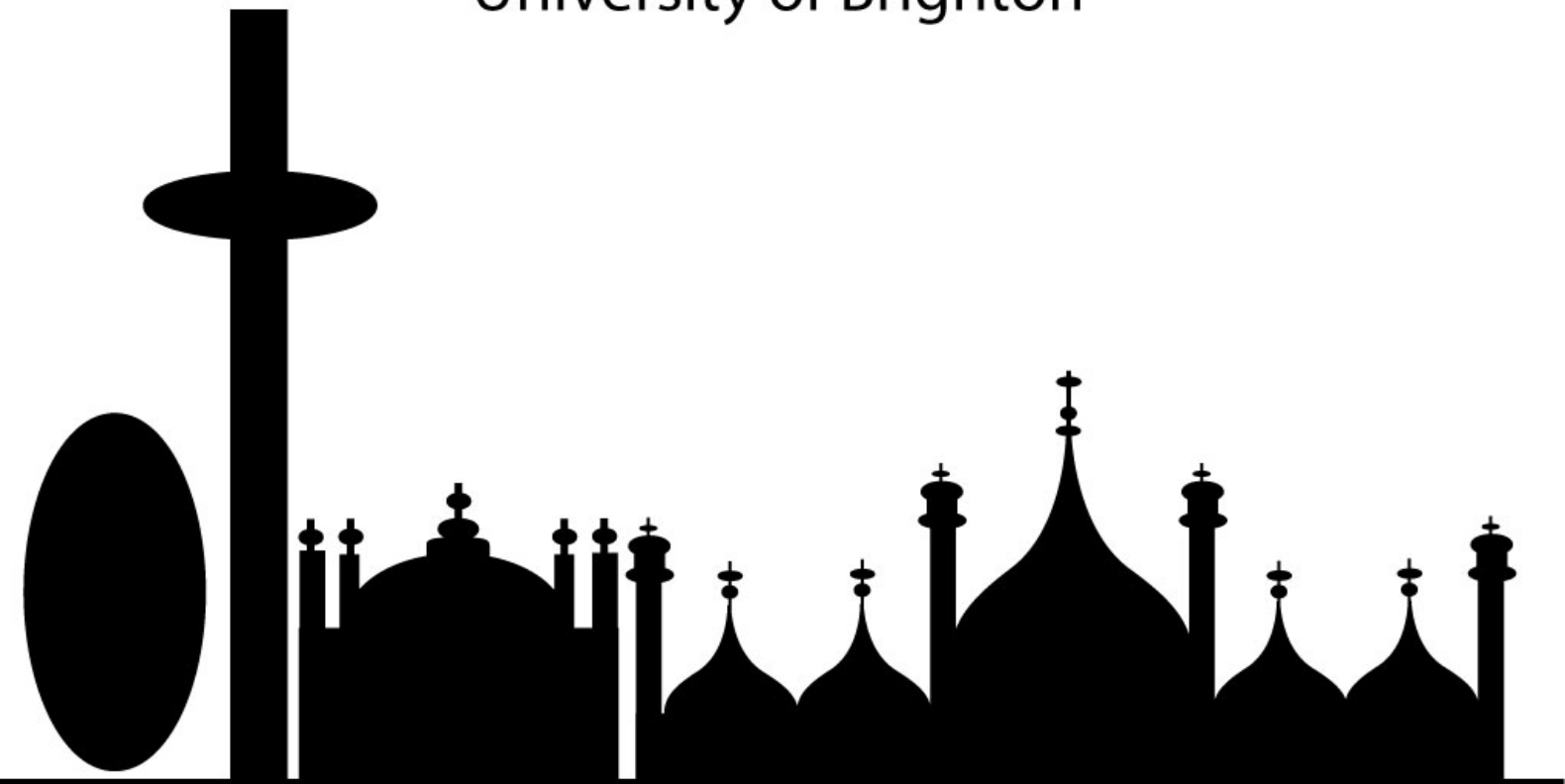
SEAHA

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

3rd International SEAHA Conference

19-20 June 2017

University of Brighton



Brighton, UK

http://bit.do/SEAHA-Conference-2017

University of Brighton

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University of Oxford

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#SEAHAconf17 @seahaCDT

Endorsed by: Icon The Institute of Conservation; National Heritage Science Forum

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Researcher; University of Oxford

Co-organisation and Endorsement

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 endorsed by the Institute of Conservation (Icon) Heritage Science Group and the UK National Heritage Science Forum (NHSF). Additionally, Icon HSG and NHSF generously supported student travel bursaries and early career research bursaries.

The conference is also supported by the University of Brighton Doctoral College.

Exhibitors

HEXAGON MANUFACTURING INTELLIGENCE | AICON 3D Systems

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.

AICON 3D Systems is a leading manufacturer of optical and portable non-contact 3D measuring systems for industrial manufacturing. Since April 2016, the company is part of Hexagon AB, a leading global provider of information technologies that drive productivity and quality across geospatial and industrial enterprise applications. Founded in 1990 and based in Braunschweig, Germany, AICON has been meeting the measurement needs of renowned companies in the aerospace, shipbuilding and other industries for over 25 years. Its technology portfolio includes portable coordinate measuring machines for universal applications and specialised optical 3D measuring systems that enable efficient, high-precision monitoring, quality assurance and control.

Flexible configuration: The AICON Scanners are adjusted exactly to the customer's requirements

The digital acquisition and documentation of cultural masterpieces is increasingly gaining importance – be it in architecture, fine arts, archaeology or palaeontology. The contact-free 3D scanning technology of AICON 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 colour textures for thorough studies without using the original. AICON 3D Systems is an industrial partner of SEAHA and is actively involved in scientific research projects at national and international level.

3D model without colour information

Standard colour information per vertex

3D model with high-resolution textures: improved colour reproduction, clearer contrast, higher texture resolution

The National Heritage Science Forum (NHSF) brings together the producers and users of heritage science to improve collaboration, help practitioners make better use of research, and demonstrate the public benefit of heritage science.

Member organisations determine the direction of the Forum. Current initiatives include:

Kit-Catalogue – an online database of members' equipment and facilities used for heritage science research. The database is publicly searchable from the NHSF website and supports the sharing of equipment and knowledge about equipment.

Grants for Gold Open Access publication – NHSF provides a number of grants to improve access to heritage science research by funding Gold Open Access of articles (see application criteria).

Improving the visibility of heritage science research – the Forum also works in partnership with Wikimedia UK to enhance and add to heritage science content on Wikipedia. It is running a series of workshops in 2017-18 to give people the skills and confidence to edit Wikipedia.

Policy and influence – NHSF engages on behalf of members and the wider heritage science community with policy bodies and opinion formers to ensure a sustainable UK heritage science sector.

National Heritage Science Strategy – through these activities and others, the Forum works through its members to deliver the National Heritage Science Strategy. 2017-18 will see the Forum working in partnership to build on its work to 'Fill the Gaps' in heritage science research and refresh the strategy so it is fit for the future.

See www.heritagescienceforum.org.uk for further information, including how to join.

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PRO-LITE TECHNOLOGY

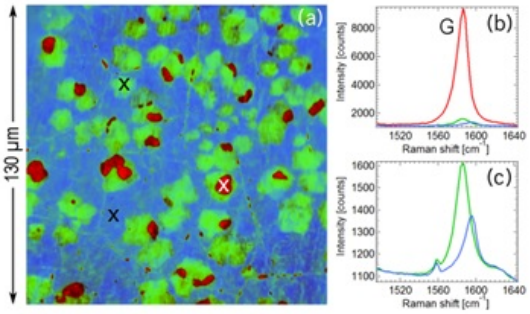
Pro-Lite is a supplier of specialist equipment and services for a range of photonics applications including instruments for measuring light and the optical properties of materials.

Working with a selection of leading equipment manufacturers Pro-Lite offer a range of hyperspectral and multispectral imagers including push-broom and snapshot imagers as well as hyperspectral microscopy. Pro-Lite also work with a range of spectrometer manufacturers providing broad wavelength range field-portable spectrometers, high-sensitivity Raman spectrometers, Optical Coherence Tomography instrumentation, photometers, colorimeters and laser safety eyewear.

Hyperspectral Imaging

Multispectral Imaging

Hyperspectral Microscopy



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Raman Spectroscopy

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Welcome Address

We are excited with the programme that we have to offer for the 3rd International Conference on Science and Engineering in Arts, Heritage, and Archaeology (SEAHA) at the University of Brighton! We hope that this conference will influence the emerging field of heritage science by supporting, connecting, and inspiring stakeholders and researchers in the field.

Similar to previous years, the conference aims to provide a platform for scientists, researchers, engineers, professionals, practitioners, entrepreneurs, and policy-makers, to engage and discuss advances in the field of heritage science. In addition, this year's conference focuses on the interdisciplinary nature of heritage science research looking at interdisciplinarity: the challenges, successes and impacts of research crossing boundaries.

Heritage science is a cross-disciplinary field connecting science and the humanities. It demonstrates the rising interest in and application of interdisciplinary research in the sciences, in addition to the challenges with bridging disciplines. Heritage science research is faced with navigating through interdisciplinary research, and this is a wider discussion that requires input from various stakeholders. This conference aims to provide a platform to enable this discussion. We have encouraged presenters to go beyond the statement that their research and projects are interdisciplinary, and to engage in a discussion about what interdisciplinarity specifically looks like in heritage science research, the challenges and the successes of research crossing boundaries, and the impact of collaborative research with a shared mission.

The programme has continued to develop and expand from the 2015 conference at UCL and the 2016 conference at University of Oxford. The programme builds on the success of two previous events by diversifying the session topics and presentations. The introduction of workshops and discussions in 2016 promoted dialogue between users and providers of technologies and diverse stakeholders in heritage science issues, which will continue with the 2017 programme. Additionally, this year's conference will include an art exhibition in the Grand Parade Gallery contemplating the convergence of art and science at the core of the field of heritage science specifically looking at digital technologies and the creation and documentation of heritage.

The members of the organising committee are incredibly grateful to those have contributed to the planning, preparation and running of the conference. In particular, we would like to thank the personnel from the School of Computing, Engineering & Mathematics, the College of Arts & Humanities, the Doctoral College and other constituents of the University of Brighton for providing logistics and technical support. We would also like to thank all participants in this year's conference for your continued support.

