SEAHA
EPSRC CENTRE FOR DOCTORAL TRAINING
SCIENCE AND ENGINEERING IN
ARTS HERITAGE AND ARCHAEOLOGY

1st International Conference

Science and Engineering in Arts, Heritage and Archaeology

Book of Abstracts

14-15 July, 2015

University College London
London, United Kingdom

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Co-organisation and Endorsement

The conference is a joint event of EPSRC SEAHA CDT, the EU FP7 Marie-Curie Action Project: Initial Training Network on Digital Cultural Heritage (ITN-DCH) and of the Heritage Consortium.

The SEAHA conference is organised with endorsement by the UK National Heritage Science Forum.

Exhibitors

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Introduction

This is the first international conference on heritage science research, innovation and best practice in the interpretation, conservation and management of cultural heritage. Heritage science is the cross-disciplinary field connecting science and the humanities.

The conference aims to provide a platform for scientists, researchers, engineers, professionals, practitioners, entrepreneurs, and policy-makers, to engage and discuss emerging trends in the field. There is an ongoing dialogue over global issues, which define the research and technological applications of heritage scientists.

We are delighted, and grateful, that the conference attracted such interest worldwide, and proud that the programme includes 24 talks, 75 posters as well as that the conference is generously supported by 6 commercial exhibitors. We would like to express our sincere thanks to the Steering Committee of the EPSRC Centre for Doctoral Training in Arts, Heritage and Archaeology, for their advice and guidance.

We hope you will enjoy the conference and that you will consider joining us again next year, in Oxford.

The Organising Committee

Opening Address

OA

Looking back; thinking forward: SEAHA's contribution to the development of heritage science

May Cassar

Director, UCL Institute for Sustainable Heritage
Director, EPSRC Centre for Doctoral Training SEAHA
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The years 2005-2015 can be described as the decade of heritage science. Between the House of Lords Science and Technology Select Committee Inquiry on Science and Heritage (2005-2006) and the launch of the EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology (2014-2015), heritage science has emerged as a widely recognised cross-discipline inclusive of archaeological, building and conservation sciences, and more recently digital and engineering sciences and technology.

A communitiy's preparedness for change depends on the strength of its institutional, organisational and technological capability. Heritage science in the United Kingdom has demonstrated clear signs of growing strength in the first two of these three aspects with good prospects for the third.

A dedicated research programme, the AHRC/EPSRC Science and Heritage Programme (2007-2014) has boosted the growth of heritage science, giving it a strong platform and providing a clear intellectual framework for seven years of cross-disciplinary research collaborations. Working intensively with heritage partners, arts and humanities research questions framed research design and methods clustered around key programme themes: the nature of transformation; authenticity, authentication and security; interpretation and representation; cultural encounters and explorations; human and machine interfaces, and resilience and adaptation.

The organisational capacity of heritage science has been reinforced by the emergence of a Heritage Science Vision and Strategy underpinned by three reports: the role of science in the management of the UK's heritage; the use of science to enhance our understanding of the

past and understanding capacity in the heritage sector. The recommendation of the Strategy was that organisations engaged in heritage science research should create together a Forum. This was established in 2013.

Mirroring this development has been recognition of the need to build future capability in heritage science. The 2014 launch of the EPSRC Centre for Doctoral Training in Arts, Heritage and Archaeology is the single most significant opportunity to train the next generation of heritage scientists. By 2022, sixty new heritage scientists will graduate with knowledge and skills ranging from advanced science responding to arts and humanities questions, to interpersonal and public engagement skills.

But what of the technological infrastructure required by future heritage scientists? This question cannot be answered solely by building new facilities or acquiring new equipment. Ensuring existing facilities and equipment are used to capacity is a necessary and credible first step as these are not often used as intensively for examples during evenings and weekends. This may be because traditional work patterns are hard to shift.

However, work patterns will change, even if slowly. As career paths become more individual and mobile, managers of fixed facilities may need to be more flexible in the way they operate. With the economic pressure on public finances likely to continue, and with the emergence of enterprising heritage scientists, those with facilities will need to respond to new and imaginative business models. This presentation will think forward at some of the options.

Keynote Presentations

Science, society, stories and impact: Historic England and heritage science

KN1

Steve Trow

Director of Heritage Protection, Historic England, UK

Historic England is the new name for the UK government's statutory advisor on the historic environment in England, formerly known as English Heritage. We are a non-departmental public body and defined by government as a Public Sector Research Establishment, with a long track record in research and heritage science.

This paper will emphasise the role of publicly funded science and technological development in relation to the archaeological and built historic environment, not only in enhancing understanding but also in engaging the public imagination through exciting narratives of innovation and discovery. It will also consider how science and engineering are making heritage conservation more efficient and more cost effective to the benefit of owners, developers and others who interact with heritage assets. It will provide a critical assessment of the extent to which advances in heritage science actively influence public policy. And it will consider how, in a time of significantly reduced public expenditure, partnerships between the Research Councils, higher education institutes and Public Sector Research Establishments can effectively address the impact agenda, secure benefits for all partners involved and enhance the skills base. The paper will be illustrated by recent technological developments and new approaches by Historic England.

KN2

Interdisciplinary skills & standards in sustainable conservation: Achievements and challenges in the practices and sciences of place-based conservation

Seán O'Reilly

Director, The Institute of Historic Building Conservation, UK

Looking first at what conservation is, and in particular at 'place-based' or 'area' conservation, the presentation will explore how the landscape of practice and learning has evolved in line with traditional disciplines. Following from this it will examine both how and why - in conservation especially - we need to operate as inter-disciplinary practitioners dependent on multi-disciplinary skills.

Evaluating inter-disciplinary and multi-disciplinary standards in practice is, however, especially challenging. For example – and somewhat confusingly – the origins and genesis of in interdisciplinary practice, in part at least, has been as a specialism within a more traditional discipline.

The IHBC's Conservation Cycle offers one model to guide interdisciplinary evaluation and multidisciplinary learning. The model aligns with both national and international practice standards (ICOMOS) and charters, as well as international practice models, notably from the World Bank. As these criteria are based in the first instance on interdisciplinary practice, they can be seen to represent a key achievement in in line with the title of the talk.

However challenges also arise in generating advocacy for area-based heritage conservation as the science that it needs for successful policy-making needs to reflect its practice. For that, clearly, the underpinning science has to reflect those interdisciplinary and multidisciplinary funadmeentals as well.

The talk concludes with two strands: one exploring how opportunities in field of science expand dramatically if heritage conservation becomes the starting point; and another indicating the kinds of questions that conservation practice generates, a starting point for considering how the science of heritage – rather than heritage science – might offer a platform for a more sustainable future.

Evidence, Persuasion and Policy in Heritage Science

KN3

Nancy Bell

Head of Collection Care, The National Archives, UK
Co-Chair, The National Heritage Science Forum

Using research-informed evidence is increasingly recognised in institutions and governments as a necessary if not vital element of decision making, policy formation, influencing and advocacy. In this context heritage science has much to contribute to wider social and political challenges, particularly risk mitigation, as well as improving access to, the interpretation of, and the preservation of cultural heritage. To contribute meaningfully to debates and to inform practice, it is necessary to understand the nature of heritage science evidence, how it is used, and to understand various pipelines of communication. These points will be illustrated through case histories, and I will argue the imperative for better evidence gathering for our sector, particularly to inform questions of risk management, a central area for debate. I will consider how to harness our research outputs to create a vibrant heritage science sector.

Digital Session

D1

Mining historical documents – technical and enterprise perspectives

Roger Evans

School of Computing Engineering and Mathematics, University of Brighton, UK

Over the past three years, my group has been involved in two digital humanities projects concerned with automatic analysis of text in (digitised) historical documents. The first project, ChartEx, led by the University of York, was concerned with contractual transactions in medieval charters and provided tools to support historical research. The second, Traces through Time, led by The National Archives, focused more specifically on references to people across a broader historical archive (from medieval to early 20th century) in order to enrich the linked databases The National Archives provide to support a range of users who access their data.

In this paper I will give an overview of the two projects, their technical approaches and achievements, and discuss how they represent two different approaches to the SEAHA data-knowledge-enterprise cycle from modest resources. On the one hand, an end-to-end pipeline can capture and exploit the semantic richness of the specific pilot domain. On the other, a more enterprise-oriented approach can address the inherent variety of larger scale archives and deliver larger coherent datasets albeit with simpler structure. I will consider the challenges in bringing these two perspectives together to deliver the ideal of large scale semantically rich document mining solutions.

D2

CultLab3D tested 3D scanning system at Museum of Natural History

Matevz Domajnko[1], M. Ritz[1], T. Reimar[1], H. Schmedt[1], R. Monroy[1], O. Posniak[1], C. Fuhrmann[1], H. Mallison[2], P. Santos[1], D. Fellner[1,3]

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CultLab3D, the worldwide first 3D mass digitization pipeline for cultural heritage artefacts, was tested at the Museum of Natural History in Berlin from November 10th to 15th 2014. The aim of this test was to explore opportunities and challenges of the automatic 3D digitization process at the CultArc3D, the first scanning station of our CultLab3D scanning system. CultArc3D is comprised of nine cameras on the first arc and nine ring lights on the second arc. Both arcs describe a full hemisphere and in this way cameras capture objects from all sides in just a few minutes. The digital 3D model is then obtained using image-based reconstruction methods.

Natural and cultural collection objects of various materials, colours, sizes and textures were scanned under different light and camera parameter conditions in order to identify challenges and opportunities along all steps of the photogrammetric 3D mass digitization. Challenges and opportunities were divided in three groups: camera and light challenges (effect of opposing light, environmental light, camera focus, Bayer interpolation), data acquisition challenges (capturing images of long objects, surface reflectance, holes and occluded areas of objects) and 3D reconstruction challenges (selection and number of images for 3D reconstruction, image processing, feature detection and image matching on poor textural images, GPU processing to speed up the reconstruction process, and finalizing 3D models for archiving).

Testing of the CultLab3D digitization pipeline showed the opportunities and challenges of photogrammetric 3D mass digitization and that one of the most important features of mass digitization is processing time per artefact, which needs to be reduced without affecting the quality of the output 3D models.

Revealing the Inscriptions on an Egyptian Obelisk

D3

Lindsay MacDonald

3DIMPact Research Group, CEGE, Faculty of Engineering, UCL, London, UK

In 2014, Oxford University's Centre for the Study of Ancient Documents (CSAD) joined forces with the National Trust for a detailed study of the Philae obelisk which stands in the grounds of the Kingston Lacy estate in Dorset. The pink granite obelisk, 6.7 metres tall, is the crowning glory of the extensive Egyptian collection of William John Bankes which is on permanent display in the house and grounds. It is of international importance to Egyptologists as a key object in the early 19th century, which, together with the Rosetta Stone, led to the decipherment of hieroglyphs.

The obelisk is topical because on 12 November 2014, the landing module Philae, from the European Space Agency's robotic spacecraft Rosetta, successfully touched down on the comet 67P/Churyumov–Gerasimenko. This lander was named in honour of the obelisk at Kingston Lacy.

In anticipation of the comet landing, imaging specialists from CSAD, UCL and GOM UK Ltd in early October 2014 set up their equipment on a specially-constructed scaffold platform to capture surface details on all four faces of the monument. The surface was photographed under flash illumination, to produce sets of approximately 50 images at each of four elevations on each of the four faces of the shaft of the obelisk. From these image sets, visualisations of the Egyptian inscriptions were produced by the reflectance transform imaging (RTI) technique. In addition the entire obelisk was 3D scanned and a point cloud produced. Using the 3D data as a geometric framework, the overlapping RTI sections are being 'stitched' together by a new technique, to be described in this presentation, to form long vertical swathes over the full height.

D4

3D image quality indicators – what do heritage professional users really want from 3D digital surrogates?

Mona Hess

UCL Civil, Environmental and Geomatic Engineering, UCL, London, UK

Whilst there are guidelines for evaluating 3D sensors in engineering metrology, there is neither a tool for independent testing of 3D sensor capability for museums, nor guideline for specifications or production of 3D images of artefacts. To achieve this, tools to integrate 3D digital documentation into museum practice are required and a framework for better 3D image recording is proposed. Qualitative research explored heritage professionals' requirements via interviews and online survey for the international heritage community. Survey outcomes inform about current adoption of 3D imaging, priorities for 3D image quality and visions of future use. Despite barriers, there is a high interest in 3D imaging technologies across heritage institutions and museum sector. User testing was undertaken and observers' perception of digital surrogates in different digital representations (2D, 3D, 2.5D) examined the original qualitatively (visual display) and quantitatively (metric accuracy). Interviews informed about requirements, viewing habits and 3D digital image criteria for research, visual inspection and condition reporting. Outcomes are expressed through psychometric values in relation to spatial resolution, a Metric Heritage Test Object with a rigorous metric evaluation procedure, and case studies with museum artefacts. A graphical representation for 3D quality indicators is used to match 3D sensors to user requirements and object properties. This proposed framework, including project brief and quality control, allows heritage professionals to plan fit-for-purpose 3D imaging and assess digital 3D surrogates for analysis and research use. The 3D imaging framework methodology is transferable and will benefit project planning of 3D imaging programmes in heritage institutions.

D5

Enabling Immersive Visitor Experiences of Cultural Heritage using Portable Full Dome Projection Spaces and Real Time Interactive Virtual Reality Media

John Tredinnick[1,2], P. Richens[1], D. Adshead[2]

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[2] National Trust, UK

Through an academic-industry collaboration between The Centre for Digital Entertainment and National Trust are developing an approach to using full dome projection in engaging visitors groups with visually immersive and interactive virtual experiences. Virtual heritage offers the capability to generate detailed, compelling and interactive three dimensional virtual environments in which a variety of cultural heritage assets can be explored. A key element of virtual heritage is the ability to enable visitors to immerse themselves in the tangible and in-tangible heritage of a site. However the methods through which visitors experience this media has been limited to conventional approaches which limit a viewer's spatial awareness and sense of immersion. Furthermore new technologies such as head mounted displays do not fit with the large and varied audiences that heritage organisations have.

The Discovery Dome, is a form of full dome based on an inflatable fabric form in which a parabolic mirror and digital projector are used to create a 360° view of virtual media, this in principle is capable of generating visually immersive experiences for its audiences whilst being within reach of cultural heritage organisations to implement either at a site or in a remote location such as a school.

In collaboration with NT's Chedworth Roman Villa such a dome system has been used to deliver a number of user studies to assess the domes effectiveness. These have looked at assessing and improving the domes visual quality, viewer interaction and camera motion control as well as the practicalities of deploying the system both at and remotely from a heritage site by volunteers.

Environmental Session

E1

Particle sources and deposition in the indoor environment of historic churches

Roman Kozłowski, M. Strojecki, A. Mleczkowska, Ł. Bratasz

The Jerzy Haber Institute of Catalysis and Surface Chemistry Polish Academy of Sciences, Krakow, Poland

The study reports on examination of the particle sources and deposition in the indoor environment of historic churches in Poland, differing in size, construction and heating strategies. The particle concentrations indoors and outdoors were monitored for at least one year. The air exchange rate was determined by fitting exponential decay curve to recorded concentration of visitor-generated CO2 after the visitors left the church. The two-parameter mass balance equation, taking into account the particle sources and sinks in the indoor environment of churches was used to determine the particle deposition velocities and penetration factors. Large indoor and outdoor concentration variability helped to separate the effects of penetration and deposition losses. Liturgical services regularly generated high indoor particle concentrations, owing to burning of incense. During the particle concentration decay after the services, losses due to deposition could be reliably determined, whereas the events of high outdoor aerosol concentrations with no emission of particles indoors allowed the penetration factors to be precisely determined. The minimal AER values of between 0.1 and 0.2 h-1 were observed in monumental brick churches especially during the night and in the cold periods when the natural ventilation is limited. Typically, area-averaged deposition velocities for particles of diameters below or above 1 µm were 1.7·10-5 and 2.0·10-5 m/s. Penetration factors ranged between 0.6-0.8. For a typical church, indoor particle sources, mainly burning incense, accounted for approximately 10% of yearly deposition, the 90% being the outcome of infiltration of the outdoor aerosol. This research was supported by Grant 2011/01/D/HS2/02604 from the Polish National Research Centre.

E2

In models we trust: how collaboration helped make a useful and accurate model for particulate matter deposition in indoor heritage

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[5] Wellcome Trust, UK

Environmental models are usually distrusted, and for good reasons: their visually appealing results make strong statements that mask the great uncertainties associated with them and veil the absolute dependence on input parameters. But there is a way to produce reliable and useful models of the most complex kind, and this is through careful validation, and close collaboration with heritage partners and end-users of predictions.

We developed a computational fluid dynamics model of particulate matter deposition in indoor heritage environments. Collaboration between UCL and heritage institutions informed all the stages of the process, from the model conception to its experimental validation. We have used the model very successfully to simulate the deposition of fine particles in the Wellcome Collection, Apsley House and the Wellington Arch, the last two managed by English Heritage, and coarse dust in the Hampton Court Palaces, managed by Historic Royal Palaces. All these case studies were much more than mere applications of the model; they constituted scientific collaborations that were based on interdisciplinary communication.

