2nd International Conference on Science and Engineering in Arts, Heritage and Archaeology

Book of Abstracts

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Oxford, UK
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The SEAHA conference is organised by the EPSRC SEAHA CDT between University College London, University of Brighton and University of Oxford.

The SEAHA conference is endorsement by ICON and the UK National Heritage Science Forum and sponsored by the Royal Society of Chemistry.

Exhibitors

Non-commercial partner
Welcome Address

This is the second international conference on heritage science research, innovation and best practice in the interpretation, conservation and management of cultural heritage. 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: such as climate change and sustainability, economic viability and efficiency, development of novel technologies, and a pressing need for documentation and digitisation. The programme builds on the success of the inaugural event in 2015 by diversifying the number of podium speakers. The introduction of workshops and discussions promotes dialogue between users and providers of technologies and diverse stakeholders in heritage science issues. The members of the organising committee are incredibly grateful to those have contributed time and effort to planning and preparing for the conference. We would also like to thank personnel from the School of Geography and the Environment and other constituents of the University of Oxford for providing logistic and technical support and accommodation.

Scott Allan Orr  
Chair, SEAHA Conference Organising Committee  
Doctoral Student, EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage, and Archaeology

The 2nd International SEAHA Conference promises to be an exciting, diverse and innovative event, continuing the trend set by the 2015 conference hosted by University College London. This year we received even more abstracts than last year, covering a very diverse range of topics of relevance to heritage science. Archaeology, museum objects, and built heritage are all covered in this year’s conference, with many presentations using innovative methods to record, document, understand and conserve heritage around the world. The organising committee are very grateful to the journal Heritage Science for supporting a special issue which will feature a selection of papers from the work presented at the conference. I would like to thank all participants in this year’s conference for your continued support, and look forward to seeing you all next year in Brighton for the next conference in the series.

Prof. Heather Viles  
Co-Director, EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage, and Archaeology  
Head of School, School of Geography and the Environment, University of Oxford
One of the unique features of this CDT is the training we provide to SEAHA students to support their development into confident researchers prepared for careers in academia, industry or policy. This conference, which is an integral part of the students training, promises to provide a platform to showcase their research to the heritage science community as well as promoting collaboration and a discussion interface for researchers, practitioners, managers and policy makers. The heritage science community is growing internationally and while there are a growing number of opportunities for heritage science to be presented at conferences, seminars and workshops, the SEAHA conference is unique in its focus on heritage science. Though only in its second year, it is quickly becoming a landmark event for the cross-disciplinary community of heritage science worldwide.

Prof. May Cassar  
*Director, EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage, and Archaeology*  
*Director, UCL Institute for Sustainable Heritage*  
*Vice-Dean (Public Policy), The Bartlett Faculty of the Built Environment, UCL*
Programme

Day 1

8:45 – 9:30 Registration and Coffee

9:30 – 9:35 Opening address (Chair, Conference Organisation Committee)
Scott Allan Orr, University of Oxford

9:35 – 9:55 Heritage Science and Social Justice
Prof. May Cassar, UCL

9:55 – 11:00 SESSION 1: Policy and management
Chair: Cecilia Bembibre

Keynote: Heritage science and the citizen
Sir Philip Campbell, Nature

Conservation in the Ashmolean Museum- how things have changed
Mark Norman, University of Oxford

Together or apart? A policy exploration of heritage & sport evidence
Shaun McKinnar, UCL

11:00 – 11:20 Break

11:20 – 11:40 SESSION 2: Imaging
Chair: Ian Maybury

Painting by Numbers Part II: Identifying 18th century pigments at the Bodleian Library
Dr Richard Mulholland, University of Oxford

Improving RTI methods for research on early prints: a collaborative approach
Dr Lothar Schmitt and Andrea Bianco, Universitàt Basel

Reproducibility and comparability of imaging for monitoring cultural heritage objects
E. Keats Webb, Smithsonian Museum; University of Brighton

Predictive digitization, restoration and degradation asessment of cultural heritage objects
Dirk Rieke-Zapp, Aicon 3D Systems GmbH
12:40 – 13:25 Lunch

13:25 – 14:50 SESSION 3: Environments
Chair: Lucie Fusade

Keynote: Current environmental challenges in heritage management: putting the research into practice
Dr. Ewan Hyslop, Historic Environment Scotland

Interviewing Museum Professionals: How is Museum Lighting Selected?
Danny Garside, UCL

SmartStone: Mobile environmental monitoring system for heritage science based on smartphone technology with infrared camera module using image analysis
Dr. Katrin Wilhelm, University of Oxford

Epidemiology the missing link?
Dr David Thickett, English Heritage

14:50 – 15:10 Break

15:10 – 16:30 SESSION 4: Analytical I
Chair: Mark Kearney

Cleaning treatments for museum plastics: a closer look
Anna Fricker, Imperial College London

Islamic Paper Detective: Survey of the Wellcome Library Collection
Hend Mahgoub, UCL

Unravelling 19th century Turkey red textiles: Approaches for heritage science through historical re-creation and chemical analysis
Julie Wertz, University of Glasgow

Non-invasive analyses of illuminated manuscripts. The MINIARE project at the Fitzwilliam Museum
Dr Lucia Pereira-Pardo, University of Cambridge

16:30 – 16:40 Short break

16:40 – 18:00 SESSION 5: Analytical II
Chair: Natalie Brown
Bacterial and fungal colonization of historical Pergola – studies of seasonal changes in diversity and activity of biodeterioration agents
Dr Agnieszka Laudy, Museum of King Jan III’s Palace

Unfolding the complexity of nutrition at the dawn of modern humans. A multi-layered digital 3D storytelling approach
Prof. Laura Longo, Nanyang Tecnological University

Nanostructured SERS substrates for highly sensitive detection of degradation products of modern paintings
Manuel Gomez, Santiago de Compostela University

Modelling the degradation of historical paper induced by iron gall ink
Yun Liu, UCL

19:15 Optional: Dinner at St. John’s College

Day 2

8:45 – 9:30 Registration and Coffee

9:30 – 10:30 Breakout Session A

10:30 – 11:00 Break

11:00 – 12:00 Breakout Session B

12:00 – 12:45 Lunch

12:45 – 14:10 SESSION 6: Novel techniques in cultural heritage
Chair: Anna Pokorska

Keynote: Using non invasive chemical analysis with mobile instruments to understand artists motivations
Prof. Philippe Walter, University Pierre and Marie Curie, Sorbonne Universities

Nano-scale Localised Thermal Analysis (LTA) for the characterisation of artificially aged synthetic polymers for the conservation of modern art
Donald Sale
Using Supercritical Carbon Dioxide to Rehydrate Oven Dried Samples of Modern and Historic Wood with and without the use of a Co-solvent
Georgina Hammond, University of Birmingham

Use of gold nanorods for SERS analysis of ballpoint pens and felt-tip pens
Daniela Iacopino, Tyndall National Institute

14:10 –14:35 Break
14:35 –15:35 SESSION 7: Conservation techniques
Chair: Hayley Simon

Underlining Heritage: The science of damp-proofing with clay
Martin Michette, Potsdam University of Applied Science

Preservation In Situ of Underwater Cultural Heritage in Estuarine Contexts: Understanding the relationship between the material remains and their environment
Mitzy Antonieta Quinto Cortés, University of Southampton

Biopolymeric alternatives to traditional conservation materials
Dr Yvonne Shashoua, National Museum of Denmark

15:35 –15:55 HIGHLIGHT: Organisations and heritage science
National Heritage Science Forum – Nancy Bell (NHSF chairman)
Analytical Methods Committee, Heritage Science Subcommittee, Royal Society of Chemistry – Lucia Burgio (chair)
Working Party on Chemistry for Cultural Heritage, European Chemical Sciences – Lucia Burgio on behalf of Brenda Keneghan (EuCheMS working party member)
Heritage Science Group, ICON – Natalie Brown (student representative)

15:55 – 16:40 POSTER SESSION

16:40 – 17:40 SESSION 8: Digitisation
Chair: Panos Andrikopoulos

A Refinement of the Parametric Model of Byzantine Church Domes Lighting Method
Dr. Wassim Jabi, Cardiff University and Prof. Iakovos Potamianos, Aristotle University of Thessaloniki
The Hidden Landscape of a Roman Frontier Project
Nick Hannon, *Canterbury Christ Church University*

How we used open digital heritage data to keep updating our conservation plan for 1200 historic buildings
Dr Pavlos Chatzigrigoriou, *Cyprus University of Technology*

17:40 – 17:50  Closing remarks
Prof. Heather Viles

18:00  Reception at Divinity Schools, Bodleian Library
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Heritage science and the citizen

Sir Philip Campbell

Editor-in-Chief, Nature

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Sir Philip Campbell is Editor-in-Chief of Nature and of the Nature Publishing Group. His areas of responsibility include the editorial content of Nature, and assuring the long-term quality of all Nature publications. He is based in London.

He has a BSc in aeronautical engineering, an MSc in astrophysics and a PhD and postdoctoral research in upper atmospheric physics. Following his research, he became the Physical Sciences Editor of Nature and then, in 1988, the founding editor of Physics World, the international magazine of the UK Institute of Physics. He returned to Nature to take on his current role in 1995.

He has worked with the UK Office of Science and Innovation, the European Commission and the US National Institutes of Health on issues relating to science and its impacts in society. For ten years until 2012 he was a trustee of Cancer Research UK. He is a founding trustee and now the Chair of the research funding charity MQ: transforming mental health. He is a Fellow of the Royal Astronomical Society and a Fellow of the Institute of Physics, and was awarded an honorary DSc by Leicester University and Bristol University, and an Honorary Professorship by the Peking Union Medical College. He is a Life Member of Clare Hall, Cambridge University.
Dr Ewan Hyslop is Head of Technical Research and Science at Historic Environment Scotland (formerly Historic Scotland), where he manages conservation and digital research, heritage science, and the agency’s climate change programme. His primary role is to coordinate collaborative research programmes and to ensure the application of research to improve decision-making for the historic environment in Scotland; both for properties and sites in the care of the state, and to the wider historic environment in Scotland. Ewan joined Historic Scotland in 2010 having been project manager for building stone research and consultancy with the British Geological Survey, specialising in petrographic stone matching (selection of stone for repairs to historic buildings) and identification and analysis of stone decay. Ewan lectures widely to professionals in building conservation, and was part-time lecturer at the School of Architecture, Edinburgh College of Art (2005-2010). He is a Trustee of the UK National Heritage Science Forum and is External Examiner in Conservation and Material Science at University of Cardiff. Ewan’s current research interests are the effects of climate change on traditional building materials, and developing strategies to minimise damage to historic structures, including improved selection and specification of materials. Ewan has a BSc in geology, a PhD in mineralogy/geochemistry and an MSc in architectural conservation.
Using non invasive chemical analysis with mobile instruments to understand artists motivations

Prof. Philippe Walter

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Prof. Philippe Walter is head of the Laboratory of molecular and structural archaeology (Sorbonne Universits/CNRS/UPMC) in Paris, France. He is developing new instruments adapted to the in situ and non-invasive study of ancient materials. His main research interests are focused on the use of analytical chemistry to understand the development of chemistry for health and beauty during Antiquity or the elaboration and use of new painting materials, for instance during the Renaissance period. He received a MS degree in physics at the Ecole Normale Suprieure de Lyon and a PhD degree in geochemistry from Paul Sabatier University, Toulouse, France in 1993. Working at CNRS since 1995, he has received the silver medal of this French research organization in 2008 and the Franklin-Lavoisier prize at the Chemical Heritage Foundation (Philadelphia) in 2010. He was appointed as Professor at College de France for the academic year 2013-2014, with the chair Liliane Bettencourt of Innovative Technology.

Abstract

The precious character of the most famous works of art and their uniqueness imply particular cautions and require instruments which may give the maximum of information directly on the objects, in-situ in the museums or in the archaeological sites. The implementation of new analytical tools, including mobile instruments, allows a deep insight on the archaeological and artistic materials.

We will show the performances of different new mobile instruments we built to allow in situ characterization of materials, alteration products and modes of preparation of different pigments. Through several examples, we will show how the painters were able to create the perception of depth in their paintings by modulating carefully the relationship between shadows and light, thanks to the realization of dark areas, the work in sub-layers and the choice of pigments. They were then able to obtain particular shades reproducing light reflection on metallic objects or performing an atmospheric perspective.
Conservation in the Ashmolean Museum- how things have changed

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Established in 1999, the role of the Department of Conservation in the Ashmolean Museum has evolved significantly over the past 16 years with its focus shifting from traditional interventive work to one that is informed by material science, is question-led and is forensic in its approach. Through strategic investment in its own analytical capability, and building collaborative partnerships with both internal and external academic partners that have facilitated access to world class analytical systems and expertise, the Ashmoleans conservators are now able to add significant value to the work of both their own department and that of other heritage science specialists in the University. This is reflected in the outputs from a number of projects including conservation as part of the re-display of the Egyptian collections, investigation of the Wellby Collection of European silverware and, currently, the technical examination of the 40 finest Raphael drawings in the Ashmoleans collection. These and other initiatives currently underway or being planned, will be reported upon at this conference.
Together or apart? A policy exploration of heritage & sport evidence

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The 2007 Cabinet Office Capability Review of DCMS stated: “The Department needs to strengthen its research capability and use of evidence to inform policy making” (1). In 2009 DCMS set up the Culture & Sport Evidence Programme (CASE) to gather evidence of the impact of Sport England, English Heritage & Arts Council on Health, Wellbeing, Crime Reduction, Social Capital & Education. The 2015 CASE Review identified Sport as the outstanding contributor to social impacts. Heritage was described as lagging considerably behind in both the quantity and quality of evidence on their social impacts & in being particularly deficient in hard evidence (2). This presentation explores the Heritage-Sport-Policy relationship. We asked: What added social value can be derived from shared Heritage & Sport evidence including Heritage Science & Sport Science? Our hypothesis is that indicators of Social Capital & multiple impacts may be more effective in revealing the social impact of Heritage & Sport because many are inter-related, making Heritage, Sport & their respective Sciences potentially highly cost effective interventions. We tested our hypothesis on Newmarket, an English historic racing town & cultural landscape. By studying its twin pillars, the National Horseracing Museum & The Jockey Club, we concluded significantly that Heritage Science as well as Sport Science can contribute to Place-Shaping, a key driver of Public Good under whose umbrella all CASE social impacts gather.

References:
Painting by Numbers Part II: Identifying 18th century pigments at the Bodleian Library

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The challenges of identifying artists’ materials in works of art on paper are numerous, not least because the removal of samples is rarely permitted. Although much has been written on watercolour materials and techniques in the 19th c., the late-18th c. has received little attention in the literature, despite the period being an important transition point in the history of watercolour materials.

A collaborative research project between the Bodleian Libraries, Durham University and the University of Northumbria, (introduced at SEAHA 2015) has allowed a great deal of information to be gathered on the colour palette used by the botanical artist Ferdinand Bauer (1760-1826), facilitating the unravelling of the complex colour code system used he used. This paper will focus on the challenges of identifying 18th c. artists watercolour pigments using non-destructive, in situ methods. In particular it will discuss the complimentary use of Raman spectroscopy, XRF and VIS/VNIR hyperspectral imaging for the identification, mapping and characterisation of 18th pigments.

The results so far show that it has been possible to identify many of the pigments used by Bauer in both his plant and animal paintings, and provide a unique overview of his usage of pigments during the period 1787-1794 to achieve often stunningly accurate colour in his work.

Our results also serve to demonstrate the efficacy of these three techniques used together to identify pigments on works of art on paper in situ. Though not without the additional benefit of some historical detective work, the use of these analytical methods have already corrected many old assumptions about how Bauer worked, and have enabled a better picture of the working practices of one of the greatest natural history artists to have lived.
Improving RTI methods for research on early prints: a collaborative approach

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If historic objects are considered as works of art, the sensory experience is mainly focused on visual perception. This explains why reliable photographic records are important for art historical and cultural heritage research. With the advent of computational imaging new ways of generating pictures have been developed that go beyond conventional, static photographic reproductions.