Sarah Hunt and E. Keats Webb, Conference Chairs
On behalf of the SEAHA Conference Organising Committee

In Memoriam

David Arnold

(1951–2016)

MA, PhD, FBCS, CEng, CITP

In October 2016, Professor David Arnold suddenly passed away. David was one of the pioneers of SEAHA and was the SEAHA Co-Director for the University of Brighton until his retirement in February 2016. With the 3rd International SEAHA Conference taking place at the University of Brighton, we want to recognize David's achievements and contributions to SEAHA and the cultural informatics and digital heritage community.

David was instrumental in getting SEAHA funded, launched and running efficiently. His broad interests, as well as his long and successful track record of handling large and complex, multi-centred projects, made him an excellent Co-Director. He had tenacity, wisdom and vision – and used these attributes effectively to help steer the direction of SEAHA. Perhaps his most important legacy to SEAHA was his commitment to ensuring productive and diverse student training opportunities for all our students.

David's career spanned many realms. He was involved in over 45 years of research in the design of interactive computer graphics systems and their application in architecture, engineering, cartography, scientific visualisation and, over the past 18 years, in cultural heritage. David was educated at the University of Cambridge and had an MA in Engineering and Computer Science and a PhD in Architecture. He subsequently spent 24 years at the University of East Anglia and 14 years at the University of Brighton.

David was the founder of the Cultural Informatics Research Group at the University of Brighton in 2002, and he remained its director until his retirement in Spring 2016. David's vision was of a multi- and inter-disciplinary research group, which could provide academic research in support of the cultural heritage sector. Additionally at Brighton, he was Dean of the Faculty of Management and Information Sciences and later the University's Director of Research Initiatives and founding Dean of the Brighton Doctoral College.

But it was Davids impact on the cultural heritage community for which he was best known. David was co-ordinator of the EPOCH Network of Excellence under the EU's Framework 6 programme (FP6), involving 95 partners. It was this project perhaps more than most that sealed David's position as a leading light in the European digital heritage community. More recently he coordinated 3D-COFORM, a large scale integrating research project under FP7 and, of course, he also co-founded SEAHA. He was the founding Editor-in-Chief of the ACM Journal on Computing and Cultural Heritage and was a past Chair of the European Association for Computer Graphics.

With so many roles, David touched the lives of many, but it was his humanity that truly defined him. Compassion and warmth were always at the core of everything he did. Those around him all benefited from his amazing generosity, his huge sense of humour and his sheer kindness. David was an absolute gentleman, unstinting in nature, supportive, scrupulously fair and very caring.

In recognition of his contribution to the programme, the SEAHA Board has created the David Arnold Memorial Studentship, to support a project reflecting David's commitment to interdisciplinary, use-inspired research in cultural informatics.

2017 SEAHA Exhibition

The 2017 SEAHA exhibition aims to stimulate conversation and debate about the relationships between the arts and science, specifically looking at how new technologies can be used to preserve heritage and make this available and accessible to scholars, design historians, students, the wider public as well as contemporary designers.

The EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage, and Archaeology (SEAHA) was created to respond to a need for training of interdisciplinary scientists and engineers to meet challenges set by the heritage sector, industry and government.

At the core of SEAHA is heritage science, a cross-disciplinary field connecting science and the humanities. This exhibition looks at this connection and interdisciplinary field specifically investigating the technologies that are used to design and manufacture modern heritage and to measure, monitor, and conserve older heritage. It consists of three connecting components: VES-EL by Gareth Neal, Heritage Science research Posters and digital documentation by Rani Ki Vav.

Special thank you to Alan Boldon, Director of Cultural Engagement and Innovation, University of Brighton, who helped with the creation and execution of the exhibition.

Gareth Neal

VES-EL

VES-EL is the result of a collaboration between Gareth Neal and Zaha Hadid. The origin of this collaboration was a project organised by the Victoria and Albert museum in which world-renowned architects and designers were asked for their 'wish list' regarding emerging designers they would most like to work with. Zaha Hadid selected Gareth Neal and the result of the collaboration is Ves-el.

Gareth Neal says of the project:

> *We were excited to be paired with Zaha Hadid whose brief was simple and open: to create tableware made from wood. We approached the project by thinking about the fluid dynamic of Zaha Hadids designs. These original forms were inspired by traditional water carafes and the language of her work. We were keen to engage with Hadids advanced computer modelling software, pushing the boundaries of digital craftsmanship further. As the design progressed we became interested in the idiosyncrasies of traditional hand processes such as thrown pottery, raised silverware, or fluted carving and how these forms could be simulated through digital fabrication. Using the traditional vessel form as starting point and subverting its appearance to dramatic extremes, the design embodies a sense of the handmade and*

though the arm of a robot, questioning the viewers perception of craft and the handmade.

Ves-el was the winner of the Wood Awards Bespoke Category 2015

Ves-el by Gareth Neal blurs the boundaries of art, design and technologies. Neal describes his design as a "part of [his] broader inquiry into kind of reflecting traditional craft processes and recontextualising them for a modern audience." He focuses on a traditional technique and presents it in a contemporary way working to provide craft techniques longevity. Neal, in a lineage of designers and artists, has sought out heritage to inspire contemporary design and art. Neal describes his fascination of process. His work explores process, place and people using both traditional and digital tools conversing and interpreting historical techniques and aesthetics.

Neal uses digital technologies for inspiring, designing and producing new heritage, these same digital technologies are being used to research and conserve heritage sites and objects.

For further information about Gareth Neal and his work, please visit
http://garethneal.co.uk/

Heritage Science Posters

Extending beyond digital technologies discussed in the other parts of the exhibition, the research posters highlight heritage science research, innovation, and best practice in the interpretation, conservation, and management of cultural heritage.

The 2017 SEAHA Conference is specifically looking at interdisciplinarity: the challenges, successes and impacts of research crossing boundaries. The field of heritage science demonstrates the rising interest in and application of interdisciplinary research in the sciences in addition to the challenges with bridging disciplines. The field is faced with defining and navigating interdisciplinary research.

The posters engage and discuss emerging trends in the field and the on-going dialogue over global issues, which define the research and technological applications of heritage scientists.

Digital Documentation: Rani ki Vav

SCOTTISH TEN

C D D V Centre for Digital Documentation and Visualisation

While Gareth Neal uses digital technologies for designing and producing new heritage, similar digital technologies are being used to research and conserve heritage sites and objects. The digital documentation of Rani ki Vav in Gujarat, India by the Centre for Digital Documentation and Visualisation with CyArk show how modern technologies are used to measure, monitor and conserve ancient heritage sites. The digital documentation of Rani ki Vav was part of the Scottish Ten project.

The Scottish Ten

The Scottish Ten project set out in late 2009 to digitally document Scotland's then five World Heritage Sites and a further five international heritage sites to create accurate 3D data to help with their conservation and management, their interpretation and virtual access. It is a collaborative project between Historic Environment Scotland and The Glasgow School of Art's School of Simulation and Visualisation (working together as the Centre for Digital Documentation and Visualisation), with CyArk.

Rani ki Vav

The Scottish Ten team hoped that digitally documenting Rani ki Vav in 2011 would raise the profile of the royal stepwell, little known outside India. UNESCO inscribed Rani ki Vav as a World Heritage Site in 2014.

Significance

Stepwells were used in India from around the 7th century as a communal source of water and shade. Often architectural masterpieces, stepwells were also social hubs, as people would gather on the lower levels to escape the heat.

Rani ki Vav, or the Queens Stepwell, dates from between 1022 and 1063. Udayamati is believed to have commissioned the stepwell, in memory of her late husband Bhimdev I.

Silt backfilled the stepwells seven levels over centuries, brilliantly preserving its ornate decoration until the sites rediscovery in the 1950s. Each terrace has multiple pillared pavilions that feature intricate sculptures of Hindu deities.

Selection for the Scottish Ten

A shortlist of potential Indian heritage sites was agreed between the Scottish Government and the Archaeological Survey of India (ASI).

Rani ki Vav was on Indias Tentative List for inscription as a World Heritage Site at the time it was scanned in 2011. The Scottish Ten team hoped that digitally documenting the site would raise its profile. UNESCO inscribed Rani ki Vav as a World Heritage Site in 2014, and our 3D data played a role in the monuments management plan as part of the nomination.

Digital conservation was also an important factor. ASI can now use our very accurate, high-resolution 3D survey to inform the heritage management of Rani ki Vav.

Project challenges

Rani ki Vav was digitally documented over two weeks in 2011. Rani ki Vav is 27m deep and has almost 400 wall niches that hold delicate carvings. The sheer number of complex carvings was the major challenge of digitally recording the site. To respond to this, the team used a number of new and adapted 3D scanning technologies and photogrammetry.

A special rig was needed to scan the interior walls of the well itself. Access is difficult and the rig let the team suspend the scanner over the edge of the well and lower it into the depths.

Temperatures of 38 to 40°C were a further challenge for both the team and its equipment.

Valuable outcomes

ASI has been able to add our high-resolution 3D survey to its existing survey record. This will inform the ongoing conservation and heritage management of Rani ki Vav.