The different stages of the project - planning of monitoring, data collection and interpretation, definition of case studies, post-processing and communication of results- were shaped by the inputs of the scientific and heritage partners. The result is a model that can inform decision making, that has already produced useful and accurate predictions, and that has remarkable industrial applications.

Our achievements -and mistakes- provide many insights on the collaborative nature of Heritage Science, and how can it contribute solutions that are both practical and rigorous - even using the most complex and visually appealing of modelling tools.

E3

Understanding long-term daylight exposure: A combined high-dynamic range measurement and lighting simulation study

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The use and control of daylight illumination is a major factor in the environmental management of collections in museums, galleries and historic buildings. In the National Trust, monitoring of light levels is carried out at 'spot locations' using small wireless sensors and dyed textile samplers called blue wool dosimeters. However, light levels in a room can vary greatly from one position to the next.

This presentation describes an in-progress research project to investigate the applicability of a novel camera-based method to measure light exposure in heritage spaces. The camera measures the luminance of the surfaces in the room using a technique called high-dynamic range (HDR) imaging. Each HDR image is 'compiled' from a computer-controlled sequence of multiple exposures. The aim is to extract from the HDR images the illuminance, i.e. the light falling onto the surfaces. Thus it will become possible to measure the light exposure across all the surfaces 'seen' by the camera. The space under evaluation is the Smoking Room at Ickworth House (Bury St Edmunds). This project is believed to be the first use of the HDR technique to measure the long-term light exposure in historic buildings.

In parallel with the HDR monitoring is a lighting simulation study of the Smoking Room using a technique called climate-based daylight modelling (CBDM). The CBDM simulations are used to evaluate the spatio-temporal dynamics of daylight exposure in the Smoking Room, and thus the consequences of changes in usage patterns and management of daylight in the room.

The initial findings from Phase I of the combined measurement and modelling study will be presented.

E4

The recent experiences & future needs of users of exhibit enclosures for local environmental control of indoor cultural heritage collections

James B. Crawford

Department of Physics, University of Warwick, Coventry, UK

This global survey of users of display cases & glazed frames for environmental control of indoor heritage materials follows in the wake of national & international guidelines which recently revised climate targets. Continued attempts to counter a “one size fits all” approach to collections care, increasing concerns for ecological & economic sustainability & the aims of a group of lending museums have relaxed thermohygrometric set-points, i.e. acceptable daily & yearly temperature & relative humidity spans. The risks of these set-points to heritage collections & the benefits to ecological & economic resources are being debated. Meanwhile the guidelines point collections managers toward exhibit enclosures as long-recognised tools for locally controlling temperature & humidity; plus light, human interference, pests & gaseous & particulate pollution.

But how fit for purpose are display cases & glazed frames for countering extreme & fluctuating temperature & water vapour levels, especially in view of more frequent extreme global weather events? Which types of enclosures & treatment & monitoring methods for enclosed atmospheres are presently used? Are they proven & efficient? What are their limitations & side-effects? Could advances be made in environmental control, while using green & affordable technologies? Could measurement & modelling of environments & enclosure envelopes be more widely exploited to predict and improve enclosure airtightness & conservation strategies? And can large & small museums alike deploy such approaches? This survey begins to answer these questions by taking a snapshot of the current behaviours & opinions of enclosure users. It will guide the future manufacture, testing and use of enclosures for more efficient & sustainable exhibit conservation.

E5

Risk index calculator – a software tool for a quantitative assessment of risk of physical damage to objects vulnerable to climate variations

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Sustainable indoor environmental management in museums, libraries and archives requires quantitative understanding of interrelation between the intensity of the hazard (climate fluctuations), the damage caused (cracks or deformation), and the cost of controlling the hazard. In this study, risk index calculator (RIC) has been developed for a quantitative assessment of risk of physical damage to vulnerable cultural objects. RIC analyzes the impact of specific one-year (or multiyear) temperature and relative humidity data measured in a given gallery or simulated for various climate-control scenarios. Such relative humidity and temperature histories are decomposed into elementary climatic variations using the Fourier transform. Elementary climate variations generated are used as the input into the finite element numerical simulation describing the moisture movement and the resulting strain fields in objects. A strain history engendered by the investigated microclimate is then obtained by superposition of the elementary strains. Strain cycles of various magnitudes are obtained from the strain histories and their damage potential is assessed using failure criteria derived from mechanical properties of the objects or from epidemiological studies of collections. The tool has been so far extensively tested on wood covered with decorative layers - the key representative of a complex multi-layer structure composed of humidity-sensitive materials. The RIC software is an open tool - with the research progress, the data base of the cultural heritage objects analyzed is being enlarged, in particular to encompass vulnerable library materials like parchment. This research was supported by Grant PBS2/A9/24/2013 from the Polish National Centre for Research and Development.

Materials Session

M1

Integrating Heritage Science and Academia in the USA: Consolidating and Enriching Effective Research Collaborations

Fenella France

Library of Congress

The Library of Congress's Preservation Research and Testing Division (PRTD) has long recognized the importance of engaging in ongoing collaborative heritage science research with academic partners. There are many advantages to developing and pursuing these collaborative relationships; access to instrumentation to advance specific research, access to university science students to work on research projects, and access to specific expertise not residing with PRTD staff. Additionally, these opportunities have allowed Library heritage scientists to increase knowledge and expertise, and the academic institution staff and students have benefited from teaching and training provided by Library staff, including the opportunity for students to work on an applied heritage research project. Collaboration research has also included the development of instrumentation and heritage preservation tools. Collaborative research with three academic institutions will be outlined: the University College London, Center for Sustainable Heritage, Collections Demography project, the University of South Carolina magnetic tape degradation research with development of a non-invasive assessment tool, and a research industry partner, FujiFilm, and collaboration with George Washington University Forensic Science Master's Program where PRTD staff teach on the program, and develop and supervise Master's research projects to advance students forensic capabilities and heritage science skills. Although these collaborations have unique features, they have all enabled specific materials research goals to be completed that could not have occurred with existing staffing, and have been the impetus for development of preservation tools that address serious risks to large segments of materials in our collections.

M2

The results from the cross-disciplinary research project studying the Anglo-Saxon Staffordshire Hoard

Pieta Greaves[1], C. Fern[2] , P. McElhinney[1], E. Blakelock[1], L. Miller[1]

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The discovery of the Staffordshire Hoard in 2009 led to the development of a cross-disciplinary programme to conserve research and disseminate the find. The Hoard is the largest assemblage of 7th century Anglo-Saxon gold and silver objects to be discovered, consisting mostly of battle regalia.

The research carried out has built upon previous work, by various scholars and academics, studying Anglo-Saxon objects from the Sutton Hoo burial, the composition of the precious metals used, the types of pastes used under the garnet cloisonné work, and the nature of the glass and niello used. However, the integrated nature of the work is also uncovering new secrets of the Anglo-Saxon craft-workers, such as the identification of deliberate surface treatments, the organic pastes used to fix the sword fittings in place and a new type of decorative inlay. It is also shining new light on Anglo-Saxon art styles and continues to improve our understanding of society in the period. Throughout the research project the Staffordshire Hoard has been on display to the public at four locations, therefore, in addition to the academic research and dissemination, there has also been a concurrent public outreach programme.

This presentation will outline the unique nature of the Hoard research project which has drawn on specialists in the fields of archaeology, conservation and material science to work together on the project Contextualising Metal-detected Discoveries: the Staffordshire Anglo-Saxon Hoard. Funded by Historic England, Birmingham Museums Trust and the Potteries Museum & Art Gallery, Stoke-on-Trent, on behalf of their respective city councils who acquired the Hoard.

M3

How to address the risk assessment of salt laden building materials of archaeological sites?

Hilde De Clercq, S. Godts

Royal Institute for Cultural Heritage (KIK-IRPA)

Crystallization of salts is a major factor in the degradation of porous materials in built heritage. In the absence of a liquid moisture source crystal growth in a porous material is always the result of a phase transition reaction induced by changes in temperature or relative humidity. Hence, unfavourable environmental conditions may cause repeated cycles of deliquescence-crystallization, which can lead to the decay of building materials.

Most of the literature on the subject however deals with single salts. Situations get more complicated if one passes from single salts, of which the deliquescence points are well documented, to real practice situations characterized by a complex mixture of ions for which the prediction of the behavior of salts is complex.

The assessment of the critical environmental conditions of salt laden porous building materials, and hence potential risks of salt damage, requires the knowledge of the thermodynamics of the relevant phase transition reactions. For that, a computer program ECOS (Environmental Control of Salts) is used capable of predicting the crystallization behavior of salt mixtures and hence environmental conditions to minimize salt damage. The output enables the user to determine 'safe' ranges of relative humidity and temperature in which phase transitions are kept to a minimum.

In this contribution, the results of some archaeological built constructions are discussed such as, the ice houses of Oudergem and the Coudenberg archaeological site in Brussels. The experimental determination of the salt content of building materials is dealt with, in the framework of a proper rehabilitation project and a prediction of the behavior of the salt mixture related to the climate.

The Use of VOC Analysis in the Care of Modern Materials

M4

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The analysis of volatile organic compound (VOC) emissions as a diagnostic tool within medicine is a rich area of current research.[1] This work aims to assess the value of a similar approach to the conservation of modern materials and to explore the use of VOC emissions to diagnose the condition of modern heritage objects in collections. [2][3] VOC emissions from over 200 plastic and rubber objects have been analysed using solid phase microextraction gas chromatography mass spectrometry (SPME-GC/MS), including artificially and naturally aged objects. VOCs relevant to material degradation have been detected from many objects and the way in which detected levels of degradation products change following artificial degradation is shown. These results are related to visible evidence of deterioration. Multivariate data analysis has been used to explore how combinations of VOCs can be used to distinguish between objects in different conditions. The practical application of this research to the analysis of real museum objects will be demonstrated, through the example of work done in collaboration with the Museum of London. SPME-GC/MS analysis of plastic objects from the Museum's collection was performed on-site and in the laboratory.

[1] C. Di Natale, R. Paolesse, E. Martinelli, and R. Capuano, "Solid-state gas sensors for breath analysis: a review," Anal. Chim. Acta, vol. 824, pp. 1–17, 2014.
[2] G. Mitchell and L. T. Gibson, "Emissions from polymeric materials: characterised using thermal desorption-gas chromatography," Polym. Degrad. Stab., vol. 107, pp. 328–340, 2014.
[3] K. Curran and M. , "Polymers and Volatiles: Using VOC Analysis for the Conservation of Plastic and Rubber Objects," Stud. Conserv., 60(1), pp. 1-14, 2015.

M5

A non-destructive method for assessing the degradation of wool yarns within historic tapestries in situ

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Tapestries are unique from other textiles as the image portrayed in a tapestry is inherently embedded within the tapestry's structure. It is the mechanical strength of the weft yarns which will ultimately determine its ability to sustain its own weight while hanging on display. Therefore the ability to assess the strength of weft yarns quantitatively and without the need for sampling would benefit conservators by providing consistent measures of condition. This project used NIR spectroscopy to enable analysis to be not only non-destructive but also to be carried out in situ.

A predictive model was created using the PLS method which calibrated the specific stress (N/tex) values of 139 historic tapestry samples with their individual NIR spectrum. The accuracy was evaluated using an independent validation set of a further 63 tapestry samples. The difference between the actual and predicted strength was on average 0.011 N/tex. The model was then successfully applied to the prediction of specific stress across a whole tapestry while ¬it was hanging on display at Hampton Court Place. It presented a convincing pattern of weaker yarns towards the top of the tapestry. This was in agreement with previous research that suggests yarns at the top of a tapestry will experience most strain as they have to carry more weight.

This research has indicated the potential of NIR and predictive models in providing a tool for qualitative condition assessment without the need for sampling or removal from display. Inevitability due to the novel nature of this research some yarns presented difficulties for the prediction, yet overall this has led to a greater understanding of the capability of NIR for the assessment of wool yarns and areas of further research have been identified.

Geomorphology and conflict; getting to the bullet point

M6

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WWI is currently a vivid topic in the British media, as this year marks one hundred years of recovery, relapse, and remembrance. However, damage to the built environment created through armed conflict continues to be an under-researched subject, particularly within weathering studies; bullet holes, shrapnel impacts and other damage to stone surfaces are visible in buildings around Europe while newspaper reports show the extensive damage currently inflicted in Syria, yet we know nothing of the long-term weathering of these sites. Here we present the results of a study into the effect of impacts on stone surfaces and subsequent deterioration.

A field study was carried out at the Complutense Universidad, Madrid. The campus was assaulted 15- 18 November 1936 in the Civil War, soon after the buildings were finished. In this study, we focused on the window ledges of the School of Medicine, built with “Almorqui” sandstone. We measured Ultrasound Pulse Velocity and rebound hardness over impacted and non-impacted areas to assess stone matrix deterioration.

We found that both fracturing and compaction of the impact areas takes place, creating a complex environment for weathering processes. We therefore carried out laboratory tests to investigate the micro-morphological impact of artificially created bullet holes. .22 calibre bullets created small-scale impact areas which were monitored using surface hardness, internal moisture cycling, and thin section microscopy to assess point-specific deterioration and response to environmental change.

This novel approach to weathering studies not only addresses an increasingly urgent problem but also opens up a new and timely research field.

M7

Biomolecular codicology: Illuminating the hidden secrets of parchment through non-invasive techniques

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In an ever more digitally centred age the importance of using primary sources is often overshadowed by the need for preservation. The debate as to whether destructive sampling is ethical is still ongoing but has spurred the development of less destructive or even non-invasive techniques.

The potential information to be obtained from the large corpus of codices and documents written on parchment is immense. Aside from the obvious textual information that is the object of study of paleographers, there is a wealth of biomolecular information trapped in the fibres of the parchment itself. By analysing the collagen that forms the basic structure of skin we can determine what animal was used to make the parchment and even assess its quality.

In collaboration with conservation staff at the Borthwick Archive at the University of York, we have developed a non-invasive method for sampling parchment. Using conventional conservation erasers we are now able to 'dry sample' parchment in situ using a non-invasive procedure that requires no specialist training. From the eraser waste collected we are able to extract minute amounts of collagen, sufficient to be analysed by mass spectrometry.

The implications of such advances spans both humanities and science. Until now the identification of the animal origin of many manuscripts has often been contentious or uncertain, depending of the skill of those trained in follicle pattern analysis. Our new technique can offer new, objective, unbiased evidence for species identification of parchment. The importance of this technique can be shared both by national repositories as well as local archives, whose boxes of parchments were most likely written on skins from local herds and flocks and could hold significant biological value.

Automatic generation of complex reaction networks for oil paint modelling

M8

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A dynamic and quantitative model of chemical and structural changes occurring in oil paint networks would be a useful tool to make predictions about how museum environments and treatment interventions impact artworks on time scales not easily observed in lab. A microkinetic model built from elementary steps allows changes at the molecular level to be connected to macroscale properties of interest and is easily extensible to various conditions. However, building such a model requires thorough knowledge of species and chemical pathways involved, often on the order of 10^4 for autoxidative systems. We have constructed a model containing 160 unique species and 400 reaction channels which recapitulates early curing behavior of oil-based coatings such as the production of hydroperoxide intermediates and mass uptake by the paint film model system. To capture late stage curing and degradation behavior, we have assembled an expanded reaction network using the computational tool NetGen to automatically generate species from a set of reaction rules based on permissible types of chemistry. Additionally, we have addressed the challenge of determining kinetic parameters for such a large reaction network by utilizing kinetic correlations and calculating parameters not available in the literature from first principles and transition state theory to ensure a fundamental basis for evaluation of the mechanism. Mathematical modeling has traditionally been overlooked in the field of cultural heritage science, but the computational approach described here presents a critical new tool to develop comprehensive models of oil paint networks so as to deeply enhance our understating of the temporal evolution of these systems, as well as to advance our ability to treat and preserve oil paint films.

Gel Cleaning: What is happening at the interface?

M9

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An increasing number of gels are being introduced to the conservation community as a means to deliver liquids to the artwork surface during cleaning treatments in a controlled manner. A primary concern is the ability to limit the diffusion of the gelled liquid both laterally and orthogonally so as to affect only the targeted area and to reduce the deposition of residues from the gel network on the treated artwork. Both factors depend on interactions between the gel system and the artwork surface – a topic which has largely been unexplored.

Most gel systems used in conservation treatments are composed of networks of polymers which have reactive functional groups and polyelectrolitic character. Due to the dynamic nature of soft matter systems, the macromolecules of the gel network will orient themselves at the artwork interface to maximise favourable interactions, a process which may aid solubilisation or affect the rate of solvent ingress into the artwork surface.