Reflectance transformation imaging (RTI) is such a method. Contrary to conventional photography, RTI images visualize material properties of surfaces interactively. Our research project enhances RTI to meet important demands of art historians. We therefore developed an integrated solution composed of a portable capturing device (LED light-dome) and an innovative web-based viewer. The later is embedded in a virtual research environment (VRE) for collaborative examination of such reproductions. The viewer allows the user to interactively modify the visual appearance of the originals by changing illumination parameters. Within the VRE regions of interest can be specified, that are annotated and interlinked with other digital sources. The development is following sustainability guidelines, based on open, well-documented metadata and file-formats. Several works of art have been captured with the system and evaluated by art historians. Due to the feedback of those experts, the visualization of the objects and the work environment could be optimized according to the needs of the researchers.

At the SEAHA conference we want to show the results of our research on a rare group of 15th century prints that combine complex gloss, colour, and relief effects. Contrary to conventional photographs, our approach enables scholars to take a closer look at the supple and fragile surface of these prints.
Reproducibility and comparability of imaging for monitoring cultural heritage objects

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Museums and their conservators are charged with the stewardship of cultural heritage objects made from materials that decay and deteriorate with time. Currently conservators monitor objects through condition surveys, written reports, diagrams, annotated images, and 2D before/after treatment photographs. Recently photographs have been supplemented with advanced imaging techniques such as spectral and 3D imaging for object documentation. Spectral imaging produces 2D images that record the variable absorption, reflection, or fluorescence of different wavelengths of radiation by an object, and 3D imaging produces 3D models that record the surface geometry of an object. Whether in written reports or with imaging techniques, reproducible and comparable data is essential for recording change in the condition of objects over time instead of variations in the recording process. These changes can include distortion, fading, delamination, corrosion, staining, and cracking. Test objects were designed and created to evaluate and assess the reproducibility and comparability of spectral and 3D imaging, specifically infrared and ultraviolet imaging, photogrammetry, and white light scanning. Additionally experiments will be presented to illustrate the repeatability of image acquisition and processing for these techniques. By increasing the reproducibility and comparability of spectral and 3D imaging, variations in the recording process that could be interpreted as change will be reduced. This would allow museums and conservators to more accurately assess the change in the condition of cultural heritage objects. This research is a component of a larger project investigating an integrated approach to spectral and 3D imaging to enhance the monitoring of cultural heritage objects.
Predictive digitization, restoration and degradation assessment of cultural heritage objects

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This contribution will provide an overview about the final results of the EU funded research project PRESIOUS - Predictive digitization, restoration and degradation assessment of cultural heritage objects (http://presious.eu/). The project was conducted over a period of 36 months collecting 3-dimensional data from cultural heritage objects for in situ degradation assessment as basis for newly developed predictive scanning algorithms, i.e. completion of objects from partial scans or comparison of partial scans to similar objects in a data base. In situ measurements in Norway and Greece were used in combination with laboratory erosion simulation experiments to quantify long term effects of different erosion processes, i.e. freeze/thaw, acid rain, salinization and others to run erosion prediction on 3-dimensional data that were compared to results seen in the field. The collected 3-dimensional data as well as research outputs including predictive scanning software is available from the project homepage. Aicon was involved in PRESIOUS as commercial partner and was directly involved in most work packages. As provider of commercial hard- and software solutions Aicon was able to develop new features that were already introduced in standard products. Significant improvements were accomplished with regards to automatic scan alignment as well as data processing, merging and presentation. The next generation of hardware will also benefit from the PRESIOUS project providing mobile fringe projection scanners.
Interviewing Museum Professionals: How is Museum Lighting Selected?

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Museum lighting must satisfy a broad range of criteria; most critically needing to make museum objects visible, whilst preserving them as much as possible. Further to these requirements, museum professionals who are responsible for the selection of lighting must also consider a range of other factors, such as cost (including maintenance), energy efficiency, longevity, colour temperature, flicker, etc.

The way in which museum professionals select lighting is not well documented and it is presumed that a great variability exists in the selection process from institution to institution. We hereby report the initial findings of an interview based survey, conducted to inform development of a standardised set of tools for museum lighting selection.

The results of a number of semi-structured interviews with museum professionals, including conservators and curators from different heritage organisations in the UK, are reported here. The aim of this research was to investigate: the way in which decisions are made in relation to museum lighting choices; the importance placed on industry parameters such as the colour rendering index (CRI), correlated colour temperature (CCT), and energy efficiency of light sources in decision-making; and the use made of light-emitting diode (LED) light sources.

Preliminary results indicate that museum lighting selection is a complex process involving a variety of museum professionals comprising internal staff and outside contractors, a range of guidance legislature and literature, operating in the context of a lighting market experiencing an unprecedented rate of technological advancement. The tools currently available to aid the selection process are limited in scope and applicability, and are sometimes misunderstood and mistrusted.
SmartStone: Mobile environmental monitoring system for heritage science based on smartphone technology with infrared camera module using image analysis

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This paper introduces our novel approach to scientifically exploit smartphones with an infrared camera module as mobile, easy-to-handle, remotely-accessible environmental climate monitors. They can be used by scientists, conservators, and building managers to collect, store and transmit climate data. Climatic impact is the future concern for present cultural heritage preservation. With climate change posing increased risk on heritage assets there is a pressing need for a better understanding of the interaction between environmental climate and cultural remains on a local scale. Thus, measuring of environmental parameters in-situ (opposed to local weather stations as a data source located often too far away from the site of interest) can significantly inform decision-making in cultural heritage protection. The data derived from climate monitoring can be hard to interpret and progress on applied conservation might be inhibited. As a solution our project builds on the easy availability and recent rapid development of smartphones. In 2015 a smartphone infrared camera module has become available, which visualizes temperature gradients. In our study we combine the infrared images with the smartphone camera images to a) quantify the environmental parameters we are interested in (temperature, relative humidity and light) in situ (measuring an area instead of single points) and b) to visualize results using images, which is more user-friendly and enhances understanding of climatic processes. Images are recorded as time lapse video and allow to evaluate climatic trends over time periods. This paper gives an overview on the progress of development of the SmartStone system, its adaptability to a range of research questions and its actual performance on-site.
Epidemiology – the missing link?

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A vigorous debate is taking place about safe relative humidity and temperature levels for objects. There is extensive experimental based evidence that many object types can safely withstand wider ranges than previously recommended. However, this is predominantly based on studies of replicas, and serious doubts exist about the properties of aged materials. Epidemiology, the study of the distribution determinants of observed damage or events can provide valuable information to inform the debate and improve practice.

Large scale criteria anchored surveys, combined with analyses, have been undertaken using epidemiological methods with Birkbeck College. These studies validate laboratory research for archaeological metals.

The sample size for randomised cohort studies is determined by the smallest change detectable. Advances in instrumentation (FTIR, OCT, acoustic emission, NIR) have allowed repeat analyses of objects, giving significant improvements over visual observation. Long term stability and high repeatability are required. Studies of plastics, carved wood, furniture, enamels, polychrome stone and paper have been undertaken with UCL and Nottingham Trent University.

The studies described, measure the actual degradation rates of objects. Beyond driving improvements to environments, collating the studies provides evidence to improve the effectiveness and sustainability of preventive conservation.
Cleaning treatments for museum plastics: a closer look

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Concerns about the stability of plastic artefacts are commonly expressed when discussing the conservation of modern materials. One of the factors affecting the degradation of plastics is the presence of soil, degradation products and other contaminants on the polymer surface. Cleaning treatments for polymer artefacts may therefore increase their stability as well as improving their visual appearance. However, studies have shown that cleaning can also result in visible damage to the surface [1], while the chemical and physical changes occurring to the polymer surface at the microscale have been largely unexplored.

Advanced surface analysis techniques can provide valuable information about surface topography and chemical composition. In this work time-of-flight secondary ion mass spectrometry (TOF-SIMS) has been used in conjunction with atomic force microscopy and scanning electron microscopy to examine the effect of cleaning treatments on the surface of polystyrene. Chemometric analysis of the TOF-SIMS data reveals the presence of residues from cleaning agents and contamination from the cleaning process. Physical damage in the form of scratching is also observed. It is anticipated that this work will assist in informing future cleaning treatments for plastics.

References
Islamic Paper Detective: Survey of the Wellcome Library Collection

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A new non-destructive material characterization methodology was developed for paper produced in the Islamic cultural realm, where the use of papermaking techniques such as starch sizing and surface polishing made Islamic paper distinct. However, little is known about how these techniques affect material stability, and what proportion of Islamic paper constitutes manuscripts in Islamic library collections.

The methodology was developed using the well-characterized Islamic reference paper collection at UCL Institute for Sustainable Heritage. Chemical analytical methods and near infrared (NIR) spectroscopy were used on 228 paper samples (17th – 20th C.). Multivariate regression was used to correlate the results, which enabled the NIR method to be used as a non-destructive collection survey method.

A collection of 43 objects (17th – 19th C.) from the Wellcome Library Islamic collection was surveyed for presence of starch and polishing, as well as two chemical properties: acidity and degree of polymerization (DP). Based on the survey, a new dating method for Islamic paper was also developed. The results show that 40% of the surveyed collection is potentially of Islamic origin (starch-sized and polished). The majority of the collection is in a good state (pH > 7 and DP > 800) with a low rate of deterioration. This is the first systematic study of material properties of Islamic paper.

Following the survey, a new technique is being explored using hyperspectral NIR imaging (1000–2500nm) to explore the compositional inhomogeneity of Islamic paper. This technique allows to document the spatial distribution of the condition of an object, thus significantly improving conservation advice and evidence, and is planned to be applied in various Islamic collections.
Unravelling 19th century Turkey red textiles: Approaches for heritage science through historical re-creation and chemical analysis

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Turkey red textiles were major economic commodities for the 19th-century industrial powerhouses of Glasgow and Manchester. An accomplished feat of dyeing technology and chemical complexity, the multi-step Turkey red dyeing process and its fabled superior colour-fastness has remained compellingly mysterious for over a century. Innovative cross-disciplinary, process-based heritage science research by the University of Glasgow is now unravelling secrets of past production methods and materials to inform the preservation and display for museum and archive Turkey red textile collections.

Central to the research is identifying key chemical markers to distinguish real Turkey red from imitations for collection significance and material behaviour prediction, especially colour-fastness. Re-creation of the process by historical technical research informed by modern dye chemistry and organic synthesis, combined with comparative analytical studies of historical examples by \(^{1}\text{H}\) and \(^{13}\text{C}\) NMR, ATR-FTIR, diffuse FTIR (DRIFTS), UHPLC-PDA and LC-MS, reveals signature material markers for true Turkey red and explains why such a chemically-complex process was needed. Hand-held DRIFTS is proving highly useful for non-invasive screening of historical collections to detect oil residues as chemical signatures of the true process, while increased sensitivity from UHPLC-PDA greatly reduces sample sizes for dye analysis to detect photosensitive and labile components and to distinguish the anthraquinones of traditional natural madder dyes from synthetic alizarin equivalents used commercially from 1870. Placing the analytical results within historical contexts of commercial technology is offering a unique perspective on primary material evidence for the collections care of Turkey red textiles.
Non-invasive analyses of illuminated manuscripts. The MINIARE project at the Fitzwilliam Museum

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The materials and techniques of more than 100 illuminated manuscripts from the Fitzwilliam Museums collections have been systematically analysed during the past four years, in the framework of the cross-disciplinary research project MINIARE (www.miniare.org). The main objectives were to help solve questions relative to technical art history and conservation and to better understand the cultural and historical context of the manuscripts investigated. The analytical protocol used consisted in a combination of non-invasive techniques: infrared imaging, optical microscopy, UV-Vis-NIR-SWIR fibre-optic reflectance spectroscopy (FORS), X-Ray Fluorescence (XRF), external reflectance FTIR and Raman spectroscopy.

The results obtained on a 15th century manuscript fragment from Siena attributed to the Master of the Osservanza (FM Marlay Cutting It 12) will be presented to illustrate the potentialities and limitations of this analytical protocol. The results shed light on the pictorial palette, the presence of binders and the modelling technique of both flesh tones and draperies. Based on the materials identified, complex questions will be addressed, such as: what are the causes and mechanisms of the alteration observed in the illumination? Has the fragment been retouched? If so, when, how many times, under whose ownerships? Can technical analysis help inform the ongoing debate about the identity of the Master of the Osservanza? Could this artist really be the young Sano di Pietro, the famous artist active in Siena c. 1430–1480, as suggested by some scholars?
Session 5: Analytical II

Chaired by Natalie Brown

Bacterial and fungal colonization of historical Pergola studies of seasonal changes in diversity and activity of biodeterioration agents

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One of the infamous characteristics of microorganisms is their ability to colonize construction materials of historical buildings. Through physical penetration, microorganisms contribute to surface roughing, detachment, separation and crushing of some constituents of mineral grains. Microbial activity may also leads to the chemical dissolution of the construction materials by production and secretion of dissolution agents such as organic acids and ligands. The rate of biodeterioration of construction materials is strictly determined by the abundance, diversity and activity of microbial community, which in turn is dependent on various environmental factors such as humidity, chemical composition of the air and chemical nature of the substrate.

The aim of this study was to: (i) evaluate which bacterial and fungal representatives colonize the surface of historical North Pergola placed in Wilanow gardens, and (ii) assess the change in the structure of the microbial community during the different seasons using metagenomics.

High-throughput metagenomic sequencing analysis allowed the taxonomic characterizations of most microbial category components of the biofilms. Assignment of 16S rRNA bacterial gene sequences revealed that Sphingomonas genus was found to be main dominant in all samples from sandstone Pergola. Excluding dominance of the order Chlorophyta the following families: Acidobacteriaceae, Cytophagaceae, Nocardioidaceae and Sphingomonadaceae were the most abundant in the collected biofilm samples. ITS gene amplicon analysis shown distinct domination Herpotrichiellaceae, Chaetothyriaceae, and Lecanoraceae among other families of fungi. The performed analysis also determined, that distribution of dominant microbial families, was almost stable over various seasons.
Unfolding the complexity of nutrition at the dawn of modern humans. A multi-layered digital 3D storytelling approach

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Though archaeologically poorly represented and therefore underestimated, the role played by vegetable food processing in the Palaeolithic diet has been recently assessed. The production of high-energy food rich in carbohydrates as flour was a component of the food economy of mobile hunter-gatherers across Europe from at least 30,000 years ago. Flour production and consumption imply multi-step processing from harvesting to cooking to obtain a suitable and digestible food (allowed by amylase enzymes).

Here is presented a functional study that involves EUP sites dating to MIS 4/MIS 3 where both late Neanderthals (Hn) and the first modern humans (AMHs) were exploiting the same nutritional niche.

Analysing stone tools for plant processing e.g grinding and pounding, we approached direct investigation on the behavioural modernity of processing starch rich portions like USOs, fruits and seeds, to get highly energetic staple food.

We propose an innovative research approach based on functional analysis applying a multi-disciplinary characterisation and analytical measurements of EUP (Aurignacian) assemblages – Surein, Crimea, and Kostenki 14 and 16, Don River - with non-invasive, non-destructive, portable scientific equipment.

Methodology:
The identification and description of use-wear traces and residues was carried out by means of the application to wear-traces analysis of the combined potential of:

- Digital Microscopy (Hirox 8700),
- FESEM-EDAX
- High resolution moulding techniques
- Laser-scanner for accurate 3D measurement of the micro-topography of the grinding stones surface, utilizing a white light low frequency laser beam.
Nanostructured SERS substrates for highly sensitive detection of degradation products of modern paintings

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Conservation and restoration of works of art faces many problems caused by degradation of varnishes, binding media and dyes. Identification and characterization of these degradation products is of high importance. Raman spectroscopy is a nondestructive method that provides a vibrational fingerprint spectrum of the molecular structure of these materials. Raman spectroscopy is intrinsically poor in intensity, and therefore Surface Enhanced Raman Spectroscopy (SERS) is usually carried out, because it allows the detection of very small amounts of analytes through local amplification of the electromagnetic field generated by plasma excitations on the surface of nanoparticles or nanostructured metals. Common experimental protocols involve removing a small fragment of the work of art and coating it with a nanoparticle suspension before laser irradiation. In this presentation we propose new nanostructured SERS-active substrates with high performance and tunability (M.Gomez, M.Lazzari. Microelectron. Eng. 2012, 97, 208211), designed with the final aim to expand the versatility of SERS, allowing its use as a routinely analytical tool for the detection of organic and inorganic species of interest for the cultural heritage conservation. In particular we show preliminary results on the direct application of elastomeric (flexible) soft stamps onto the surfaces of interest to extract small amounts of the degradation products of binders. After removal of the stamp from the surface of interest, we transfer the analyte molecules to the nanostructured SERS substrate by rinsing the stamp with a drop of appropriate solvent, and then shining the laser to acquire the Raman spectrum.