The 3D scans can be:

- used as an interpretation and education tool
- a visual aid to explore the stepwells construction and iconography
- processed into photorealistic animations to develop virtual tours
- a conservation and management tool

For further information, please visit http://www.scottishten.org and follow us on Twitter: @histenvscot, @gsofasimvis, @scottish3D, @alrawli, @sofia_antonop, @afrostwit, @hephe1

Programme

Day 1

8:45 – 9:30 Registration

9:30 – 9:50 Opening address

9:50 – 10:15 **Science, Conservation and Scholarship in Cultural Heritage, the Need for a Global Strategy**
Dr. Robert van Langh, *Rijksmuseum and Netherlands Institute for Conservation + Arts + Science*

10:15 – 10:55 **SESSION 1: Imaging**
Chair: Natalie Brown, University College London

The Optimal Metric for Registering Multispectral Images of Cultural Heritage
Cerys Jones, *University College London*

Face to Face – Close Range Inspection of Head Vases
Dirk Rieke-Zapp, *AICON 3D Systems GmbH*

10:55 – 11:35 Break

11:35 – 12:35 **SESSION 2: Modeling**
Chair: Dzhordzhio Naldzhiev, University College London

Building Information Models for Monitoring and Simulation Data in Heritage Buildings
Danae Phaedra Pocobelli, *University College London*

Preparing Detailed Textured 3D Models of Paintings for Online Viewing with Virtex
Xavier Aure, *University of the West of England*

Direct Tracing of Micro-Damage to Support Indoor Climate Management
Leszek Krzemień, *Polish Academy of Sciences*

12:35 – 13:35 Lunch

13:35 – 13:55 **FLASH PRESENTATIONS** t

Mapping 450 Year-Old Marine Archaeological Iron Corrosion from the Mary Rose
Hayley Simon, *University College London*

Materials Analysis of Pacific Barkcloth
Margaret Smith, *University of Glasgow*

Reciprocity in MFT of Polymer-Based Additive Manufactured Materials
Carolien Coon, *University College London*

13:55 –14:20 **Invited Speaker: A Fertile Ground – Benefitting the Nation Through Interdisciplinary Research**
Mrs Katy Lithgow, *National Trust*

14:20 –15:00 **SESSION 3: Technology**
Chair: Cecilia Bembibre, University College London

Archives in the Digital World – Opportunities and Challenges for the Heritage Science Sector
Janet Delve, *University of Brighton*

Archaeological Cyborgs. Technological, Conservational and Material Mixtures in Museums
Monika Stobiecka, *University of Warsaw*

15:00 –15:40 Break

15:40 – 17:00 **SESSION 4: Environment**
Chair: Martin Michette, University of Oxford

Air-chitecture: How to use Air Motion to Prevent Degradation Agents
Josep Grau-Bové, *University College London*

Monitoring of Arsenic, Mercury and Organic Pesticides in Particulate Matter, Ambient Air and Biomonitoring of Employees in the Museum für Naturkunde Berlin
Katharina Deering, *Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, Munich*

Coping with Driving Rain: do Lime Pointing Mortar Set Better Under Damp Conditions?
Lucie Fusade, *University of Oxford*

From Standards of Collection Care to Damage Observations – and Back Again
Christian Baars, *National Museum Cardiff*

From 17:15 **Tours of Brighton Royal Pavilion**

18:00 – 20:30 **Evening Reception at the Brighton Museum**

Day 2

8:45 – 9:30 **Registration**

9:30 – 10:30 **Breakout Session A**

10:30 –11:10 Break

11:10 –12:10 **Breakout Session B**

12:10 –13:10 Lunch

13:10 –13:35 **FLASH PRESENTATIONS**

Nanothermal Analysis Characterisation of Tg Behaviour in Naturally Aged Synthetic Polymers in Modern Art After Solvent Contact
Donald Sale, *Art & Conservation Consultation & Research*

Strain Modelling in Historical Tapestries
Pedro Máximo Rocha, *University College London*

Assessing Deterioration in Negatives and Moving Pictures: an Early Warning System for Collection Managers
Jacqueline Moon, *The National Archives*

The Problem Stone Progressive Survey Technique (ProSt-ProST)
Martin Michette, *University of Oxford*

Can Cellular Automata Models be used for Earthen Heritage Conservation?
Jenny Richards, *University College London*

13:35 –14:00 **Invited Speaker: A Heritage Sector or a Heritage Industry? By Whom, with Whom, for Whom?**
Prof. May Cassar, *University College London*

14:00 – 14:40 **SESSION 5: Increasing Heritage Understanding**
Chair: Andy Wade, University College London

From Roman Glass Sherds to the Laboratory: how can Materials Science and Archaeology Benefit from Interdisciplinary Work?
Anne-Isabelle Bidegaray, *Vrije Universiteit Brussel*

Hidden Library: Visualising Fragments of Medieval in Early-Modern Bookbindings with Mobile Manuscripts Macro-XRF scanner
Jorien Duivenvoorden, *Delft University of Technology*

14:40 –15:45 POSTER SESSION

15:45 –16:45 **SESSION 6: Material Analysis**
Chair: Jennifer Richards, University of Oxford

Nanocellulose Treatments for Painting Canvas Consolidation
Alexandra Bridarolli, *University College London*

Assessment of the Photo-Stability of Plastics Found in Heritage Collections to Visible Light Using FTIR Spectroscopy and Colorimetry
Anna Pokorska, *University College London*

Addressing the Sustainability of Earthen Heritage Through Materials Characterization
Marianne Odlyha, *Birkbeck, University of London*

16:45 –17:15 Break

17:15 –18:15 **SESSION 7: Analytical Methods**
Chair: Hayley Simon, University College London

Hyperspectral Imaging for the Identification of Pigments: An Analysis of Illuminated Armenian Manuscripts
Ian Maybury, *University of Oxford*

Neutron Imaging Archaeological Wood from the Mary Rose: Differences in Drying Rate and Shrinkage Patternin Wood with Different PEG Treatments
Eleonora Piva, *Portsmouth University*

Standing up for Standing Stones: Experiences with Implementing Novel Non-Destructive Moisture Measurement Techniques in Situ
Scott Allan Orr, *University of Oxford*

18:15 –18:30 Closing Remarks

18:30 –20:00 Closing Reception

Contents

Invited Speakers

Science, Conservation and Scholarship in Cultural Heritage, the Need for a Global Strategy

19th June 9:50 – 10:15

Dr. Robert van Langh

Head of Conservation & Scientific Research, Rijksmuseum and Chair NICAS, Netherlands Institute for Conservation + Arts + Science

Dr. Robert van Langh (1968) has been head of the Department of Conservation & Scientific Research at the Rijksmuseum in Amsterdam since 2006. Beginning as a gold- and silversmith, Robert was subsequently trained as a conservator at the National Institute of Fine Arts in Antwerp. After working at the Museum of the Tropics, he became a metals conservator at the Rijksmuseum in 1995. During this time he developed the metals conservation training program now being taught at the University of Amsterdam.

In 2012 he finished his PhD at Delft University of Technology combining Materials Science and Art History with the title: 'Technical Studies of Renaissance Bronzes'.

As of 2015 Robert is also chair of NICAS (Netherlands Institute of Conservation, Art and Science), a new innovative multidisciplinary research center housed in the Rijksmuseum Conservation building, uniting art history, conservation and science.

A Fertile Ground – Benefitting the Nation Through Interdisciplinary Research

19th June 13:55 – 14:20

Mrs Katy Lithgow

Head Conservator, National Trust

Katy Lithgow has a BA Hons in Archaeology, Anthropology and History of Art from Cambridge, and the Postgraduate Diploma in Wall Paintings Conservation from the Courtauld Institute of Art, London, where she taught following an internship at the Victoria and Albert Museum, London.

She joined the National Trust in 1991 as a preventive conservator, specializing in storage and protecting collections during building works. In 1995 she became the Trust's Wall Painting Conservation Adviser and in 2002 Conservation Advisers Manager, before being appointed Head Conservator in 2005.

She has published and lectured on wall painting conservation, preventive conservation, conservation management, interpretation in conservation, heritage science and sustainability. Katy is an Accredited Conservator-Restorer (ACR), a Fellow of the International Institute of Conservation (FIIC), Chair of the PACR scheme's Accreditation Committee, and a Trustee of the National Heritage Science Forum.

20th June
13:35 – 14:00

A Heritage Sector or a Heritage Industry? By Whom, with Whom, for Whom?

Prof. May Cassar

Director of UCL Institute for Sustainable Heritage and Director of SEAHA CDT

Professor May Cassar is the Director of the UCL Institute for Sustainable Heritage and the Bartlett Vice Dean of Public Policy. May was appointed by the Department for Culture, Media and Sport as a member of its Science Advisory Council and recently to serve on the Department's Challenge Panel as part of its review of the National Heritage Memorial Fund and the Heritage Lottery Fund. May was appointed as only one of two external experts for Historic England's Science Review.

May currently directs the EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology, a multi-million pound UK Government investment to educate to doctoral level the next generation of heritage scientists. As the Director of the Arts and Humanities Research Council/Engineering and Physical Sciences Research Council's Science and Heritage Programme (2007-2014) and as Special Adviser to the House of Lords Science and Technology Committee Inquiry on Science and Heritage (2005–2006), May has led the resurgence of heritage science research activity in the UK over the last decade for which she has been recognised by the Royal Warrant Holders' Association with the award of the Plowden Gold Medal in 2012.

Podium Presentations

Session 1: Imaging

Chaired by Natalie Brown

The Optimal Metric for Registering Multispectral Images of Cultural Heritage

19th June 10:15 – 10:35

Cerys Jones[1], Adam Gibson[1], Melissa Terras[1] and Mike Toth[2]
University College London[1] and R.B.Toth Associates[2]
cerys.jones.15@ucl.ac.uk

Spectral Imaging is a common technique used to digitise historical artefacts, which has led to the revival of faded texts and drawings. In order to recover features that do not appear in the visible region, images of the object illuminated across the electromagnetic spectrum are acquired. These images are stacked to form an image cube and processed as a whole. However, misalignments may be present in the sequence of images due to uncontrollable factors such as the use of filters, and those that are less predictable such as movement of the object or camera. The misalignments must be removed to ensure more accurate results are produced by the mathematical processing techniques. These inaccuracies will be especially obvious in text or at the edges of features. Misalignments occur in the form of affine distortions, such as translations, rotations, scale changes and shear, and nonlinear distortions. Registering multispectral images is challenging due to the changes in light intensity and the sporadic appearance of features. Therefore, in this research, three registration metrics commonly used in medical imaging, namely the sum of squared differences, mutual information and cross-correlation, are evaluated and compared for registering affine distortions. The optimal registration metric will be incorporated into a registration tool for nonlinear distortions.

19th June
10:35 – 10:55

Face to Face – Close Range Inspection of Head Vases

Dirk Rieke-Zapp[1] and Elisabeth Trinkl[2]
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In this contribution we focus on Attic productions of pouring vases (oinochoai) of late archaic and early classical times which bodies are shaped as a human head, mostly female heads. Beazley (1929) categorized the vases in the form of human heads in twenty groups (Group A-W) and a miscellaneous list, according to the depicted figure and the stylistic development of the face, based on an art historic methodology. We focus on Beazleys groups N (Cook Class) and Q (Vienna Class). The vast majority of the Attic pottery is thrown by the spinning wheel. Concerning the head vases the potters used the same technique only for the upper part of the vessel whereas the head of the head vase was made by two molds. The process of production interconnects head vases and terracotta figurines. Digitization of several head vases with fringe projection systems in Kunsthistorisches Museum Wien, Staatliche Antikensammlung Mnchen, Antikensammlung Berlin allowed for digital comparison of vases. We are convinced that Beazleys groups are principally correct. Nevertheless, recent computer technology and visualisation systems can help in further refining and consolidating the original groups, with respect to chronology and production process. Conventional archaeological methods are inappropriate for these three dimensional comparisons. Calculating the difference of the resulting 3D models after co-registration revealed very little differences between the head areas of several vases. Differences are so small that it is likely that the same mold was used for several preserved head vases. Scaling the digital models by 10-15% in order to simulate the volume loss during production of a head vase, i.e. due to drying and oven burning, allowed comparison of smaller to larger head vases. Comparing results, it is not unlikely that molds were taken as negatives from oven burned head vases to produce a generation of smaller head vases.