This paper will present the use of sum frequency generation spectroscopy to investigate the interfacial interactions between surfactant-containing acrylate films and hydrogels. Initial results show that we are able to probe the surface coverage of surfactant on the film and detect its removal by the gel. Preferential alignment of the gel polymer at the interface and the presence of 'ice-like' (highly ordered) water trapped between the gel and the surface have also been observed. By studying effects on the rates of liquid diffusion into the bulk paint film as a consequence of changing surface interactions and molecular ordering, we can begin to understand the role of the gel network in the solubilisation process.

M10

Reconstructing Ferdinand Bauer's Lost Colour Chart using Portable Raman Spectroscopy and Visible/VNIR Hyperspectral Imaging

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Outside of the natural sciences, the work of Ferdinand Bauer (1760-1826), the preeminent natural history painter is little known. However, his botanical paintings on paper are considered to be among the finest in the world. Of particular interest is his unusual drawing and painting technique, recording colour in the field by annotating his sketches with numerical colour codes, to be painted later by referring to a colour chart. The Bodleian Library holds all of Bauer's original watercolours and annotated field sketches for the lavishly illustrated Flora Graeca (1806-40). However, the crucial key to his technique, the colour chart, has been lost. A three-year Leverhulme Trust research project at the Bodleian focuses on the analysis and identification of Bauer's watercolour palette, with a view to creating a historically accurate reconstruction of his lost colour chart, ultimately achieving a greater understanding of how he achieved such a high level of colour accuracy in his work. Analysis of the watercolours presents a number of challenges. They are of large dimensions and bound in sizeable volumes making access to sample sites difficult. Also Bauer used lake pigments and other organics extensively, which are often difficult to positively identify. However, a new collaboration between the Bodleian and Durham and Northumbria Universities has enabled experiments with a portable Raman spectrometer to be carried out, allowing unequivocal identification of pigments to be made in situ. Used in conjunction with Vis/VNIR hyperspectral imaging, it allows for the identification of a wide range of pigments used by Bauer. The paper will discuss recent results from this project, and the challenges involved in the analysis of 18th century watercolour pigments using these techniques

Poster Session

P1

A Diagnostic Survey for Cultural Heritage Protection, Preservation and Documentation based on Non Destructive Techniques

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All projects regarding reuse and rehabilitation of cultural heritage assets require a thorough investigation of their preservation state. Current condition diagnosis is achieved through a standard diagnostic methodology performing overall documentation, visual observations, materials characterization, in situ decay and damage mapping with the aid of NDT, in-lab study of the decay products and mechanisms, assessment of the structure's pathology and impact of various environmental factors, in order to decide upon the most appropriate conservation policy to be followed. Non-destructive techniques constitute a significant tool of the integrated diagnosis, revealing various decay phenomena that develop at the interface of materials with the environment or at the interface of materials with other materials, as a function of intrinsic and extrinsic factors.

In this work, the results coming from a diagnostic survey regarding materials decay on Architectural Surfaces (Frescoes) and Historic Structures (Masonries, Arches etc.) and an assessment for incompatible materials and conservation interventions is being presented for the Asinou Church (http://www.byzantinecyprus.com/); the first case study of ITN-DCH (www.itn-dch.eu). The Non Destructive Techniques employed to make the measurements were the Infra-Red Thermography (IRT) and the Fiber Optic Microscope (FOM). Both techniques are widely used to study the murals' surface for the detection/identification of initial wear or decay and potential incompatibility concerning intervention materials. The measurements and the processing of them revealed certain types of material decay, incompatible interventions as well as factors and mechanisms that play key role to the surfaces decay.

P2

Historical Building Information Modelling "HBIM" toward the Sustainability – Nasif Historical house case study

Ahmad Baik

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One of the most important topics over the last decade is the sustainability in the design and modern building industry. Recently, many researches have been done and focusing on using new friendly materials, which can provide the sustainability for the design and the buildings sectors. However, many of historical building around the worldwide are great example of how these historical buildings can be providing the sustainability and to be friendly with the environment. This research will focus on using Building Information Modelling "BIM" to examine one of the historical buildings in historic jeddah, Saudi Arabia as case study to find out how sustainable is with the local environment of jeddah city.

Interpreting terahertz images of ink inscriptions

P3

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Successful examples of the use of terahertz time-domain (THz-TD) imaging to extract the textual content from different layers of a document have raised the interest of archival and library conservators and curators. However, much unpublished research suggests that not all inscriptions can be revealed with THz-TD imaging, even when imaging single sheet documents. It is not always clear whether the lack of contrast in some terahertz images is due to the sensitivity of the specific THz-TD imaging system and configuration used, or the chemical composition and physical structure of the document. There is a need for deeper understanding of how terahertz pulses interact with different inks and supports, in order to define when THz-TD imaging can be a non-invasive alternative to current digitization processes, and which particular terahertz imaging technique is more likely to give well-contrasted images of a specific document.

P4

Damage assessment of parchment: a novel diagnostic approach at the nanoscale based on Atomic Force Microscopy and Localised Thermal Analysis

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The preservation of parchment artefacts represents a significant challenge for conservators due to the extreme sensitivity of this material to environment changes (fluctuation in temperature, humidity, level of organic compounds). Historical parchments are complex materials in terms of conservation strategies as deterioration cannot always be detected by the naked-eye or at the mesoscale. Thus, inappropriate conservation treatments or storage conditions may lead to further degradation of the artefacts.

Conservation of Cultural Heritage is benefitting from the translation of analytical tools and information acquired from other scientific fields. The application of Atomic Force Microscopy (AFM) and Localised Thermal Analysis (LTA) has brought greater understanding of the structure, mechanical properties and degradation pathways of collagen at the nanoscale. Thus, a new class of diagnostic techniques is now available for conservators to investigate the state of degradation of parchment artefacts without compromising the artwork itself.

Combining the nanosampling approach designed by Larsen with AFM and LTA, it is possible to have a complete understanding of the state of degradation of parchment at the level at which physical deterioration starts occurring as a result of chemical and other breakdown factors. A modern parchment and seven historical parchments were used in this study. A new protocol has been designed to evaluate the damage of collagen at the nanoscale, based on a quantitative analysis of the AFM and LTA data. Both techniques proved to be effective tools to assess damage in historical parchments since a small amount of sample is required, and they have also been successfully applied to study the impact of new conservation approaches designed for parchment.

P5

Documenting a 19th Century British Painting Using Multispectral and Computational Imaging

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The recto and verso of a lined 19th century British landscape painting were documented using a combination of portable digital technologies. Documentation of the recto consisted of Reflectance Transformation Imaging (RTI), photogrammetry, and multispectral imaging (ultraviolet reflectance and fluorescence, visible, and infrared reflectance). Documentation of the verso consisted of photogrammetry and transmitted infrared (IR) imaging to look for canvas-maker's stamps and other features on the original canvas that could be correlated with a date when the canvas was supplied. Close-range photogrammetry generated a calibrated three-dimensional (3D) surface model of the recto and verso of the painting, allowing high-resolution multispectral image cubes to be stitched into complete orthorectified images for each waveband. Transmitted IR images of the verso revealed two canvas-maker's stamps that were partly obscured by the horizontal cross-brace of the stretcher. To allow more detailed comparisons and measurements of the canvas stamps, registered visible and transmitted IR images of the canvas were aligned with the 3D model. A transmitted IR orthophoto of the verso was exported from the 3D model, allowing measurements of the outer dimensions of the stamps to be taken. Additional transmitted IR images were captured with the camera positioned at an angle above and below the stretcher's cross-brace to capture more of the obscured text of the stamps. The distortion-corrected images of the stamps were stitched together for archival purposes and to allow detailed study and comparisons between the two stamps. The stamps identified the name and location of the canvas supplier in London and established a date range for when the original canvas was supplied (1834 to ca. 1860).

Dust in the Old Library, Trinity College Dublin – rubbing salt into the wounds

P6

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Trinity College Dublin

As an iconic building type The Old Library, Trinity College Dublin has multiple values. For its collection of books and manuscripts, the Old Library is a both a repository and a display case.

For the people who use it, the Old Library is both a place of work and a place of recreation. The existence of pollutants, their dispersion, character and source are being explored through an ongoing programme of risk analysis for the collection and the Old Library. Dust is the stuff of life (and of decay). It is created, moved around, and removed. Or moved around again.

Dust in the Old Library needs to be managed. For practical and aesthetic reasons its removal is desirable although it is damaging to maintain a continuous programme of cleaning. For the preservation of the collections the dust in the Old Library is potentially deleterious and controls are needed to moderate its impact. Studies of this persistent pollutant are ongoing and a picture is emerging through the use of various techniques including XRD, XRF, SEM-EDX, Raman and infrared spectroscopy.

Dust accumulation appears to be influenced by the time of year, and associated events. The building as a leaky envelope has been established, and the incursion of large volumes of dust from external sources is clear. Most significantly, salts are a pervasive component of both historic and contemporary dust. Now that we know what's peppering the collections, the challenge is what to do about it.

P7

Integration of New Materials Based on Chitosan Derivatives and Plasma Technique in Sustainable Solutions for Paper Heritage Conservation (PAPHERCON Project)

Elena Bobu

"Gheorghe Asachi" Technical University, Lasi, Romania

PAPHERCON project aims to develop and implement an innovative method for paper heritage conservation by combining cold high frequency (HF) plasma as decontamination technique with chitosan derivatives (ChDs) as strengthening and protective materials. The project has a multidisciplinary consortium that brings together experts in paper engineering, paper heritage conservation, polymer chemistry, plasma physics and equipment engineering.

The poster presents a summary of midway results. First, several studies on model paper allowed us to identify optimal combinations of ChDs that improve paper strength properties important in conservation (e.g. up to 250% increase of folding endurance), reduce 2-3 times water absorption capacity and inhibit both bacteria and fungi growth. Secondly, an exhaustive study was aiming to analyse the influence of plasma parameters (gas type - N2 or Ar:O2=90:10 and treatment time) on decontamination effectiveness and paper properties. The results have shown that full decontamination requests long treatment time for both gases, which results in paper desizing and strength decrease. Therefore, a new plasma generator was design to achieve full decontamination with minimum impact on paper strength. The integration of plasma treatment with ChDs coating was evaluated on model and natural aged paper and results evidenced a higher increase of strength indexes than simple coatings, without affecting the potential of ChDs to develop barriers against humidity and microbial attack

Acknowledgment: Romanian Government and UEFISCDI Agency are acknowledged for funding PAPHERCON project in the frame of national research programme PN-II-PT-PCCA-2011-3.2-1281, Grant Agreement 221/2012.

Modified nanolimes dispersion: structure and colloidal stability

P8

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An important part of the Built Heritage is made of calcareous stone and lime-based plasters and renders. When exposed to weathering, these materials may suffer from several degradation processes. Decay patterns, as powdering and/or sanding, can arise and induce a loss of cohesion. Consolidation treatment is a common practice to restore degraded historical materials. Nevertheless, when considering calcareous materials, there is a lack of efficient and compatible consolidants.

Nanolimes, i.e. colloidal dispersions of calcium hydroxide, intend to overcome the limitations of traditional consolidants and have demonstrated to properly recover the superficial decohesion. However, nanolimes do not always guarantee a in depth consolidation, necessary e.g. in the case of decayed stone or render. In fact, the high kinetical stability and volatility of the nanolimes inhibit the phase separation of the lime nanoparticles from the alcoholic solvent. A modification of the solvent appears a promising strategy to enhance nanolime deposition in depth. The aim of this research is to study the behaviour of new nanolimes, dispersed in ethanol, isopropanol, butanol or water.

The nanosize and morphology of the nanolimes were assessed by SEM-EDS and DLS, and the kinetical stability studied by Uv-Vis spectroscopy; the absorption and drying kinetics of the new nanolimes, applied on Maastricht limestone and lime-based mortars, was measured.
The SEM-EDS observations and the DLS analyses show that lime nanoparticles have rounded to hexagonal shape and nano to submicrometric size (70 to 500nm). Compared to nanolime dispersed in ethanol, the new nanolimes in butanol and water have lower kinetical stability and faster drying rate. This is expected to favour the precipitation of nanoparticles in depth.

Non-destructive Material Characterisation of Chinese Paper

P9

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Many institutions across the globe hold large Chinese collections, however to date there has not been a systematic study of the material properties of modern Chinese papers and how they age. The material properties of a paper directly affect its permanence, and by understanding the chemical composition, the process of degradation can be significantly slowed down and suitable conservation methods developed. Traditionally, destructive tests have been necessary to establish these properties, however using Near-IR Spectroscopy (NIR) a non-destructive approach has been developed.

Building on the body of research where NIR has been used on large collections of Western paper and Islamic paper, material properties such as pH, degree of polymerisation, fibre composition, elemental composition, and mechanical properties, are being determined on a large reference collection of 19th and 20th century (modern) Chinese papers. Using a multivariate calibration method (PLS), the analytical data can be compared with the NIR spectral data and quantitative non-destructive methods of material characterization can be developed and applied to unknown Chinese paper collections.

It has so far been established that papers from the reference collection do not follow the typical acidity patterns of modern Western paper, which is likely to lead to higher chemical stability of Chinese paper. However, some standard test methods e.g. mechanical testing, need to be adapted significantly due to the extraordinary thinness and heterogeneity of composition of some traditional Chinese papers. This shows how diverse and still relatively unknown a material paper still is, despite its ubiquity.

The presentation will discuss the results to date, including historical and modern papermaking processes, pH and DP.

P10

Are limestone samples good indicators of the effectiveness of shelters for stone conservation at archaeological sites?

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Shelters are structures built over archaeological sites. They can slow down stone deterioration by reducing direct solar radiation and rain. They can, however, also negatively affect the preservation state of remains, as has been shown for mosaics for example (Stewart et al., 2006). This paper evaluates a novel method to assess the effects of shelters on the preservation of archaeological sites by quantifying stone deterioration rates and processes of limestone indicators located inside and outside of the shelter at two case study sites. Assessment is based on monitoring dry weight, elasticity, surface hardness, ultrasonic pulse velocity and surface colour of Globigerina and Coralline limestone samples. These were located both inside and outside the lightweight open shelters at the Bishop's Palace (Witney, England) and Hagar Qim (Malta) from August 2013 to July 2014. In addition, ambient and surface temperatures as well as ambient RH were monitored simultaneously using small and discreet data loggers. Results indicate that this approach can be an effective way of assessing the influence of shelter on stone breakdown, and allows comparative analyses between different environments.

P11

Using Micro-scale chambers/thermal desorption for the sampling and analysis of VOC and SVOC from material used in museum cabinets

Hannah Calder, C. Widdowson

Markes International

This paper discusses the evaluation of volatile organic compounds (VOCs) released from museum display case construction materials as these compounds might have an unfavourable impact upon the condition of the artefacts kept inside them. Generally, museum artefacts are protected against many environmental factors such as dust, excess moisture, exhaust gases, cigarette smoke, spores, pollen, smoke particles, and VOCs from skin and breath. These artefacts were thus placed inside airtight display cases that had limited air exchange rates.

However, the purpose of protecting the artefacts is complete only if the materials used in the display case are low-emitting. Otherwise, overtime VOCs accumulate and cause damage to the artefact. The other complication is that certain artefacts themselves emit harmful chemicals such as acetic acid, nitrogen dioxide, formic acid, and formaldehyde (all are corrosive to metals), calcareous objects, and cellulose-based artefacts such as paper.

Thus, the need to identify the chemicals, residual solvents in materials, and semi-volatile pesticides used for pest control is essential. There is a demand for quick processes for testing as well as some formal standards that can be adhered to when testing all the above-mentioned harmful effects. One such standard testing method is the BEMMA assessment scheme. This methods utilises micro scale chambers and thermal desorption GC/MS instrumentation, and will be described in this paper.

P12

The Cleaning Heritage project: Durability of anti-graffiti and self-cleaning coatings for their implementation in the protection of cultural heritage

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Graffiti and soiling put built heritage in danger. Not only do they cause aesthetic damage themselves, but also the cleaning methods used to remove them alter material surfaces and can facilitate the penetration of paints and dirt (both at present and in future).

Prevention of graffiti and soiling with protective treatments could be an effective solution considering that both technical and financial resources for conservation of Cultural Heritage are limited. Anti-graffiti coatings prevent paint adhesion by generating low energy surfaces, whilst self-cleaning coatings decompose air pollutants and hamper dirt adhesion due to the photocatalytic effect of TiO2 nanoparticles. Such products have not been extensively developed for historic substrates because of the special requirements they must fulfil: efficient protection with minimal modification of the surface and without promoting future damage.

The EU FP7 Marie Curie IEF Project “Cleaning Heritage” aims to extend the current, limited knowledge of the performance of both types of products on natural stone and concrete under realistic conditions in order to evaluate their role in the conservation of built heritage. This two year project is based at the Oxford Rock Breakdown Laboratory, SoGE, University of Oxford and is testing the durability of a range of coatings along periodical painting/cleaning cycles in a climatic chamber and at a field site at Wytham Woods.