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Modelling the degradation of historical paper induced by iron gall ink

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The damaging effect of iron gall ink on paper has been scientifically studied for 250 years, however, the kinetics is still not clear, nor are the outcomes of value to preventive conservation. We took these two challenges as major foci of this research. Firstly, analytical experiments were undertaken and designed to minimise sample consumption. Ten sacrificial historical paper documents with ink were used in accelerated degradation experiments at 50-80 °C / 20-80% RH. Arrhenius analysis of the apparent activation energy of thermal degradation of inks confirmed that degradation pathways were dependent on moisture content and hydrolysis was likely to play a dominant role in the natural ageing process. Analysis of degradation rates indicated that the presence of ink accelerated the degradation of paper by a constant factor of 1.8 in comparison to paper without ink. Therefore, the quantitative correlation between degradation rate of paper with ink and T, RH and pH was initially established based on the dose-response function for historic paper. In order to develop a model for prediction purposes, we conducted a non-destructive collection survey and collected NIR spectral data from a selection of 16th to 20th century iron gall ink documents from the National Archives (UK). The data were used to mathematically quantify and validate the contributions of each potential parameter, i.e. T, RH, pH, ink application intensity, paper grammage and iron content. The developed model can be applied to predict the fitness for use of iron gall ink documents, examine various environmental scenarios and evaluate the probable outcomes of preventive conservation approaches to support collection management.
Session 6: Novel techniques in cultural heritage

Chaired by Anna Pokorska

Nano-scale Localised Thermal Analysis (LTA) for the characterisation of artificially aged synthetic polymers for the conservation of modern art

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In a pilot study involving adhesive assessment and analytical methodology development for the conservation of modern art made of transparent PMMA, nano-scale Localised Thermal Analysis (LTA) was used to investigate glass transition (Tg) behaviour of artificially aged butyl methacrylate resins. Samples of the resin mixture 1:1 Paraloid B-67 / Paraloid F-10 (isobutyl methacrylate / n butyl methacrylate or piBMA / pnBMA) that were aged artificially with heat, light and combinations in previous studies, and stored in the dark for 23 years, were characterised with LTA to investigate nano-scale glass transitions on the surface of the samples.

LTA revealed a trend in transition temperatures related to aging which was similar to the trend identified in bulk sample material characterisation with Dynamic Load Thermal Mechanical Analysis (DL TMA); higher Tgs were found in samples exposed to light and heat combined for fractional periods of a dose, while samples exposed to light or heat alone for a full dose had a lower Tg.

This investigation highlights advantages of LTA characterisation of thermal mechanical properties which include minimal preparation and rapid measurements directly on the sample surface; in this study samples were measured 40 times. The data adds to the understanding of BMA aging, its use as an artist and conservation material, and the development of analytical methodologies and assessment protocols involving artificial aging.

This collaborative project involved LTA characterisation in the Biomaterials and Tissue Engineering Department, UCL and Birkbeck, University of London, DL TMA in the Getty Conservation Institute, and sample preparation, artificial aging and analysis in the Tate Gallery, funded by the Gabo Trust.
The presence of dry and brittle materials such as wood, leather and paper is not uncommon within museum collections. A variety of established methods are used by conservation professionals to help stabilise and preserve these materials for continued public enjoyment. These approaches, although effective, do not always seek to strengthen the materials but simply stabilise them.

This presentation describes an in-progress research project that looks to investigate the use of supercritical carbon dioxide (scCO$_2$) as a non-toxic solvent within a high pressure system for hydrating and strengthening oven dried historic and modern wood samples. The technique has been successful to varying degrees with and without the use of a co-solvent, Methanol (CH$_3$OH). All samples retained a stabilised constant mass three weeks post treatment. Mechanical analysis in the form of a three point bend test demonstrated that the mean strength of the samples was improved post treatment with both scCO$_2$(PURE) and scCO$_2$(CH$_3$OH). Diffuse Reflectance Infrared Fourier Transform (DRIFT) spectroscopy was performed to help deduce if any trends in the OH/CH and OH/Cellulose peak area ratios can be established with the nature of the treatment and the type of wood used. Spectroscopic analysis was performed by Chiralabs, Oxford. Collaboration and advice from conservation professionals at the Pitt Rivers Museum and the Ashmolean has been key to the development and relevance of the technique for use in modern conservation practices.

To exploit the potential of this method further historic leather and textile samples will be investigated. Initial findings for the suitability of the treatment on the leather samples, provided by the Leather Conservation Centre, Northampton will be presented.
Identification of inks formulations and elucidation of processes leading to colour fading are exceedingly important for dating, active conservation and long-term preservation of paper artworks. Dyes and pigments in inks can be difficult to identify, due to the presence of other chemicals in the mixture and patent protection. All these factors pose serious challenges for paper art conservators. Available characterization techniques require both the use of relatively large amount of sample (mg) and harsh destructive extraction methods, which are generally non applicable to works of art. Recently Surface Enhanced Raman scattering (SERS) has been identified as suitable spectroscopic technique. Blue and black inks in ballpoint pens were identified with the use of silver colloidal solutions. However, SERS spectra had to be taken within 10 min of colloid deposition due to fast silver oxidation. Additionally, chemical treatment of the colloidal solution had to be carried out. In this work we have use gold nanorods for the SERS analysis of BIC pens and felt tip pens in combination with thin layer chromatography (TLC). TLC was used to separate the dye components in the ink mixture. High concentrated nanorod solutions (nM) were used to take SERS spectra of separated components. Comparison between Normal Raman (NR) spectra and SERS spectra taken with laser excitation 785 nm showed SERS enhancements up to 2 orders of magnitude, especially evident with blue colors. The origin of the enhancement was attributed to the anisotropic shape of the particles as well as to their plasmon mode in resonance with the excitation wavelength.
In recent years clay damp-proof coursing has witnessed a small renaissance in German heritage conservation. Clay waterproofing techniques are amongst the oldest in the world and are still present in some fields of engineering today, despite declining in use during the 19th Century. They are regaining favour not only for their use of natural materials and low embodied energy, but also for their reversible application. This makes them highly suitable for protecting built heritage at risk from groundwater intrusion.

This presentation will discuss research undertaken on three commercially available clay damp-proof masses at the University of Applied Science, Potsdam in 2014. Two specialised clay mixtures and one naturally occurring clay were analysed for composition, hygroscopicity and swelling behaviour. These investigations were supported by a series of simulations, and an experimental set-up for field based characterisation. The overall aim was to gain a detailed understanding of the waterproofing mechanisms, and establish what characteristics make naturally occurring clays suitable for use as damp-proof courses.

Considerable differences were uncovered in the composition and behaviour of the natural clay and the specialised mixtures; different waterproofing mechanisms were evident in each. The natural clay relies on a high lime content and associated sorptive behaviour. The specialised mixtures rely on a precise grain size distribution and osmotic swelling. All benefit from high moisture retention. It was not possible to simulate measured moisture retention in Delphin. This led to a new theory for clay materials desorption which does not fit the standard moisture retention curve. A set of instructions for optimising natural clays was also developed.
Preservation In Situ of Underwater Cultural Heritage in Estuarine Contexts: Understanding the relationship between the material remains and their environment

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Preservation in situ of Underwater Cultural Heritage (UCH) is becoming a universally accepted approach towards the long-term conservation of material remains. Although there are studies about the characterisation of the marine context, there is still considerable work required to understand decay dynamics in fresh water. This paper shows the first results of an on-going PhD research regarding in situ preservation of UCH in estuarine environments, developed by the Centre for Maritime Archaeology of the University of Southampton and the Mary Rose Trust, England.

One of the case of studies featured in this initial research is the Grace Dieu shipwreck. Built c. 1416 AD, she is considered to be one of Henry Vs great ships due to her considerable size, design and building technique. She was anchored in the Hamble River, Southern England, where she was struck by lightning and burnt to the waterline in 1439. Even though she is entirely submerged in mud, her remains are still evident at extreme low water during equinoctial spring tides.

As part of the assessment process, diverse analytical techniques have been used to characterise the biological, chemical and physical properties of the material remains (shipwreck) like FTIR, SEM, moisture content, compression and flexural testing; and of the environment such as particle size analysis, SEM, moisture content and XRF.

The first results have shown a good conservation state of the planking sampled suggesting that the burial conditions seems to promote a favourable environment to its preservation.
Biopolymeric alternatives to traditional conservation materials

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Although concern about the environmental sustainability of conservation of cultural heritage was formally recognized in 2009, the research described is the first study of plant-based biopolymers in conservation. This project focused on two applications of biopolymers to conservation: commercial bioplastics as substitutes for traditional plastic packaging and in novel adhesives, consolidants and cleaning agents.

Bioplastics that, based on manufacturers data sheets, appeared to be equivalent to traditional polyethylenes, polyesters and cellulose-based products used in conservation were evaluated against the traditional materials. Bio-polyethylenes showed similar optical, chemical and thermal properties to traditional polyethylenes. Cellulosic food boxes were also suitably stable. Cellulose acetate evolved acetic acid on ageing and was therefore deemed unsuitable. Polylactic acid food containers became brittle and opaque in the presence of water. FTIR spectroscopy and thermogravimetric analysis suggested that PLA hydrolysed to produce acids.

Commercially available soya protein was used to prepare a water-based adhesive. A 3–4% by weight solution was an effective adhesive for wood, paper, cotton and glass but adhered poorly to rubber and polyethylene. Humic acid-based solutions formed cohesive films which adhered well to glass, paper and soil. Despite high reversibility in cold water, humic acids brown colour limits its applications. Biopolymer polyvinyl alcohol was used to synthesize hydrogels found commercially in time-release patches for medicines and nicotine. Porous hydrogel was loaded with detergent and applied to a model wallpainting. The hydrogel released detergent into the surface pores and removed resistant soil after 48 hours.
A Refinement of the Parametric Model of Byzantine Church Domes Lighting Method

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Byzantine church domes are paradoxically brighter than all surrounding surfaces. In order to achieve this effect, the original Hagia Sophia dome in Istanbul was designed by Anthemius as a combination of two reflectors. The reflector designs, found in the architects extant writings, had been combined in a specific way in order to generate the luminous impression described by the eye-witness Procopius. This hypothesis has been proven in terms of geometrical, topographical and textual evidence in our previous papers.

While being of a significantly different design, subsequent Byzantine church domes also achieved luminosity. The first attempt to generate a universal model accounting for the luminosity of all byzantine domes was presented in a recent conference. The model incorporates variables such as a drum of varying height, one or two dome curvatures above it, openings varying in number pierced in the drum or the lower curvature, the openings proportions and the varying slope of the window-sills which reflect light upward, etc. The model presented here incorporates the capability of a third curvature since such a case has been identified in a Mistras church.

Accurate digital daylighting was employed to measure lux values and visualize the illuminance of the surfaces while animated particle systems were employed to visualize the travel path of light and reflections. These parameters were encoded in a fully user-configurable graphical interface that modifies the dome geometry in real-time within a 3D visualization environment. The user can then initiate the simulation and observe the behavior of light hitting that particular dome instance.
The Hidden Landscape of a Roman Frontier Project

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The Hidden Landscape of a Roman Frontier is a collaborative project run and funded by Canterbury Christ Church University and Historic Environment Scotland. It is intended to run for a 3-year period and started in October 2015. The project focuses on the landscape archaeology, history and heritage management of the Antonine Wall, a World Heritage Site located in Central Scotland.

The Antonine Wall is a Roman military frontier that stretches for 62km between the Firth of Forth to the east and the Firth of Clyde to the west. Construction commenced in c.AD142 on the orders of the Emperor Antonius Pius and the frontier was abandoned less than a generation later when after the legions returned to Hadrians Wall.

The primary dataset for the project was captured for the Scottish Ten project in 2010 and is formed of 0.50 m² LiDAR coverage of the World Heritage Site; terrestrial laser scanning data was also captured in 2013 for Rough Castle and Bar Hill forts. Additional datasets have been obtained to supplement this data and include colour infra-red imagery, Environment Agency LiDAR, geophysical survey and archive aerial imagery. These data have been combined to maximize their utility supporting a mixed methods approach to remote sensing.

The outputs from this project will help to further understand the function of the frontier and support future management of the site. This presentation will provide an introduction to the research aims of the project, discuss the proposed methodology and present some preliminary results.
How we used open digital heritage data to keep updating our conservation plan for 1200 historic buildings

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When a long-term research finishes, there is always a question about implementation and further development. In the case of HER.M.E.S, the HERitage Management E System of the Historic City of Hermoupolis, in Greek Aegean Island of Syros, it was also a question about raising awareness. The research proved that 2.4 historic buildings collapse every year, as a result of abandonment. This phenomenon was intensified by the severe economic crisis in Greece. The research proposed an optimal conservation plan for the city, after carefully evaluating variables through a multi-criteria model using an algorithm and an innovating point system. But in order to apply this plan, we need to be able to update the data, as buildings are constantly changing through time. Updating a database with more than 1200 historic buildings, with no funds, is a huge challenge. Soon, we decided that the only way to succeed is to use a crowdsourcing method. Developing a digital heritage collection portal, using free open source software and serving crucial data for every building, was the answer to our problem. We asked citizens to check the data base, report mistakes, update the conservation status, add stories & photographs and use the portal to learn about their city. This effort led us to a huge digitisation project, with up to 1290 historic buildings, 14.400 geo-tagged photos and more then 15.000 fields of information. The project HER.M.E.S., as a research and a heritage digitisation project won the 2015 European Union Europa Nostra Award.
Assessment of moisture induced damage in Blickling Hall in Norfolk, England, via environmental monitoring

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In the last few decades extreme weather events mostly characterized by more intense and frequent precipitation and wind incidents have risen, and current climatic projections strongly suggest that this trend will keep its pace also in the future. These climatic conditions pose additional hygrothermal loading onto the built environment, which may lead to moisture induced deterioration and damage, hence strength reduction. This is especially threatening for historic buildings because of the accumulated material deterioration and damage that come down from their past service lives. The PARNASSUS project was set up with the aim of identifying and quantifying the impact of environment on historic buildings in the face of a changing climate. As part of this project, an extensive environmental monitoring campaign was carried out between 2012 and 2015 at the Blicking Hall, a National Trust property in Norfolk, England, with the aim of providing further insight on the buildings overall performance under hygrothermal loading. Environmental monitoring work targeted not only indoor and outdoor conditions, but provided information about the temperature and relative humidity profiles across the walls by means of in-wall probes. The wind and rain gauges helped quantifying other environmental parameters. This paper presents the findings from this environmental monitoring work, with specific emphasis on the Long Gallery, where the estates valuable library is kept.
Spectrally tuneable LED illuminators are slowly being adopted by museums. However tuneable LEDs that provide illuminants with Spectral Power Distributions (SPD) outside the Planckian locus comes with challenges and there is a need for standardization and characterization of light sources. Previous work on assessing colour discrimination with the gamut area has been done by Thornton and criticized later by Royer et al. However none of this studies identify colour discrimination thresholds or assess psychophysically the relationship between the perceived magnitude of colour difference with the difference in stimuli. The Farnsworth Munsell 100 Hue test is performed for ten observers with normal colour vision aged under 35 years, under illuminations of different SPDs achieved by a spectrally tuneable LED illuminator in different hue directions. Eight hue directions are selected for narrowband (primary colours) and wideband SPDs. The relationship between saturation and colour discrimination is being studied and a mathematic formula is being populated to allow theoretical predictions colour discrimination capabilities for known hue and saturation. Colour discrimination fails in the area of saturation above 60%. Saturation thresholds for colour discrimination capability are being identified.
Exploring Novel Tailored Systems for Cleaning of Plastic and Synthetic Paint Surfaces: The NANORESTART Project at Tate

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The NANORESTART project is a research consortium comprised of 27 museums, academic institutions, private conservators, and private companies in Europe and further afield, working together to find new, nanotechnology-based methods for the conservation and preservation of contemporary art. Each partner contributes to different streams of research, according to their strengths and capabilities. At Tate, we will work on the systemic evaluation of novel systems for cleaning the sensitive surfaces of modern and contemporary artworks made of plastic or painted with synthetic polymer paints. Project partner CSGI, Research Centre for Colloid and Surface Science, in Florence, Italy will provide us with a variety of nano-structured liquids and gels which have been determined, through extensive physical and chemical analyses, as potentially suitable cleaning agents for plastics or synthetic polymer paints. Along with key heritage-based project partners, Tate has collaboratively produced a State of the Art report on current cleaning practices. We have also met with curators and conservators to compile a list of candidate artworks from Tate’s collection which could benefit from being included in the project, and selected a short-list of three case studies which will be explored over the upcoming 18 months. Currently, we are preparing mock-up samples which best approximate the selected artworks and developing an experimental methodology for the complete evaluation of the surfaces before, during, and after cleaning tests. Our study aims not only to observe how the novel NANORESTART systems function in the real world conservation studio, but also to evaluate them relative to cleaning strategies and materials already used by conservators.
3D moisture mapping: combining image-based data and 3D point clouds

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3D moisture mapping is a collaborative project between the Digital Documentation and Science teams at Historic Environment Scotland, which aims to develop a method for analysing and presenting the environmental behaviour of historic buildings by combining different datasets. In this case, environmental information in the form of 2D moisture maps is overlain on 3D geometric data from laser scanning. The resulting datasets retain the colour-coded environmental information (moisture levels) with the spatial accuracy of 3D laser scans, thus creating a metrically accurate 3D model of the environmental condition of a building. This can be used as a tool for analysis, interpretation, and presentation of image-based environmental data for the purpose of informing conservation decisions.

