Oral communications: a brief introduction

21 April 2010

Topic 1 – session 1

Preventive conservation and restoration; a technical and financial challenge for local authorities
F. André
The local examples which will be presented to the participants by the managers of our cultural and heritage services will try to convey the difficulty we have in reconciling the protection of our heritage, the anticipation of disturbance caused by preventive conservation and staff training, regular restoration by professionals, the application of standards and technological means which have come out of the research in the field, but also of the wealth of heritage and culture maintained thanks to the commitment of owning authorities.

Topic 1 – session 2

Involvement of conservation professionals in an EU funded project
E. Dahlin et al.
Presentation of the main objectives and achievements of the EU funded project "Improved protection of paintings during exhibition, storage and transit" - PROPAINT (SSP1 – 044254).

Implementing preventive measures in the development process of display cases for the *Brandenburg State Museum of Archaeology*
A. Jeberien et al.
The communication will describe a project that is focused on the development of flexible display cases by the class of conservation and restoration at *Berlin's University of Applied Sciences (HTW)* and the *Brandenburgian Heritage Conservation Department and State Museum of Archaeology (BLDAM)*.

Managing environmental control in Gripsholm Castle – a study of the decision process
G. Leijonhufvud et al.
This case-study will explore how decisions about the indoor environment in Gripsholm Castle are made and how different interests are negotiated.

The view of different stakeholders on the compromise between energy use, preservation and human comfort will be examined and discussed. Barriers to energy conservation and improved preservation will be identified.

Pollution mitigation: The gap between research and application
E. Spiegel et al.
Since the 1970s numerous methods for testing display and storage materials have been developed within the museum sector. The primary goal of these methods is to prevent damage to the objects caused by the materials' potentially harmful emitted substances.[1]
The focus of the present work refers to an extensive empirical study that not only examines the current situation with regard to indoor air pollution but also the way in which materials that emit contaminants are handled in German collections. The main question is if the problem itself has been acknowledged, and if a standardized method regarding material pollution mitigation has been established.[2]

[1] Hatchfield, P. (2002) Pollutants in the museum environment: Practical strategies for problem solving in design, exhibition and storage. London. p 44-45.
[2] Spiegel, E. (2009) Emissionen im Museum – Eine empirische Studie zur aktuellen Situation und zum Umgang mit Schadstoffen in deutschen Sammlungen. In: Drewello, R. (Hrsg.) *Restaurierungswissenschaften – Beiträge zur Erhaltung von Kunst- und Kulturgut*, Band 1. Bamberg: University of Bamberg Press (UBP).

22 April 2010
Topic 1 – session 3

Modelling of air quality for paintings in microclimate frames, and experiences of the Norwegian Institute for Air Research, NILU, in providing "air quality services for cultural heritage professionals"
T. Grøntoft
A more technical presentation of modelling of air quality for paintings in microclimate frames will be followed by a brief discussion of the experiences of the Norwegian Institute for Air Research NILU, in providing "air quality services for cultural heritage professionals"

The Dutch archival act and harmonisation
J.B.G.A. Havermans
In 1993, the first document on indoor air quality parameters was presented to improve the storage conditions for archival records. Since 1995, these recommendations were included in the Dutch Archival Act. The conditions were based on international and national studies, presented by Vosteen for the Rijksgebouwendienst [1-5]. Now, more than 10 years after the implementation, it is time to have a closer look at these conditions, and to compare the conditions with measurements from practice.

Air quality assessment in cultural heritage locations by dosimetry
S. Lopez-Aparicio et al.

This presentation will report results from measurements with dosimeters in locations in cultural heritage institutions. In addition, the application of dosimetry measurements as part of a strategy for the better preservation of artefacts and the encountered difficulties with their use will be discussed.

'Heritage Intelligence'
Environmental monitoring with wireless intelligent sensor systems
I. Spulber et al.

Multi-parametric wireless sensors networks are now available for use in museums and historic buildings, for objects in transit, and for large outdoor heritage assemblies and sites. This contribution reports on the integration of a range of chemical and physical sensors - such as temperature, relative humidity, light, volatile organic compounds, formaldehyde, dust - onto a single wireless node. The node network permits remote and reliable data gathering through the exploitation of very low energy consumption, self-powered, geographically-distributed wireless mesh networks.