Session 2: Modeling

Chaired by Dzhorzhio Naldzhiev

Building Information Models for Monitoring and Simulation Data in Heritage Buildings

19th June 11:35 – 11:55

Danae Phaedra Pocobelli[1], Josep Grau-Bové[1], Jan Boehm[1] and Paul Bryan[2]
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This research analyses the existing Building Information Modelling (BIM) process that is currently used for heritage building digitisation and how it could be improved. In a second phase the geometric model will be enhanced by implementing a heritage-dedicated computational tool.
This investigation started with the digitisation of a case-study, the Jewel Tower, using Autodesk Revit, a commonly-used BIM platform. We aimed to check if conventional conservation practice is effectively convertible into BIM technology. The following considerations were made:

1. The BIM model does not contain any smart object representing architectural details. They had to be drawn through a Computer Aided Design software, as Revit does not provide a satisfactory dedicated tool, and, moreover, Revit families do not include a specific template that could be used to model them as smart objects. This issue meant that, when these details were added into the BIM model, they were just images, i.e. they did not provide any other information apart from visual ones. This concern clashes with the key concept of BIM, intended as Building Information Modelling.

2. Faade weathering had to be modelled outside the BIM environment, and then imported as images. In heritage buildings weatherings are usual and are solved with ordinary maintenance: being able to monitor and forecast them would avoid severe degradations and extraordinary/expensive interventions.

These observations highlight the need for further research. We have identified an important software gap when a faade weathering survey is required. Since humidity is a major factor in the weathering of faades, being able to forecast and monitor it is one of the main ways in which predictions of weathering can be introduced in BIM. These predictions can be made using damage functions already validated, available in the literature, and produce a computational model, which can be inserted into BIM platforms using their extendable capabilities.

19th June
11:55 – 12:15

Preparing Detailed Textured 3D Models of Paintings for Online Viewing with Virtex

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Displaying and interacting with realistic 3D models usually requires vast amounts of computing power. When it comes to visualisation of paintings the 3D models become extremely dense and complex if they are to display accurate surface texture. Fine brush strokes, thickly applied impasto or gold punchwork require highly detailed meshes to resolve for all these details.

To solve this problem, we proposed the use of tangent space normal maps. We borrow some of the techniques used in the computer graphics industry to produce highly detailed 3D models of the surface of paintings. We take advantage of the normal maps generated from existing 3D and 2D data and incorporate them into the 3D models. The normal maps allow us to create the illusion of a highly detailed texture without the strain of a multimillion polygonal mesh. By reducing the polygon count we can produce 3D models that are computationally efficient for online viewing.

The final 3D models are then exported to Virtex for online visualisation and interaction. Virtex is an open source 3D object viewer built with three.js supporting browser-based and WebVR visualisations.
The Universal Viewer (http://universalviewer.io) has a 3D extension that uses Virtex to display content delivered via a IIIF manifest with associated metadata. The Universal Viewer allows users to easily share and embed this content elsewhere.

We include a demonstration of the viewer and some practical applications on how to generate normal maps and how to incorporate them into the 3D models. We discuss how collaboration across disciplines contributes to enhance heritage engagement.

This work is part of an AHRC funded CDA between the Centre for Fine Print Research in Bristol, the National Gallery in London and Edward Silverton.

Direct Tracing of Micro-Damage to Support Indoor Climate Management

19th June 12:15 – 12:35

Marcin Strojecki[1], Leszek Krzemień[1], Boris Pretzel[2], Arkadiusz Kupczak[1], Roman Kozlowski[1], Artur Dzialo[3], Michal Lukomski[4] and Lukasz Bratasz[5]

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The issue of material environmental requirements for the protection of cultural heritage objects in a responsible manner has received much attention, especially in terms of reducing energy use and carbon emissions. To quantitatively assess environmentally-induced risk of physical damage to vulnerable objects, a web-based decision-supporting tool HERIe is being developed by a collaborative effort of several institutions. The risk is assessed by calculating and analyzing strain-versus-time histories engendered in specific objects by real-world microclimates. Selecting the critical levels of the dimensional response resulting in damage – that is the damage criterion - is the crucial step in the analysis. The damage criteria may come from laboratory studies but also monitoring of original objects. Acoustic emission and digital speckle pattern interferometry were used for monitoring in situ crack propagation or decorative layer delamination induced by strains experienced by elements of decorated historical furniture. The extreme sensitivity and reproducibility of the acoustic and optical methods allowed the strain-damage relationships to be derived at the micro level. The procedure are illustrated by the results of long-term monitoring of selected wooden objects: a wardrobe displayed in the Gallery of Decorative Arts in the National Museum in Krakow, a French commode decorated with panels of Japanese-export lacquer exhibited in the Furniture Gallery of the Victoria & Albert Museum in London, and diverse artefacts subjected to controlled relative humidity variations in a laboratory study of the Getty Conservation Institute. HERIe is available for testing at http://herie.mnk.pl. Detailed information on the software is available at this website, along with a step-by-step guide and tutorial climates.

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

Session 3: Technology

Chaired by Cecilia Bembibre

19th June
14:20 – 14:40

Archives in the Digital World – Opportunities and Challenges for the Heritage Science Sector

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In the past few years, the notions surrounding what constitutes traditional archiving have changed dramatically. With the onset of open access and e-government policies, the image of the archive as the place where precious documents are kept hidden away forever has had to give way to alternative scenarios. E-government legislation across Europe and beyond has brought about a situation whereby national archives are obliged to accept digital data on an ongoing basis. However, many of them do not have any kind of digital archiving infrastructure, and where systems or practices exist, they are not harmonised or globally utilised. As a result, this sea-change in archival practice has resulted in a huge challenge for national archives across the globe.

But housing the data is only one facet of the grand challenge now facing archives. The desire to valorise archival material and make it accessible to all, particularly via Big Data methods for large scale and complex data, is also part of the sea-change. Academic researchers; analysts from enterprise and commerce; and citizens; are all seen as new users of these digital riches, and new discovery methods need to be developed for them to access the wealth residing in European digital archives of all shapes and sizes, for underpinning and expanding our Digital Economy, as well as exploiting our diverse digital cultural heritage.

This paper will present the tools, specifications and standards developed within the E-ARK European-funded digital archiving project (2014-2017), demonstrating in particular how they can facilitate discovery in digital archives of many shapes and sizes, and showing their potential use for Digital Cultural Heritage in general, and museums and galleries in particular, drawing on exemplars and use cases from the project. Database archiving will be presented as being of especial interest within Heritage Science.

Archaeological Cyborgs. Technological, Conservational and Material Mixtures in Museums

19th June 14:40 – 15:00

Monika Stobiecka
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Interdisciplinary projects that are very often realized under the auspices of museums are mainly focused on technological and conservational improvements that can be applied to delicate matter of artifacts and monuments. This fruitful marriage between technology and conservation, that in museums takes part in creation of powerful and convincing reconstructions, is definitely too rarely a subject of philosophical reflection.

In my paper I propose to reconsider the products of technological and conservational relation presented in selected European museums (Museum of Underground Market Square in Cracow, Poland; New Acropolis Museum in Athens, Greece; Museo Ara Pacis in Rome, Italy; Kalmarland Museum, Sweden). I would like to introduce the term archaeological cyborg to underline the philosophical character of material interventions that are performed on historic and archaeological matter while using technologies like augmented reality, virtual reconstructions, simulations, visualizations. The main goal of the paper is to prove that technological tools are not merely about educational merits, but also they contribute to visible redefinition of archaeological matter and the idea of protection and care about heritage. Technology challenges the normative concept of care understood as preservation of fragile artifacts from distant past; instead of solely preserving that, what is left, new methods are supplementing the fragmentary objects. Creatures that are born from those processes are no more only artifacts, they are archaeological cyborgs that widen our insight into objects and their past meaning, without any material disturbance that might be visible on delicate body of past objects.

Session 4: Environment

Chaired by Martin Michette

19th June
15:40 – 16:00

Air-chitecture: How to use Air Motion to Prevent Degradation

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Air motion is the unsung driving force behind many degradation processes in historic materials. It is widely acknowledged that most agents of change (gases, particulates, spores, humidity and heat) are transported by air. This paper investigates, using new and existing data, the relationship between air motion and four physical processes: mould growth, plasticiser migration, dust deposition and salt efflorescence.

Agents of change interact with materials not only through chemical and biological processes but also through transport phenomena at the interface between air and the object. The rates of mass and heat transfer at the surface are often the bottleneck of degradation processes, and are usually highly dependent on air motion. However, the role of air motion in many of processes has never been systematically studied.

Our findings suggest that changes in air motion can have contradictory effects. In general, both rates of transfer from the surface (such as evaporation) and towards the surface (such as deposition of aerosols or spores) are increased when air velocity increases. In practice, however, low velocities are not always advisable. Salt efflorescence or plasticiser migration in polymers are increased by air motion. Conversely, air movement indoors can increase evaporation rates, reducing the water activity of surfaces, and thus reducing the risk for mould development.

Air-chitecture is the interdisciplinary approach to the control of degradation by the informed design of air motion patterns. This paper estimates the ranges of air velocities that can be considered safe in regards to different processes. It proposes a definition of near wall air-motion that can be generalised to the diversity of processes presented, as well a method to measure it. Finally, it proposes a simple mathematical model to describe surface mass transfer rates. This model can be used to understand the non-linear relationships between air motion and surface phenomena.

Monitoring of Arsenic, Mercury and Organic Pesticides in Particulate Matter, Ambient Air and Biomonitoring of Employees in the Museum für Naturkunde Berlin

19th June 16:00 – 16:20

Katharina Deering[1], Elise Spiegel[2], Christiane Quaisser[3], Stephan Böse-O-Reilly[1], Susann Böhm[1], Rudolf Schierl[1] and Dennis Nowak[1]

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This contribution will introduce a current research project about handling hazardous objects in museum collections funded by the German Federal Environmental Foundation.

