern architecture, demands the new materials possessing a complex of the set properties. Locally available and renewable resource wood is a traditional building material due to unique combination of mechanical, workability and serviceability properties. Research in the field of fundamental wood science create the scientific basis for the use of wood as a natural functional material for performative and resource efficient constructions. It is known that wood is capable to react to environmental changes through its own structure and properties. This process is autonomous and self-organizing. The structural elements made from wood are able to respond to changes of environment more sensitively than any high-tech engineering device and to implement it without sensors, motor functions or even energy. Wood demonstrates properties of smart material possessing shape memory effect, can memorize several forms. Programmable mechanical action allows to receive a wide range of possible reactions on changing environmental conditions. Research of behavior of wood as actively moving material, observed at change of physical conditions, also is very important. Thus, researches of physical properties, deformative conversions, structure, memory effect of wood open new opportunities for use and expand a range of applications of wood in modern architecture.

Session 6/2 – Future Aspects

Chair: Howard N. Rosen / USA

IAWS - Abstract Paris 2016
==========
Title:

Resource efficiency of cascading wood using a LCA-based exergy analysis

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Abstract:
Wood is a renewable but limited resource. The demand of wood increased over the last years and will likely exceed the supply within the next decade. Thus, a more efficient use of wooden resources is necessary to meet future needs. Policy and environmental science therefore support the concept of cascading, defined as the sequential use of one piece of a resource in several material applications with its final use for energy recovery. Recent studies revealed the potential environmental savings associated with the cascaded use of wood. However, these studies mainly focused on the environmental impacts derived from emission flows using life cycle assessment (LCA). This approach disregards the effects of cascading on primary natural resources. It further allows no conclusions on the resource efficiency of the cascading concept compared to current state of the art scenarios. To fill this gap, available resource depletion methods from LCA were analyzed with respect to their resource coverage as well as characterization and aggregation methods. Secondly, resource efficiency indicators were analyzed with respect to their LCA-applicability and their utilization with the resource depletion methods. Both groups were evaluated based on their suitability for cascading scenarios of renewable resources. The results indicate that exergy based resource accounting methods are currently the most suitable impact methods. The cumulative degree of perfection was identified as the most suitable resource efficiency indicator that matches with the impact methods. To verify the results, both indicators are applied on a LCA-based cascading scenario from the wood sector.

IAWS - Abstract Paris 2016
==========
Title:

Next generation biorefineries and forest circular bioeconomy - an overview

Author(s) names and affiliation(s):

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Abstract:

The review demonstrates new bio-refineries, new technologies, and advanced smart materials, e.g. electricity generated directly from liquid biomass (the liquid-catalyst fuel cell of the so called redox flow battery), biomimetic hybrid materials (organic + inorganic), steam exploded plant biomass electro-spun nanofibers, etc. Significant influence is expected to come from the infrastructure of forest bio-economy. In nearest years Europe will provide research of circular forest bio-economy (Horizon 2020 ERIFORE project). The suggested future European research infrastructure will then facilitate the development towards enhanced utilization of renewable raw materials, waste streams, and renewal of established European process industries. The review attempts to analyze the influence of the anticipated fourth industrial revolution "Industry 4.0" on the bio-economy, particularly forest bioeconomy. The three previous industrial revolutions have proceeded as mechanization with water and steam power in 19th century, mass production on Henry Ford's production line since 1915, the use of electronics and IT from the 1970s onwards. The new Industrial revolution will result in "smart factory". Smart factory will bring suppliers and customers close together in real time. Industry 4.0 is one of questions and expectations at the World Economic Forum 2016 in Davos.

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IAWS - Abstract Paris 2016
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Title:

Towards a cellulose-based society – current trends, future scenarios, and the role of the wood biorefinery

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Abstract:
The pulp and paper industry is today facing large challenges and is in a process of redirecting towards new products. This is mainly a result of the changes in consumer habits resulting in dramatic decreases in the newsprint and magazine sector. There is also an increasing trend towards development of biomaterials, towards a bio-based society, and a future bio-economy built on the concept of circular economy. Industrial stakeholders and politicians are presenting the forest as the new “green gold”, which should contribute to the solution to the climate issue, at least partially. Raw materials from the forest industry are acquiring a more clear role in the solution to major global societal and environmental issues at all levels. In such a future, the pulp mill biorefinery may be a crucial node. The road ahead will need to be identified and demonstrated, inspired by opportunities and challenges that society is facing.

In order to map the road from a fossil-based society to a cellulose-based society, Innventia has made a global survey with various players throughout the bio-economy field. Based on the input from these sources, several current trends that affect the road to a cellulose-based society have been identified. These trends are describing the effects of urbanization, consumer behaviour, new business models, material recycling, open innovation, and the need for early demonstration of new research. The trends have been combined with uncertainties such as oil price, geopolitical stability and pace of innovation into different but plausible scenarios describing the society and the role of cellulose in the year 2030.

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Title:

The Decline of Wood Science & Technology Education in the Times of High Edu-Business

Authors:

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Abstract:
One of the most significant aspects occurred last 30 years at the universities in the Northern hemisphere is the decline of wood science & technology (WST) program. Traditional WST programs have been curtailed and/or merged, particularly in English speaking countries. Many research-oriented universities which emphasized a strong research and doctoral education have excluded the program of WST from their universities. It is not certain whether this trend would be a temporal or cyclical. However, as long as the current socio-economic situations and changing attitudes to higher education continue, declining trend would not be restored to its previous position. Universities across the world are now being challenged. Market-oriented society and neo-liberalists are impatient with the tradition of open-ended inquiry systems. Education environment has been transformed; traditional products-based programs such WST are severely affected. Boundary-respect conception in the universities has been transformed into the boundary-suspicious one. In addition, the prevailing model of single subject department-base degree would not be appropriate to provide the entire scope and spectra of knowledge for next generation. The life span of knowledge is too much short when compared to the last century. We don't have a magic word to rescue the WST from declining. To survive and remain competitive WST in a rapidly changing market place, however, "the most recalcitrant organization" tries to reflect the needs of students, the societies (clients) and changed conception of higher education without losing the intellectual dissatisfaction.

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