Topic 2 – session 1

Indoor air quality within museum showcases
A. Schieweck et al.

Indoor air quality within museum showcases is still a great concern of conservators. Even though a lot of problematic materials have been eliminated as far as possible during showcase construction, damages and odorous loads are still reported. A research project aimed therefore to investigate basically indoor air quality within showcases of different types and ages [1,2].

[1] The two-year research project was financially supported by Stiftung Industrieforschung Köln, Germany.
[2] Schieweck, A. (2009) Airborne pollutants in museums showcases. Material emissions, influences, impact on artworks. PhD thesis, Dresden Academy of Fine Arts, Germany.

The scent of degradation: VOCs as a source of information
M. Strlič et al.

Although long discussed, it has not been shown yet what kind of quantitative information is carried by volatiles emitted from degrading materials. In a collaborative piece of research, and using multivariate data analysis, we quantitatively correlated the emissions of volatile degradation products with historic paper properties: rosin, lignin and carbonyl group content, degree of polymerisation of cellulose and paper acidity. This research offers a proof of concept for the development of a 'sniffing' tool for identification of library and archival objects at risk.

Relationship between the emission of volatile organic compounds from paper and cellulose degradation

O. Ramalho et al.

The ability to carry out a global yet precise investigation of the state of conservation of paper documents while preserving their physical integrity is currently one of the major challenges in paper conservation research and has direct relevance for museums, libraries and archives. Macromolecular characterisation of cellulose, which relates directly to material properties, can only be carried out using destructive or micro-destructive techniques, while the volatile organic compounds (VOCs) produced during the paper degradation can be analysed using non-destructive techniques. In a comprehensive approach to the study of paper degradation, we investigated both the cellulose macromolecule and the low-molar mass by-products from oxidation and hydrolysis reactions of cellulose, hemicelluloses and lignin in various types of papers. Relationships between these two levels of chemical degradation of paper were studied using statistical tools such as principal component analysis (PCA) and partial least square regression (PLS). The aim was to better comprehend alteration phenomena and to explore the potential of using the relative abundance of specific target VOCs and their emission rates, studied with non-invasive techniques, for determining the state of conservation of a paper object. This research was carried out in the framework of a project funded in 2006 by the French Ministry of Culture.

Assessment of the degradation of polyurethane foams from contemporary art objects

A. Lattuati-Derieux et al.

With the rapid evolution of the chemistry during the 20th century all kind of synthetic polymers have been made available and used for the production of artifacts and materials used by artists to create important pieces that are recognized nowadays as works of art. Unfortunately, some of these polymers are degrading faster than had been expected, and their medium to long term preservation is a challenge to those who care for such items.

This work focuses more precisely on objects made of polyurethane (PU) foams. PU foams are widely present in museum collections, natural history museums, fine art museums, modern art museums, either as part of the artifacts, or as a mean for their storage. PU foams are also largely used in daily home furniture, automobiles, and thermal insulation.

Polyurethanes are a large family of polymers whose composition has evolved over time. They often exhibit specific conservation issues, particularly when they are in the form of foams. The thermal and photochemical degradation mechanism of these foams is not yet fully understood, even if it appears established that they are based on oxidation and/or hydrolysis reactions [1].

Our study focuses on the characterization both of the volatile organic compounds (VOCs) emitted during the natural and artificial ageing of PU foams, and the solvent extractable and polymerized fractions. The aim is to identify potential chemical markers that would provide information about the mechanisms of deterioration of PU foams. The impact of some environmental factors on the foam deterioration are under evaluation and might allow to suggest some protective methods. This research is part of the Popart project supported by the European Commission (grant agreement n° 212218).

[1] Szycher, M. (1999) *Handbook of polyurethanes*, CRC press.

Topic 2 – session 2

Airborne microbiology in museum through molecular approach: preliminary study

C. Gaüzère et al.

Museums, as institutions receiving public are subject to large crowds. Air is an effective vector for microorganisms but its microbial content is still few describe. In museum, microbial quality of air is particularly relevant. Indeed, airborne microorganisms involved in respiratory symptoms among occupants and many studies have demonstrated their role in the degradation (partial or total) on the media they colonize (wood, textiles, paper, pigment, varnish ...) [1].