The case study focuses on Skelmorlie Aisle, a 17th century chapel in Largs, Scotland. The Science Team at Historic Environment Scotland have been regularly monitoring and analysing the environmental conditions inside the chapel, collecting data on temperature and moisture levels. In the case study, the data from microwave moisture meters (2D moisture maps) are combined with laser scan data (3D point clouds) captured by the Digital Documentation Team. The methodology developed for 3D moisture mapping can also be applied for other image-based information, such as thermal imaging.
Using traditional (analog) book in combination with interactive technology, for a multi-sensory digital heritage experience

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This research explores alternative methodologies on disseminate information from a holistic documentation of a monument with the use of interactive technologies. A monument includes data from its memory that conduct diverse forms of multimedia such as: 3D model, images, video, audio and text. Transparent complex data can be filtered and presented, assembled into a visible form to human eye through an installation that can be adapted and functional to almost any group of users acting as an educational environment.

Development of an interactive book is in initial stage at the moment, available as a form of an educational environment that grasps all the multimedia data that thrive from a monument but at the same time present them in a user friendly experience. The installation includes multiple interactive pages which host multimedia content. Simultaneously as we refer to a book, it has printed text in the same volume of pages as the interactive ones. This combination of an analog book and new digital technologies is more preferable as it keeps the traditional feeling of the book as a way of communication but also transforms it into a real time digital environment with a massive library of content.

As this technology is at initial stage in Digital Heritage sector, through Digital Heritage Research Lab of Cyprus the target is to develop it into a working prototype as also to evaluate it in target groups of people and circumstances such as: Schools, Universities, Professionals, Academics etc. in order to have a full compilation of feedback.
Visualising surface texture through the combination of 2D and 3D data

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The National Gallery in London has recently been testing the potential of 3D scanning technology to record and measure the surface of paintings, using a Lucida laser scanner designed and developed by Manuel Franquelo and custom built by Factum Arte.

One of the common issues regarding the use of complex 3D data is the vast amount of computing power required to visualise and interact with the final processed traditional 3D meshes. In order to solve this problem, the software, provided with the scanner, outputs 3D information as a 2D greyscale depth-map file, which can then be used to generate both 2D shaded renders of the textured surface in addition to the traditional 3D triangular meshes.

Even though the greyscale rendered images can display surface texture illuminated from a range of defined positions, they are individual static images that cannot convey texture information as a full interactive 3D model. However, by combining an appropriate number of rendered images lighted from different directions we are able to process them with the Reflectance Transformation Imaging software to generate a final interactive image. In addition, the resultant RTIs can be further explored, by registering existing colour, Infra-Red and X-ray images of the painting to the shaded renders to visually compare the relationship between the textured data and the other image base examination techniques.

The augmentation of 3D data with additional information from existing 2D images to generate further RTI images provides a way of visualising possible relations across paint layers and whether hidden layers actually show on the surface of a particular painting.

This study is part of an AHRC funded CDA between the Centre for Fine Print Research in Bristol and the National Gallery in London.
A nose for books: a new tool to describe heritage smells

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We don’t know much about the smells of the past. Yet, smells play an important role in our daily lives and can be considered part of our intangible cultural heritage, as outlined by the Burra Charter*; not only for their own value, but through their connections to language, tradition and tourism.

There are several ways to explore the connection between olfaction and heritage. This work focused on the smell of historic objects and spaces as an integral part of their identity. The smells of a historic book and a historic library were chosen as a case study of heritage smells for their familiarity and the fact that historic paper has been extensively researched. The volatile organic compounds (VOCs) emitted by the artifact and the space such as acetic acid, furfural and benzaldehyde were sampled and analysed using headspace solid phase microextraction (HS-SPME) and gas chromatography mass spectrometry (GC/MS). The smells were also characterised using an untrained sensory panel. The chemical information was then combined with the odour descriptors to create historic paper and historic library odour wheels. These are new tools linking the human noses experience of heritage smells to their chemical composition, opening up the potential to characterise, understand and possibly recreate these aspects on intangible heritage.

*The Australia ICOMOS charter for the conservation of places of cultural significance (the Burra charter). Canberra, Australia ICOMOS 1981.
Endangered Archaeology in the Middle East and North Africa (EAMENA)

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This paper will present the latest results of the EAMENA project, which began in January 2015, based in the University of Oxford, in partnership with the University of Leicester, and funded by the Arcadia Fund.

The EAMENA project uses satellite imagery and historic aerial photographs to locate, assess and interpret archaeological sites in 20 countries from Mauretania to Iran. It has created a database of archaeological records to provide the information so that the sites can be better understood and preserved in the future. The threats to sites in the Middle East and North Africa are increasing.

Archaeological sites across the Middle East and North Africa are at risk from a range of threats: intensification of agriculture; population growth and the concomitant expansion of villages, towns and cities; industrial developments, dam and road building; looting and the illicit traffic of artefacts; warfare; and deliberate and targeted destruction of heritage for religious or ideological reasons.

Creating a record of previously unrecorded sites using this methodology, may be our the last chance before they are destroyed. The projects priority is examining areas of high archaeological interest and significance and assessing the threats in those areas.
Uncertainty of Damage Functions in Preventive Conservation of Collections

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Damage functions are mathematical models of the relationship between environmental variables and damage to artefacts. Artificial ageing techniques are often used to develop damage functions. Applying these models to predict a natural ageing process can contain uncertainty as the prediction is based on a different rate of change. In a case study using historic paper from the Institute of Sustainable Heritage as a material, a damage function will be derived using design of experiment principles and artificial ageing, conducted at The National Archives, UK. Colour change will be assigned as the damage variable and the environmental variables studied are relative humidity, temperature and illuminance. Using regression models, the impact of different functional forms on the fit to the data and on the predicted damage will be explored. The uncertainty of the damage function, applied to natural ageing, can be described by the confidence and prediction levels to aid decision-making in preventive conservation.
Nanocellulose and new developments in the consolidation of painting canvases
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This study investigates the applicability of a novel nanocellulose-based treatment for the consolidation of historic canvases as an efficient alternative to lining and current temporary reinforcement solutions. Nanocellulose (NC) is an emergent and renewable compound made of nano-sized chains of cellulose. It has recently attracted the interest of numerous fields of study for its astonishing mechanical, optical and barrier properties.

The modifications brought by NC treatment on canvases properties is evaluated mechanically (DMA), chemically (DP, pH) and through surface analysis (SEM). The results provide a global assessment of the treatments from the nano- to the macroscale.

Commercially available cotton canvases have been treated by NC. The response of the NC-treated unaged and aged materials to variation in RH at a selected T has been studied using DMA-RH. It measures stiffness and gives a measure of change in the viscoelastic behaviour of materials. DP and pH measurements have been performed on unaged, aged and then treated canvases. SEM has been used to determine whether the cellulose nanofibrils interact with cellulosic fibres of a canvas as a coating or a filler regenerating the fibres from the core.

This research provides a preliminary screening of the effect of the consolidation treatment. An improvement in canvas mechanical properties has been observed. The results stress the suitability of DMA-RH for the evaluation of the mechanical performance conferred by a new consolidation formulation to the canvas fabric. The treatment action mode could be evaluated through DP and SEM analysis. This project builds solid foundations for the future in context studies of NC-treated canvases.
Near-infrared spectroscopy as a characterisation tool for 19th and 20th Century Chinese paper

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Chinese literature is a significant component of library and archival collections, however there has been no systematic scientific study of these materials to date. Building on the body of research where near Infrared spectroscopy (NIR) has been used on collections of Western paper [1] and Islamic paper [2], material properties such as pH, degree of polymerization (DP), lignin content, tensile strength properties, and date were determined on a reference collection of 175 19th and 20th century (modern) Chinese papers. Using multivariate calibration and classification methods, the analytical data was compared with the NIR spectral data and quantitative non-destructive methods of material characterization were developed and applied to unknown Chinese paper collections.

It has so far been established that the reference collection does not follow the acidity distribution patterns of modern Western paper, indicating the prevalence of traditional methods of paper making well into the late 20th Century, which likely leads to higher chemical stability. Due to the low grammage (mass per unit area) of many of these papers standard methods of mechanical testing and interpretation have been modified.

References
Long-term working conditions of anti-graffiti and self-cleaning coatings on concrete and stone

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Current knowledge about the interactions, effectiveness and durability of anti-graffiti and self-cleaning coatings in materials of built heritage is limited. These coatings could contribute to improve the efficiency of cleaning and conservation of our Cultural Heritage, they aim to provide long-lasting efficient protection with minimal modification of the historic substrate and without encouraging future damage.

This study aims to assess the performance of three of these coatings, a permanent and a sacrificial anti-graffiti and a self-cleaning product, under long-term working conditions on stones commonly used in the UKs built heritage (Portland limestone and Woodkirk sandstone) and concrete (material extensively used in construction today which is a big part of the most recent built heritage).

The efficiency of coatings exposed for a year on outdoor conditions in the South of England (Wytham Woods; Oxford) and up to 2000 hours in a QUV chamber with UVB radiation and condensation cycles was tested periodically. Changes in the surfaces of the material regarding colour, gloss, water-repellency and degree of cleaning after staining or painting episodes were determined, enabling the performance of the coatings in natural and accelerated weathering conditions to be determined.

The results of both natural and artificial weathering exposures have revealed a loss of cleaning efficiency on the anti-graffiti coated surfaces. The permanent coating is greatly damaged on sandstone and concrete and the sacrificial treatment loses its natural water repellency. The self-cleaning coating also loses its photocatalytic activity as it is removed from the surfaces.
"Midyat stone" is one of the most precious and unique structural materials in Turkey. From geological aspect it is aged between Middle Upper Eocene and known as Midyat formation. It consists of MgO–MgO₃ (20-45%), CaO–CaCO₃ (30-55%), SiO₂ (~0.5%) and Fe₂O₃ (<0.1%), by weight. In addition to its aesthetic appearance, it shows very important lithologic properties such as ease of shaping and great thermal properties, and has been used in buildings as bearing and decorative elements since ancient times. Nowadays, due to relatively higher prices, comparing to modern materials, it is used for artistic purposes for building decoration and creating small objects, and only be affordable as building material for restoration projects. In this work; in order to determine the convenience of using artificially aged stones in restoration and to investigate the success of accelerated aging methods, a comparison study on fresh, naturally aged and artificially aged stone samples has been done. Samples have collected from two different quarries in Midyat (Mardin) region. Ageing methods covered; wetting-drying, salt crystallization, freeze-thaw cycles, and the tests in weathering chamber to investigate the effect of temperature, relative humidity and UV light.

The final examination will cover the measurement of mechanical, chemical and optic properties. Significant characteristics such as, Young modulus, porosity, water absorption, compression strength; mineralogical composition and spectrophotometric properties will be determined and compared.

Overall results will be served to quarries and Turkish Ministry of Culture and Tourism for future restoration projects.
Engaging with heritage through audio: experiences from the Conserving Oxford Stone Heritage (COSH) walking tour

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This poster reflects on the achievements and challenges of a free audio-based walking tour, designed and produced by academics, to engage the general public with stone heritage science and conservation issues within Oxford city centre. The project was funded via a HEIF Knowledge Exchange Seed Fund grant administered by the University of Oxford. The aims of the Conserving Oxford Stone Heritage (COSH) tour are to: (1) engage visitors to Oxford with aspects of the city's built heritage not currently considered by other city tours, and (2) showcase the range of stone conservation research undertaken within the Oxford Rock Breakdown Laboratory (OxRBL) within the School of Geography and the Environment.

The COSH tour consists of ten core stops each with a dedicated audio clip, linked by a 1.5 mile circular walking route. Stops were chosen to reflect different aspects of stone conservation science, linked to particular themes and/or OxRBL research projects. Audio clips are hosted via the PodBean platform (http://oxfordstoneheritage.podbean.com/) accessed via smartphone or tablet (using GoogleMaps) and via a dedicated webpage (www.oxrbl.com/audiotour). The biggest challenge in developing such a project was to provide audio that is engaging, informative and accessible to a general audience. This challenge was met with mixed success, but an attempt to keep the clips short (3 to 4 minutes) and non-technical was seen as paramount.

The COSH tour went live in July 2015, and here we provide an initial analysis of usage (nearing 2,000 downloads) via PodBeans built-in analytical tools. Metrics considered include audience retention between stops, access platform (desktop or smartphone) and country of access.
Problems with Prototypes: Microfading Rapid Prototype Polymers

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With the rise of additive manufacturing, objects and artworks printed by means of Rapid Prototype (RP) technologies are entering museum collections and have also been adopted for use in conservation. Unfortunately, RP technologies were never designed to produce durable products, and it is a significant concern that due to post-processing or digital preservation issues, re-printing is often impossible. A natural ageing experiment was set up and in only 8 months it was possible to identify the least stable RP polymers.

RP artworks are extremely complex objects due to unknown processing parameters and chemical composition. Rapid developments in the field mean that new systems and materials continuously enter the market, not leaving enough time for in-depth study. A tool to quickly assess the photostability of individual RP artworks as they become part of collections would be beneficial. Microfadometry has successfully been used to identify fugitive objects in museum collections and was assessed as a tool for rapid identification of photosensitive RP artworks. Initial results indicate that reciprocity did not hold when fading polymers due to limited oxygen diffusion. This and other issues related to the fading of RP polymers and measures taken to overcome these will be discussed.
A new environmental test chamber for optimizing atmospheric protection of heritage exhibits by passive showcases

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Heritage collections managers are advised to fully exploit passive showcases for customisable, low-tech and low energy environmental protection of exhibits, according to recent international and UK strategies:

2. IIC ICOM-CC Declaration on Environmental Guidelines (2014)

However, over 90% of showcase users surveyed in 2015 claimed sub-optimal environmental control by showcases. And 39–64% of passive showcase users reported having to renew RH sorbents every 4–6 months or more frequently. Some managers avoid RH sorbents because they are burdensome in the extreme on staff.