Testing of the coatings in the lab and field follows a standard approach: environmental conditions will be monitored, superficial properties of the materials before and after being coated, weathered and painted/stained such as colour, roughness, contact angle, chemical composition… will be determined, enabling the efficiency of the treatments to be evaluated.

Characterization of semantic relations in Medieval Illuminations

P13

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This presentation focuses on medieval history, visual arts, and knowledge engineering. From the cultural heritage of the Middle Ages, this collaborative work raises on the medieval illuminations as representations of knowledge. Medieval Illumination refers to symbolic and graphic representation of a context-sensitive knowledge constantly in evolution. To model this type of context-sensitive system, our approach is based on web semantic technologies, especially ontology.

Ontology is considered here as an explicit specification of a conceptualization. From this specification, a decidable system can be developed to help in the analysis, classification and better understanding of the story told by the medieval illuminations.

The hypothesis is based on the fact that the polysemous properties of the medieval images provide the potentiality to translate and to visualize many significant relations into ontology. The interdisciplinary method is to characterize semantic, taxonomic and lexical relations from medieval system of representation for the implementation of an ontology dedicated to medieval illuminations knowledge. The integrative methodology relies on the visual, semantic and symbolic properties of the medieval illuminations. Painted in manuscripts, these pictures are realised within programmatic networks of thematic, symbolic, cultural relations. Their significant potential evolves in relation to the different contexts.

Purposes. From the interface between the medieval cultural heritage in visual arts and the semantic intelligence research, the shared task aims to characterize and classify semantic relations. The underlying industrial goal is the development of a new approach to represent social-network knowledge as a graphical “Modern Illuminations”.

Does ivy protect stone from frost? An experimental evaluation

P14

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Ivy growing on historic walls and buildings is often considered a conservation problem. In many cases this is justified, yet recent efforts have been made to untangle the varied roles that ivy can play, both good and bad. Such a balanced approach is important if heritage asset owners are to make informed decisions about when, and when not, to undertake costly maintenance interventions. One potentially positive role of ivy is its ability to buffer against frosts, yet the implications of this for actual stone breakdown rates have not yet been assessed.

Based on field monitoring at a test wall in Oxfordshire, England, we designed a laboratory experiment to assess whether the influence of ivy on the frequency, magnitude ('hardness') and duration of frost events might have implications for stone deterioration rates. Samples of Elm Park limestone were exposed to two different accelerated thermal regimes in a climatic chamber ('bare stone' and 'ivy-covered'). After a 6-week period (roughly 170 cycles) the rate of debris release and weight loss was significantly lower for samples exposed to the 'ivy-covered' regime; 'bare stone' samples lost an average of 0.26 ± 0.04 g (n = 5) compared to 0.19 ± 0.03 g (n = 5) for 'ivy-covered' samples, a difference of about 31% (Student's t = 3.63, d.f. = 8, p = 0.007). Whilst these values represent relatively small losses, supplementary measurements of surface hardness (using an Equotip device) and ultrasonic pulse velocity, and microscope observations, further indicate differences in the degree of breakdown for 'ivy-covered' samples. The implications of these results for stone heritage conservation require careful evaluation, but our data demonstrate how previously implied protective roles of ivy can occur with respect to frost damage.

P15

Remote sensing in Digital Cultural Heritage: Where can we go from here?

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As the appeal to apply remote sensing to cultural heritage documentation increases, so too do the ways in which it's use matures. However, a crucial point must be raised towards its role in the holistic framework currently being developed by the ITN-DCH project. Using different examples and contexts to best illustrate the advantages and future challenges, this presentation will offer recommendations for this emerging field of research specifically from the perspective of archaeology.

From moveable objects to modified landscapes, scale will continue to be a challenge and demand distinct acquisition schemes. Furthermore, from deserts to tropical forests and everything in between, environmental conditions determine the most appropriate ways remote sensing may be implemented.

As archaeological projects begin to employ technology in unique ways, decision on best practices should be discussed openly and widely. Where site surveys are large but can be revisited with new technology, excavations can only be done once. Our hope is to augment how research has been previously completed and the amount of documentation recorded in the future, while reducing both the time and cost of investigation.

To best demonstrate these topics, we will look through the lens of the case-study of Asinou in Cyprus, while also touching on situations in other parts of the world. We will use past research in various situations, while focusing on what can be done in the future.

Investigation of the copper age gold treasure of Hencida using analytical techniques

P16

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The Hencida treasure is one of the very first and - beside the other biggest hoards (Moigrad, Csáford, Chotnica etc.) and the well-known, extremely rich Varna cemetery - the most important evidence of the use of gold metallurgy during the Copper Age in Europe. This typologically heterogeneous assemblage - consists of 12 pendants (1 bigger disc + 11 little pendants) – was found in an Early/Middle Copper Age settlement in the vicinity of Hencida, in Eastern Hungary, in 1965.

In this work we introduce the results of investigation on the objects of Hencida treasure using several analytical techniques (Optical Microscopy (OM), Scanning Electron Microprobe (SEM), Furier Transform Infrared Spetroscopy (FTIR) and Particle induced X-ray emission method (PIXE)).

As a result we identify that the samples belong to at least 3 (or possibly 5) different groups based on their composition, which corresponds with the traditional archeological typology. The comparison of the pendants differs from the elemental composition of the gold mines in the Roşia Montana Golden Quadrangle area, which implies the possible use of the other sources of raw materials. The elemental mapping shows homogeneity in the element distribution of pendants, which may be a piece of evidence for casting. Moreover surface investigation using SEM confirm this assumption. At the same time the PIXE examinations also confirmed the production of the various pendants on different occasions and from different raw materials.

In order to install the objects into a wider range of copper age artefact, PIXE measurement was carried out on 24 Copper Age gold objects from the Gold collection of the Hungarian National Museum and 9 gold objects from the Museum of Damjanich J., Szolnok.

P17

Sensing and understanding the resilience of Scottish sandstones

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When considering the state of decay of a historic building it is often challenging to determine the progression of weathering and generate empirical data. It is therefore important to understand the extent and exact timescale of weathering processes. In Scotland, the decay of sandstone is a serious problem that urgently requires new approaches to preserve the built heritage and to reduce maintenance costs.

Our project aims to develop two new non-/minimally invasive tools to investigate this issue: a drilling tool to quantify the structural properties of the building material and a laser interferometer to do a time resolved measurement of the microscopic dilatation of the samples.

The ultrasonic drilling tool uses a piezoelectric transducer to convert electrical energy into an ultrasonic vibration. The vibration causes a free mass in the drilling tool to oscillate at varying frequencies and transmits this energy intermittently to a drill bit. The applied force needed to drill a hole of some millimetres allows the sample's structural properties to be deduced. This device utilises less force compared to current drilling systems and thus indicates changes in the porosity/durability at different depths and may even locate salt occurrence.

The laser interferometer measures path length differences of reflected beams to indicate the relative movement of a mirror attached to a sample. A precise measurement of various weathering processes will be possible. The high time-resolution of the device will allow us to investigate and ultimately distinguish the time and frequency characteristics of different processes.

Once demonstrated in the laboratory, our aim is to use the devices in the field where possible in order to predict behaviour of building stones under site conditions.

Transfer of learning between screen-based and gallery-based content: an initial study

P18

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We ran a participatory design and evaluation of a paper prototype mobile application, called Digital Islam, to engage visitors and provide additional information in the British Museum's Islamic Gallery. An evolutionary paper prototyping exercise involving 28 visitors aged 18-60 was run for 3 weeks. As visitors interacted with the paper prototype, we manipulated the prototype, observed the visitors as they interacted with it and took notes. We asked the visitors to "think aloud" while interacting with the prototype. The prototype rapidly evolved as visitor feedback was fed back into the design. Visitors usually do not receive explicit training in the use of museum applications, instead relying on tacit training that may have positive or negative effects depending on what learning is transferred. Our study appeared to show negative transfer between visitors' interactions with content in the gallery and content in the application. Visitors were asked to perform 3 tasks, finding (A) content in the gallery; (B) textual content on screen; and (C) video content on screen. Redesigns of the interface had little impact on users' performance. The order of tasks and consequent transfer of learning between them seemed to be more important. Visitors found Task B particularly challenging when preceded by Task A. When we introduced Task C between A and B, performance on task B immediately improved: users found the on screen content more easily and faster and no longer looked fruitlessly for it in the gallery. The study suggests that introducing additional content in mobile applications intended to improve the visitor experience can harm that experience without careful consideration of the tacit training and learning effects when combining content in the gallery and in the application.

Ancient Biomolecules Analysis: a valuable tool in Cultural Heritage

P19

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The modern concept of cultural heritage refers to the production of culture by a social group. Thus, the reference to the cultural value leads to the abandonment of the mere aesthetic concept toward the assumption of a conception of history and anthropological membership of the human being. Current definition of cultural heritage applied to archaeology refers to culture, whose content is customized by several disciplines: the scientific ones have led to a new approach in studying archaeological remains. Scientific surveys allow us to get a huge amount of information about the composition of archaeological materials, that could be linked to several cultural aspects. The analysis on biomolecules, such as DNA and collagen, is currently performed to support archaeological data to better understand the life condition in the past. The human skeleton is one of the archaeological material that could be scientifically analyzed to deepen our knowledge on the lifestyle of past populations. Ancient DNA analysis could aid in supporting hypothesis related to demic dynamics, sex determinations, kinship analysis and identification of several biological features roughly linked to physical characterization. The protein fraction of the bone is also useful to hypothesize the dietary habits of ancient communities through the featuring signs that food leaves on the chemical structure of bones and teeth.

Currently, we are also engaged in molecular typing of several writing media such as ancient Egyptian papyri to ensure their authenticity. The mentioned applications would represent a series of case studies to highlight the importance of a multidisciplinary approach to the analysis of archaeological materials, that is able to maximize the information about human cultural heritage.

Reversible mortar for stone repair: viscoelastic analysis of the thermal stresses

P20

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Repair of altered stone using mortar is an interesting strategy, since it avoids replacement and extends the lifetime of the original stone. However, the stresses that could arise due to a mismatch of dimensional changes between the repair layer and the stone substrate can significantly reduce the durability of the repair and affect the historical material. In this study we analyze the magnitude of the thermal stresses that originate in an acrylic-based artificial stone used for the reprofiling of natural sandstone. This kind of artificial stone has been developed in the late 70's in the Ecole Polytechnique Fédérale de Lausanne (EPFL, Switzerland) for its peculiar property of reversibility in an organic solvent. To evaluate the thermal stresses we propose an analytical solution that considers the viscoelasticity of the repair layer. The temperature profile used in the numerical evaluation has been measured at the interface between the two materials in the Catholic Church of Notre-Dame de Vevey (Switzerland), where the artificial stone has been used in a restoration campaign. The viscoelastic behavior of the artificial stone has been characterized by stress relaxation experiments in the laboratory. The analysis reveals that, on the temperature range found on-site, the viscoelasticity of the repair material allows relief of a large part of the stresses built by the thermal expansion coefficients mismatch and accounts for the durability of this particular repair material, as observed by the practitioners.

P21

A multidisciplinary approach to the care and conservation of a group of African hair combs

Pia Kristina Edqvist

The Fitzwilliam Museum, Cambridge, UK

The exhibition 'Origins of the Afro Comb, 6,000 years of Culture, Politics and Identity' was on show from 1st July to 3rd November 2013 at the Fitzwilliam Museum and the Museum of Archaeology and Anthropology (MAA), University of Cambridge, UK.

The exhibition consisted of over 200 combs from the late 19th and early 20th century CE from the collections of the MAA. This collection had never been examined from a technological point of view, assessed in terms of its conservation and preservation needs or even properly documented. To enable the collection of the maximum information about material composition, context and condition of objects, a multidisciplinary approach was adopted. A team of researchers was assembled that, included archaeologists, anthropologists, conservators, scientists, material specialists, sociologists, artists and specialists in African culture and hair. A committee of members of the U.K. African community was also integral to the planning and investigation of the overall project.

Material compositions were investigated using a wide range of analytical techniques, including fibre optics reflectance spectroscopy (FORS), X-ray fluorescence spectroscopy (XRF), X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FT-IR). The characterization of the materials of the combs has contributed to the study of technology, provenance and history of the use of the combs and has provided information on their state of preservation. This also helped inform decisions on display and future care and storage of this collection of objects.

P22

The Use of VIS-NIR Fibre Optic Reflection Spectroscopy (FORS) in the Speciation of Wood: Potentials and Problems in the Analysis of African Hair Combs

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In 2013 The Fitzwilliam Museum and The Museum of Archaeology and Anthropology mounted a major exhibition of combs from Africa ('Afro combs'). Prior to exhibition, the collection of over 200 combs was subjected to a detailed technical analysis, both for conservation purposes and to understand the technical aspects of their construction.

The majority of the combs, originating from western Africa and mostly 19th to early 20th century CE in age, were manufactured from single individual pieces of wood. The aim of this study was to determine the range of wood types (species) used in their construction.

Methods for speciating wood involve the examination of gross morphology and the taking of thin sections. In the case of the Afro combs, visual inspection was complicated by patinas and other surface characteristics of the wood. The physical removal of even small samples was not permissible. UV-VIS-NIR reflection spectroscopy using fibre optic probes (FORS) is a non-destructive, minimal contact analytical technique widely used in the wood and timber industries for many purposes, including speciation.

An appropriate range of sample woods were sourced from colleagues in western Africa. It was not usually possible to identify the comb materials by simple visual comparison of spectra – chemometric techniques based on principal components analysis, were required. The best results were obtained using simple reflectance (i.e. untransformed, non-derivative) measurements and full spectrum matching over the region 1010 nm – 1790 nm. Initial results were promising and demonstrated the effectiveness of the technique but the limited number of standards available was a major limitation as were surface treatments applied to some of the combs.

Neutrons and music: Imaging investigation of ancient wind musical instruments

P23

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A set of seven musical instruments and two instruments cares from the 'Fondo Antico della Biblioteca del Sacro Convento' in Assisi, Italy, were investigated through neutron and X-ray imaging techniques. Historical and scientific interests around ancient musical instruments motivate an intense research effort for their characterization using non-destructive and non-invasive techniques. X-ray and neutron tomography/radiography were applied to the study of composite material samples containing wood, hide and metals. The study was carried out at the NEUTRA beamline, PSI (Paul Scherrer Institute, Switzerland). Results of the measurements provided new information on the composite and multi-scale structure, such as: the internal structure of the samples, position of added materials like metals, wood fiber displays, deformations, presence of adhesives and their spatial distribution and novel insight about construction methods to guide the instruments' restoration process.

P24

The National Monument in memory of Francesco Baracca in Lugo di Romagna (Ravenna, Italy): materials, techniques and conservation aspects

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This poster will briefly report the results of scientific analyses made on the National Monument in memory of Francesco Baracca (a captain of the Italian air force), located in Lugo di Romagna (Ravenna, Italy). Created by the artist Domenico Rambelli in 1936, this Monument is considered to be one of the most relevant icons of monumental Italian 20th century architecture. The whole structure has an extension of 1.040m2 and it is an assembly of: a stepped base, a colossal airplane wing and a bronze statue, representing the aviator, standing on a cylindrical pediment. Excluding the statue, the Monument is entirely made of Travertine. Scientific analyses were directed to support the first significant restoration work (held in 2014) concerning the Monument. Firstly, a preliminary naked eye observation was combined with mineralogical (XRD) and chemical (micro-chemical spot tests) analyses to localize and characterize the degradation pathologies affecting the surfaces, indicative of ongoing phenomena. Then, a multi-analytical approach (RLM, SEM/EDS, μ-FTIR) permitted to characterize the materials and techniques used by the artist to obtain different kinds of surface finishing, emphasizing specific parts of the Monument so to achieve well-defined optical effects. Finally, VIS-RS, RLM and SEM/EDS investigations were performed to evaluate the application of a surface coating recently introduced and tested in the field of Cultural Heritage, the titanium dioxide in nanoparticles. In conclusion, the project, besides being a valuable support for the restoration, represented an occasion for studying an eminent artistic product of an epochal monumental architecture, symbol of recent history now deserving a renewed attention.

P25

Architectural paint research and cultural built heritage – how material science informed the conservation-restoration of the Robert Adam Library at Kenwood

Meredith Freeman

University of Lincoln, UK

The number of heritage buildings requiring conservation is increasing due to many reasons: industrial buildings no longer fit for purpose; ecclesiastical buildings not used by the community; increased awareness of built structures as cultural heritage. In order to get best value from taxpayer money in this environment of increasing demand, organisations funding heritage conservation require applicants to identify the importance of the built heritage, show outcomes that positively impact on the community or heritage as a whole, and demonstrate a strategy that will sustain those outcomes into the future.

Architectural paint research (APR) combines the empirical information gathered from scientific analysis of material evidence (paints, binders, varnishes, renders) with archival evidence (architectural designs, tradesmen accounts, personal journals, public documents) to support an archaeological approach to the conservation-restoration of cultural built heritage (CBH).