[1] Hyvärinen, A, Meklin, T, Vepsäläinen, A, Nevalainen, A. (2002) Fungi and Actinobacteria in moisture damaged building materials - concentrations and diversity. *International Biodeterioration & Biodegradation*, 49, 27-37.

Characterization of airborne particles in the Baroque hall of the National Library in Prague

J. Smolik et al.

Airborne particles are one of the major pollutants in outdoor and indoor air. Together with adverse health effect they may negatively influence also ecosystems and cultural heritage. Particles deposit on artworks exhibited in museums and on the surfaces of books in libraries and archives. Coarse particles are abrasive in nature and they can damage works of art by mechanical abrasion when artefacts are moved or handled. Fine particles of acidic or alkaline character may penetrate into the books where they may cause chemical degradation or moistening due to their hygroscopicity [1, 2]. In this study we have focused on size-resolved chemical characterization of particulate matter (PM) in the indoor environment of the Baroque Library Hall in Prague.

[1] Bioletti, R., Goodhue, R. (2008) Study of Old Library Dust, Trinitty College Dublin, *Proc. 8th Indoor Air Quality 2008 Meeting*, , Vienna, Austria, 17th-19th April 2008.
[2] Nazaroff, W. W., Salmon, L. G., Cass, G. R. (1990) Concentration and Fate of Airborne Particles in Museums, *Environ. Sci. Technol*. 24, 66-77.

The preventive conservation of cultural heritage in "indoor" environment: the biological pollutants monitoring potentially biodeteriogens

M. Fornaciari et al.

The effectiveness of the protection and conservation of cultural heritage derives from the preparation of an appropriate security level, environmental monitoring and from the management, care and treatment of the exhibition areas which will protect the works of art from chemical and physical damages. Since the ageing of materials is a spontaneous and irreversible process that cannot be stopped, we can only try to slow it protecting the objects and artefacts from the degradation action of many agents that contribute to increasing its speed. The prevention techniques, therefore, takes a central role in conservation. In particular, preventive conservation, as direct/indirect actions to slow the effects of degradation on cultural heritage caused by time and use, plays a fundamental role allowing continuous monitoring of the artefact condition. Within these actions, the indoor air composition analysis of both biological and chemical pollutants plays an important function as it helps to define the actual situation of risk for artefacts [1]. In particular, the qualitative and quantitative study of the aerospora in libraries, archives and museums can be crucial for preventive conservation to avoid or slow down bio-deterioration phenomena, to optimize environment protection procedures and to assess the hygienic risks on human health [2]. The aim of this study was to analyze the indoor environment pollution level of fungal particles in order to promptly detect the presence of airborne microorganisms potentially bio-deteriogens. Moreover, other aims were to assess the risks of environmental biological contamination on the exposed artistic artifacts and to identify emission sources allowing appropriate interventions.

[1] Ruga, L., Bonofiglio T., Orlandi F., Romano B., Fornaciari M. (2008) Analysis of the potential fungal biodeteriogen effects in the "Doctorate Library" of the University of Perugia, Italy. *Grana*, 47, 60-69.
[2] Ruga, L., Bonofiglio, T., Romano, B., Fornaciari, M. (2006) Control of biodeterioration using aerobiological monitoring: indoor investigations for the conservation of artistic patrimony. In: Galan C. & Clot B (eds.), *Abstracts of the 8th Int. Congr. Aerobiol.*, 270, Neuchâtel, Switzerland, 21-25 August 2006.

Moulds detection by their volatile organics compounds: use for heritage conservation

Y. Joblin et al.

Fungi are common microbial contaminants of indoor environments. Many studies have demonstrated their role in the partial or total degradation of materials they colonize (wood, textiles, paper, pigment, varnish ...). Since 2005, a new technique based on chemical tracers has been developed and validated during different measurements campaigns. This approach is now applied and adapted to various indoor environments (houses, offices,

schools, child cares…) and enables the detection of recent and/or hidden contamination.
This technique contributes to the development of a system composed of chemical micro-sensors adapted to field measurements. This system does not require analytical laboratory processing and as such saves valuable time. Another practical implication is to allow continuous monitoring of fungal contamination in indoor environments. Combined with the classical methods, the system would improve identification of the involved fungal species and assess exposure levels.