As the first step in a renewed effort to optimize the efficiency of passive showcases, this presentation describes a new laboratory for monitoring test environments and measuring showcase air exchange rates. The set-up of the laboratory, its operating procedures and features incl. air temperature, RH and air pressure sensing will be detailed.

Its dedicated test chamber and continuous monitoring of environmental parameters and tracer gas concentrations countered errors on air exchange measurements caused by occupant respiration and volumetric gas analyses; issues neglected in field testing of showcases. Monitoring of the temperature stable test chamber evidenced showcase air leakage driven by barometric and thermal pumping mechanisms.

The laboratory recorded a 7 to 10-fold decrease in the air exchange rates in two showcase prototypes: allowing 7 to 10 times less frequent sorbent renewals and lower labour and energy costs. The laboratory and collaboration with a museum showcase manufacturer contribute towards more sustainable microclimates for preserving indoor heritage.
Leaving black crust: the lesser of two evils?
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Black crusts on building stones are known to be one of the most severe types of soiling. They are indicative of deterioration by pollutants and can also initiate other forms of decay to buildings such as detachment. Aesthetic impairment is another main reason for removing this outer layer. Could this damaging outer layer (from sub-millimetres to centimetres) possibly be beneficial to prevent further decay and could it perhaps add a characteristic gloomy charm to the historic buildings?

This project focuses on black crusts occurring on sandstones. A case study has been carried out at the Main Building of the University of Glasgow, where replacement work has recently been undertaken. The black crusts of ten samples are analysed with SEM, XRD, and Raman spectroscopy to determine the different decay processes and mineral phases appearing on the outer surface. This investigation is ongoing and will show whether there is a difference in the composition of the occurring mineral phases in relation to the different sandstones.

We investigate if the outer layer can be beneficial for the conservation of the building stone; how the philosophy of repair influences best practice; and what information is needed to make an informed decision on whether to remove or retain the black crust.
If These Bones Could Talk: The Tales Human Skeletons Can Tell Us

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Cultural Heritage is an expression of the lifestyle developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. Frequently its definition has been restricted to cultural practices inspired by disciplines such as sculpture, picture or poetry even though biology is beginning to represent a valuable tool in the field. Human remains constitute themselves the main documents of their living conditions, food consumption and generally the activities through which humans ensure their existence or manifests their culture. The human skeleton is one of the archaeological material that could be scientifically analyzed to deepen our knowledge on the lifestyle of past populations, though its organic and inorganic components. Detailed chemical-physical analysis on inorganic fraction could be useful to understand the ritual practices used to be performed by past populations, as well as their critical evaluation aids in determining bone preservation state. This roadmap has been followed for the remains of a notable historical character in order to determine which postmortem practices were utilized. Organic component analysis allows us to perform Stable Isotopes Analysis on several prehistorical and historical samples: 13C and 15N should be considered reliable proxies to ascertain food preferences and diet. Spectrometric analysis has been extended to strontium and oxygen isotopes that are able to record the geobiology of humans, giving astonishing hints about both demic migrations and individual movements. The provided results represent only a selected instance of the skeleton potential as a huge source of Culture about our ancestors.
Mitigating Driving-Rain Ingress to Historic Buildings: The Role of Additives in Lime-based Pointing Mortar

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In several areas in England, historic masonry is particularly exposed to driving-rain and moisture ingress is an on-going issue. It leads to internal dampness, preventing good use of many historic buildings. Mitigating rain penetration and drawing moisture from the wall are the main roles of masonry joints, especially pointing mortar. Developing a suitable mortar for repointing intervention, porous, permeable and able to mitigate rain penetration is necessary to prevent dampness. In designing repair mortar, additives, such as wood ash, can be added to enhance mechanical or physical properties. Wood ash has been historically used to prevent water ingress. This research examined the effect of wood ash on the physical properties of lime mortars made with non-hydraulic and natural hydraulic (NHL) limes. Wood ash from biomass boiler was used in three concentrations as part of the aggregate (0%, 50% and 100%), with 0% being a control mix. The permeability of each mix was assessed by determination of the water absorption by capillarity coefficient (EN 1925:2000) and by drying rate tests. The open porosity was evaluated by means of the liquid absorption method (BS EN 1936:2006). Optical microscopy on thin-sections was also performed, as well as assessment of the depth of carbonation. Wood ash added in a mix was found to significantly increase the degree of carbonation and to influence the porosity of lime mortars by increasing the number of very small pores. Of greatest interest to prevent dampness in buildings, wood ash was also found to increase the drying rate of lime mortars. This research, in collaboration with Historic England and The Churches Conservation Trust, will ensure that repair interventions contribute to better preservation of historic masonry at risk.
Experimental investigation of damage of steel sword inside its scabbard using cone beam computed tomography (CBCT)

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Cesme is a settlement and a harbor situated on the promontory of a peninsula that projects out over the Aegean Sea, in Western Anatolia.

In Turkish Naval History, Cesme also grieves in rememberance of The Sea Battle of Cesme, which had an important impact on Turkish maritime history when the Ottoman Armada was destroyed by re ships sent by the Russians in 1770. As a result, the fortress, and city were looted by the Russians. In this war, the burning main mast of the Turkish vessel fell onto the ship The admiral ship called Yevstafiy and in a few minutes Yevstaïy blew off.

Diving studies was started in 1997 and a sword was removed from the Yevstafiy wreck. This sword hasn’t been touched in 20 years and this year moved to the laboratory for conservation.

In this study, CT was used for the 3d model and to see the corruption of the sword in the scabbard.

Cone-beam computed tomography (CBCT) systems have been designed for imaging hard. CBCT allow for rapid scanning of 3D micro-scale internal damage down to the scale of individual internal body of sword.

Tomography technique (CBCT) for studying internal damage in sword. Structures has not been reported. By this way, the current article tries to identify the internal body of sword. Newtom 5G CBCT (Cone Beam Computed Tomography) scanner. Scan parameters, Fixed 110kV and mA ( Auto adjusted by scanner ) 360 degee rotation, during rotation every 0.75 deg. Recived one sampling images, total 480 images comes for one scan period, Which is called Raw Dataset. Raw dataset is reconstring with Feldcamp algoritim for to make analyze , 3D and measurements on the images. After recostricution we can see each voxels on x-y-z coordinates which are Axial-Sagital-Coronal slices.
Ancient Beiting Town relics is located at northwest in China, and was built of rammed earth at the Tang dynasty. However, it is suffering from the serious deterioration caused by rain, snow and wind.

A method named Replaceable Conservation Layer (RCL) is adopted to protect the relics. As a traditional building method in China, RCL is achieved by adding the wheat husks and bast fibre into soil and adhere it on the surface of earthen architecture. In this research, lots of tests including artificial rainfall, dry-wet cycle and freeze-thaw cycle, permeability, chromaticity, physical and mechanical properties of RCL are adopted to validate the RCLs function.

Compared to the original soil mass, the shrinkage rate of RCL reduces to 8%, and there is almost no change at the heat sensitivity. Strength increases due to admixture of the bast fibre and decreases due to admixture of the wheat husks. Both the bast fibre and wheat husks can improve the air permeability of RCL, however, the former is superior to the latter at function of preventing cracks from growing in RCL. Durable tests prove that the damage to Ancient Beiting Town Relics by rain, wind and snow greatly decreased because of RCL with some plants. Moreover, RCL with husks show better conservation effect than RCL with fibre on resisting wind and rain erosion on the top of earthen walls. As a conclusion, RCL admixed by bast fibre is a feasible method to protect the earthen wall of Ancient Beiting Town Relics.
Study on the weathering characteristics of the Yumen glutenite in Mogao Grottoes, Dunhuang

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Weathering is one of the most deterioration forms that causes the destruction of the surrounding rock, which seriously threaten the long-term preservation of the Mogao Grottoes. To study the weathering characteristics of Yumen glutenite in Mogao Grottoes, a series of field experiments were carried out. The method of step by step dissection was adopted and a variety of analytical instruments were used, such as X-Ray diffraction test, soluble salt test, field acoustic wave test and rebound test. Finally, the main laboratory testing methods were wet and dry cycles test, the freezing-thawing cycles test and the soluble salt cycle tests to evaluate the environmental durability of samples. The results indicate that the main salts involve Na2SO4, NaCl and CaSO4, and the main minerals are quartz, feldspar, calcite, dolomite while clay mineral is chlorite. The mechanical strength reduces due to the influence of weathering, which is confirmed by the field acoustic wave test and rebound test, and both of the results rise with the increase of depth. Dry and wet cycles test has little effect on the test samples, the freezing-thawing cycles lead to the drop of the gravel particles on the samples’ corner; salt weathering cycles cause the surface of the rock mass gradually powdering. By analyzing meteorological data and the test results, the change regulation of rock mechanical strength during the weathering process is discussed. (1) Temperature stress causes damage to the rock mass structure and fracture; (2) the main mineral calcite in the cement is easy to convert into soluble Ca(HCO3)2, which can affect the cementation of rock mass structure; (3) salt transportation and accumulation along with moisture is a key factor that causes damage to the cohesion between different particles.
The Effects of Drying Oils on Corrosion when Combined with Moisture

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Drying oils have been used in paints for centuries not only by artists but also for the preventing corrosion on metal, for example red lead paint for example was originally made with linseed oil.

A load of research has been done into the conservation of paint, this is mainly been done in the area of analysis of the paints used during certain periods, and the paints used on particular objects or paintings. Most of this research has been done within the area of paintings conservation. In recent years there has been little research into how paint reacts with the substrates that it is used on. This is in part because the effects of acids in boards is well known and most of this paint analysis stems from the conservation of paintings and decorative objects.

This project investigating the effects of drying oils on metal when combined with water. There have been some observations that drying oils work well until moisture is introduced, then the corrosion appears to react differently. Differences also appear when just moisture is present with no drying oils. This research is at early stage with only few tests complete, this paper is presented as a work in progress.
Could using Digital Negatives Printed using Ink Jet Printers on Acetate film Create an authentic photographic print?

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This paper will make the case that photographic originals should be printed in the correct style as digital prints have a different appearance to than silver gelatin prints. The Author of this paper recently undertook a research project that investigates strategies for future display of photographic images taken on film and then digitised by researching the quality of digital negatives, created on acetate film using ink jet printers to match as closely as possible the original historic printing process used by the Photographer in the period. This process will allow the originals to remain in cold storage, reducing damage to the originals.
Environmental Assessment of the Mary Rose Museum

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The salvage and conservation of waterlogged archaeological artefacts are challenges faced by many museums throughout Europe. One of these museums is the Mary Rose museum in Portsmouth. The costly recovery and conservation of this large collection make conservational management a priority to ensure prolonged display lifetimes. However, the effects of air quality on such collections, which typically involve display cases with mixed materials (metals and organic materials), are currently poorly understood.

Display cases protect their contents from outdoor sources of pollutants, however low air exchange rates can result in high concentrations of potentially harmful gases from the cabinet and/or artefacts within the showcase. In the marine archology context, it is common practice to treat waterlogged wood with polyethylene glycol (PEG), however, it has been reported that this treatment doesn’t prevent the development of high acidity and the degradation of PEG might result in the off-gassing of formic acid. Oak is known to be an emitter of organic acids, however it is not known if waterlogged marine oak artefacts, such as those in the Mary Rose Museum, are significant emitters.

This poster highlights the likely gases to be present inside display cases and methods to detect pollutants present at the Mary Rose Museum, along with initial environmental monitoring results. In addition, an improved coating method for piezoelectric quartz crystal sensors, utilising inkjet printing, is displayed, which is hypothesised to increase the repeatability of these devices.
Conceptual life cycle assessment to evaluate the sustainability of conservation-grade packaging materials used in collections storage

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The unsustainable aspects of Conservation-grade packaging materials, which are safe for long-term use with collections, can be identified using conceptual Life Cycle Assessment/Analysis (LCA). LCA involves the assimilation of a qualitative system inventory, comprising of inputs to (raw materials, energy and water) and outputs from (emissions to air, water, land) the product system to the environment, through all stages of the product life cycle from raw material extraction, through production, use and end-of-life treatment.

As consumers of packaging materials in the product life cycle, collections care professionals form the link between the conservation-grade material suppliers and waste management companies. The upstream environmental impact associated with the life cycle of the conservation-grade packaging materials can be reduced by following the principle of green procurement. A major contribution to reduce the ecological impact of conservation-grade packaging materials can be made at the stage of material use and reuse at the collections care level. To shrink the downstream environmental impact of these materials, waste management and informed recycling must be practiced. The implementation of all the above practices is governed by the conceptual life cycle inventory of each packaging material, which provides a complete picture of the flow of materials throughout the life cycle of the product and can enable collections care professionals to identify opportunities available to them in product supply chains to shrink the ecological footprint of their preventive preservation practices. As a result, more sustainable alternative routes can be used to direct the inflow or outflow of materials to or from the product system.
Preserving the Image Quality throughout the Current Pipeline of Multispectral Imaging

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Multispectral imaging is an effective technique for uncovering hidden information, such as faded ink and watermarks, from historical documents. Images are acquired of the manuscript illuminated in different wavelengths of light across the electromagnetic spectrum and then digitally processed to reveal features that are not visible to the naked eye. This research involves a newly installed multispectral imaging system, developed by R.B.Toth Associates and Equipoise Imaging LLC, at UCL. The system is intended to be used by archives, museums and libraries to enable them to acquire multispectral images of their collections without the need of an imaging scientist. However, the current system needs to be characterised, from the initial placement of the document right through to the image processing, in order for this to be possible. Therefore, in this research, I will characterise the different steps in the imaging procedure, and identify and improve the bottlenecks using historical documents provided by UCL Special Collections. The main aim will be to ensure that the image quality is preserved throughout the post-processing pipeline. This research addresses both the materials and digital research themes of the conference because it involves acquiring and processing digital multispectral images of different materials, such as parchment and paper.
his master thesis explores the applicability of Digital Heritage in functioning churches (Cathedrals, chapels). It is divided in two parts. In the first part, alongside its main use as a religious site, the church is dealt with as a historical and cultural site. Following studies on human behavioral patterns within cultural spaces, cultural sites account for an extensive database of visitors’ space, time and content-related practices. We use this data to develop design strategies that enhance the visitor’s perception of the visited site.

In the second part, the church is handled as a virtual site. We invoke the theories of UX (User Experience) Design to examine the visitor-site relationship through the lens of technology. The focus is set on the interaction of the visitor/user with the Cathedral’s cultural environment through the use of Digital Mobile Guides. Taking into consideration the particularities of a Cathedral in use for congregational worship, we seek to design an effective mobile application that combines tradition with innovation.

The implementation stage took place at the Cathedral church complex of San Giorgio in Syros, Greece. We approached the Cathedral’s ecosystem as a large-scale interface and the mobile application as the visitor’s tool to navigate the history of the site and its components. The mobile application presents an attempt to provide the end user with an interactive browsing experience based on variations of the visual and auditory representation of the church complex. Every step of the design process was documented in relation to the applied UX design methodological tools.
Smelling the decay of plastic artworks
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My poster will introduce the research questions, goals and initial results of Masters research that will form the basis of future work to be carried out during the PhD. The project is focused on using Volatile organic compounds (VOC), which have been emitted from polymers, to characterise the polymer family type and if decay markers are present. Research into polymers found within heritage collections has been identified as a key area in need of greater information by a number of organisations at both a UK national level and an international level.

Through a literature review, we have found that VOCs can be poorly treated within heritage organisations. In many instances it is the Total VOC that is collected rather than specific VOC; while the latest guidelines (PAS 198:2012) recommends this, key information regarding the health of the collection can be lost by not gathering information on specific VOC.

Another key finding from the literature review was that the types of materials studied was limited to paper and some types of polymers. When polymers were studied there was a preference for new polymers rather than naturally aged polymers which would be found in a heritage environment.