Currently, many cultural heritage collections are contaminated with inorganic and organic pesticides through preventive and curative conservation treatments. Biocides that have been used in museum collections are for the most part carcinogenic, mutagenic and toxic for reproduction. This is a potential health risk for staff as they are exposed to contaminated objects. For that reason, there is a great need for a purposeful method to be used in a protection plan covering employees and objects in museum collections.

The Museum für Naturkunde Berlin, a research institute and natural history museum hosting about 25 million zoological objects treated and conserved with a whole range of different biocides, serves as a perfect model organisation for this project. Central to the research conducted in the project is to know the level of pollution in the ambient air and particulate matter in the Museum fr Naturkunde Berlin and how that could affect the employees health.

The representative assessment of exposure and the potential health risks was organised in a four-phase model: determination of biocides in indoor air, indoor dust and particulate matters, inspection of the workplace situation respectively the pathways of contamination and a human-biomonitoring of exposed employees. Depending on the results a clear recommendation for risk assessment and handling pesticide residues in museum collections will be developed.

The aim of the research project is to systemize and professionalize the handling of contaminated objects in museum collections and should provide support for preserving cultural objects without any health risks for employees.

19th June
16:20 – 16:40

Coping with Driving Rain: Do Lime Pointing Mortar Set Better Under Damp Conditions?

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In England, many historic buildings of architectural significance are particularly exposed to harmful environment, such as wind and driving rain. Moisture is one of the key factors in the deterioration of building materials, leading to salt efflorescence and biological growth. To ensure preservation of historic masonry, rain penetration needs to be mitigated. This is one of the main roles of masonry joints. To draw moisture out of a wall, the mortar should be highly permeable and able to set under damp conditions. Mortars made with natural hydraulic lime (NHL) set through a two-phase process comprising a hydraulic set and carbonation. The rate of hardening depends of the environmental conditions and affects other properties of the mortar such as the pore size and distribution. This research, in collaboration with Historic England and The Churches Conservation Trust, examines whether lime mortar is able to set under wet curing conditions and to what extent key properties of the mortar are affected.

Four mixes were designed, using NHL 2, siliceous or calcitic aggregates with a lime to aggregate ratio of 1:2 and 1:3. Samples were exposed to wet conditions, similar in average to those found inland in South West England in Summer: 15°C and 85% RH compared to standard curing conditions: 20°C and 65% RH. Testing occurred at two ages of curing: 28 and 90 days. The depth of carbonation was assessed by phenolphthalein staining indicator. The effect of carbonation was determined by evaluating the open porosity by gravimetric measurement (BS EN 1936–2006) and by measuring the compressing strength (BS EN 1015–11–1999). The pore size distribution was determined by microscopy. Preliminary results show that wet curing conditions are beneficial for some key properties of the mortar. This research ensures that pointing lime mortar applied on very damp buildings will help mitigate the ingress of driving rain, contributing to the overall preservation of historic buildings.

From Standards of Collection Care to Damage Observations – and Back Again

19th June 16:40 – 17:00

Christian Baars and Jana Horak

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The observation of damage to objects in museum collections is not, in itself, a sign of failure of the implementation of appropriate standards. Detailed guidance exists for the long-term storage of some materials, but much contradictory guidance is published by entirely reputable authors on 'ideal storage conditions for, for example, geological collections. This is the result of a lack of knowledge about the precise nature of damage caused to minerals and fossils by oxygen, water molecules and gaseous indoor pollutants in a similar way as there is a paucity of research on the reactions of carboxylic acids with archaeological iron. Any development of appropriate collection care standards for such collections requires, in the first instance, an understanding of the relationship between the chemistry of minerals and various agents of deterioration. This, in turn, assumes knowledge of the symptoms of change to specimens which would be defined as damage. And even if damage was defined concisely it is not clear presently that change can be monitored routinely and effectively by collection care professionals. Hence, work at National Museum Cardiff currently investigates the development of collection care standards starting at first principles of establishing what and how to measure damage. The expertise required for such work is not available widely in the museum sector but successful interdisciplinary partnerships with chemists and engineers from the academic sector are expected to help in the development of smart phone-based technology to assist with monitoring collections and producing reliable, non-biassed condition assessments. From this foundation, levels of damage caused by specific variables can then be quantified. It is anticipated that this work will result in improved practical guidance for conservators and curators.

Session 5: Increasing Heritage Understanding

Chaired by Andy Wade

20th June
14:00 – 14:20

From Roman Glass Sherds to the Laboratory: How can Materials Science and Archaeology Benefit from Interdisciplinary Work?

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Nowadays, people tend to underestimate how skilled Roman glassmakers were and how important the glass production scale was. Yet an improved awareness of Roman glass production has key implications. Not only does it improve our understanding of Roman trade and technology but it also raises unanswered materials science questions. To this end, innovative interdisciplinary work is absolutely crucial.

In this presentation, we propose to tackle the issue of Roman glass colours and to discuss how fundamental glass science is deeply intertwined with ancient glass production. Roman glass contains iron oxide, a sand impurity which causes a blue-green colour. Upon the addition of minerals containing manganese or antimony oxides, glass was decoloured. The interaction of iron and manganese in glass is complex: for the same composition, a glass can be either purple or colourless depending on redox reactions in the glass melt. Understanding how and why these glasses were produced appear to be linked to cultural trends, socio-economic changes and political/military events.

These important historical questions challenge glass science as there is yet no full understanding of the interactions between manganese, antimony and iron in glass. Glasses with the chemical composition of Roman glasses were produced in laboratory conditions and at Roman glass furnace reconstructions. Glass colours and redox states were analysed using in-situ high-temperature XANES and optical spectroscopy. By acquiring a more clear insight into glass redox, we suggest that glass colouring and decolouring relied to quite an important extent on the choice of raw materials. This multi-analytical study leads to a more nuanced view on Roman glass production and fundamental glass science. It shows us that there were different production models, that the empirical mastery of glass colours is not obvious to trace back nowadays and that redox reactions in the glass melt are more complex than what is thought.

Hidden Library: Visualising Fragments of Medieval Manuscripts in Early-Modern Bookbindings with Mobile Macro-XRF Scanner

20th June 14:20 – 14:40

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After the invention of the printing press in the 15th century the production of manuscripts went down and bookbinders increasingly recycled the parchment leaves to reinforce bindings of printed books. Our interdisciplinary research project demonstrates the large potential of macro-XRF imaging for systematic, non-invasive investigation of these fragments. In a preliminary experiment four bookbindings were scanned as case studies with a Bruker M6 Jetstream mobile XRF scanner. The discoveries included a 12th-century excerpt of a text by the Venerable Bede in the binding of a 16th-century book. Another bookbinding from the 16th century contained a 15th-century calendar fragment underneath an endpaper showing the feast day related to the beheading of John the Baptist. In addition to these case studies, we were able to separate the lower and upper text of the famous Leiden palimpsest and visualise a few lines of the 10th-century version of Oedipus Tyrannus by Sophocles. The main limitation of the current set-up is the scanning time. Additionally, the uneven surface of the fragments poses a problem regarding the focus of the scans. Nonetheless, in this experiment hidden texts were visualised underneath black paint, paper, and parchment at sufficiently high resolutions that they could be read and dated. Fragments like this are commonly found in early-modern books and a systematic investigation of this hidden library will provide valuable information about transmission and variant readings of medieval texts. With these four case studies of limited size but substantial historical interest we show that the macro-XRF technique is extremely suitable for non-destructive visualisation of fragments of medieval manuscripts in early-modern bookbindings.

Session 6: Material Analysis

Chaired by Jennifer Richards

20th June
15:45 – 16:05

Nanocellulose Treatments for Painting Canvas Consolidation

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The aim of this work is to investigate the efficiency of novel nanocellulose (NC) consolidants for canvas paintings. It offers a possible alternative to lining and common consolidants adhesives whose use has been questioned and their risks documented. NC consists of an emergent and renewable compound made of nano-sized chains of cellulose. This results in high compatibility between NC particles and canvas substrates to be treated. Their promising mechanical properties as well as their optical and barrier properties recently raised interests in paper and painting conservation. Three different types of nanocellulose, i.e. nanofibrillated cellulose (CNF), carboxymethylated nanofibrils (CCNF) and nanocrystaline cellulose (CNC) are investigated in this study. A model cotton canvas as well as both original and model linen canvases were treated by brushing with the prepared NC formulations. The surface appearance of the canvas before and after treatment was assessed by electron microscopy (FEG-SEM). Mechanical testing of the samples was carried out using tensile testing at 30% RH and 25°C. Its impact on the mechanical response of the canvas was assessed by controlled humidity dynamic mechanical analysis (DMA-RH) using programmed relative humidity (RH) fluctuations (20-60-20%, 25°C). The evaluation of the combined response of the canvas samples before and after treatment gave the first assessment on the merit of this approach for the consolidation of painting canvases.

Besides the immediate mechanical stabilisation effect of the treatment, the long-term stability of the treatment is being assessed by physicochemical assessment of the samples before and after accelerated ageing (60% RH, 90°C, 17 days).

This study will provide a detailed assessment of the advantages and disadvantages of different NC treatments for canvas reinforcement and provide a solid basis for possible applications of NC on Artworks requiring this consolidation.

Assessment of the Photo-Stability of Plastics Found in Heritage Collections to Visible Light Using FTIR Spectroscopy and Colorimetry

20th June 16:05 – 16:25

Anna Pokorska[1], Lindsay MacDonald[1], Elise Talgorn[2], Boris Pretzel[3], Stuart Robson[1] and Katherine Curran[1]

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Despite a wealth of academic and industrial literature on the subject of polymer photostability, the majority of research is focused on the effect of UV radiation, and therefore sensitivity of plastics to visible light remains largely unexplored. In fact, institutional guidelines for display of those artefacts can be rather vague and tend to treat different plastic materials as one. However, as more plastic objects are entering museums and galleries there is a compelling need for more research that addresses their conservation requirements. In this experiment, photo-stability of plastic materials commonly found in museums and galleries to visible light exposure (400-700nm) was assessed through accelerated photodegradation over 8 weeks at two different light intensity levels: (i) between 33-38 klux (116-133 W/m^2) and (ii) at 8.3 klux (31 W/m^2). Chemical stability was investigated with ATR-FTIR, while visual appearance was measured using reflectance spectrophotometry. In general, most samples were found to be resilient to the visible light exposure used in this experiment, with the exception of some polyurethane foams, ABS, cellulose nitrate and polycarbonate samples, which showed discolouration and chemical changes consistent with literature. LED and fluorescent light sources were also compared for their damaging potential, with the latter causing similar degradation rate despite a much lower overall light dose. However, the effect of different temperature fluctuations as well as spectral power distribution in both of those setups would have to be further investigated before firm conclusions can be drawn. This study highlights that the light sensitivity of plastics is complex and needs more in-depth study in order to improve museum guidelines. In particular, the effect of colourants on the stability of plastics when exposed to visible light will be explored in future research.