<u>Topic 3 – session 1</u>

Thenardite-mirabilite cycles in historical buildings

D. Camuffo et al.

It is known that at High RH levels and low temperatures, Thenardite (Na_2SO_4) is transformed into Mirabilite, i.e. the hydrated crystalline form including 10 H_2O molecules. The combination of high RH levels and high temperature brings to deliquescence and dissolution. When RH drops, the crystal changes structure, loosing water. Such cycles may be dangerous to structures for the crystallisation pressure. This paper is concerned with the study of how the frequency of these cycles has been changed in the case of unheated historical buildings, as they were in the past centuries, and in the case that heating systems are operated for people comfort.

The role of organic pollutants in the alteration of alkali silicate glasses

L. Robinet et al.
Following the discovery of a widespread alteration in the National Museums glass collections, a research was carried out to understand the effect of organic pollutants on the structure of the alkali silicate glasses and the reaction kinetics and mechanisms involved in the alteration. The paper will discuss the results from the analysis of museum objects and ageing experiments and the role of the difference organic pollutants in the alteration.

Monitoring of indoor air pollution in the stacks of the Swiss National Library

G. Di Pietro et al.
In 2008, we performed a survey of the air quality in the underground stacks of the Swiss National Library, including the surrounding working areas and two public areas. We measured a range of gases, both outdoor and indoor generated, with passive samplers (1). The results we compared with the levels measured by active samplers and with the air corrosivity levels monitored on metal plates.

[1] Radiello passive samplers, see http://www.radiello.com/

Characterisation of fading behaviour of coloured papers during simulated display in anoxia

J. Thomas et al.

Coloured papers, either as a primary support, collage material, or secondary support, can be found in most graphic art collections. They have been used by many artists including, Stanisław Ignacy Witkiewicz (Wikacy), Abraham Walkowitz, and Jackson Pollack. The relative impermanence to light of many of the materials used to produce the papers is well documented [1], and the resulting discolouration, due to yellowing of the lignocellulosic substrate and fading of the colorants, drastically changes the appearance of the objects and greatly affects the viewers' aesthetic experience. Anoxia has been proposed as a preventive conservation display technique for graphic materials [2] allowing for longer display of sensitive objects through the limitation of oxidative degradation and interaction with exogenous pollutants.

[1] Irving, J. (1997) Construction Paper: A Brief History of Impermanence. *The Book and Paper Group Annual*, 16.
[2] Thomas, J., Townsend, J. H., Hackney, S., and Strlič, M. (2010) A Review of Anoxia as Applied to Works of Art on Paper. *Reviews in Conservation*, (in press).

23.04.2010

Topic 3 – session 2

Carbonyl vapors and their impact on paper degradation

J. Tétreault et al.

During ageing, paper produces a wide array of volatile organic compounds (VOCs) from the degradation of cellulose, hemicelluloses, lignin and other components. However, much is unknown about how these VOCs can affect paper stability. When generated by a stack of paper in an archival container, these VOCs stay trapped and can build up in significant concentrations within the container. The VOCs with carbonyl functionalities are potentially harmful to paper by accelerating its degradation rate. The authors have previously established that acetic acid vapour can be detrimental to paper when present in its immediate environment [1].

[1] Dupont, A.-L. and J. Tétreault, (2000) Study of Cellulose Degradation in Acetic Acid Environments. *Studies in Conservation* 45, 201 - 210.

Volatile organic compounds in libraries atmosphere: effects on the written and printed cultural heritage.

T. P. Nguyen et al.

If it has now been well established that outdoor atmospheric pollution, sulphur dioxide, ozone or nitrogen oxides in particular, has detrimental effects on library collections, this of the indoor pollution is still underestimated by most written heritage keepers. But with the development of "airtight libraries", these effects become obvious. The

National Library of France (BnF) was recently confronted with this issue [1,2]. Although most of the preservation parameters were taken into account when constructing its new building in 1996: scrupulous choice of the construction material, installation of outdoor air purification systems, a survey of air indoors revealed an evident contamination by sulphur pollutants, the source of which are in particular, some kinds of boxes used for the conditioning of documents [3]. This survey clearly showed the disastrous consequences of these pollutants on the indoor air quality and the building materials. But the question of their contribution to the degradation of cellulose containing collections was remaining.