In order to build on the previous research, this project will carry out Solid Phase Micro-Extraction (SPME) GC/MS, which is a non-invasive passive method for the collection and classification of VOCs, on a range of natural and artificially aged polymers. We will also be carrying out in-situ experiments to gain information on the feasibility on analysing objects on open display in heritage environments. The masters research will aim to identify polymers to study to a greater extent in the PhD.
Finding the Molecular Link between Fibre Strength and Chemical Degradation in Tudor Tapestries

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The complex environmental processes resulting in fibre degradation leave historic tapestries hung on open display at a risk of material and fibre strength loss. This can present a challenge for condition assessments. Previous studies have used size exclusion chromatography (SEC) and tensile strength to infer the mechanical strength properties of historic silk potentially highlighting this risk. Investigations with historic wool degradation however, remain limited. Within this research, sacrificial wool threads from a collection of historic tapestry repair samples at Hampton Court Palace are explored using a range of methods including keratin reduction, SEC and Fourier transform infrared spectroscopy. The extracted keratin molecular information and multivariate data analysis will be incorporated into a previously developed non-invasive tool for condition assessment based on near infrared spectroscopic analysis (NIR) and the tensile properties of historic wool. Using NIR as a non-invasive tool, conservators may be able to assess the condition of wool fibres in historic tapestries providing valuable information to support the prioritisation of future treatment.
The influence of microorganisms to the archaeological wood after conservation

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After excavation, waterlogged wood requires proper treatment. Today, different methods are used for the dimensional stability: sucrose (sugar) method, PEG or freeze-drying. The research were performed to compare the influence of microorganisms to Neolithic archaeological wood after its treatment with this three methods. The studies provide interesting results for this kind of material. It confirm that, it is important how to storage monuments and which methods of conservation gives the most optimal results.
The influence of alkaline bath used for the metal preservation on wooden objects

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Many wooden and iron monuments of various ages and varying degrees of degradation have been moved to the National Archeological Museum in Warsaw.

The iron objects are delicate and corroded, and Museum usually uses for these a special alkaline bath. But there, was a need to know what influence it will have to a wooden objects? The Museum, together with the University of Life Sciences in Warsaw has made a research on the influence on selected kinds of wood. This time the scientist checked physically properties of wood after alkaline bath. Along with the first part (chemical properties) studies provide interesting results.
Modelling collections and their environments

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Significant recent advances in environmental and material modelling have accompanied the publication of a recent environmental guideline (PAS 198) that recommends institutions to develop individual environmental policies tailored to their collections, so that fixed environmental set points could be avoided and preservation outcomes optimised. Yet, little guidance is provided on how this could be done in practice. In collaboration with the Smithsonian Museum Conservation Institute (US), the National Archives (UK) and the company Lichtblau e.K. (Germany), this research is working towards modelling collection change to aid the implementation of the new guidance via an integrated open platform that responds to the needs of the conservation community. Such a platform will be developed based on damage functions as collection models and enable data upload and interpretation, scenario evaluation as well as for development of environmental strategies for management of various collections. The development of such a platform requires an understanding of the correlation among collection type, environmental impact, and damage indicator, which this poster contribution will qualitatively explore in an interactive way. The collected results will contribute to enlarging the database supporting the platform. In addition, presentations of outputs of the platform will be discussed and acceptable levels of uncertainty of the outputs will be surveyed to gain a better understanding of the need to make decisions for collection management with large uncertainties.
Multidisciplinary Analysis of Roman Coins

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COSCH is a European network of researchers, conservators and museum professionals, supported by a transdomain EU COSTAction (TD1201), exploring high-resolution optical techniques, defining good practice and open standards for state-of-the-art documentation of CH.

One case study applies imaging and analytical techniques to digitise coins and evaluate 3D multimodal visualisation. Numismatic collections continue to rely on traditional documentation methods, predominantly black-and-white 2D photography. Such representations are not accurate in terms of dimensional and spectroscopic information. Two ancient Roman silver denarii were selected as test objects to establish whether the proposed digital recording methods can support professional comparison of features and properties. The coins raise interesting questions concerning their provenance, authenticity, design, purpose of issue and historic usage. They pose considerable recording challenges due to material and surface properties. The coins have been examined by:

- Dome photography image sets for PTM/RTI visualisation
- X-ray microtomography for detection of cracks/impurities
- Scanning electron microscopy (SEM) for detailed surface investigation
- Energy-dispersive X-ray spectroscopy (EDX) for elemental analysis
- Micro X-ray fluorescence (XRF) spectrometry mapping
- Laser and structured light scanning for 3D spatial capture
- Photogrammetry with structure-from-motion software
- Hyperspectral imaging for reflectance over wide range of wavelengths

The results indicate the feasibility of such techniques for museum documentation and as contribution to scientific examination of coins in general. The target beneficiaries are numismatic researchers and scientists, historians, collectors, conservators and educators.
Assessment of hyperspectral imaging systems for digitisation of a Russian icon

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Colour and Space in Cultural Heritage (www.COSCH.info) is a European network of researchers, conservators and museum professionals, supported by the COST programme. This trans-domain Action (TD1201, 2013-16) is exploring high-resolution optical techniques, defining good practice and open standards for documentation of CH.

In a study of multi- and hyper-spectral imaging systems, a Round Robin Test (RRT) assessed the performance of different systems for the spectral digitisation of artworks. Five objects were captured at twenty-one institutions around Europe. One of the test objects was a Russian icon, manufactured in Moscow in 1899, printed by chromolithography onto a tinned steel panel and nailed onto a wooden support. The quality of images produced by ten different systems was assessed by observers, and the reflectance spectra at selected points were reconstructed to characterise the icons coloured materials and to obtain a quantitative estimate of accuracy.

Observers judged that the best results were obtained with a push-broom hyperspectral system and a camera with transmission filters, while the least acceptable result was an LCTF multispectral system. There was a surprisingly wide variation in the quality of imagery, caused by unwanted reflection from both glossy painted areas and metallic gold areas of the icons surface. Specular reflection from the surface also degraded accuracy of the reconstructed reflectance spectrum. This indicates the importance of control over illumination geometry. In addition the systems differing spatial resolutions affected their ability to resolve fine details in the printed pattern. Some devices that gave excellent results for matte colour charts proved to be inflexible and to have poor performance for this demanding test object.
Assessing storage areas for archeological records

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English Heritage cares for over 400 sites. It has collections numbering in excess of 500,000 objects, the majority being recovered from archaeological excavations on those sites. The excavation records are the provenance of these objects and hold much of their value. The archaeology is primarily held in 6 large stores with separate rooms created to hold the mainly paper excavation records. The preservation environment inside the stores has been assessed with a variety of analyses of environmental data. Temperature and RH have been evaluated for compliance with the archaeological archives standards in the UK. Analysis of the initial conservation heating systems indicated the slope of paper isoperm lines was steeper than the slope of the equal moisture lines on a psychometric chart. Hence the reduction in RH caused by the optimum efficiency conservation heating will be more than offset by the increased temperature effect, leading to reduced permanence. Following this analysis conservation heating systems were replaced with drying wheel dehumidifiers. This type of dehumidifier was used in preference to condensing dehumidifiers due to its superior performance at low temperatures in the unheated stores and removal of liquid water. The time weighted preservation indices, pure cellulose degradation rate and a paper damage function have been assessed from temperature, RH and pollution data. The stores have better permanence indices than the conditions required for BS5454. Mould is a major risk and mould risk indices have also been calculated. The performance of archive boxes used and the environments within them have also been separately assessed. Nine pollutants known to accelerate paper deterioration have been measured in a number of boxes and the risk they pose assessed.
Photogrammetry of lost heritage: optimisation for a limited set of pictures

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With the increase of technology, photogrammetry became a tool within heritage institution and project in archaeology to document artefacts and historical sites. This technique uses a set of pictures from all around the object of interest to produce a 3D model. However, it is a complex task for lost artefacts since a large set of pictures, a correct coverage and good parameters of the camera are required. Moreover, the research on photogrammetry currently focus on the optimisation of the picture acquisition which is not an option for lost heritage.

When dealing with lost subject for photogrammetry, different sources must be considered in order to obtain a reasonable number of pictures. This implies that the pictures will have different quality and properties. Therefore they can be processed before the photogrammetry algorithm in order to optimise the output: a 3D model.

The present study compares results that can be achieved when using different image processing on the same set of pictures. The processing methods considered in this work can be performed with the software Fiji or MatLab. The software for photogrammetry is 3DF Zephyr Pro version 2.308 which includes function to assess the quality of the images. The use of Zephyr involves 4 steps: the sparse reconstruction, dense point cloud generation, mesh extraction and texture mesh generation. The quality of the last 2 steps are fully related with the quality achieved in the first 2 and for that reasons the first steps are more developed in this study.

This work was performed to produce a 3D model of Nimrud for ProjectMosul.
Identification and mapping of pigments using hyperspectral imaging

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Hyperspectral imaging is a well-established technique in the fields of remote sensing, and astrophysics and is more recently being applied to problems in other areas including food science, medical science, and heritage science, as a relatively new technique to this field its possibilities have yet to be fully explored. This MRes project looks into the application of hyperspectral imaging equipment to the investigation and preservation of manuscripts at The Bodleian Libraries in Oxford, and has been successfully used to reveal hidden details such as text and images previously thought to be lost.

We hope to establish a database of pigments which could be used to map the materials and pigments used throughout a document's history in order to better understand an object and aid in its conservation either by revealing or clarifying details or simply by recording its current state for future reference. The project will utilise Raman, IR, and XRF alongside hyperspectral imaging to aid the characterisation of materials and pigments.

In order to build such a database and use it for the mapping of manuscripts and other objects problems such as the variety of the spectra and computational processing of the huge hyperspectral data cube will need to be overcome.

This EPSRC funded interdisciplinary project is carried out in conjunction with The University of Oxford, UCL, and The Bodleian Libraries.
Adaptation of the antique wooden buildings to modern standards

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Poland is characterized by vast forest and timber resources, which is reflected by the abundance of wooden architecture. In addition to their historical value, these buildings also present environmental, health and aesthetic qualities. Unfortunately, in Poland, they are often left to themselves, which leads to their deterioration and loss of their charm. Such is the case of the wooden architecture of the vicinity of the wider river, called "widermajar", which is particular to Poland and specifically to Mazovia, and unheard of anywhere else. A grassroots social initiative, connecting people of different professions, formed in order to save these wooden monuments. The responsibilities are divided between the Departments of Wood Conservation and Architecture of the Warsaw University of Life Sciences, and the Androlli Foundation. In result of this cooperation, extensive restorative works were performed on the historic Villa Agatka of Otwock widermajar. A team of students of Wood Conservation Department prepared the assessment of the technical condition of the monument. Another team, composed of the students of Architecture, attempted to save the original monuments' substance and proposed a new form of adaptation for the Villa. The enthusiasts of old wooden architecture from the Andriolli Foundation researched the history of the building and took care of the legal aspects. The aim of the presentation is to present our experiences of cooperation between different organizations and universities, focused on the common goal of saving a wooden building. The results and the method of cooperation motivated the participants of the project to further joint actions for the protection of other cultural heritage in Poland.
Reigate Stone was used extensively in South-East England between the 11th and 16th Centuries, contributing to a legacy of medieval heritage that ranges from parish churches to royal palaces. It is a glauconitic malmstone, a unique building stone to the British Isles. It was easy to carve decoratively, however also highly susceptible to degradation. By the 15th Century many buildings were already in an advanced stage of decay. Long subject to wide-scale replacement, attempts at conserving what little remains have increased in accordance with modern practice. The Tower of London has been a testing ground for a range of methods, yet the causes of decay remain poorly understood.

The MRes project will employ a field-based methodology; learning from the current condition of Reigate Stone in situ, informed by knowledge of both their history (previous treatments and environmental data) and their current local environment. This will focus on the Tower of London, given its relatively large stock of Reigate and the long history of conservation efforts. Research will be supported by investigations at Hampton Court Palace, to assess the influence of local climate (e.g. pollution). A range of environmental monitoring and non-destructive testing methods will be employed. Following an initial stock take, a more detailed survey will be conducted on noticeable typologies. These should inform a database of situations and conditions.

This stage of the project will cover the anamnesis and initial diagnosis of Reigate Stone decay, by providing a full condition survey of two key sites. This data will assist laboratory testing, to be conducted during the DPhil. The overall aim will be to develop a system dynamics approach, by linking degradation to measurable parameters.
Using 3D imaging to map bullet impacts in sandstone

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Bullet impacts on heritage surfaces are increasingly a concern for conservation scientists; the escalating conflicts in the Middle East are often in the news for the deliberate targeting of heritage sites. The full destruction of sites, using large-scale force such as dynamite, has dominated the headlines over the past year. However, impacts such as bullets and shrapnel add to the wider spectrum of damage sustained during conflict but are often overlooked. To understand the long-term consequences of this type of damage we need to increase our understanding of the alterations to the surface and underlying stone of building materials.

This poster presentation reports on the use of x-ray and simple 3D imaging to map damage sustained through bullet impacts. This information can then be used to map out pathways to long-term damage and advice remedial efforts.
The assessment of yellowing in silver gelatine photographs and the care of the photographic collection at The National Archives, U.K.

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Silver gelatine photographs are prone to discolouration (yellowing), mirroring and fading. Experts have used the degree of discolouration to infer causes of deterioration using visual observation with the naked eye. Discolouration due to high relative humidity can appear more yellowish brown, whereas discolouration due to residual processing chemicals can appear more reddish brown.

A Master of Research in Heritage Science by a photograph conservator from The National Archives (TNA) investigated the correlation between the perceived discolouration of silver gelatine photographs and changes to the image silver using visual observations, chemical spot tests, colour and density measurements, FTIR and TEM. The aim of the project was to establish whether visual observations and/or colour measurements could be used by non specialists to assess the condition of a silver gelatine photograph. The results showed a good correlation between perceived yellowing and the size and shape of image silver particles in laboratory made samples. This was also inferred through a limited set of historical samples.

The project will have practical application at TNA which holds more than 8 million photographs, the majority being silver gelatine prints. These have not been comprehensively surveyed due to the resources required. A systematic survey is now underway using volunteers to build an accurate picture of the collection to generate collaborative research, to inform conservation treatment, rehousing, storage and loan requests. The survey team identify process type and assess condition using visual observation due to the scale of the survey. The results from the MRes will inform this assessment as well as how and when scientific instruments could be used.
Evaluation of pollutant impact on organic-based cultural heritage and novel nanoformulations for its preservation

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The physic-chemical characterisation of organic-based cultural heritage in several EU projects has made use of non-destructive and minimal invasive test methods along with other techniques to establish markers of damage. The work reported here refers to their application on varnished surfaces, collagen-based materials (parchment and leather), and cellulose-based materials (paper and 19th cent. canvas) in the framework of two EU projects Mt EMORI (Measurement, Effect Assessment, and Mitigation of pollutant impact on movable cultural assets-innovative research for market transfer) and NANOFORART (Nanomaterials for the conservation and preservation of movable and immovable artworks). In MEMORI the effect of exposure of organic-based cultural heritage to volatile organic acids (acetic and formic) has been studied. In this paper the results of effects on varnished surfaces, collagen and cellullosic materials will be presented. Dynamic mechanical analysis and Micro-thermal analysis were used to measure the glass transitions (Tg) of the varnished surfaces. The shift of Tg to higher values has been observed to correlate with increase in dose of acetic acid received and was linked to increase in crosslinking as observed also in the mass spectrometric data. Surface analytical techniques (XPS) and SIMS provided useful information particularly for the synthetic varnishes Laropal A81 and Regalrez 1094. In parchment changes in the fibre morphology correlated with alterations observed at the nanoscale level as seen by atomic force microscopy and micro-thermal analysis. For the NANOFORART project case studies will be reported which include paper and canvas deacidification, cleaning of canvas using nanostructured gels, pH adjustment of historical leather samples using nanoparticles.
A novel model for spatially-resolved gravimetric calibration and visualisation of moisture distributions in porous building materials

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Water is one of the main factors involved in the weathering of porous building materials including stone, mortar, and concrete. Non-destructive sensors use surrogate signals to monitor micro- and macro-scale movements of water through these materials, which are related to quantitative moisture contents through gravimetric calibration. This involves equating the sensor output to a quantity of water present in a sample at various stages of saturation. However, this is based on the assumption that water is homogeneously distributed in the sample – a scenario that, in practice, is rarely found to hold true. This study sought to develop a novel system of spatially-resolved gravimetric calibration and 3D visualisation of moisture distributions by interpolating multiple, overlapping non-destructive moisture sensor readings. A microwave moisture sensor with multiple depth-penetrating sensor heads was used to monitor the gravimetric calibration of building stone monoliths. From this, models of localised moisture contents were produced from intersecting weighted sensor measurements in volumetric cells from 9 – 36 cm³, each representing 0.1 – 0.2% of the total monolith volume. The relationship between the models and the basis calibration measurements was assessed, as well as the internal variation from multiple sensor outputs within volumetric cells. Specific scenarios of drying were created to observe if expected spatial and temporal behaviour would be reflected in the model. This study demonstrated the feasibility of a non-destructive tool that can determine how water is moving through the depth of building fabric, which could be further developed into an important diagnostic tool for building and conservation professionals.
'POLYGNOSIS”: Educational Knowledge Web Platform and semantically linked Thesaurus on optical and laser-based techniques for Cultural Heritage analysis and diagnosis

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Due to their unique properties, laser and optical technologies hold today an important role in the protection and study of Cultural Heritage (CH), since they are used in a wide range of demanding analytical and diagnostic applications. Considering the rapid and vast technological development of their methodologies and tools, it is necessary to make this new knowledge more reachable and comprehensible to heritage scientists.