20th June
16:25 – 16:45

Addressing the Sustainability of Earthen Heritage through Materials Characterisation

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Earthen architecture (EA), based on the use of unfired earth, is one of the oldest forms of construction in the world. According to UNESCO, over 10% of the World Heritage encompasses earthen constructions. The increasing awareness of the existence of an immense tangible and intangible earthen heritage - and of the challenge of its sustainability - highlights the necessity of targeting issues of its preservation and explains the growth in interest (and concern) for EA in recent years.

According to the Getty Conservation Institute, EA has been selected by choice by several civilisations and the preservation of EA is not only the preservation of earthen buildings, but is also the safeguarding of traditions and human ingenuity used to adapt the built environment for specific needs. In Brazil, EA was introduced in the XVI c. by the Portuguese as a solution to the deficiency of stone and lime in the interior and, up to the end of the XIX c., it was the preferred option in building practice. Subsequently, there has been a progressive loss of both historical buildings and craftsmanship.

The goal of this paper is to characterise the materials used in the earthen structures and assess options for restoration and preventive conservative actions. To achieve this aim the potentials of the different analytical methods are considered. The discussion is based on a case study focussed on samples collected at the historical site of Vale Histrico Paulista, in South-East Brazil (XIX c.), with special attention devoted to the use of thermogravimetry (TGA) and Differential Scanning Calorimetry (DSC). To evaluate the response of these materials to moisture, Dielectric Analysis with controlled Relative Humidity was also used. Preliminary results showed soil composition to consist of mainly iron oxide containing clays with quartz. Similarities and differences in the composition and in the response to moisture absorption of adobe, rammed earth and wattle and daub samples were observed.

Session 7: Analytical Methods

Chaired by Hayley Simon

Hyperspectral Imaging for the Identification of Pigments: An Analysis of Illuminated Armenian Manuscripts

20th June 17:15 – 17:35

Ian Maybury[1], David Howell[2], Melissa Terras[3] and Heather Viles[1]
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Hyperspectral imaging (HSI) has many applications in heritage science, owing to its ability to both characterise and map the surface of objects, and detect in the UV and IR which can be used to reveal hidden images, making it a powerful technique. HSI gives a complete reflectance spectrum for each pixel of the scan image. The equipment used in this study (Headwall Photonics) detects 972 wavebands between 400 and 1000 nm giving a high spectral resolution in UV, VIS, and IR regions.

This study evaluates the performance of HSI in identifying pigments from a set of illuminated Armenian manuscripts held by the Bodleian Library, University of Oxford. Such studies identifying pigments are important to conservators and researchers and this corpus provides an excellent example of genuine interest to both. Results from HSI were compared to those from Raman spectroscopy (Raman equipment from Prof. Andrew Beeby, Durham University). A database of known pigments was collated using HSI, then Raman spectroscopy was used to identify pigments on a sample of 9 folios in 7 manuscripts dating from the 11th – 18th century by sampling 88 spots. HSI was then performed on the same folios and the spectra taken were compared to those from the database using ENVI. These HSI results were then compared to those from Raman spectroscopy and the HSI results were found to agree with Raman spectroscopy 88% of the time. Whilst currently less accurate than Raman spectroscopy, the main advantage of HSI is that it could scan the entire page in a relatively short space of time, and characterise the entire surface. This is a huge advantage to conservators and overcomes problems inherent in spot techniques.

20th June
17:35 – 17:55

Neutron Imaging Archaeological Wood from the Mary Rose: Differences in Drying Rate and Shrinkage Pattern in Wood with Different PEG Treatments

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The Mary Rose, flagship of Henry VIII's fleet, sunk during a battle against the French fleet in 1545, and was recovered from the seabed outside Portsmouth Harbour in 1982. After spending 437 years under the sea bed, she is the only surviving Tudor warship and a time capsule giving a unique insight into Tudor life. To preserve this important shipwreck for future generations, the wood has been sprayed for 19 years with polyethylene glycol (PEG) – a polymer used to mechanically stabilise archaeological waterlogged wood. In 2013 the Mary Rose finally started to dry under controlled environmental conditions (19°C, 54% RH). The success of this step is critical: despite the PEG treatment, cracking, shrinkage and/or collapse of the wood cells can occur due the loss of both free and bound water. Monitoring the moisture content in the wood is essential to evaluate the drying progress, and to understand the impact it will have on the mechanical properties of wood and on the movement currently taking place on the ship structure.

PEG is a common conservation treatment but its impact on wood properties and water desorption mechanisms is still to be fully explained. To further our understanding we successfully used thermal neutron radiography on Mary Rose wood samples – at varying degrees of degradation, treated with PEG 200 and PEG 2000. Neutron imaging provides unique information that cannot possibly be captured using other techniques: it allows us to spatially resolve the quantity of water within the samples during desorption experiments. Our objectives were to determine the water diffusion coefficients while concurrently documenting the swelling/shrinkage deformation in archaeological wood during controlled desorption. The findings, which can be relevant for any work on waterlogged material that retains water, will be specifically used to inform future drying, storage and potential treatments that will ensure the long term stability of the ship.

Standing up for Standing Stones: Experiences with Implementing Novel Non-Destructive Moisture Measurement Techniques in Situ

20th June 17:55 – 18:15

Scott Allan Orr[1], Alick Leslie[2], Dawson Stelfox[3] and Heather Viles[1]

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Stone monoliths have stood erect for millennia but are not exempt from environmental weathering. Most stone deterioration mechanisms are directly caused, or enhanced by, the presence and movement of water – characteristics that are difficult to assess in situ. Portable non-destructive tools use proxies for moisture such as electromagnetic propagation and infrared thermography. These techniques can rapidly provide an overview of moisture behaviour. The degree to which sensors can be used on site to provide more nuanced information about distributions of moisture remains unknown. This paper reflects on experiences with adapting laboratory-tested microwave tomography*, high-resolution radar, and infrared thermography to investigate standing stones at Machrie Moor – an important Neolithic site on the Isle of Arran, Scotland at risk from a shifting water table and climate change. Specifically, we share insight into:

- developing attainable interdisciplinary research goals,
- surveying at a site with significant visitor volume, and
- upscaling novel techniques for practical surveying.

The investigation of the standing stones especially highlights challenges associated with using sensors developed for contemporary constructions of regular geometry for the unique characteristics of weathered surfaces with complex roughness in situ. Understanding the pattern and effect of moisture movement can inform decision making: whether interventions are required either to the monument or the surrounding environment, or in extreme cases by removing the monument to a controlled environment. These experiences have important ramifications for developing and implementing interdisciplinary surveys to inform conservation of complex heritage environments.

*Orr et al (2016). 'A novel model for spatially-resolved gravimetric calibration and visualisation of moisture distributions in porous building materials'. SEAHA16, Oxford, UK. June 20–21, 2016 (POSTER).

Flash Presentations

There are two flash presentation sessions, where each presenation will last five minutes and will be accompanied by a poster, displayed in the gallery.

Session 1

19th June
13:40 – 13:45

Mapping 450 Year-Old Marine Archaeological Iron Corrosion from the Mary Rose

Hayley Simon[1], Ian Freestone[1], Eleanor Schofield[2], Giannantonio Cibin[3], Robert Turner[4] and John Merkel[1]

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The conservation of archaeological iron is a serious challenge, particularly for objects buried in a marine environment. Artefacts are typically unstable and continue to deteriorate in the museum environment or store. Conservation treatments for archaeological iron aim to stabilise the metal through the removal of chloride, Cl^-, from corrosion products using a number of desalination techniques. However, the impact of treatment methods on the chemistry, structure and elemental distribution of the corrosion layer as it progresses through an artefact has yet to be thoroughly explored. This work is part of a larger project investigating the corrosion of 1,248 cast iron shot from the Tudor warship the Mary Rose using a combination of laboratory- and synchrotron-based methods. In this poster, the results of the first stage of the study is presented; an analysis of shot stored in alkaline solution for ∼34 years. Preliminary results from elemental analysis suggests that no detectable Cl- remains in the artefacts after long-term soaking, while diffraction studies have not identified chlorinated corrosion phases. A cross-section cut from one ball has been examined with the complementary techniques powder X-Ray Diffraction and X-Ray Absorption Spectroscopy, which shows that the predominant products are magnetite, Fe_3O_4 and goethite, α-FeOOH, in changing distributions across the artefact and within the corrosion layers. Overall, this study looks at the impact of long-term immersion on archaeological iron corrosion, an under-studied area with important implications for conservation.

Materials Analysis of Pacific Barkcloth

19th June 13:45 – 13:50

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A three year research project Situating Pacific Barkcloth Production in Time and Place is currently underway at the Centre for Textile Conservation and Technical Art History at the University of Glasgow (2016–2019). This project employs a materials scientist, Pacific art historian and ethnographic conservator, demonstrating its multidisciplinary nature. The role of the scientist is to both carry out analytical analysis and to coordinate scientific analysis from external sources.

The materials used in the production of Pacific barkcloth, unlike many art collections, have rarely been investigated scientifically. Determination of materials will be in part guided by the findings from the historical documentation on the making and decoration of barkcloth and also through questions posed by conservation. However, crucially, the identification of materials needs to be independent of influences that may lead to misplaced identification.

There are a number of strands of scientific investigation:

- Identifying the pigments, dyes, and their binders is being carried out using a number of techniques: Raman, XRF and HPLC/DAD/MS and GC-MS and microscopy of cross-sections.

To determine the species of tree used to make the cloths:

- FTIR is being used as it creates a molecular fingerprint of the barkcloth, together with SEM to image the fibres.
- DNA and proteomics are also being investigated

The results of the scientific analysis to date will be reported here.

19th June
13:50 – 13:55

Reciprocity in MFT of Polymer-Based Additive Manufactured Materials

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Additive Manufactured (AM) objects are increasingly forming part of museum collections either as artworks, surrogate objects or for conservation applications. AM systems however are primarily still based on Rapid Prototyping (RP) technologies, which were never designed to last. A significant concern is that due to post-processing or digital preservation issues, re-printing may not be possible.