My presentation will explore how APR influences the conservation of built heritage, how it constitutes another vocabulary that can contribute to the historiography of CBH, and provides a material vehicle for collaboration between funding bodies, vested stakeholders and the general public. The presentation will review two case studies in particular: a community-led project to conserve and repurpose a remote Cumbrian mining village Chapel located in Nenthead, and a government-funded restoration project of Kenwood, an established English Heritage property located on the outskirts of London.

A collaborative approach to evaluate cleaning protocols for museum plastics

P26

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As one of the world's foremost museums dedicated to art and design, the Victoria and Albert Museum (V&A) counts a large number of plastic artefacts among its collections. These range from the first synthetic plastics to contemporary works. It is recognised that these polymeric artefacts behave differently to more traditional materials and they can experience severe and sudden degradation. It is therefore unsurprising that conservators are interested in how best to preserve the numerous and diverse plastic artefacts in their care.

Cleaning is one of the most common interventive treatments and is performed both to preserve the appearance of the object and to maintain its stability. However the act of cleaning can potentially cause damage to the artefact, either immediately or at a later date. This is the focus of a collaborative project being undertaken by the V&A and Imperial College London, which aims to look for changes occurring on the surface of polymeric substrates after undergoing cleaning treatments commonly used in conservation. The relative efficacy of these cleaning treatments is also being studied.

Advanced surface analysis techniques, including time-of-flight secondary ion mass spectrometry (TOF-SIMS) and white light interferometry, have been used to examine polymeric substrates for changes resulting from the application of cleaning agents or from mechanical action. This work will report on some of these findings and on the use of chemometric techniques to identify contaminants and residues present on the surface before and after cleaning. The very high sensitivity of TOF-SIMS combined with principal component analysis enables trace amounts of these contaminants to be detected. The physical changes to the substrates will also be discussed.

P27

What makes a good repointing mortar for damp towers? Characterisation of the hygric properties of lime-based mortars

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Moisture is the most common agent of degradation in historic buildings, leading mainly to structural disruption, biological growth and dampness. Moisture mainly enters through joints by capillary absorption. Overtime, repair interventions of re-pointing have used impermeable mortar, such as cement, that trapped moisture inside the wall. In being softer, more porous and more permeable than the historic masonry, a repair mortar acts as a sacrificial material preserving the stones and has physical and mechanical properties that are compatible with the surrounding stones. For this reason, lime, a breathable and permeable material, was traditionally used.

11 mixes of mortar were designed using different types of lime: non-hydraulic lime, under the form of lime putty and quicklime, used in hot lime mixes (HLM), and natural hydraulic lime (NHL). Because their setting and carbonation differ, the performances of the hardened mortars vary. Wood ash was also used in some mixes as a pozzolanic additive.
The hardened mortars were tested at ageing of a 100 days. Prior to the application in-situ, criteria of evaluation have been formulated based on a specific problem: mitigating driving-rain ingress in damp towers through pointing mortar. Hence, the capillary absorption coefficient, the permeability and of these different lime-based mortars were evaluated. Physical characteristics contributing to the permeability such as hardness, open porosity and pore size distribution were also assessed.

Combining laboratory experiments, on-site monitoring and understanding of masons' workmanship, this research provides fundamental understanding of the hygric properties of different types of lime and the effect of the addtive of wood ash.
Characterising these materials will inform the future design of repair mortars. It will also ensure that repair interventions, conducted by experienced masons, contribute to a better preservation of historic masonry at risk, especially church towers.

Object lighting in the British Museum

P28

Daniel Garside

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The British Museum is home to some of the most important and impressive historical artefacts on earth. Caring for them and displaying them so that they may be shared with the public involves difficult compromises, balancing care for the objects and accessibility of the public. Here I consider specifically the lighting considerations undertaken, with a focus on the colour appearance of objects and how this relates to visitor satisfaction.

Conservation Studies of 18th Century British Cast Iron Cannon

P29

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Although they are simply classified as “metals”, the sea-discovered metal foundlings are one of the most difficult cultural heritage pieces for conservators. For being exposed to rush salt water environment for long time,corrosion and degradation kinetics are different than the ones survived underground or open air atmosphere.Because of this, underwater metal foundlings have to be treated as quick as possible with an approved procedure.

As a good example to this kind of artefacts, a cast iron cannon have been survived by Marmara Sea in Feb 2015. It has been moved to Istanbul Rumeli Fortress Museum.After cleaning the deposits from surface by mechanical methods, some identical information have been found out such as type and production data. WCo stamp on the surface proves that the cannon had produced by British Walker Company,is patented by Armstrong and dated to period of King III:George.It has dimensions of 3.05 m length, muzzle diameter of 0.40 m and breech diameter of 0.52 m.

Electrochemical processes like deposition have been used in industry for years because of their advantages such as effectiveness, being easy to apply, low-cost and high processes efficiency. It is also a popular method for conservation sciences.

In our situation the cannon is decided to be removed by deposits by electrochemical method. In order to determine necessary electrochemical parameters, first the corrosion type will be discovered. The metal compounds will be determined by portable XRF and 3D scanning device will be used for authentication.

This work comprises the electrolysis variables, like different electrolytes, concentration, current density and circuit connection.Later on,the authentication progress of cannon,conservation studies and examination of exhibition conditions will be discussed.

Monitoring stone surface change: from fresh to failed?

P30

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Moisture ingress and the migration of soluble salts into stone is perhaps the most crucial control in the progression of stone degradation. Without moisture salt weathering, one of the most prominent processes in stone decay would not occur. One property that influences moisture and soluble salt ingress is permeability as this controls the amount of moisture and dissolved salts that can penetrate stone and facilitate decay. Connected pores permit the movement of moisture into the stone interior thus facilitating the migration and accumulation of soluble salts. Building stones, both structurally homogenous and heterogeneous, will have areas of variable permeability, which can create preferred pathways for moisture and soluble salts. This poster reports a timeline of events for Locharbriggs Sandstone in which changes in permeability are monitored from a freshly cut sample, its subsequent salt loading, post water repellent surface treatment application, followed by its weathering response to simulated weathering cycles. Permeability is non-destructively measured using a 'TinyPerm' portable gas-probe permeameter and will investigate the relationship between change in permeability and that of stone surface stability.

TISCH: Terahertz Imaging & Spectroscopy in Cultural Heritage

P31

J. Bianca Jackson

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Terahertz spectroscopic imaging is a nascent technique—established only in the last 20 years, and developed only in the last several years for cultural heritage applications. Terahertz (THz) radiation—lying between the microwave and infrared (IR) bands—penetrates most non-polar, non-metallic media. Many dielectric materials that are opaque or highly scattering at optical frequencies are transparent at terahertz frequencies. It is the combination of material characterization, time of flight imaging and the penetration of optically opaque materials that gives rise to applications for subsurface imaging of many culturally significant objects. Moreover, the variety and adaptability of the many electronic, photonic, and hybrid terahertz systems allows for versatile approaches to measurements. Because it is non-ionizing, moderate exposure to terahertz radiation poses significantly less long term risk to the molecular stability of the historical artifact and humans than other forms of radiation, and portable systems are becoming increasingly available.

In this presentation, the technique of time-domain terahertz imaging and spectroscopy will be explained and several cultural heritage applications will be presented, including: examinations of hidden wall paintings and mosaics, ceramic vessels, mummies, corroded metal objects, and wood panel paintings.

P32

Pulling Threads: Understanding Wool Protein Fibres in Historic Tapestries at a Molecular Level

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Historic Royal Palaces

The combination of light, thermal, and humidity processes leading to material failure can often make the condition assessment of historic tapestries difficult. Despite previous studies on the degradation of animal protein fibres like silk within historic tapestries (Howell and Hallett, 2005) and other textiles, the analysis of historic wool degradation is limited arguably due to the complexity of the wool protein structure.

Within this research, sacrificial wool threads taken from a collection of historic tapestry conservation samples at Hampton Court Palace are explored. Size exclusion chromatography and dissolution methods including protein reduction are investigated to extract keratin proteins and determine their molecular weights which can be related to mechanical fibre degradation. Multivariate data analysis will be used to incorporate this data into a previously developed tool based on near infrared spectroscopic analysis and the specific stress properties of historic wool (McCullough, 2014). The use of NIR spectroscopy as a non-invasive tool for the condition assessment of Tudor tapestries on open display at Hampton Court Palace will be explored further.

With this information the ability to anticipate when fibres are more likely to deteriorate via mechanical failure is potentially enhanced and may be useful in improving the condition audit process and assisting conservators in prioritising the treatment of historic tapestries on open display

Art historians do not need scientific analysis of artworks. Or do they?

P33

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How the drapery folds fall along the body can define the period in which an artwork was executed; how the painter carried out the hands of the figures reveals his dexterity; the modeling of the faces and eyes can point towards a specific author or workshop… All these tools, and many similar, can help to understand an artwork, its style and artistic influences, can situate it chronologically and, with the study of old documents it is possible to delineate its principal characteristics. But is it enough to understand the artwork completely? Many art-historians would agree. The eye and the sensitiveness are the most important tools for this purpose. But others, together with conservators and restorers are opening their minds towards the new, interdisciplinary approach to the art analysis. The knowledge on materials applied, painting techniques used or later interventions that suffered the object, are as well an important factor – not only for the insight to the degradation processes, but also to understand its visual aspect. In some cases, on the bases of obtained results, art-historical hypothesis should be changed, as it can be shown on several gothic mural cycles from Slovenia, studied in situ and on samples by OM, SEM-EDX, XRF and FTIR. Therefore, the collaboration between Science and Humanities is essential. Today, still, mostly scientists enter the art territory and sometimes forget that the principal objective of the research isn't the use of equipment or its improvement, but principally the knowledge on the artwork. It is time that also art historians start to manipulate more frequently different techniques, especially non invasive ones like UV, IRR or XRF, as applied, for example, in the collaboration between the Fine Arts Museum and CNA, both in Seville.

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Conservation dilemma: what to protect iron sword or wooden scabbard? The influence of special bath used for the metal preservation on wooden objects

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During the Second World War a lot of polish cultural artifacts was looting by Nazi German and Soviet Union. A large part of them still can't be reclaim. It is probably a reason why in Poland have a great respect to monuments. Here even little piece of archaeological wood help to commemoration and recreate again polish history.

To National Archaeological Museum in Warsaw come wooden monuments with varying degrees of degradation. Time ago Museum has got a unique iron sword in wooden scabbard. Unfortunately, it is impossible to separate sword from scabbard. It makes a real conservation dilemma: what we should more protect? Both of them are really unique for polish heritage and it is important to save them. They were in wet ground and now sword is really deep corroded and wooden part is oversaturated with iron ions. For corroded iron objects, Museum usually uses special repeated alkaline bath. This process protects iron objects from further corrosion, but we don't know, how it influences to wooden objects? So can we use this special bath in presence of wood with impunity?

Museum together with WULS has started research about influence on the chemical composition of selected species of wood and structure of wood. In this step was made first research of structure by microscope and check first chemical influence. Results of the first studies has shown interesting information but it still not obviously how it influences. Some change content of the microscopic structure and main structural components in wood are not significantly changed and their relatives change of content comes from elimination hemicellulose.

The results are not the end of study. It is the first step to discuss and find an answer: How to protect this difficult objects?

Dose-response function for paper containing iron gall inks

P35

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Being the ink of choice for centuries in western history, the chemical instability of iron gall inks has caused a major threat to paper-based heritage. The accelerated degradation of paper induced by iron gall inks has been extensively studied from both conservation and material science point of view. Based on these results, this research developed a dose-response function to quantitatively evaluate the synergistic effect of environmental agents of deterioration and material properties on the degradation rate of paper containing iron gall inks. From the perspective of long-term storage of archival collections, paper grammage, acidity, iron (II) content and application intensity of ink lines, as well as temperature and relative humidity were considered as the most important deteriorating agents that significantly contribute to the rate of degradation. Data for modelling were obtained from historic samples using both analytical experiments, such as viscometry, pH tests and accelerated degradation, and epidemiological experiments, such as Near-infrared spectrometry and chemometrics in collaboration of UCL Institute of Sustainable Heritage (UK) and the National Archives (UK). The modelled dose-response function demonstrated the potential and necessity to be further developed into a damage function in the context of value. It will support collection management by prioritizing manageable parameters to control and predicting future life of paper-based collections containing iron gall inks.

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Conservation and Interpretation of the archaeological discoveries from the Shatin to Central Link, a subway development project in Hong Kong

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A large archeological project has been conducted since 2012 at the Sacred Hill area of Hong Kong for the construction of To Kwa Wan Station for a subway project, the Shatin to Central Link. Significant archaeological remains, such as wells, remnants of building structures and numerous ceramic sherds of Song-Yuan period (10th - 14th century), indicate that there was a settlement about 800 years ago. The discoveries yielded public attention and discussion on the appropriate conservation and interpretation of the unearthed archaeological data. This paper will introduce the progress and discoveries of the archaeological work as well as the formation of the conservation plan with emphasis on the rationale based on the principles of heritage preservation. The interpretation of the archaeological findings to be on display in the future subway station and the archaeological features to be preserved in-situ will also be highlighted to epitomize how the preservation of archaeological heritage in infrastructure project can be achieved through the collaboration among the archaeologists, conservators, consultants, antiquities advisory board, heritage authority, project proponent and general public.

Digital recording, repair, and reproduction of historic wallpaper at Windsor Castle

P37

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This paper will argue that the use of digital technology is a cost and time efficient method of reproducing wallpaper to conservation standards and ethics. The reproduction of historic wallpaper using traditional techniques, particularly concerning the reproduction of complex patterns, is often time consuming, expensive and therefore inefficient and impractical unless used on a large scale.

A method of efficiently and effectively recording, repairing and reproducing a section of damaged historic wallpaper in order to fill a small but substantial area of loss was explored through the use of digital scanning and manipulation software. Using wallpaper from Windsor Castle Deanery as a case study, the full process from image input to physical output was followed to ascertain the potential benefits and limitations of digital technology in small scale reproduction of complex patterned wallpaper, whilst avoiding damage to the original fragment.

The method of scanning the original wallpaper was determined by the fragment's size and fragility, and its attachment or detachment to the wall. The ease of digital repair through photo-manipulation was dependant on the intricacy of line, complexity of colour, completeness of pattern and aptitude of the conservator/user. The final and most challenging stage was the physical output of the recreated image to match existing wallpaper. This was due to variables such as paper texture, weight, material compatibility and consistency of colour and scale when printing.

Thus, although successful, the effectiveness and suitability of this technique is dependant on the capability of the conservator, the condition of the wallpaper and the availability of suitable paper.

The use of 3D technology to make safer supports for fossils

P38

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The use of 3D technology is becoming a widespread tool in conservation for paleontological heritage's inventory, cataloging and documentation.

The 3D technology is starting to generate, with great accuracy, real and virtual replicas, replacing the molding and management needs of some of the specimens to study. Another use is to generate packing and exhibition structures, such as the specimen of study, the skull of the Mesoeucrocodylian Eocene crocodile Iberosuchus from the Duero Basin (Salamanca, Spain). This specimen is housed in the "Sala de las Tortugas" of the University of Salamanca. The skull is particularly fragile and handling for study is risky. Therefore, giving it an adequate support was considered as a priority for the protection of the fossil, and it should meet the goals of protection and aesthetic that will allow its exhibition.

The support for the specimen was made from a digital copy of the sample by constructing a 3D mesh obtained by photogrammetry techniques. The digital model is used to design a structure with a complementary surface of the areas where the specimen will rest during its display. It have been modified also in order to improve its efficiency and distribute the loadings from the weakest structures of the skull.

The digitally generated structure has been printed in a 3D printer to produce a support in ABS (acrylonitrile butadiene styrene) thermoplastic. The ABS support has a high strength. The support has a variable thickness and are perfectly adjusted to the lower part of the specimen.

The use of 3D technology to make supports is an advantage for preservation and exhibition. The possibility of a better fitting for the supports while reducing the need of handling the original specimens will improve the preservation of the fossils.

P39

Working with water in Prehistory: A biographical approach to watercraft technologies in the Mesolithic of Denmark

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It has long been known that marine resources and watercraft technology made up an important part of Mesolithic subsistence practices, especially in Denmark. My Masters research joined artefact biography with the theory of taskscape to explore two organic watercraft artefacts found at the site of Tybrind Vig, Denmark. The joining of these two methods allows for the exploration of the knowledge that would have been needed to create and use an object. This information allows for a more holistic, human inclusive interpretation, showing the true complexity of hunter-gatherer lifestyle and society, as well as the shifting meaning of the object.