Towards this end, a knowledge web-based platform (POLYGNOSIS) is being designed with educational orientation regarding the laser analytical and diagnostic techniques that have been developed at the Institute of Electronic Structure and Lasers (IESL) of FORTH. This educational digital tool seeks to highlight the efficiency and potentials of modern optical and laser technologies in CH documentation, as well as, promote the dissemination and deeper understanding of their applications to conservators, archaeologists, art historians, material and laser scientists.

In particular, emphasis is given on the state-of-the-art laser-based and imaging techniques for the highly sensitive, remote imaging, sensing and diagnosis of CH objects and monuments. "POLYGNOSIS” represents accumulated knowledge regarding the selection of the diagnostic tool and the suggested methodology, with simultaneous display of examples of actual experimental procedures. The model relates those examples with the relevant terminology of the Thesaurus, the information about the object under examination and the metadata resulted from those experiments.

The current study concerns the collection and data curation for the enrichment of the Knowledge Platform, as well as, the definition and classification of terms for the semantically linked Thesaurus.
Plastics in heritage collections and their sensitivity to visible light

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The relatively short history of synthetic and semi-synthetic materials in art and design, compared to their more traditional counterparts, has resulted in a currently still limited amount of research on the subject of their preservation. However, several institutions now contain within their collections substantial numbers of historical and art objects made partly or entirely of various types of plastics. The great variety of polymeric materials which have been made available, and improved on, throughout the years makes it a challenging area to research. Furthermore, despite the general practice of excluding UV light from museum galleries, our knowledge of the sensitivity of those artefacts to visible light has not been examined in much depth so far. The main purpose of this project is to identify the long-term effect of the most common light sources on the physical appearance and chemical structure of modern materials. By combining our knowledge of polymer chemistry, accelerated degradation and lighting technology, we will assess if and how plastic objects deteriorate when exposed to visible light. The data obtained would be compared to known spectral power distributions (SPD) of the most commonly encountered light sources in the heritage sector to assess their suitability for use with modern materials. The final stage of research would be to improve lighting guidelines for display of plastic objects in collections as well as to examine how this information can be applied in practice to improve the appearance of discoloured objects.
Colour Monitoring and Microfading in Old Masters Picture Gallery Dresden

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Recently a cooperation project between the Dresden Old Masters Picture Gallery and Lab of nature sciences in conservation at the Academy of Fine Arts Dresden has lunched. Background of the project is on the one hand the redevelopment of the Old Masters Picture gallery. And on the other hand the need of controlled illumination levels for the paintings and the known poor light fastness of Prussian blue. One highlight of the gallery is the work of Bernardo Belloto called Canaletto with his famous views of Dresden in the 18th Century. In his paintings Prussian blue was detected.

Microfading tests on the more than 200 year old paintings have confirmed, that the parts containing Prussian blue are still losing colour.

The ongoing project combines two methods. First, Microfading tests and prediction of colour change on self made samples of Prussian blue and other colours. These tests are made to predict the colour change of the samples, which are exposed to different illumination levels in the gallery. And second, colour monitoring with conventional colour measurement of the samples and the paintings of Belloto.

The aim is to get deeper knowledge about relation between predicted and real colour change and to prevent Bellottos paintings from further colour change.
Something Old, Something New: Dust Monitoring at the V&A

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This poster presentation refers to a project-part of an Erasmus traineeship-at the V&A’s Conservation Science department, a collaboration with the University of Porto, Masters in Museology. The project aims to better understand the air quality of the galleries and minimize the risks for collections by gathering information on airborne particulates in suspension inside the museum, instead of deposition rates. Dust monitoring for museums is not novelty and historically many air quality studies have been developed by the V&A, using passive monitoring techniques to determine particulate deposition rates with of the earliest work done in 1996, by Stuart Adams, validating the glass slide technique at the Theatre Museum, Covent Garden. These studies continued but mainly focused on exhibitions with a great number of visitors and textiles on open display, being more susceptible to particulate deposition related damage. The V&A FuturePlan project, Exhibition Road Building Project is currently transforming the whole west wing of the museum. The intense building works that this project entails and the proximity of the building works to the galleries present challenges to the environmental management of the museum, its overall air quality and specifically the amount of particulates entering the museum. Air particulate monitoring is being undertaken by Science Section in 2016, as a way to determine the most affected areas. New equipment, a handheld particle counter employed to undertake monitoring and the subsequent data visualisation using mapping software available for free (R, Tableau and Google) are successfully being employed to determine problematic areas and assess the practical solutions.

Keywords: Environmental Management; Particulates; Indoor Air Quality; Dust Monitoring; Mapping.
Towards minimum reporting standards for microfading

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Defining the light sensitivity of collection items is crucial for their preservation. Microfading is a tool to assess the light sensitivity of heritage objects: A very small area of an object is exposed to light of high intensity and the change of reflectance conventionally converted into colour change is measured simultaneously by a spectrophotometer. The test is micro-destructive and relatively quick.

Diverse materials such as graphic media, textiles, photographs etc. are assessed by microfading tests. However, the technique has not been standardized and there are no generally agreed test protocols to ensure reproducibility and comparability. There are some aspects that define and limit the use of microfading in relation to natural ageing and other accelerated degradation techniques: instrument design, which can vary significantly; measurement of change, i.e. change of reflectance or colour change; reciprocity; impact of different material characteristics and the use of Blue Wool Standards as reference scale.

The project aims to answer the following questions:

- How do material characteristics such as texture, translucency, glossy and matte surfaces affect microfading measurements?
- How does microfading compare to conventional colorimetric measurements?
- How does the instrument design impact the measurements?
- Can a protocol be developed that optimises microfading tests?

It is hoped that a better understanding of the fundamental aspects of microfading will help towards achieving reproducible and comparative data, which will hopefully facilitate inter-laboratory exchange of reliable fading data in the future.

This project is supported by the Engineering and Physical Sciences Research Council (EPSRC), the Wellcome Collection and Townshend & Thomas LLP.
Characterising cast iron cannonballs from the Mary Rose

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In July 1545, the Tudor warship the Mary Rose sunk of the coast of Portsmouth, taking with her a snapshot of life during the reign of King Henry VIII. Buried beneath layers of silt, the supply of \(O_2\) was limited, which allowed the ship and its contents to survive in seawater for over 400 years. When the ship was raised in 1982, a large collection of 1,248 iron shot was excavated alongside the wreckage. Presenting some of the earliest examples of mass produced cast iron in Britain, each shot was manufactured using a similar method and cast into the same spherical shape, at a range of diameters. Dating to shortly after the introduction of the blast furnace to England, this set of shot provides a unique insight into an experimental phase of a technology that would go on to fuel the industrial revolution. This work aims to assess the metallurgical and chemical composition of the shot and its associated corrosion products, to determine the variation in iron composition across the sample set. In this poster, the preliminary results of the project will be presented, based on a study of unconserved shot stored in sodium sesquicarbonate since excavation. Analyses will include scanning electron microscopy coupled with energy dispersive spectroscopy (SEM-EDS) and powder X-ray Diffraction (XRD) to characterise the internal metal structure and corrosion layers.
Preliminary investigation of reflectance transformation and 3D imaging techniques to assess the Palace of Westminster murals

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There are around 52 large-scale mural paintings decorating the State Apartments in the Palace of Westminster. They were commissioned by the Fine Arts Commission under the presidency of Prince Albert to decorate the newly built Houses of Parliament. They date from the mid-1840s and were painted in fresco, until the artists abandoned this in favour of Waterglass technique in the late 1850s. In essence this technique involves painting on dry plaster with pigments applied in water, then fixing with a spray of liquid Potassium Silicate to bond the paint to the plaster surface; a technique that was developed and researched in Germany and was employed by four artists at Westminster Cope, Ward, Herbert and Maclise from 1859-65. Unfortunately the levels of pollution were so high at the date that the mural paintings became dirty, even blackened, which led to some ill-advised restoration only a few years after they were painted.

Reflectance Transformation Imaging and 3D scanning techniques have multiple uses in cultural heritage today as they enable and enhance visual analysis providing advanced examination and digital recording. The main objective of the present pilot study is to assess the application of these techniques on the Westminster mural paintings, and to evaluate them as tools for condition assessment and for characterisation of the painted surfaces. Combined with infrared imaging, hidden surface information is detected which facilitates a more detailed and focused condition assessment. Here we have used these techniques to study some of the 19th century Palace of Westminster mural paintings revealing finer details not typically visible with direct observation.
Automatic Motif Detection and Segmentation for 3D models of Egg-and-Dart Ornamental Mouldings

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We develop a novel method for automatically detecting and segmenting unit motifs for various 3D models of egg-and-dart ornamental mouldings. Previous methods usually involve a certain amount of human effort to find geometric regularities within 3D models. Our automation is achieved by analysing the specific geometric features of egg-and-dart ornamental patterns. With the help of several 3D computer graphic techniques such as 3D edge detection, mesh saliency, Heat Kernel Signature and outlier refinement, our method extracts the desired meso-level information corresponding to the structural regularity of the motifs. Based on such meso-level information, motifs are recognised and segmented out of a large 3D model.
Lost world of the Kazakh Deer Stones: myth, perception and reality in cross-cultural research

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International research offers unique opportunities to explore, document and collaborate on global heritage themes. However, promise and practice are fluid concepts as original ideas, cooperative methods and best intentions may go awry. In this 2015 study we pursued elusive Kazakh Deer Stones across the EurAsian steppe in search of Bronze-Age history, local heritage and a departments first English publication. Our expectation of what was heritage science, its academic and cultural value and investigative techniques differed from our hosts. Objectives, methods and outcomes politely clashed. As time proceeded deer stones turned out to be Turkic warriors, new methods and equipment went unappreciated, investigation faltered and funding, tied to the falling price of oil, evaporated. Yet researchers remained determined to overcome obstacles and bring international academics together. In 2016 new sites have been identified, expertise recognised and a plan for summer fieldwork has developed. Can hopes and reality bring ancient deer stones and contemporary cross-cultural research together on the Kazakh steppe?
3D and composition documentation of small metallic archeological objects by SEM

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Use of scanning electron microscopy (SEM) for documentation and study of small objects is well established technique for decades. The main reason of its popularity is unmatched combination of detail, magnification and depth of the view in comparison to other observation techniques. However the physical principle of SEM enables shape and topography of observed objects to be perceived, techniques for obtaining quantitative 3d data from the micrographs are getting more popular only in recent years. Among published approaches to 3d microimaging there is a method based on photometric stereo principle. This method has been made possible with the advent of detectors divided into quarters enabling the same micrograph scene to be rendered in four different ”illumination” setting – a necessary prerequisite for photometric stereo. Data obtained from four-quarter detector enable to reconstruct 3d topography of the surface and also enhanced surface atomic composition separated from influence of topography. The use of this technique is demonstrated on small metallic archeological objects yielding 3d surface data and composition enhanced map. It can be concluded that however the ”composition map” obtained this way is only semi-quantitative and cannot compete in precision and information content with element maps based on EDS, but the advantage is that the composition map is created with the same resolution as surface image and can be virtually spatially manipulated along with the obtained topography.
System SurveNIR - identification type of plastic materials experiences

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This poster is presenting a practice experiences with system SurveNIR. This system is used for non-destructive identification of synthetic materials in collection of books of National Library of the Czech Republic. System SurveNIR had been developed for statistical characterization of paper objects in libraries and archives, for survey of mechanical and chemical properties of paper. Measurements is based on Near-infrared-spectroscopic technology and software incorporating multivariate chemometric analysis of the spectra. Thanks to extended database of NIR spectra 45 types of plastics is now possible using the SurveNIR for identification type or group of synthetic materials. Evaluation is based on common characteristics of NIR spectra of the unknown sample and NIR spectra of the known sample from the database. Survey is necessary for the selection of correct conservation process, conservation surveys and for the appropriate preventive care of a synthetic materials. During natural degradation plastics, PVC or PUR are not stable and have negative effects on adjacent materials of books. Knowledge of the type of plastic helps planning preservation activities in books collections. The results needs to be used critically for elimination incorrect conclusions. Correct identification is influenced by the selecting the appropriate sample type and experiences with identification of plastics, including the knowledge of the history of plastics.
Rapid non-destructive analysis of historical artefacts: Spectroscopy, Light Measurement, Multispectral and Hyperspectral Imaging

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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 and spectral imaging 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. Easily deployable, hyperspectral sensors are used to reveal secrets of famous documents such as the Gettysburg Address, ancient maps, and archaeological artefacts such as pottery shards (ostracons) that represent the oldest known representation of Hebrew writing.

Analytik are suppliers of a wide range of non-destructive analytical equipment including Visible and Near-Infrared (Vis-NIR), FTIR, Raman, Multispectral and Hyperspectral Imaging, and Light Measurement to UK and Ireland conservation and heritage organisations. With a range of spectroscopy and spectral imaging techniques, Analytik is able to provide heritage specialists with the latest technology, providing real-time analysis where and when required.
Multi-experimental setup to analyse lined canvas exposed to uncontrolled environment

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Canvas lined paintings represent a significant proportion of artworks in historic house collections. However, due to restrictions on built heritage it is not possible to carefully control the environment of these paintings. As a consequence, wide relative humidity (RH) fluctuations generate physical stresses within such paintings, often exacerbated by the interactions between original composite materials and historic re-lining techniques. In their simplest form re-lining treatments for canvas paintings consist of the adhesion of new canvas to the reverse of the painting with a view to providing additional support to damaged or degraded canvas. Given the desire for a minimal interventionist approach understanding the state of repair in historic re-lining treatments, and optimum protocols for retreatment in fluctuating environments, is paramount.

Non-invasive analytical techniques offer the potential for on-site condition monitoring, providing information on the condition of re-lining treatments on open display, with the particular advantage of analysis within the paintings display environments.