[1] Nguyen, T.P., Dubus, M., Bouvet, S. (2007) Indoor air pollution in the new building's storage areas of the BnF : effects on the corrosion of copper and silver and on the paper cellulose-I.First results, *Journal of Art technology and preservation*, 21 (2), 250-255.
[2] Dubus, M., Nguyen, T.P., Prosek, T., Tate, J., Aucouturier, M. "Low corrosive environments in cultural heritage: interpretation of field studies", *Studies in conservation*, In print.
[3] Nguyen, T.P., Dubus, M., Saheb, M., Mareynat, S. (2007) « Qualité de l'air dans les magasins de stockage de la BnF, I-Premiers résultats », *Support tracé*, 6, 48-57

Volatile aldehydes in libraries and archives

A. Fenech et al.

Volatile aldehydes are well-known products of degradation of paper and other cellulose-based materials. This may result in their accumulation in archival and library repositories and thus a systematic study was implemented to investigate the concentration of these chemical species in various libraries and archives. In the frame of this study, passive sampling was carried out at 14 locations in 4 libraries and archives– the Nationaal Archief, The Hague (Netherlands), the National and University Library, Ljubljana (Slovenia), The National Archives, Kew (UK) and St Paul's Cathedral (UK).

Volatile organic compounds in books after mass deacidification

I. Kralj Cigić et al.

Paper stability crucial depends on its acidity/alkalinity, and it is well known that acid paper degrades more intensively [1]. In order to prolong its lifetime, different deacidification treatments are available also on a large, "mass" scale. Some of these processes make use of organic solvents, which may remain in the deacidified material after treatment. Additional volatile organic compounds (VOCs) may be produced during neutralization reactions and emitted from deacidified paper material. Therefore, their determination is important as emitted VOCs may be associated with health risks and risks to objects.

[1] Strlič, M., Kolar, J. (2005) Ageing and stabilisation of paper. Ljubljana: National and University Library.

Topic 4 – session 1

Understanding microclimates in museums and their impact on heritage materials

M. Odlyha et al.

This paper will describe monitoring in museum environments and damage characterisation of selected heritage materials. Monitoring was directed at detection of volatile organic acids released from wood: in the PROPAINT and SENSORGAN projects. In both cases the factors to consider were the air exchange rate, and the type of wood used. Studies of the effect of environmental factors (inorganic pollutants) were made in the IDAP project and of volatile organic acids on varnishes of paintings in frames in the PROPAINT project.

Questions such as "How do the microclimatic conditions in frames and the higher levels of volatile organic acids affect varnished surfaces of paintings?" and "How do varying levels of pollutants and damage to collagen in parchment affect the mechanical response" will be addressed.

[1] Larsen, R., Ed., *Improved damage assessment of parchment*, EC Research Report 2007, No.18, ISBN 978-92-70-05378-8.
[2] Bergsten, S.J., Odlyha, M.,Bratasz L. and Camuffo D. "Sensor System for Detection of Harmful Environments for Pipe Organs"http://www.iaq.dk/iap/iaq2008/iaq2008_abstracts.pdf.
[3]. Grønthoft, T., Dahlin, E., Odlyha, M., Mottner, P.., Scharff, M., Andrade, G., Obarzanowski, M., Hackney, S., Thickett, D., Wadum, J., Colombini, P. "Dosimetry for Characterisation of Environmental conditions for paintings in Microclimate Frames" http://www.iaq.dk/iap/ iaq2008_abstracts.