Expiration of patents has resulted in rapid developments in the industry with materials becoming more and more complex. Inkjet technology offers the option of 1000 different formulations of base polymers with varying properties to be printed in a single object. Experimental materials are also being made commercially available at competitive prices for brief periods of time. Many AM materials, particularly photopolymers have shown to be unstable. Due to unknown material compositions a quick method to identify fugitive objects (or areas within an object) as they enter collections would be of great benefit to museums tasked with preserving early RP and AM objects as document of what has been described as a manufacturing revolution.

Microfading Testers (MFT) has successfully been used to identify light sensitive objects in museum collections. If applicable to AM materials, MFT would be an excellent method to use as it is micro-destructive and provides quick responses. Initial assessments using Xenon MFT to identify photosensitive AM materials were unsuccessful. Exposure at 17 Mlx resulted in unnatural mechanisms, possibly due to limited oxygen diffusion, not permitting valid extrapolation to real conditions. Reciprocity testing with LED MFT at intensities between 0.8 - 0.18 Mlx proved reaction rates to be proportional . These results as well as investigations into MFT in anoxia and oxygenated environments indicated towards the potential of MFT as an analytical tool to explore the photochemistry of these materials.

Session 2

Nanothermal Analysis Characterisation of T_g Behaviour in Naturally Aged Synthetic Polymers in Modern Art after Solvent Contact

20th June 13:10 – 13:15

Donald Sale[1], Angelica Bartoletti[2], Laurent Bozec[3] and Marianne Oldyha[4]

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Synthetic polymers found in modern and contemporary art were characterised with nanothermal analysis (nano-TA) in pilot studies investigating glass transition (T_g) behaviour after solvent contact and aging. In one study, nano-TA was used to compare surface T_g of polymethyl methacrylate (PMMA) samples that had been immersed in conservation solvents for specified periods, and naturally dark aged for 29 years. The samples immersed in solvents that attack PMMA had a lower T_g than the control, suggesting polymer chain scission and justifying further investigation.

In another study, nano-TA revealed a compelling trend in surface T_g associated with the environmental conditions used to age synthetic paint and varnish media on PMMA. Samples exposed to light or heat had a higher T_g than the dark aged control, and those exposed for fractional periods of light followed by heat, or vice versa, had the highest T_g. A similar trend was observed in the T_g of bulk material, but nano-TA was ideal for the limited thin layered samples, offering 40 rapid measurements directly on the polymer film surfaces without destroying them. In these studies nano-TA was useful in measuring surface T_g and appears promising when investigating chain scission and cross linking, which effect the solubility and stability of synthetic polymers used in art and conservation.

These collaborative studies are part of an investigation into the development of analytical methodologies and assessment protocols for the conservation of synthetic paint media, plastics and varnishes in modern and contemporary art. These studies involved nano-TA in the Biomaterials and Tissue Engineering Department, University College London, DSC in Birkbeck, University of London, complementary analysis in the Tate Gallery, and Getty Conservation Institute funded by the J Paul Getty Trust, and sample preparation in the Los Angeles County Museum of Art funded by the University of Delaware / Winterthur Museum Art Conservation Department.

20th June
13:15 – 13:20

Strain Modelling in Historic Tapestries

Pedro Máximo Rocha[1], Dina D'Ayala[1], Constantina Vlachou-Mogire[2], Josep Grau-Bové[1] and Levente Klein[3]

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Historic tapestries are among the most important and complex European works of art. Their intricate woven structure of weft and warp yarns presenting different mechanical characteristics on each direction makes these objects anisotropic(1). Recent research carried out by Duffus(2) shows that historic tapestries are weaker and more fragile than modern artificially aged woven samples. Therefore, there is an urgent need to understand the mechanical and hygroscopic properties of historic tapestries. This research is a collaborative project between EPICentre at University College London, Historical Royal Palaces (HRP) and IBM aiming to understand the influence of hygrothermal conditions and permanent hanging on stress-strain states in tapestry structures, and advice about the most suitable conservation techniques. Experimental laboratory work and advanced computational modelling techniques are being used to identify their mechanical characteristics and simulate their behaviour with the objective of determining the impact that physical and environmental conditions have on the ageing and damage of tapestries. The development and validation of the computational work also relies on the in situ environmental and strain monitoring system deployed by IBM(3) on The Sacrifice of Isaac, one of the Abraham series tapestries on display in the Great Hall at Hampton Court Palace.

The poster presents current developments of experimental work for the characterization of the mechanical and hygrothermal response of historic tapestries. Experimental tests were performed on samples extracted from a collection of historic tapestry fragments housed at the HRPs conservation and collection care department. Hygrometric tests exposed samples to different levels of relative humidity and the mass uptake was recorded. In these tests at 80% RH, an increase of moisture content up to 9% was verified. Tensile tests on the weft direction of historical samples were also performed. Results indicated that the tested samples were stiffer and started to fail at earlier stages of strain than what is shown in literature(2).

1. Sahin, M. et al. in Tapestry Conservation: Principles and Practice (eds. Lennard, F. & Hayward, M.) 8 (Elsevier, 2006).

2. Duffus, P. Manufacture, Analysis and Conservation Strategies for Historic Tapestries. (University of Manchester, 2013).

3. Schrott, A. et al. Concealable Strain Monitoring and Modeling of Relative Dimensional Changes in Art Objects. in AICs 42nd Annual Meeting, Research and Technical Studies Specialty Group Postprints 5, (2014).

Assessing Deterioration in Negatives and Moving Pictures: an Early Warning System for Collection Managers

20th June 13:20 – 13:25

Jacqueline Moon[1], Lora Angelova[1] and Kieron Webb[2]

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The British Film Institute (BFI) and The National Archives (TNA) are exploring opportunities for heritage science research to inform the management of large collections. Both organisations are focussing on the BFIs collection of very early British film, which they have been digitising for online access as part of the Unlocking Film Heritage programme. The collection requires management, preservation and conservation; these aspects will be discussed in our poster.

The negatives used to produce photographs or moving pictures are manufactured in sheet or roll on supports including cellulose nitrate (CN, 1889–1950), cellulose acetate (CA, 1925-present day) and polyester (1955-today). The limited lifespans of cellulose nitrate and acetate are well known; both are prone to irreversible chemical and physical changes such as yellowing, distortion and embrittlement.

Conservation scientists and collections managers are assessing the usefulness of Fourier transform infrared (FTIR) spectroscopy in identifying these processes before they become visible to the naked eye. This technique has been extensively used in CA and CN film and object analysis, but our research aims to develop a methodology for assessing damage and degradation as an early warning system for collection managers.

Conservation scientists at TNA have been researching the process variations and physico-chemical conditions of film samples using polarising light microscopy, spot tests, ultraviolet induced visible fluorescence, X-ray fluorescence spectroscopy (XRF), FTIR, and dynamic mechanical analysis (DMA). As a part of the research, FTIR spectroscopy will be performed on historical samples and artificially aged mock-ups exhibiting different phases of degradation. The study will attempt to correlate the effects of artificial ageing to those observed in historical samples. The results will be used to make a reference library of photographic film deterioration phases.

20th June
13:25 – 13:30

The Problem Stone Progressive Survey Technique (ProSt-ProST)

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This poster presents the Problem Stone Progressive Survey Technique (ProSt-ProST), an integrated approach to diagnosing stone decay mechanics at vulnerable built heritage sites. The Bell Tower at the Tower of London is chosen as a suitable example for piloting the technique, given its large stock of Reigate Stone. Reigate Stone was widely used in medieval London and is presently in a condition of advanced deterioration at a number of important sites. Whilst it has been the subject of past research, underlying mechanisms of decay are poorly understood. The pilot study tests the initial stages of a proposed methodology, linking the results of metric surveying, stone mapping, decay mapping and portable non-destructive techniques in order to progressively define and assess specific Reigate Stone conditions. Stone mapping located extant Reigate Stone and was useful for investigating structural and historic parameters in present day condition. Decay mapping recorded diverse Reigate Stone weathering patterns and intensities, categorised according to the ICOMOS glossary. Two distinct patterns were analysed with a Portable Petrographic Pilot Pack (PoPePiPa), consisting of an Equotip Piccolo to measure surface hardness, a spectrophotometer to assess glauconite content, an electric resistance moisture-measuring device and a thermal imaging camera. Devices were chosen to test initial hypotheses on Reigate Stone deterioration, based on findings of the mapping stages and previous research. Results suggest the tested stages are appropriate for designing environmental monitoring strategies and selecting representative samples for more detailed petrographic analysis.

Can Cellular Automata Models be Used for Earthen Heritage Conservation?

20th June 13:30 – 13:35

Jenny Richards[1], Heather Viles[2], Richard Bailey[2], T. Learner[3] and W. Xudong[4]
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Earth is one of the oldest and most universal construction materials, forming an important part of our collective built cultural heritage. However, the complexity of earthen heritages interactions with environmental processes has been overlooked despite earths vulnerability to degradation. Conservation strategies have had a limited impact on reducing – and in some cases increased – degradation rates. Furthermore, their long term their effectiveness is generally unknown. To address this problem, modelling could be used as a tool to simulate the long term effects of conservation strategies.

The use of the Vegetation and Sand TrAnsport (ViSTA) cellular automata model in earthen heritage conservation was investigated. ViSTA was adapted to improve its representation of earthen heritage sites by adding code that allowed for multiple walls and a porous vegetative windbreak to be present in the model; and code that automated data analysis (mean and standard deviation) from the output files. The impact of initial environmental conditions on sediment flux in ViSTA was assessed by systematically varying initial conditions one at a time.

Multiple walls and a windbreak were successfully inserted into ViSTA; the sediment flux generally responded to changes in environmental variables in accordance with previous literature; and code to calculate the mean and standard deviation of outputs from multiple model runs could be successfully run in ViSTA. This suggests ViSTA is a versatile model that, with further work, could be applied to earthen heritage to model the long term interactions between environmental processes and conservation strategies. Future work should initially investigate the influence of the edge effect present in the model and develop a vertical cellular automata model which can be inserted into ViSTA to model wall degradation processes.