For this research we are employing single-sided nuclear magnetic resonance for the analysis of moisture diffusion into canvas. In addition, digital image correlation (DIC) will be used to image mechanical stresses in combination with a tensile tester used to maintain the sample under stress and determine the modulus. A custom built environmental chamber will allow for RH control during mechanical testing and simultaneous analysis by DIC.
Coordinated and collaborative research of imaging spectroscopy devices and methods for cultural heritage documentation

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In recent years the application of non-invasive imaging spectroscopy techniques, specifically hyper-spectral imaging, in the visible (Vis) and near infrared (NIR) has increased in the art conservation field. These techniques have expanded capabilities over that of spot (1D) spectroscopic techniques and have the ability to map the spatial distribution of materials, to extract reflectance spectra for material identification, to enhance and reveal underdrawings, to identify past treatments, and to measure colour. The increased use of these techniques, correlating with the availability of a larger number and variety of instruments, has introduced a diversity of users and usages that require reproducibility and comparability of the resulting data. There is a need for a better understanding of the spectroscopic instruments, the elements of data acquisition, and the accuracy and reliability of the data from different instruments and institutions, in addition to minimizing the knowledge gaps of imaging spectroscopy users. This need is acknowledged and addressed through the European Cooperation in Science and Technology Action Color and Space in Cultural Heritage (COSCH), an initiative to identify, characterize, and test spectral imaging techniques. A round robin test was carried out to assess various spectral imaging systems and to develop standardised methodologies and best practices for cultural heritage. Five test objects were analysed by nineteen institutions (academic, research, heritage, and industrial institutions) with various systems, setups, and users to compare the different instrumentation setups and accuracy of their data. The COSCH and the round robin initiative will be introduced, the assessment and comparison methods outlined, and initial findings presented.
Pre and post-retrofit monitoring of a timber-framed National Trust let property

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From the 1st of April 2018 all let properties must achieve an Energy Performance Certificate (EPC) rating of E or above. In addition to the 300 historic buildings open to the public, The National Trust owns 52 villages and has a let property portfolio of over 5000 homes. Whilst since January 2013 listed buildings have been exempt from requiring an EPC, not all of the National Trusts private rented accommodation is listed. In order to address the challenge set by the upcoming EPC minimum standards legislation, The National Trust launched a new set of environmental standards in February 2015 specifically for their let estate. These standards aim to ensure that their housing is healthy and affordable to heat, has a lower environmental impact, and achieves an EPC of E or above. At the same time, they acknowledge that the heritage of the buildings must be respected, and that any measures to improve the environmental performance must be appropriate to, and enhance these special places. This poster will present the monitoring pre and post-retrofit of one of the National Trusts let properties on their Brockhampton Estate in Herefordshire. The Oaks is a timber-framed cottage with sections dating from the 16th, 17th and 19th Centuries. Following the end of a long lease, the property was in need of complete refurbishment. This gave the opportunity to include measures to improve the dwellings energy efficiency with the fitting of secondary glazing and installation of roof insulation. Pressure testing and thermography, undertaken before and after these improvements, enables an evaluation of their impact. This monitoring forms part of PhD research studying the Low Carbon Retrofit of Historic Timber-Framed Buildings in the UK.
Public Benefit, Cultural and Economic Impact and Growth Prospects of Heritage Science Research

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A decade on from the 2006 House of Lords Science and Technology Select Committee Inquiry report on Science and Heritage, heritage science is still an emerging discipline. In order to increase its resilience, the wider impact of heritage science research needs to be demonstrated and, in our current cross-disciplinary climate, this means that collaboration with a range of partners including business, commerce and industry is increasingly necessary.

This poster reports on an AHRC-funded Impact Fellowship which, following the successful completion of the AHRC/EPSRC Science and Heritage Programme (2007-14), focuses on the developing relationship between heritage science research and industry. The aim is to promote innovation and inform policymakers of the value of heritage science to both culture and the economy. Following on from the development of a project database, workshops and selected semi-structured interviews, the poster will present evidence for the impact of publicly-funded heritage science research projects during the last decade, identifying the industries and sectors most likely to be impacted upon and the types of impact generated.

Leading heritage science researchers and industry representatives have discussed how heritage scientists and partners from industry and business can best connect with each other, raising issues that include the emergence of data as a critical currency for heritage, difficulties in finding research partners, a lack of definition and understanding of the existing market for heritage science research, and the need for a mechanism to bring the two sides together. The project aims to provide evidence for policy development that will help to promote mutual recognition and added value among heritage science researchers and industry sectors.
This paper develops and presents a method to assess the vulnerability of historic buildings due to tidal flooding in Bristol city through a vulnerability index model and physical models, culminating together as Parnassus v2.0. At present, studies of the vulnerability of historic buildings to flooding is limited, providing a novel field to explore. The vulnerability of historic buildings in this paper is defined as the exposure, susceptibility and resilience of listed historic structures to tidal flooding. To carry out an analysis, field data has been collected concerning selected buildings in Bristol, particularly listed buildings affected by a 1 in 200 year flood event.

The historic buildings assessed have differing grades of vulnerability, and this is spatially represented using GIS software. Furthermore, an increasing number of buildings will be affected in the future, as climate change will worsen the situation due to an increase in sea level (Watts et al. 2015). To account for this, flood maps at years 2010, 2060 and 2110 have been used. Physical models allow structural integrity analysis of the building façades to hydraulic action of flood water (Jalayer et al. 2016). By illustrating the location and level of vulnerability of each building, flood defence strategies have been recommended based on patterns that arise.

Existing studies referenced to primarily include the Central Area Flood Risk Assessment (CAFRA) (Hyder 2013) and the resulting River Avon Flood Defence proposals (Cox 2014). Other notable sources include independent studies, which feature previous Parnassus methodologies (v0, v1.0) for defining qualitative and quantitative vulnerabilities of historic buildings (Forbes 2013; Stephenson & DAyala 2014).
Breakout Sessions

Presentation: Insights into Publishing

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This session will look at why publishing research is important, what's involved in the publishing process, and what publishers actually do in all this. I'll also look at data and ways that data and results can be presented and shared in online publishing (i.e. new innovations in article publishing such as moving or 3D figures, ELNs etc.).

Workshop: Spectrometry in heritage science

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Spectrometry in heritage science, showing how light measurement can reveal hidden information in heritage artefacts and guide best practice for display and conservation. Applying the latest scientific analysis techniques to ancient artefacts unlocks secrets hidden from human eyes for centuries!

Workshop: Smellwalk of Oxford

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Every day we experience hundreds of smells. A smellwalk is an exploration of the olfactory environment (the “smellscape”); a tour where your nose gets priority. This event will focus on the smellscape of Oxford, gathering qualitative data on odour description. In pairs, we'll become aware of smells on a guided route, considering their sources, intensity, notes and comparing personal responses.

*Please wear comfortable shoes and bring an umbrella or waterproof clothing.*
Workshop: Introduction to white light 3d scanning with hands-on training

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AICON3D
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After a brief introduction in the theory and practical applications of white light scanning, participants can work hands-on with a white light/fringe projection system. Participants are encouraged to bring their own samples for scanning (please contact the organizer before the workshop if you plan to bring an object).

Workshop: SEM in materials characterisation and conservation

Chris Doherty
Research Laboratory for Archaeology and the History of Art (RLAHA), University of Oxford
chris.doherty@rlaha.ox.ac.uk

This session will be a hands-on demonstration of scanning electron microscopy (SEM) on various heritage materials, from the Song Dynasty Imperial porcelains to 9000 year-old plasters from Anatolia. This will be interpreted with discussion on common challenges and potential opportunities for applying SEM in cultural heritage.

Workshop: Physical investigation tools for cultural heritage

Shirley Underwood
Proceq
shirley.underwood@proceq.com

Proceq produces a wide of tools that can be used to investigate the material properties of movable and built heritage, which will be demonstrated and discussed.
Workshop: Microfading testing (MFT) a tool for object and collection surveys

Dr. Jacob Thomas¹, Carolien Coon², Bettina Sacher²
Department of Conservation, University of Gothenburg¹ and UCL Institute for Sustainable Heritage²

jacob.thomas@conservation.gu.se, carolien.coon.12@ucl.ac.uk and bettina.sacher.14@ucl.ac.uk

A short introduction to MFT instrumentation variants will be given with a discussion of the pros and cons of the different MFT designs. Different applications (object and collection surveys as well as research applications) will be discussed. A retro-reflective MFT designed by the workshop leader will be demonstrated.

Workshop: Smartphone adaptation for low-cost sensing in heritage science

Katrin Wilhem
School of Geography and the Environment, University of Oxford

katrin.wilhelm@ouce.ox.ac.uk

This workshop will explore the potential to exploit smartphone technology for use in heritage science for scientific analysis and environmental monitoring.

Tour: Conservation Department, Ashmolean Museum

This session will bring participants into the conservation facilities of the Ashmolean Museum, the world's first university museum.

Tour: Conservation Department, Bodleian Libraries

This session will grant participants access to the newly-refurbished conservation studios of the Bodleian Libraries, recently refurbished as part of the reopened Weston Library (formerly known as the New Bodleian building).
Tour: Research Laboratory for Archaeology & the History of Art (RLAHA) and Radiocarbon dating

The Research Laboratory for Archaeology and the History of Art (RLAHA) is dedicated to the development and application of scientific methods to the study of the past. A tour of the radiocarbon chemistry laboratories explaining the various methods of chemical pretreatment of samples for radiocarbon dating with a discussion on how to select the best samples for dating or to ask any other questions you may have.

Tour: Oxford – a heritage walk

Prof. Heather Viles
School of Geography and the Environment, University of Oxford
heather.viles@ouce.ox.ac.uk

The centre of Oxford contains a wealth of cultural heritage resources, and provides an ideal venue for an exploration of the challenges facing built heritage in a busy urban centre in the 21st century. The tour will also provide an introduction to Oxford building stones and their deterioration and conservation.

Discussion: Heritage science research and Brexit

Prof. May Cassar¹, Prof. Graeme Reid²and Dr. Adam Cooper³
Director of EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage & Archaeology; Director of UCL Institute for Sustainable Heritage and Vice-Dean (Public Policy) of the Bartlett Faculty of the Built Environment, UCL¹, Chair of Science and Research Policy, UCL²* and Lecturer in Social Science and Public Policy, UCL³

*Graeme was Specialist Advisor to the House of Lords Committee on Science and Technology during their recent inquiry in EU membership and UK Science.

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The 2nd International SEAHA Conference brings together researchers from around the globe, but includes a particularly strong presence from the United Kingdom and Europe. The Conference is taking place immediately before the UK holds a national referendum on whether or not to remain in the European Union. The ramifications of the vote for scientific research and, by association, heritage science research and collaborative projects in the UK, European, and global contexts will be discussed.
Presentation: Insights into Publishing
Samuel Winthrop
Chemistry Central, SpringerOpen
samuel.winthrop@springer.com

This session will look at why publishing research is important, what's involved in the publishing process, and what publishers actually do in all this. I'll also look at data and ways that data and results can be presented and shared in online publishing (i.e. new innovations in article publishing such as moving or 3D figures, ELNs etc.).

Workshop: Microfading: a brief introduction into a non-destructive method to detect light sensitive objects
Thomas Prestel
Technical University of Dresden
thomas.prestel@tu-dresden.de

A short introduction into the basic principles of colour measurement is given together with an illustration of the setup of the Micro-Fading-Test-System (MFT). A typical MFT-measurement will be carried out live.

Workshop: Spectrometry in heritage science
Adrian Waltho
Analytik
ksenia.semina@analytik.co.uk

Spectrometry in heritage science, showing how light measurement can reveal hidden information in heritage artefacts and guide best practice for display and conservation. Applying the latest scientific analysis techniques to ancient artefacts unlocks secrets hidden from human eyes for centuries!

Tour: Oxford – a heritage walk
Heather Viles
School of Geography and the Environment, University of Oxford
heather.viles@ouce.ox.ac.uk

The centre of Oxford contains a wealth of cultural heritage resources, and provides an ideal venue for an exploration of the challenges facing built heritage in a busy urban centre in the 21st century. The tour will also provide an introduction to Oxford building stones and their deterioration and conservation.
Workshop: Introduction to white light 3D scanning with hands-on training

Dr. Dirk Rieke-Zapp
AICON3D
dirk.rieke-zapp@aicon.de

After a brief introduction in the theory and practical applications of white light scanning, participants can work hands-on with a white light/ fringe projection system. Participants are encouraged to bring their own samples for scanning (please contact the organizer before the workshop if you plan to bring an object).
Exhibitors

Analytik are suppliers of a wide range of non-destructive analytical equipment including Visible and Near-Infrared (Vis–NIR), FTIR, Raman, Multispectral and Hyperspectral Imaging, and Light Measurement to UK and Ireland conservation and heritage organisations. With a range of spectroscopy and spectral imaging techniques, Analytik is able to provide heritage specialists with the latest technology, providing real-time analysis where and when required.
AICON 3D Systems is one of the world’s leading providers of optical camera-based 3D measuring systems. The company, founded in 1990, develops and distributes systems for the business areas of inspection and testing including car safety and tube inspection. Since the acquisition of Breuckmann GmbH in August 2012, the product range also includes scanners for 3D measurement of complex geometries. On 1 April 2016, the AICON 3D Systems GmbH has joined Hexagon Manufacturing Intelligence, a leading global provider of information technologies that drive productivity and quality across geospatial and industrial enterprise applications.

The digital acquisition and documentation of cultural masterpieces is increasingly gaining importance – be it in architecture, fine arts, archaeology or paleontology. The contact-free 3D scanning technology of breuckmann Scanners works in the museum as well as at the archaeological site. It allows handling delicate objects with the utmost care and provides detailed 3D data with high-resolution color textures for thorough studies without using the original. The breuckmann Scanners are not 3D measuring systems bought “off the rack”, but rather are characterized by their high degree of flexibility: The scanner configuration is adjusted exactly to the customers requirements.

For innovative 3D research work, AICON presents the ‘Bernd Breuckmann Award’ to acknowledge and support the best ‘3D Scanning Research Idea’ of a non-profit scanning project in the field of arts and cultural heritage. Participation is open to all applicants submitting a non-commercial project proposal in the area of arts and cultural heritage, i.e. archeology, arts, history, paleontology and any related disciplines. In particular, young generation scientists are encouraged to participate in this award invitation. The call for abstracts is open until October 15th, 2016.

For more information, please visit http://aicon3d.com/breuckmann-scanner/arts-culture.html
Heritage Science Journal

*Heritage Science* is an open-access journal publishing original peer-reviewed research covering scientific, mathematical and computational methods and analysis of objects, materials, artefacts and artworks of cultural and historical significance in the context of heritage and conservation studies. *Heritage Science* is part of SpringerOpen, Springers portfolio of peer-reviewed, fully open-access journals.

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Proceq, founded 60 years ago, manufactures high-quality portable testing instruments for the non-destructive testing of material properties of metal, concrete, rock, paper and composites. Proceq designs and manufactures its products in Switzerland and with its in-house Research and Development team continues to bring products to the market that set new standards for the industry. The Swiss company with subsidiaries in North and South America, United Kingdom, Russia, the Middle East, China and Singapore provides its international customers with excellent local support.

Proceq instruments are widely used in applications for non-destructive testing of rock and masonry properties. For example: The Rock Schmidt rebound hammer is used for on site assessment of rock strength for drilling productivity assessment. The Equotip device is used for characterization of surface hardness for weathering studies and the Pundit PL-200 for characterization of rock type material and determination of elastic modulus with ultrasonic pulse velocity instrument. Correlation of rock hardness measurements with other parameters for core analysis can be done using the Equotip instrument.

The Equotip 550 provides lower impact energy than the rebound hammer for fragile test subjects or brittle samples and is now used such as the sandstone surface seen here:
The Society of Light and Lighting is open to everyone with an interest in lighting

With over 3400 members globally, the SLL is recognised as an authority on lighting and welcomes all those who are interested in any aspect of the world of light, lighting, and its design or application.

SLL is a learned body, promoting education and knowledge transfer in a variety of ways, including seminars and an events programme which runs all year round.

Lighting designers, consulting engineers, researchers, students, professors, manufacturers, sales staff and many more all contribute to and are members of the SLL.

The benefits of joining the Society include:

- Free online access to all of the SLL Publications, including the 12 Lighting Guides including LGB: Lighting for Museums and Art Galleries, the SLL Handbook and the SLL Code for Lighting, with reduced rates for purchasing hard copies of publications
- Free online access to the world-renowned journal, Lighting, Research and Technology
- With suitable qualifications and experience, you have the right to use the post-nominal AMSLL (Associate Member), MSLL (Member) and FSSL (Fellow)
- Membership gives professional recognition amongst your peers and employers
- Receive the Society’s Newsletter six times a year by post, along with the CIBSE Journal
- Receive prior notification and reduced rates for all SLL events
- Company membership is also available for design practices and manufacturers through the Sustaining Member and Sponsors in Partnership schemes

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