Preventive conservation of paintings in São Paulo (Brazil): assessment of damage risk by piezoelectric dosimeters

A. Cavicchioli et al.

This paper describes the assembly and operation of an upgraded dosimeter based on piezoelectric quartz crystals modified with a thin film of mastic varnish. The difference in the ageing rates occurring in the films during exposure in a museum area and in a control chamber is recorded in terms of oscillation frequency of the crystals and used to assess the damage risk associated with the specific characteristics of the microenvironment of that room [1]. In these novel automatic devices the simultaneous measurement of T, RH and light intensity and type through on-board sensors is helpful to interpret the response of such *impact sensor* [2]. Here, their potentials are shown in field campaigns carried out in two of the most important museums of the city of São Paulo, Brazil: the Historical Museum of the University of São Paulo (*"HM"*) and the São Paulo State Plastic Arts Museum (*"AM"*), both located in the central urban area of the city of São Paulo, Brazil.

[1] Cavicchioli, A. et al. (2008) Automatic devices for monitoring environmentally induced auto-oxidative degradation of artistic materials in conservation sites. *Sens. Actuators B*, 131, 462.
[2] Bacci, M., et al. (2008) Innovative Sensors for Environmental Monitoring in Museums, *Sensors*, 8, 1984.

Survey on air quality control in cultural heritage institutions and development of automated corrosion sensors for real time monitoring

T. Prosek et al.

Prototypes of loggers for continuous measurements of the corrosion rate of selected technical metals under atmospheric conditions were recently developed [1]. The electronic unit measures and records changes in the electrical resistance of a thin metal track applied on an insulating substrate. The developed concept offers several important advantages, such as on-line and real-time monitoring, small size, easy replaceable metal sensors, remote data access, and automatic data delivery via e-mail [2,3]. In 2009, a project that aimed at adjusting the monitoring system for highly-demanding application in the cultural heritage sphere has been launched [4].

[1] Automated corrosion sensors as on-line real time process control tools (CORRLOG), Co-operative Research Project, 6th Framework Programme, Contract No. 018207, 09/2005–02/2008.
[2] Prosek, T., Kouril, M., Hilbert, L.R., Degres, Y., Blazek, V., Thierry, D., Hansen, M.Ø. (2008) Real time corrosion monitoring in the atmosphere using automated battery-driven corrosion loggers. *Corrosion Engineering, Science and Technology*, 43 (2), p. 129–133.
[3] Prosek, T., Thierry, D., Kouril, M., Degres, Y. (2008) Automated corrosion loggers for corrosion monitoring in the atmosphere, *Proceedings of CORROSION, NACE*, Paper 08296, New Orleans, USA, March 16–20, 2008.
[4] Protection of cultural heritage by real-time corrosion monitoring (MUSECORR), Collaborative Project, 7th Framework Programme, Contract No. 226539, 06/2009–05/2012.

The factors deteriorating the historical textiles in Museum of Faculty of Archaeology, Cairo university and approaches for their prevention

O. Abdel-Kareem

This article presents a case study concerning the factors deteriorating historical textile objects in the Museum of Faculty of Archaeology, Cairo University and introducing approaches for the preservation of these textiles against the deterioration factors threatening them.

Topic 4 – session 2

The generation of indoor air pollution from surface reactions

M. Ryhl-Svendsen

Simple mass balances are typically used to model the deposition loss of outdoor pollutants to indoor surfaces. For ozone this allows for a fairly close estimate to the amount of ozone molecules which react on the surface of, say, one museum object. However, for pollutants which are at the same time both generated and re-deposited on surfaces within the same room, such estimates are more difficult to make. This makes concentration measurements difficult to interpret as it is the flux of pollutants to a surface which is the main damage factor with regard to pollution related deterioration.

The assessment of air quality at the "Galleria dell'Accademia", Florence, Italy

F. Vichi et al.

The Galleria dell'Accademia in Florence contains the "David" by Michelangelo, one of the finest statues in the world. Previous studies of air quality within buildings housing cultural properties have shown that there is great variability for pollutants indoors due to air exchange with outdoors. In the light of this variability, techniques are needed to survey the area of interest for estimating air pollution in order to map the penetration of pollutants indoors.

Long term prediction of marble erosion for the conservation of the statue of David of Michelangelo

L. de Santoli et al.

This study presents the study of the decay of a marble surface generated by solid particles impingement, in order to estimate the effect of an hypothetical bad working of the new hvac system, currently at the designing stage for the protection of the statue of David of Michelangelo [1].