Monitoring of indoor air quality in different types of repositories and archives

P40

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To determine contribution of outdoor air and indoor sources to indoor air quality in different types of repositories and archives the detailed characterization of indoor air was performed in four archives in the Czech Republic during four seasons of the year. The measurements were carried out at four locations: rural, small town, industrial area, and large city and included determination of I/O particle number concentrations and size distributions and monitoring of gaseous pollutants, temperature, and relative humidity. Further, size resolved sampling of particulate matter (PM) was performed for subsequent chemical analyses that yielded elemental composition, water soluble ions and content of elemental and organic carbon. The results showed that up to 80% of indoor PM was in submicron range and originated from the outdoor air and activities of the staff as a main source of coarse particles. The dominant component of both fine and coarse fractions was organic matter that made 50-80% of the PM mass. The next most abundant components of fine PM were soot and ammonium sulfate and in coarse fraction crustal matter. To find out a possible effect of dust indoor PM1 and PM10 particles were deposited on pure cellulose filters. The decrease of the DPv of cellulose after artificial ageing showed a negative correlation with the deposited mass of sulfate in submicron particles. Monitoring of gaseous pollutants revealed higher indoor concentrations of ammonia compared to outdoor ones. Preliminary results indicate both decomposition of ammonium nitrate that penetrated from the outdoor air and degradation of the organic additives used during building constructions as possible sources.

This work was supported by the Ministry of Culture of the Czech Republic under grant DF11P01OVV020.

P41

Building materials, technics and building types of the 20th century: historical analysis of the events and the interventions for the dangerous seismic conditions in Cosenza

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In the 21th century the preservation of the cultural heritage is a necessity. Often there is an intervention on the cultural heritage without the activation of a deep study for the characterization and for the vulnerability classification. Every building has a discreet number of informations for the historical-critical study that cannot be disregarded from the architectonic plan and, therefore, the knowledge of manufactured past is fundamental for the comprehension of the future behaviours of the same heritage. In particular, the analysis of events and operations tolerated by a construction precedes the real architectonic relief and considers material description, constructive technics, eventual deteriorations, instabilities and rearrangements. Historical research applied to the architectonic heritage is a fundamental moment in the study of the mitigation of the effects of catastrophic events because through the analysis of the seismic dangerousness and vulnerability can be obtain qualitative and quantitative informations. Dangerousness analysis is a reconstruction of damage scenery of previous events uses historical-descriptive informations to arrive to concrete possible seismic behavior of a particular area. Vulnerability is analysed by the reassembling of the constructive history of a single wealth or historical centre. This is a multidisciplinary study in which every phase needs particular competences and tools. Historical research can't follow the technical intervention: the preservation of a wealth starts from the direct knowledge. The true technological innovation is the research, if it is leaded with critical methodology, veracity and constancy.

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Non-invasive optical imaging of collagen-based artefacts for the evaluation of state of preservation and conservation treatments based on nanostructured $Ca(OH)_2$

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Optical Coherence Tomography has demonstrated over the last decade its potential as a characterisation tool in Cultural Heritage conservation for its ability to perform relatively high resolution imaging and sub-surface analysis in a non-invasive and non-destructive way. Because of the non-existent sample preparation and the speed of acquisition, OCT can be considered as better alternative to more invasive approaches for the cross-sectional investigation of complex materials, performing at the same time in situ examination of artefacts in their own display or storage environment.

In this study, OCT is proposed as a day-to-day tool for the non-destructive and non-invasive evaluation of the state of preservation of collagen-based artefacts, as well as the effectiveness of novel consolidation procedures. Deteriorated elephant tusks and bone fragments were analysed, allowing the detection of several microfractures and delamination processes as a result of natural ageing or storage conditions, subsequently considered for consolidation purposes. Taking into account required properties such as compatibility and stability, novel treatments based on inorganic nanomaterials were recently proposed for remineralisation purposes on archaeological bone conservation, as a new treatment in opposition to traditional methods. We therefore synthesised and characterised Ca(OH)2 NPs with FTIR, XRD, SEM-EDX and TEM and investigated their application with OCT. Scans were then compared with SEM images in order to assess the effectiveness of OCT to detect the penetration depth of the NPs.

The overall outcome of this study is to demonstrate that OCT has the potential to be used as a routine imaging tool, as well as a complementary technique to monitor conservation protocols at different stages.

P43

Exploration of Alternative Inkjet Printing Methodologies to Improve Colour Accuracy in Old Master Painting Reproductions

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One difficulty in producing inkjet reproductions of Old Master paintings lies in accurately replicating colours found within dark paint passages. Limitations in inks and media currently restrict the inkjet printer's ability to replicate the vast number of colours observed in the original paintings. To achieve dark colours, inkjet technology typically mixes the available colour inks with high proportions of black to darken the hue. However, this concentration of black ink tends to be visibly dominant, leading to a smaller perceivable gamut of printed dark colours. As a result, the subtle variations seen in the original painting tend to be lost.

To investigate methods to improve the reproduction of dark colours, research is being carried as a collaboration between the University of the West of England, Bristol and the National Gallery, London. The research aims to create a more accurate colour reproduction by extending the obtainable range of dark colours using inkjet print technology. This has been undertaken by incorporating alternative printing techniques not ordinarily employed within current workflows in order to improve the match between colours measured within paintings from the Gallery's Collection and those achieved in inkjet printing. For this project, colour measurements were taken of the dark paint passages in Michelangelo Merisi da Caravaggio's "The Supper at Emmaus" and compared to printed samples using both traditional and alternative printing methods. The results of this comparison show the alternative printing techniques are capable of producing a range of dark colours that more closely match the painted original.

This presentation recapitulates research published in the proceedings of the 2015 International Colour Association's Mid Term Meeting in Japan.

P44

Conservation management scenario appraisal for painting canvases at Museu Nacional d'Art de Catalunya

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At the Museu Nacional d'Art de Catalunya (Barcelona), 31 canvases made of natural fibres were surveyed using non-destructive near infrared spectroscopy in order to determine the pH and degree of polymerisation (DP) of the supports. All the canvases were from the period of 1890-1910, acidic (pH 5.1±0.4) and degraded (DP 710±260). Based on the Collections Demography dose-response function for cellulosic materials we calculated the rate of degradation using pH, DP, T and relative humidity (RH) as inputs. Furthermore, we calculated the period of time until the point when the canvases become so fragile that their handling could lead to mechanical damage and thus risk the integrity of paint layers.

Having calculated isochrone plots and demographic curves for the collection, we were able to explore a number of conservation management scenarios and compared them with the expected rate of degradation under current conditions (21 oC, 58% RH). The comparison clearly shows how the period of time until loss of fitness could be prolonged if the storage temperature is decreased, or if the canvases are deacidified.

'Wet walls': Developing 4D moisture survey techniques for historical masonry

P45

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Detecting the presence of moisture in historical masonry is essential to understanding how a structure relates to the environment, and diagnosing the potential for damage from a range of physical, chemical, and biological processes. In-situ, non-invasive diagnostic techniques have been developed in preference to coring, sampling and other methods that require irreversible modifications to a structure. These techniques include: electrical resistivity, microwaves, and infrared thermography. Independently, these approaches provide limited snapshots of surficial and internal moisture regimes; this project seeks to assess the comparability of multiple techniques and assess the feasibility of synthesising the data into a single cohesive output.

Other interests are the potential of interpolative models of internal moisture regimes and analysing climate data to produce susceptibility maps of driving rain spells.

Understanding the conditions in which instruments optimally perform streamlines moisture surveys and makes building surveying more efficient. Assessing the potential for instrument synthesis might produce comprehensive, four-dimensional representations of moisture ingress and movement in masonry constructions, enabling more informed sustainable heritage management of the historical built environment.

P46

Ground Penetrating Radar technology (GPR) – a feasible tool for mapping the structure and assessing subsurface condition of historic buildings walls. A case study of a 14th century merchant house in Toruń, Poland

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The old town of Toruń, dating back to 1200s, is a famous architectural gem considered one of the Polish national treasures. Examples of sites include: the red brick Town Hall, one of the most magnificent buildings of this type in Europe, the Teutonic Castle, gothic churches, and a collection of historic tenement houses, like the glorious gothic house where the noblest citizen of Toruń, Nicolaus Copernicus, was born. However, beside these remarkable objects, well preserved and cared for, there are some less fortunate, on which time has left its mark. They became the focus of our research team, currently completing a project aiming to develop a coherent strategy for diagnostics, preservation and conservation of such buildings.

A multidisciplinary team from Institute for Conservation Restoration and Study of Cultural Heritage from Torun's University, has worked for the past year on the documentation of one of the finest tenement houses, which suffered from severe fire in 2007 and since then has been left with no public funding for any conservation work.

The 14th century building, consisting of three separate town houses, had undergo many architectural changes and part of the project was to detect them. To do so, the GPR technology was implemented bringing some stunning results. Over 900 separate scans were made to map the changes in the structure of walls, which resulted in locating walled up niches, passages between buildings, storeys modifications and differences in used material.

This is only an introduction for making a statement that GPR technology can be an effective and non-invasive method of structural investigation of historic objects. It provides a broad spectrum of information on the condition of the building, without damaging its substrate whatsoever.

Ecology of fungal and bacterial spoilage of the written heritage

P47

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Recent works based on culture-independent methods showed that the complexity of the microbial and fungal community structure on biodeteriorated written heritage is often higher than what suspected before the advent of the molecular approach. Further studies are needed to comprehend the mechanisms underlying some kinds of well-known, but poorly understood damages occurring to paper and parchment. The ecology of extreme environments appeared very similar to that of microorganisms which have recently been associated with severe phenomena of biodeterioration. Fungi and bacteria are able to live at low water activities, because they can thrive in microclimatic niches caused by condensation, lack of ventilation or water retention by hygroscopic materials, but they can also modify their close environment with translocation of salts and secretion of specific compounds. Both paper and parchment contain inorganic compounds: salts coming from manufacturing processes like sizing minerals or impurities, or metals from inks are present in most of the library materials. Some examples of the complexity of the ecological interactions between microorganisms, heritage materials and the conservation environments will be illustrated, like the purple spots on ancient parchments, the spreading of the fungus Eurotium halophilicum inside compactus shelving or the precipitation of fungal oxalates in paper. The analytical techniques that better allowed to unravel some of the most intricate mechanisms of colonisation and spoilage of materials were the environmental scanning electron microscope equipped with Energy Dispersive X-ray Spectrometry, and DNA-based methods addressed to microbial identification.

Hunting Dragon-Kings: A New Approach to the Conservation of Historical Buildings

P48

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The traditional approach to conservation of built heritage rests on the assumption that the behaviour of materials is governed by a coherent function of degradation versus the intensity of degradation agents. This led to designing many laboratory tests with an exaggerated intensification of the damaging conditions, poorly representing field conditions.

In this work, we present a new approach to this dilemma that relies on identifying the occurrence of critical events known as "Dragon-Kings". These are predictable, meaningful outliers that in stone conservation correspond to the events during which most degradation occurs

The Dragon-King theory itself [1] is a recent chaos theory for the prediction and prevention of crises, which belongs to the family of analysis of rare events. This field of research has raised the interest of the conservation community [2], yet without ever being adopted in practice.

Here we apply this approach to study the degradation of the cathedral of Lausanne. More specifically, we examine the degradation of clay bearing sandstones consolidated with ethyl silicates which is known to be driven by cycles of wetting and drying [3]. Placing on-site sensors capable of determining water transport in stones, we intend to identify the critical cycles and reproduce them in the laboratory with an instrument specially built for this purpose.

With these weapons of accurate on-site investigations and faithful reproduction of the weathering in the laboratory, our goal is, so to say, to hunt the Dragons of the Cathedral.

[1] D. Sornette, Eur. Phys. J. Spec. Top., 205 (2012) 1–26.
[2] E. Doehne and C. A. Price, Stone Conservation: An Overview of Current Research, 2nd Ed. GCI, 2011.
[3] I. J. Gonzalez and G. W. Scherer, Environ. Geol., 46 (2004) 364–377.

Materialising conservation science research for historical textiles

P49

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In heritage object conservation, all paths lead to materials. Ethical and effective decisions for treatment, handling, display and storage of objects link to their chemical, biological, physical and mechanical nature. This scientific underpinning is not all. The materiality of a heritage object today and tomorrow is inextricable with its materiality of yesterday. This too must be addressed through where, when and how it was made, and how it has been used and valued. The Centre for Textile Conservation (CTC) is the UK's only textile-specific training programme. Its ethos is object-centred professional practice, placing materials at the core of CTC's culture. Research therefore focusses on the impact of conservation on object materials, and the materials and methods of conservation.

Answering conservation-relevant scientific questions about historical materials demands three essentials: robust scientific methodologies, robust point of historical reference, and robust scientific and historical frameworks for interpretation.

Being within the School of Culture and Creative Arts alongside dress and textile histories and technical art history, the CTC takes full advantage of integrating the scientific, historical and cultural studies of historical textiles. Three conservation science research case studies from the CTC, all in collaboration with museum and archive partners, epitomise this integrated approach:

1. Understanding the historical textile material context: the importance of appropriate analytical references for identification
2. Significance and value of historical materials: challenges of sooty soilings
3. Effect of conservation on textile material properties: informed tapestry repair yarn choices and in-situ strain monitoring.

P50

A little more reflection, a little more depth: applications of Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) in heritage textile conservation

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Diffuse reflectance infrared spectroscopy (DRIFTS) overcomes the limitations in attenuated total reflectance Fourier transform IR (ATR FTIR) analysis of low beam penetration into materials, and reduced signal from scattered specular reflectance for thin layers on uneven surfaces. Using a handheld 4100 ExoScan FTIR spectrometer with a diffuse reflectance sample interface, in-situ non-invasive micro-analysis was successful in three fibre residue and fibre degradation studies:

1. Evaluating the non-ionic detergent Dehypon LS54 for wet cleaning. Dehypon LS54 is a new commercial detergent available for textile conservation. DRIFTS was used to assess its removal from fibres in the cleaning process. Detergent traces in washed but unrinsed fabrics showed characteristic spectral peaks. ATR FTIR could not detect any detergent.

2. Identification of oils characterising historical Turkey red (TR) calico dyeing.
DRIFTS revealed traces of oils on calico fabric for historical TR manufactured in mid-19th century. Distinctive spectral absorbances for oil bonded to fibres were detected in known TR textiles. These were absent in un-oiled calico and textiles that looked like TR but not made by the process. Thus DRIFTS offers a quick, non-invasive analytical screening tool to identify historical TR textiles.

3.Degradation assessment for historical viscose rayon fibres.
Viscose rayon is weak when wet - an issue for textile conservation. Its strength reflects excess hydroxyl groups, amorphous polymeric structure, and low degree of polymerisation, and is affected by manufacturing methods and ageing. DRIFTS enabled historical rayon yarns to be grouped as low, moderate and extensive degradation from spectral information of hydroxyl groups, and peak sizes and shapes.

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New WUFI®Plus module for modelling indoor climate and energy consumption in museums, libraries and archives

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WUFI®Plus is a specialized software to model indoor climate and energy consumption in buildings based on a transient balance of temperature and moisture. In this study, a new module was added to the software which took into account the buffering effect of collections in museums, libraries and archives on temperature and relative humidity fluctuations. For libraries, a statistical bookshelf was created basing on measurements of book sizes and numbers in storages of the National Library in Warsaw. This allowed a model book block to be developed for which water vapour sorption and diffusion in response to step changes in ambient relative humidity was simulated using the finite element analysis. General sorption isotherms and diffusion parameters obtained by fitting the entire sets of data available for various library materials were used as input parameters. The simulation results agreed with experimental measurements for real books if the compression of their pages was taken into account. The characteristics of the water vapour sorption and diffusion processes obtained for the model book block were implemented into WUFIPlus by transforming the block into the equivalent 'library wall' in which the one-dimensional moisture diffusion takes place. Such transformation makes the computing very efficient in terms of calculation time. The calculations carried out for an exemplary library space demonstrated that daily relative humidity fluctuations were reduced by about 5-10 % if the buffering effect of the collection was taken into account. A 10% reduction of energy demand for heating was also obtained as books accumulated heat from the solar radiation.

This research was supported by Grant PBS2/A9/24/2013 from the Polish National Centre for Research and Development.

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Wall coverings painted on canvas from Louis Philippe's room in Bodø (Norway) – research of the technique and technology of Gottfried Ezekiel's decorations

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The thesis is a result of the international cooperation in the field of works of art research – Department of Painting Techniques and Technologies at Nicolaus Copernicus University in Torun (Poland) and Cultural Memory Section of Government Nordland (Kulturminner, Nordland Fylkeskommune). The subject of work was to conduct the interdisciplinary and comprehensive research of the techniques and technology of a canvas wall coverings from the former rectory of bishop N. Friis, from 1754. These works of art attributed to Gottfried Ezekiel are located in the Ludvig's Filip Room in Bodø, North Norway.

The presentation included: brief information about the founder, artist and history of the works. After a short introduction about the evolution of this rare type of decorations, also chosen examples of similar wall coverings from the area of Norway will be presented, as well as an attempt to localize them in the context of European "wallpapers" painted on canvas, from approx. the half of 18th century. In the strictly analytical part of the project the non-invasive analysis of paint layer and the support of the works was carried out, involving also modern methods of instrumental analysis of samples, i.e.: microphotography of cross-sections of the samples in VIS and UV light and in color infrared IRC, SEM-EDS, GLC, FTIR spectral analysis. In parallel, the traditional microchemical research was conducted on the prepared samples of paint and priming layers. Only by combining the results of several analytical methods specialized knowledge was obtained which was used for a detailed characterization of the materials identified in objects of research. Likewise, the copies of selected fragments of investigated decorations was made to present the painting technique.

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The Conservation of Historic Doped Aircraft: A collaborative research project between Imperial College London and the Science Museum into the material characteristics of doped aircraft surfaces and tear repair of tensioned fabric structures

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Historic aircraft were constructed by covering an internal frame with a fabric skin, and then applying a chemical substance known as 'dope' to tauten and protect the fabric. Tears in such material within museum collections can occur, and a collaborative, doctoral research project has been established between the Science Museum London and Imperial College London to investigate methods for arresting such deterioration on the Science Museum's historic aircraft.

The main objectives are to:
- Determine the material properties of doped fabrics and characterise the materials used in making dopes.
- Identify the aging mechanisms of doped fabric surfaces and the causes of tears.
- Evaluate the effect of current conservation techniques, which involve adhering a new textile patch over the tear using fresh dope.
- Suggest alternative materials and techniques that might be suitable for conserving such damage in the future.

The task of recommending new techniques for conservation is complicated by the difficulty in accessing and working on many of the Science Museum aircraft, which are suspended from the ceiling of the Flight Gallery at its South Kensington site. Difficulties in accessing the interior surfaces and the tautness of the material due to the presence of dope are further challenges to be overcome. An initial plan is to adapt trekker systems found in paintings conservation to realign the tear edges.

Characterisation will be undertaken on historic and artificially aged 'model' material using a range of scientific analytical technique, including Scanning Electron Microscopy, X-Ray Diffraction, Fourier Transform Infra-Red Spectroscopy and Raman Spectroscopy. It is also hoped that bi-axial tension testing may be carried out in collaboration with the Courtauld Institute of Art.

P54

Artsorb® in microclimate frames: Oddy testing to evaluate the corrosive potential of lithium chloride dust and the efficacy of Tyvek® to mitigate dusting

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Three 19th century oil paintings will be on permanent exhibition in an historic Portuguese Tide Mill. The Mill is subject to an uncontrolled environment with extreme daily fluctuations in relative humidity (RH) and temperature. To protect the paintings, microclimate frames using buffering material to modify RH response is desirable. Artsorb® sheets currently appear to be the most widely used for microclimate frames. A previous study (unpublished) by the authors carried out for 12 months in an uncontrolled environment with similar extremes in daily RH fluctuations, confirmed the effectiveness of Artsorb® in significantly reducing RH response for model paintings in glazed frames. Concern regarding the presence of lithium chloride in the composition of Artsorb® and its potential to form a contaminant dust in the back of the frames, has led to the present study. The use of Tyvek® as a cover to avoid dusting has been suggested (www.cwaller.de). In order to test Artsorb® in relation to its corrosive potential and to know if Tyvek® efficiently controls dusting, an Oddy Test is underway. As well, sets of framed and glazed model paintings with Artsorb® with and without Tyvek® (and controls, without buffering material) have been placed in situ at the Tide Mill. The interior RH and temperature is being monitored with data-loggers to determine if the Artsorb® still performs efficiently with a Tyvek® cover. Since a substitute material will be required if Artsorb® is found to be unsuitable, the experiment at the Tide Mill includes framed and glazed model paintings with silica gel as the buffering material. The silica gel has also been included in the Oddy Test.

VOCs and Archives: SPME/GC-MS as an assessment tool

P55

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Whenever the subject of assessing volatile organic compounds (voc's) in an archive environment is raised, conservators and curators turn for scientific support. However defining the voc's optimal levels is not an easy task. Depending on the kind of collection and climate, the optimal range can change significantly.

The Archive of the University of Coimbra (AUC) and District Archive of Braga (ADB) hold a vast collection of parchments, ranging from the 12th century, some of which present pending lead and wax seals.

The documents with lead and wax seals have been kept in wood cabinets, in between paper folders, generating an atmosphere "saturated" with voc's. The microclimates inside the drawers accelerate the corrosion of the lead seals, due to corrosive organic acids, such as acetic and formic acids [1].

The AUC's collection is stored in fairly recent wood cabinets, parchments stored flat. The ADB's parchment collection has been kept in a Arcaz, an 18th century wood cabinet, stored folded as originally sent.

The solid-phase microextraction coupled with gas chromatography-mass spectrometry (SPME/GC-MS) has established itself as a reliable, fast and economical method for sampling voc's. We aim to optimize a sampling procedure with an SPME fiber and a method of analysis by GC-MS, aiming to correlate continuous monitoring with real-time changes for preventive conservation, that is levels of volatile degradation products and the degradation of heritage objects [2].

[1] Rhyl-Svendesen, M,. (2008). Journal of Cultural Heritage, 9, 285-293.
[2] Strlic M., Thomas, J., Trafela, T., Cséfalvayova, L., Cigic, I.K., Kolar, J., Cassar, M., (2009). Anal. Chem., 81, 8617-8622.

P56

Identification of volatile organic compounds emitted by selected species of moulds growing on silk

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Silk is a textile most resistant to biodeterioration. However some moulds can growth on silk presenting fibroinolytic activity, and usually the time and work consuming, classical microbiological or genetic methods are used for their investigation. An alternative for those methods could be fast assessment of active moulds growth on historical silk textiles. This can be done by measuring the set of microbial volatile organic compounds emitted by them while growing on silk. But first of all the profile of MVOCs typical for various moulds has to be establish. This was the main goal of this work.

At the beginning growth of various moulds on samples of silk was assessed. After selection of those species that showed fibroinolytic activity, they were inoculated on three types of media: on samples of pure silk placed on broths, on samples of dyed historical silk placed on broths and on broths containing amino acids that are elements of the structure of fibroin. All these were prepared inside 20ml vials. In the first and second case the broths did not contain any sources of carbon, i.e. only silk was a nutrient for the moulds. MVOCs emitted by moulds were captured inside the vials and after six days of incubation at 25oC they were sampled with SPME method. Volatiles extracted on DVB/CAR/PDMS fibres were analysed in gas chromatography – mass spectrometry system. Qualitative and quantitative analysis of data acquired in chromatograms were carried out. The profiles of MVOCs distinctive for examined moulds were established. To the best of our knowledge, this is the first work that shows measurements of MVOCs emitted by moulds growing on silk.

The authors are grateful to the National Science Centre in Poland for founding these researches, decision reference DEC–2012/05/B/HS2/04094.

Documenting medieval mosaics with RTI

P57

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The Digital Humanities Lab and the Institute of Art History at the University of Basel are collaborating on the SNSF research project "Digital Materiality". Its goal is to develop and enhance existing methods to digitally reproduce works of art in order to support art historical research. One part of the project focuses on the visualization of medieval mosaics. Their specific surface properties make a photographic reproduction difficult because their sparkling appearance changes depending on the specific surroundings, lighting conditions, and movement of a beholder.

A number of research projects that pertain to the 3D modelling of historic buildings have already worked on mosaics, but without much avail. To obtain better results we are using Reflectance Transformation Imaging (RTI), a computational photographic method that is already applied in archaeological and cultural heritage research. Our first results show that RTI can document the surface properties of mosaics and their current state of preservation more accurately than conventional photographs, although there are limitations with glossy surfaces because the standard mathematical models are too simple.

Thus we are currently developing tools for a more detailed analysis and simulation of the reflectance behaviour. Enhanced models for representation and visualization of gloss can increase the value of digital representations of mosaics for research purposes. For collaborative applications we are working on a web based viewer application for RTI images in order to make acquired data accessible to a broader international research community.

At the SEAHA Conference we will present results of our work and discuss the implications of our concept for art history, computational photography and heritage science.

P58

Ageing study of vegetable tanned leather by non-invasive unilateral NMR and thermal microscopy. The tannin effect

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Nuclear Magnetic Resonance was discovered in 1945 and used in different areas such as physics, chemistry, biology and medicine. Since the mid 1990's, the unique and irreplaceable cultural heritage items also benefits from this noninvasive technique due to the development of the NMR MOUSE (Mobile Universal Surface Explorer) technique.

This study concerns with the investigation of the environmental degradation in vegetable-tanned leather, the traditional support of historical leather objects and artefacts, and evaluation of the tannin effect by NMR MOUSE. Thermal microscopy was used to measure the shrinkage activity of collagen and complement the unilateral NMR analysis. Modern vegetable tanned leathers obtained using various vegetable extracts such as mimosa, quebracho and chestnut were artificially aged at different temperatures and relative humidity values, both constant and alternate, for periods up to 64 weeks.

Longitudinal and transversal relaxation times T1 and T2 were measured using a PM 2 portable NMR-MOUSE with 20.05 MHz frequency. Shrinkage activity was evaluated using a recently developed automated instrument incorporating image analysis and diagnostic software. Both T1 and T2 values showed specific variation during ageing depending on tannin type and animal species, while shrinkage parameters' variation was less specific. These results revealed the presence of different water environment in relation to the integrity of collagen-tannin complex and de-tanning critical threshold, and demonstrated the great potential of the NMR MOUSE technique in the noninvasive in situ diagnosis of collagen-based historical materials and artefacts.

C. Şendrea acknowledges the Sectorial Operational Programme Human Resources Development 2007-2013 POSDRU/159/1.5/S/132395

Documentation of ancient theatres in the planning of archaeological landscapes

P59

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Theaters come to the fore as a building type enabling visitors to feel engaged in the past due to the everlasting theatre culture. So, it is not a surprise when visitors are mostly interested in these structures and events taking place in them. As a result, modern uses of theatres tend to be popular and the impact of interventions responding to such kind of human demand can be seen clearly on them. One of the common negative impacts of interventions is the restoration of ancient theatre buildings by the responsible national or local authorities as a "single architectural accomplishment" which eventually results in their isolation from the surrounding physical and social landscape. In numerous cases, we are not even able to observe their surroundings neither in their measured drawings nor in 3D representations. In fact, they were originally constructed as an integral part of the site, natural and manmade topography and landscape. They represent the combination of human effort to shape its living environment and the potentials of the nature. Therefore, their documentation processes should be planned with respect to the integrated relationship they have with the surrounding. This presentation will focus on the case of Teos ancient theatre in Karaburun Peninsula of Izmir in Turkey, to form an interdisciplinary documentation model for the ancient theatre in the planning of the Teos archaeological landscape to prove the fact that heritage is not only in the single building but in the whole landscape.

Long-term Environmental Impact in Asinou Church, Cyprus

P60

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Asinou Church is located in Troodos region, in the center of the island of Cyprus and it is one of the ten Byzantine Churches of the area, which have been included in the UNESCO World Heritage List (http://www.byzantinecyprus.com/). Therefore Asinou Church constitutes not only a national but also a worldwide cultural treasure, which needs protection. The long-term environmental factors, that could affect the Church (and the built Cultural Heritage in general), are divided in 8 categories [A1: Bio-attack; A2: Climate conditions fluctuations; A3: Aeolic impact; A4: Water (atmospheric, ground); A5: Solar radiation; A6: Particle matter and aerosols; A7: Long term loading; A8: Geological conditions (including local particularities)] (based on EU-CHIC Project). As far as environmental and geophysical conditions are concerned, Troodos region is a mountainous area with a Mediterranean climate (warm and dry summers, mild winters) and annual average precipitation from 600 mm – 1100 mm. Even though it seems that Asinou church is in a good condition, the environmental factor, which could be proved more threatening is climate condition fluctuations (A2). Within the 21th century it has been predicted that the average temperatures will be increased and the annual precipitation will be low. As a result the climate of the region will be drier leading to lack of humidity, high exposure to solar irradiation, a possible extinction of the local flora and even to erosion of the ground. The interaction of the predicted climate changes and possible changes of the local geological conditions with sudden events (earthquake, fire) as well as with the human impact (vandalism, war) could threaten the structure of Asinou Church.

P61

Compositional Analysis of early glass: a preliminary study of the technological change in the Eastern Mediterranean glass production from Late Bronze Age to Late Roman with Eastern Thessaly (Greece) as a fitting case study

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The present study explores the role of glass in Eastern Mediterranean within a broad chronological perspective examining how the invention of glass-making spread and how the technology transferred from the Levant, Egypt and Mesopotamia into the Greek mainland and the West using Thessaly as a fitting case study.

Systematic and rescue excavations of the area since 1976 have yielded substantial information providing a clear understanding of the settlement development from prehistoric through the late Byzantine period. Among the variety of finds there is a large amount of glass mainly from funerary context.

The present study examines several glass objects found in various sites in Eastern Thessaly dated from Late Bronze Age to Late Roman periods. Analytical techniques such as X-Ray Fluorescence Spectrometry (XRF), and Laser Ablation with Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) were used to determine the samples' chemical compositions, to characterise the trace elemental content in glass and to identify their raw materials and place of origin.

By characterising the glass from Eastern Thessaly, the present paper examines where the glass was produced and whether it was internationally traded and exchanged exploring how the glass industry was shaped over time in the Greek mainland and the Eastern Mediterranean and how technologies associated with glass production have transferred and adapted in the region.

Understanding the semantic meaning of 3D content in digital repositories

P62

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Once heritage artefacts are digitised using 3D acquisition technologies, the resulting 3D content is usually kept stored in a computer, hard drive or stored in a digital repository. Whatever the mechanism for storage, 3D content is at risk of being lost if there is no meaningful information associated with it. 3D content has inherently richer semantic information associated with its shape. Solutions for understanding the semantic meaning of shapes rely on the so-called shape analysis methods in computer graphics.

This presentation gives details about a shape analysis method to improve the metadata which are automatically extracted and associated to a 3D shape in a digital repository. This approach is applied to architectural elements of historic domestic interiors in order to automatically classify the 3D content according to artistic style and likely production methods. To understand the semantics within the content, the 3D shapes of the artefacts are computationally described in terms of their pattern, motif and style. In addition, we presents a novel shape retrieval method based on shape saliency. 3D shape saliency is a measure of regional importance based on human perception. The saliency map of a 3D shape highlights the most important geometric features on the surface. Thus in computer graphics, it is very promising for solving problems related to semantic analysis of 3D shapes. We also show different results of the proposed saliency-guided shape retrieval method using real 3D shape data (including holes, fragments, sensing errors, etc.) of a collection of Regency ornament mouldings.

Effects of dust particles on parchment and vegetable tanned leather

P63

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The research project "The methodology of evaluation of influence of air quality on book and archive collections" (2011-2015) should make more clear the relationship between environment quality and conditions of stored books and archive materials.

The samples of collagen materials - binding parchment and vegetable tanned binding leather -were prepared, on which dust was applied by rubbing dust in by the help of a bag made of soft unwoven fabric. Real dust from depositories of the National Library Klementinum was used for application of dust, from which crudest particle (splinters of paper, etc.) were removed. The determination of the particulate matter composition was performed in the CAS.

Dust was applied on samples according to the schedule Table No. 1.

Sample	Dust application	Ageing
1L	Flash side	Laboratory conditions
2L	Flash side	Thermal - 120°C, 24 hours
3L	Flash side	Variation in moisture 20% and 70% RH, 40°C
4L	Flash side	(Thermal + variation in moisture) 2x
5L	Flash side	Thermal + variation in moisture
6L	Flash and grain side	(Thermal + variation in moisture) 2x
7L	Flash and grain side	Thermal + variation in moisture
8L	Grain side	Thermal + variation in moisture

Table No. 1 – List of samples

Effect of dust on condition of collagen materials was assessed according to variations of shrinkage temperature, tensile strength, elongation and pH.
Dust layer on vegetable tanned leather negatively affects its hydrothermal stability. Effect of dust on hydrothermal stability of parchment was not proved.

Acknowledgements: Presented results were obtained with the support of the research project no. DF11P010OVV020 “Methodology of Evaluation of the Effect of Air Quality on Library and Archival Collections” - Ministry of Culture of the Czech Republic.

Comparison of point feature detectors and descriptors in the context of cultural heritage

P64

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Given a dataset of information, feature extraction is the process of deriving a set of discriminative features that accurately describe the initial data. These feature sets are usually used instead of the initial input to improve several computer vision procedures as Structure from Motion (SfM), visual odometry and navigation, object recognition, retrieval or classification. However, there is not a one-method-fits-all solution for feature extraction and the generation of suitable feature sets should be tailored according to the needs of each application. When it comes to the field of digital culture heritage, feature extraction algorithms have been widely used in a series of different applications ranging from SfM to OCR on historical documents and to repository management. Special needs are posed because of the complexity of the assets in conjunction with the high demands in quality and detail. Within the framework of the ITN-DCH project (www.itn-dch.eu) and as part of the project's Working Package 3, it was decided to perform a review of the state-of-the-art 2D feature extraction algorithms, and demonstrate some examples based on one of the project's case studies, the byzantine Church of Asinou, in Cyprus (UNESCO WHL Monument - http://www.byzantinecyprus.com/). Different feature detectors and descriptors such as SIFT, SURF, FREAK and ORB are implemented and compared in terms of keypoint detection, matching effectiveness and computational time. To this end, images depicting challenging surfaces were selected, such as stonewalls with repetitive patterns and highly decorated frescoes.