The system is composed by a curtain of air projected vertically from the floor, separating the statue environment from that occupied by visitors to obtain a low concentration of pollutants near the marble surfaces.

A very conservative simulation, with high air velocity and high particle concentration is performed using a CFD (Computational Fluid Dynamic) code, in order to estimate the effect of a long term exposure to the aggressive phenomenon.

[1] De Santoli, L., Mancini F., Mariotti, M. (2005) Air curtains as a protection for indoor cultural heritage: a proposal for Michelangelo's David in Florence, In: 10th international conference on indoor air quality and climate, 4-9 September, Beijing.

Different finishes of plasters – Importance for particle deposition

M. Sandberg et al.

Soiling of surfaces in churches by deposition of particles is a common problem. Working the surface of a church wall can be done in different ways depending on the wanted appearance of the wall. It gives a certain visual structure to the plaster but the working on the surface will also generate a (geometrical) unevenness. The latter is important with respect to particle deposition. The degree of the unevenness of the surface is dependent on the tool used. It is known that with increasing roughness the particle deposition increases [1]. The degree of interaction between the surface and the flow is quantified by the so called friction velocity. There are theoretical models [2] that require only friction velocity to calculate particle deposition onto rough walls. This is the basis for the present work. The friction velocity is determined experimentally and then the deposition rate is assessed theoretically.

[1] Hussein T. et al. (2009) Deposition of aerosol particles on rough surfaces inside a test chamber. *Building and Environment*, 44, 2056 – 2063.
[2] Bin, Z Jun W. (2006) Modeling particle deposition onto rough walls in ventilation duct, *Atmospheric Environment* 40, 6918 – 6927.

Topic 5

Assessing and Monitoring Visual Storage Environments

F. G. France

Monitoring anoxic and controlled environments in visual storage encasements [1] to assess the environment and air quality poses new challenges for cultural heritage institutions. Since the mid 20th century cases with anoxic and relative humidity controlled microclimates have been utilized to retard the deterioration of artefacts. These include both active and passive systems in a range of cases: including the Getty Conservation Institute for the Royal Mummies Collection in Cairo; the US National Archives for the Charters of Freedom and Magna Carta [2]; and the Library of Congress for Top Treasures…

[1] France, F. G. (2009) Best Practice and Standards in Environmental Preservation for Cultural Heritage Institutions: Goals, Knowledge, Gaps. In *Advances in Paper Conservation Research: Developing Conservation Research at the British Library:* British Library Conference Centre, London, UK, 23–24 March, 2009.
[2] Oxygen-Free Museum Cases, Editor. Shin Maekawa, The Getty Conservation Institute, Research in Conservation (1998), pp. 71.

Conservation design of a new storage building at ASTRA Museum in Sibiu, Romania

M. Guttmann et al.

In April 2009 ASTRA Museum in Sibiu, Romania, received a grant of almost 3 million Euros through EEA Financial Mechanism in order to enhance the degree of heritage conservation, this including the building of new storages and conservation studios. The paper presents the development of the funding project and the preventive conservation aspects of the building design. Computer simulations of the climate in the designed storages were performed by the specialist team of the National Museum of Denmark, based on the climate monitoring performed by INOE in 2007-2009. Accordingly, if proposed building design is respected and the construction is airtight enough, temperature and relative humidity of the fully loaded storages will be within safe conservation limits for most of the year.

Indoor air quality survey in selected Jordanian museums, storages and archives

R. Alghazawi et al.

This study seeks to identify those suitable local environmental conditions for the objects displayed at the selected museums in Jordan using the appropriate methods which will contribute to the stabilization of these objects.

In this study we selected eight museums, the main warehouse storage and the Department of Antiquities archive in Jordan, to examine how far these museums conform to recommended conditions and international standards for housing such valuable collections, through environmental reactivity monitoring method.

Portable air cleaners in churches – efficiency and practicability

M. Mattsson et al.

In many churches, indoor surface soiling due to deposition of airborne particles is of great concern. One way to diminish this problem might be to install portable air cleaners that reduce the particle concentration in the indoor air. There now exists commercially available electrostatic air cleaners that possibly are efficient and silent enough to be used in churches and similar buildings. A theoretical and practical investigation in this regard is presented here.