Authentically relighting cultural heritage models with High Dynamic Range imaging

P65

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The function and role of cultural institutions is continuously changing as there is increasing demand for access to cultural content. Virtual reality is currently one of the most promising ways to disseminate such content in an engaging manner. In particular 3D digital reconstructions of important landmarks provide the possibility of virtual travelling and exploration of heritage sites that people might never be able to see for themselves due to, for example, cost, time, political instability in the area, etc. Authentic reconstructions of sites also allow historians to investigate hypotheses of the site in a non-intrusive manner. Furthermore virtual reality offers the possibility of engaging children to learn and appreciate cultural heritage from an early age.

Increasing the level of realism and immersion when delivering cultural heritage contents is fundamental if we are to avoid the very real problem of misrepresenting the past. In this paper we show how High Dynamic Range (HDR) imaging techniques can capture the full range of light at a scene and use this to authentically relight a detailed 3D virtual model of the UNESCO heritage site: Asinou Church, in Cyprus. The HDR panoramas were captured throughout a day at the site. The relit virtual model is presented within the game engine Unity 3D on an Oculus DK2 Head Mounted Display and shows how the change of lighting in a day can influence the appearance of the site.

An open book: parchment as a reservoir of domesticate genetic history

P66

Matthew Teasdale

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The invaluable cultural reservoir of written history documented in parchment manuscripts has long been recognised. However, recent advances in DNA sequencing technologies are enabling another source of information to be reliably read from their pages; the genetic history of the animals used to produce them (Teasdale et al. 2014). Here we describe the successful sequencing of DNA extracted from parchment samples of 17th and 18th century northern English (Yorkshire) provenance. Results of which provided not only the determination of the material used for both parchments as sheep skin, but also the identification of modern sheep breeds with the closest genetic affinity to the parchment samples.

It is estimated that well in excess of one million parchment items survive in archives throughout the United Kingdom, this represents a huge wealth of animal genetic information which could be used to provide insights into the biology of important livestock species (cattle, sheep and goat) through time.

Teasdale MD, van Doorn NL, Fiddyment S et al. (2014) Paging through history: parchment as a reservoir of ancient DNA for next generation sequencing. Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 370.

P67

Developing Protocols for Minimal Intervention on Historic Metallic Objects at Fort Sumter National Monument

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Warren Lasch Conservation Center, Clemson University Restoration Institute

In 2008, a collaborative project between the National Park Service and the Warren Lasch Conservation Center of Clemson University was initiated to develop a protocol for conservation treatment on a set of ordnance and metal architectural elements. These objects are located at Fort Sumter and Fort Moultrie, in Charleston, SC. Both locations are operated by the National Park Service and are considered to have the most outstanding collection of American artillery in the country.

Previous conservation work involving six ordnance was performed at considerable expense and involved the removal and relocation of the cannon to an industrial coating facility for abrasive blasting and recoating. The aim of the research was to craft a treatment protocol that could be applied to the ordnance and architectural collection with lesser expense and risk to the artifacts. A protocol was developed involving a technique that utilizes superheated and pressurized water to remove failing paint layers and corrosion. This system presents many advantages over traditional blasting methods. Ultimately, the designed protocol proved versatile enough to be applied to artifacts of varying substrates, conditions and ages.

Where required, stabilization and monitoring was done by creating a series of microclimates around areas where complete encapsulation by the coating could not be ensured. Lastly, experimental research into high-performance coatings was performed over a period of 3 years. This research helped conservators select a system that yields a significantly longer lifespan which allows for long-term (financial, environmental, and social) sustainability. The different phases, milestones of the project, and the dynamics of the collaborative effort will be presented.

P68

Studying conservation and heritage objects with spectroscopy; rapid non-destructive analysis of historical artefacts

Hiran Vegad

Analytik Ltd, UK

Non-destructive testing and analysis is crucial while studying delicate historic objects such as paintings and manuscripts. Non-invasive identification of an artist's materials, carried out using analytical methods which do not require contact, allows researchers to further categorise and characterise the artworks following the stylistic analyses carried out over the years by art historians. The end result is a better understanding and appreciation of these types of works of art

Conservation and heritage experts have been successfully using various spectroscopy techniques to meet the challenge of non-destructive analysis. NIR-region spectroscopy has been proved to be an excellent method to analyse illuminated manuscripts. This spectroscopy technique allows for analysis of molecular vibrational overtones characteristic of functional groups such as hydroxyls, carbonates, and methylenic and amide groups associated with certain paint binders. These experts are now creating detailed maps of pigment/binder distribution in a completely non-destructive way, revealing important insights about the origins and history of their artworks.

The NIR Spectroscopy method has been also applied while developing a new, non-destructive method to diagnose a painting canvas from the back, without disturbing a single fibre, to see if it can withstand the stress of handling and travel. This non-invasive canvas health check can now improve the standard of management and care in any gallery or museum.

P69

Digitising Asinou: Holistic Approaches to Cultural Heritage Data as Shown by the Digitisation of Two Icons from the Monument of Asinou, Cyprus

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[3] University of Stuttgart, Germany, Mariano, digitalMED, Universidad de Murcia, ,

Digital applications for cultural heritage are increasingly becoming standards for work in the various facets of heritage. Soon photogrammetry will be the primary form of documenting sites, replacing the "daily photograph" of before. Excavation documentation will take place on handheld devices, immediately transferring the data to servers for safe keeping. Art restorers, material scientists, and other specialists will include publish their data directly online, linking it with the related data found elsewhere. Each of these components are realities today, yet lack the glue to bring it altogether. This paper explores the big pictures through one of the case studies of the Initial Training Network for Digital Cultural Heritage, that of the church of Asinou in the Troodos Mountains in Cyprus. The monument represents around one thousands years of history, with plenty of interventions in the recent past. The challenge, then, is to being all these data together in such a way that it is possible for the researchers and public alike to learn some of the history without having to go to several different repositories. This paper takes the digitisation process of two of the icons from the monument of Asinou, the enrichment of those scans, the publication of those data in repositories and their eventual harvest by Europeana as an example workflow for heritage professionals today. Future work by the project will continue to find ways to enrich new types of heritage data, and integrating those data into heritage frameworks and repositories, particularly that related to intangible heritage, 4D data, and other underexploited areas of heritage recording.

Protection of books and documents by application of essential oils

P70

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National Library of the Czech Republic, Prague, Czech Republic

Several plant essential oils (EO) exhibit antimicrobial activity and their application is studied in the field of agriculture and food industry. In our project, we focus on the possibility to use vapors of some EO components (EOC) as a fungistatic agent in book depositories with unstable humidity conditions to protect books against fungi development. We selected the most abundant components from plant EO having the highest fungicidal effect (mint, lime, lavender) and tested their activity against Aspergillus and Penicillium sp., which belong to frequent book contaminants. The selected EOC were tested individually and in mixtures in the form of saturated vapors. The optimal results were obtained with the mixture of citral and linalyl acetate (C+LA). Then the antifungal effect of the mixture C+LA was studied at different application conditions (vapor concentration, relative humidity of atmosphere, oxygen concentration, disinfected material, and the way of C+LA application) in laboratory glass vessels, in the multifunctional chamber of National Library CR, and in a model depository room built up for this purpose. The results of these experiments are presented. For example, infected books are stored in atmosphere with C+LA vapors of 16 % saturation. After four week storage, the books are water soaked and kept in the C+LA atmosphere and 100% relative humidity. The fungal growth on the infected surface of books is more than one week delayed in comparison with the case when the infected books are stored at normal laboratory atmosphere before and after being water soaked.

The project is realized under financial support of Ministry of Culture CR grant: NAKI DF11P01OVV028.

P71

Leather decay – model samples evaluation

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Leather can be degraded in many different ways. Mechanisms of leather degradation were described for new and historical ones in the past. On the other hand more detailed research of archaeological leather decay has not been described yet. New and historical leather decay is caused especially by oxidation and hydrolysis whereas archaeological ones are mainly affected by soil degradation and biodegradation. The aim of the survey is to provide deeper pieces of knowledge of their decay employing methods commonly used for evaluation and analysis of new and historical leather (fibre cohesion, pH, shrinkage temperature, SEM-EDX, determination of tensile strength, determination of nitrogen content). The experiments were carried out on vegetable tanned leather and chrome-tanned leather (both calfskin). Experimental samples were artificially aged by burying in soil for 12 and 24 months. The results were compared for new and artificially aged leather samples. In conclusion effect of soil on leather decay was described and the most suitable methods applicable to testing of this type of material were recommended as well.

P72

Opportunities for collaboration, education and interpretation within heritage science: a case study

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This poster proposes to use an ongoing environmental research project involving the University of Lincoln (UoL) and the Parliamentary Art Collection at the Palace of Westminster (PoW) to exemplify opportunities for collaboration, education and interpretation within heritage science.

The project to monitor and analyse the light exposure of selected textiles within Portcullis House and the Houses of Parliament involves undergraduate students from UoL, and aligns with a rolling programme of textile conservation by the PoW, which also seeks to provide annual internship opportunities for Conservation students from the Universities of Lincoln and Glasgow. Students involved at all levels benefit from access to a world-class collection, and valuable industry experience alongside heritage professionals in various disciplines.

With reference to the conference themes, the poster will illustrate:

- Practical application of heritage science: its value as a learning tool for undergraduate Conservation students, and thus as a tool for generating high quality heritage professionals of the future
- The role of science in bringing people closer to cultural heritage: opportunities to enhance the understanding of custodians, stakeholders and the public by demonstrating the science of deterioration and preservation
- The stimulating nature of the conservation discipline: demonstrating the diversity of the relationship between the humanities and sciences in Conservation practice, to students in training, and to laypersons via interpretation
- The value of experience: how a strong collaborative partnership project can add value and depth to a student's portfolio by equipping them with skills and experience incrementally, as they progress through the various stages of their training.

P73

On the surface and beyond. A new approach with Multispectral Photometric Stereo to assess Illuminated Manuscripts and their condition

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Exploring highly detailed artefacts has recently been given new challenges with high resolution imaging through Photometric Stereo (better known as RTI). The ongoing RICH project at the faculty of Arts of the University of Leuven is assessing condition of illuminations on paper or parchment with the microdome, detecting underdrawings, damages and retouches. The effects of old and recent restoration- and conservation treatments can be visualized and measured. The module is a hemi-spherical structure with a single downward looking video camera (28 million pixels). The object to be captured (maximum 180 to 120 mm) lies in the center and is illuminated from computer-controllable lighting directions, through the subsequent activation of multiple white LEDs. The different angles that illuminate the surface of the artifacts are revealing extreme details. For each illumination an image is taken by the overhead camera, in total 228 images for each object. After processing these 228 images can be explored interactively..Fine details can be highlighted by the use of specific digital filters, bringing out structures that would not be visible under single illumination (like shade, contrast, sharpening and sketch filters).

The latest generation of device (2015) is a Microdome with multispectral RTI capability. This Multispectral Microdome is equipped with 228 different LED lamps. Five different spectra are evenly distributed over the dome. A black and white sensor of 28 Mp with extended sensitivity in UV and IR is mounted on top of the dome.

The paper will illustrated the possibilities to explore the material features of manuscripts and will illustrate the potential for manuscript scholars and imaging as a documentation platform for conservation and preservation assessment.

Reflected Infrared Imaging for Heritage Documentation: Revisiting the Fundamentals

P74

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Digital imaging techniques, as non-destructive and predominately portable investigation tools, are essential for research and conservation documentation of cultural heritage (CH) materials. Conservation and research imaging aids in assessing and recording the condition, informing the care and treatment, and expanding the understanding of an object in addition to creating digital surrogates and increasing access to the objects.

Reflected infrared (IR) imaging has been an established conservation documentation technique for painting and paper conservation since the 1930s with the introduction of IR sensitive film. The technique can reveal underdrawings and preparatory sketches, expose compositional changes, provide information about artist's process and techniques, and differentiate materials. As digital camera technology and computing have evolved, the technique has continued to develop.

While reflected IR imaging is an established investigation tool for paintings and paper conservation, there is very little published on the use of the technique for 3D CH object documentation. These objects include a wide variety of materials and combination of materials, that may be similar to paintings but tend to not follow the structure of paintings (ground, underdrawing and paint layer), which influences the interaction with IR radiation and resulting imaging. This presentation will address the current applications of reflected IR imaging in conservation and research documentation looking at the fundamentals of why the technique is successful for some materials, such as paintings, and how that does and does not carry over to documentation of 3D objects.

P75

Evaluation of Cement and other Constituents in Historically-Significant Concrete Structures in Scotland

Simeon Wilkie

University of Dundee, UK

The number of listed concrete structures in Scotland is ever increasing and, as these structures age, there is a growing need for their conservation and repair.

When repairing concrete structures it is critical to match the properties of the original material as closely as possible. Failure to match the inherent and chemical properties can not only lead to an unsuccessful repair, but can also cause significant damage and accelerated deterioration to the original material. It is also important to match the physical characteristics, as this will allow the two materials to blend well, retaining the historic character of the structure.

However, there is very limited data regarding the nature of Portland cement and other constituents in historically-significant concrete structures in the United Kingdom, and that which is available covers a wide geographical area. As the properties of these materials are significantly influenced by the local raw materials and manufacturing processes used in their production, this data does not accurately reflect the nature of early cement and concrete compositions in Scotland.

This project aims to resolve such issues by developing a database relating the compositions of cement in concrete structures throughout Scotland to their date, architectural type, production source and physical characteristics, ultimately providing information on past practices and technologies to build up an in-depth understanding of the history of Scottish concrete.

Round Table

RT

The Future of Heritage Science

Moderator:
Matija Strlič

UCL Institute for Sustainable Heritage

To ensure the future of heritage science, it is essential that the new generation of heritage scientists acquires the skills that ensure their employability in a variety of sectors, and that the field develops a strong identity. The Round Table will explore (i) critical issues related to heritage science careers in industry, heritage organisations and academia, (ii) what the unique offer of heritage science graduates might be, and (iii) how cross-disciplinary training can ensure that the developed skills are competitive.

Panelists:

David Arnold, University of Brighton
May Cassar, UCL Institute for Sustainable Heritage
Scott A. Orr, SEAHA student representative
Kate Frame, Historic Royal Palaces
Robin Higgons, QI3
Heather Viles, University of Oxford

Exhibitors

GILDEN
photonics

A design and manufacture company that also supplies cost effective and innovative optical spectroscopy solutions: as components, turn-key instruments, OEM components, or customer configuration of optical solutions, including hyperspectral imaging. They are a leading supplier of hyper-spectral imaging solutions in reflectance, fluorescence and Raman modes of operation. GILDEN is well placed to support conservation and heritage specialists with extensive scientific and technical support as well as cost effective single-point and spectral imaging spectroscopy solutions. The company is delighted to announce that it will be supporting its first SEAHA studentship in the academic year 2015/2016.

This company is involved in development and marketing of non-destructive material characterisation methods based on spectroscopy and statistical data analysis. The analyses are rapid thanks to the tailor-made proprietary software, suitable for any application, from industry to cultural heritage. The company is excited to be supporting two SEAHA studentships, on 'Collections Surveys as Part of Library Document Supply Chain' and on development of an 'Online Collections Modelling Tool'.

Markes is a specialist manufacturer of instrumentation for detection of trace-level volatile and semi-volatile organic compounds (VOCs and SVOCs). It has a well-deserved reputation for its application expertise in the field of thermal desorption, supplying a comprehensive range of instrumentation, sampling equipment and consumables that enhance the analytical capability of GC-MS. In addition, Markes has gained recognition for its innovative, high-performance BenchTOF(tm) range of time-of-flight mass spectrometers for GC with award-winning Select-eV(r), variable-energy electron ionisation.

Protection of artefacts displayed in museums is paramount to sustainable heritage. The effect of chemicals on these artefacts can be detrimental, especially in the confined spaces of museum display cases. Markes International works with research institutes, museums and manufacturers of display cases to enable the quantitative analysis of VOCs and SVOCs. Markes provides sampling devices, analytical instrumentation and expert advice for the analysis of trace chemicals in the air and those released from materials, whether those used in the cases or the artefacts themselves.

The leading Swiss manufacturer is also the inventor of the Equotip, the most renowned portable hardness tester of its kind.
Proceq UK provides a complete range of portable non-destructive testing instruments for rock, metal, concrete and paper testing and has a local certified service and calibration centre. The company's strong research and development team continue to create products that set industry standards. This includes the recent Rockschmidt which was launched in 2014. Portable instruments such as the Pundit PL200, Schmidt family and Equotip are important tools that gather empirical data for the analysis of materials for use in either the laboratory or on location.