Posters

Time Resolved Prompt Gamma Activation Analysis from Epithermal Neutrons Applied to Cultural Heritage

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A new concept of non-destructive and non-invasive integrated measurements for isotope identification which takes advantage of the time structure of spallation neutron sources for time resolved spectroscopy will be presented. This technique consists in the measurement of gamma energy spectrum induced by the radioactive capture as a function of incident neutron Time of Flight, directly related with the energy of incident neutrons. Measurements on standard samples of archaeometric interest were carried out at ISIS spallation neutron source (U.K.). Through this innovative technique we shown an increase in the sensitivity to specific elements such as bronze and gold.

Smelling the Past: a Case Study for Identification, Analysis and Archival of Historic Pot-Pourri as a Heritage Smell

Cecilia Bembibre[1], Siobhan Barratt[2], Luciano Vera[3] and Matija Strlič[1]

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Our interaction with heritage objects and spaces is very often limited to a visual experience. However, our perception is multisensory, whether deliberate or not; stimuli to olfaction, can significantly affect our experience of the world, including cultural heritage. Little is known about the smells of the past, and the olfactory properties of heritage objects and places are not systematically conserved and protected. This work presents a scientific analysis of a pot-pourri identified as historic (sampling and identification of volatile organic compounds using Thermal Desorption – Gas Chromatography with Time-of-Flight Mass Spectrometric Detection, TD-GC-TOF-MS). The odour of the pot-pourri was also characterised using GC with olfactometric detection and evaluated by a sensory panel. The chemical and sensory information was used to create a historic pot-pourri odour wheel, for archival and public engagement purposes.

Crowd-Sourced Surveys in Large Library Collections

Natalie Brown[1], Tom Fearn[1], David Howell[2], Dirk Lichtblau[3] and Matija Strlič[1]
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This poster presents a systematic study into the quality of crowd-sourced data in the context of scientific research in libraries and archives. Gathering collection health data is an important element of preservation; however, the activity is often considered to be resource-intensive. As a result, surveys are not performed as routinely as might be useful. By introducing non-experts as surveyors within the daily operations of the library, we can progress beyond the current practice and at the same time engage a new segment of library users in scientific research and conservation.

A 4-month study of the general collections at the Bodleian Libraries, Oxford University has evaluated whether non-experts (non-conservators) can collect valid, reproducible data about collection items i.e. pH, degree of polymerisation, tensile strength and lignin content, using a state-of-the-art near infrared spectroscopy instrument (SurveNIR). Experiments were performed at two points of the document supply chain (the journey a book takes from repository to reader), where book fetchers at the Bodleian Storage Facility and library users at the Radcliffe Science Library (RSL) took part in the study. Data for 510 reader-requested books were collected by participants and compared to data collected by a researcher. A framework of analysis has included examining the reliability of the data as collected at different points of the chain by different stake holders, the resource implications, the required training, as well as how variables such as book size, weight and condition have affected the ability to measure a book, and the obtained results.

Preliminary analysis has shown there is a satisfactory agreement between the results obtained by book fetchers and expert. There were instances where data could not be collected due to human error; the failure rate for book fetchers was 1.5%, whereas the failure rate for readers was 13%.

Investigation of the Degradation of Contemporary Papers Aged at Different Conditions of T and RH

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As the technical revolution in the paper making industry, which took place between 1850 and 1950, led to a dramatic chemical destabilisation of paper materials, there has been a growing interest in paper degradation studies in the last decades.

Although the mechanism and the rate of degradation have been studied extensively for historic papers, it seems that less attention has been given to real contemporary papers so far. Currently, the main structural component of modern paper is a felt of cellulose fibres from different origins (e.g., hardwood, softwood, grass, bast, recycled fibres), with the addition of other compounds (sizing, fillers etc.). Due to environmental issues, there has been a significant increase of recycled paper as fibrous component of print paper over the last years.

Our research is mainly focused on the degradation of contemporary paper obtained by accelerated ageing experiments, exposing the samples to extreme conditions in terms of temperature (T) and relative humidity (RH), in order to develop a dose-response function.

The samples studied in this research consist of two kinds of contemporary papers, substantially different from each other: pure cellulose papers that meet the ISO9706 standard specifications, and recycled papers with different percentages of recycled materials.

Along with the determination of the fibre components of the papers by fibre furnish analysis and the detection of lignin by phloroglucinol tests, the degradation of the paper samples during the ageing tests are analysed in terms of pH, measured with the cold extraction method, and degree of polymerisation (DP), determined by viscometry in cupriethylenediamine solvent. These data allow to evaluate the extent of degradation of contemporary papers through a dose-response function. The elaboration of these results will lead to a comparison with the dose-response functions already modelled and/or to new dose-response function for contemporary papers.

Finters Carousel; a Case Study. Investigating the Implications of the Reversible Application of Open-Source AVR Microcontroller Technology within Dynamic Heritage Property

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The heritage case study object Finters Carousel embodies many conservation, interpretation and curatorial challenges. That is, the preservation of the delicate interplay between the human story and the tangible mechanical nature of the object in a public display space. Finters carousel is a material memory manifestation of an intimate story of human loss, transformed through gratitude into a singular work. Motivation for the creation of Finters is documented. The method of manufacture was home-craft-model engineering practice, popular throughout the earlier part of the twentieth century. Finters is a multi-media, textile, metals, plastics, and electric collage; a degrading conservation challenge that now demands specialist interdisciplinary intervention. The layered material nature of the object is further complicated by interwoven maintenance history, and object history perspectives. Underpinning much conservation practice is the cost-benefit exercise. Low-cost programmable micro-controllers appear to offer almost limitless potential to dynamic historic objects. The cost and benefit of adding yet another layer to an object, analysis of how change impacts on curatorship, context and interpretation are considered. Finters is a vehicle for exploring models of interdisciplinarity within heritage conservation. AVR technology has the potential to place influence, input and decision making outside traditional models. The open-source nature of Arduino may engender wider audience participation, beyond the interdisciplinary. Anonymity and lack of hierarchy combined with the democracy of mass input and review of an on-line and open source environment allows ideas, ideologies and concepts to free flow, forming a new space with a community of new stakeholders, investors with global prospect of access, ownership and education.

The Community Structures Analysis of Microorganisms on Painted Sculptures in Maijishan Grottoes, China

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Biodeterioration of cultural relics were mainly attributed to extent growth of microorganisms associated with multiple factors, such as temperature, relative humidity (RH), illumination, CO_2 concentration and human disturbance etc. The environmental parameters monitoring in cultural heritage site and research on correlations between microbial community and environmental factors were indispensable for control biodeterioration. Maijishan Grottoes is one of Chinas four most famous "Buddhist Caves Art Treasure House" In here, MiSeq sequencing strategy and culture-based method were used to investigate on the microbial community structures on the painted sculptures preserved in cave 4, which were built in Northern Zhou Dynasty (557-581AD). Meanwhile, environment data were collected by temperature and RH data recorder, light data logger on the sampling sites. Results revealed rich bacterial diversity and relative low fungal abundance on painted sculptures, several core groups, such as bacteria genera of Pseudonocardia was determined. These species has been proved responsible for the biodeterioration of the cultural relics in many places. Abundant microbes with deteriorative potential survived on the sculptures may results in unexpected microbe breakout and following biodeterioration of cultural heritage in appropriate conditions. Monitoring data shows that painted sculptures of Maijishan Grottoes were exposed to a high RH (70%) environment for long-term; it was benefited to the growth and reproduction of microorganisms. In addition, the visitors carried exogenous microbes flooded into the cave were also contributed to the microbial diseases. Thus, attention should be paid to the conservative management of microbial threaten and risk monitoring in Maijishan Grottoes for effective heritage conservation.

The work was supported by NSFC Projects (No.31560160, 31500430), Gansu Province Science and Technology Plan(No.1604WKCA003) and Gansu Cultural Relics Bureau(No.GWJ2014003)

Blowing Moisture Away: Impact of Air Movement on Mould Development

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The development of mould in historic materials is known to cause deterioration by releasing enzymes that enable the digestion of complex materials such as paper and leather.

Current preventive conservation strategies tend to focus on controlling ambient relative humidity and temperature and approaching rooms as a whole. In contrast with this approach, microbiology studies have demonstrated that water activity (aw) of substrates is a crucial parameter influencing mould development.

Focusing on the latter approach, there is the opportunity to develop a preventive conservation strategy using air movement to prevent mould development by impacting on aw of materials. Such a strategy would have several benefits such as reducing the energy necessary to control mould growth by focusing on specific problematic microenvironments. Mechanisms generating air movement should also be easier to use and maintain when compared with complex systems such as air conditioning.

This poster presents a methodology which explores how natural and forced convection can be used to control water activity on surfaces. Changes in water activity are assessed on leather and paper samples exposed to different air velocities. Experiments are conducted in a controlled environment (environmental chamber) using forced convection and natural convection. Air velocity is measured with an air velocity meter Velocicalc model 9565 series with thermoanemometer, and water activity is measured with a water activity meter Rotronic HygroPalm 23-AW-A.

This research aims at demonstrating that free and forced convection can be used to control aw in microenvironments. Understanding the impact of air movement rates on changes in aw on materials and the rate necessary to reach the minimal moisture conditions at the surface that support mould growth will allow developing an experiment to test the impact of air movement on mould development, potentially opening new avenues on preventive conservation management.

An Appropriate Intervention? Assessing Consolidant Performance on Historic Sandstone

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Sandstone, a commonly used structural material is particularly vulnerable to environmentally driven breakdown. In Britain, many of the most famous and valued structures are constructed using this material, and an increasing number of these are now at risk both from their surroundings, and current use or management regimes. Treatment of this stonework with chemical consolidant applications is increasing in both the commercial and curatorial conservation sectors, but no recognised strategy for assessing the long-term effects of these treatments yet exists. So, how can conservators and policy makers use non-destructive methods to assess these interventions? This project seeks to investigate a range of techniques which can be used to interrogate post- treatment conditions of historic stonework in order to better understand the material properties of both the chemical application and historic substrate, and apply this knowledge to create a set of guidelines and methodologies for use in a range of settings for complex conservation needs.

Creating an XRF Results Database For Curators, Researchers and Conservators

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This paper will focus on the creation of a XRF database that is currently under construction at Royal Armouries Fort Nelson. The purpose of this project is to create a database that would be useful to conservators for scientific information and curators who are more interested in historical information, for example, a curator might want to compare the elements in guns between countries of origin and a conservator might be looking at the elements to decide complex conservation treatments. This project has been designed to cross interdisciplinary boundaries between science and history. However, at the same time science and history create our discipline of heritage science and at times the roles could be reversed with the curator looking at the information in the database from a scientific perspective and the conservator from a historical perspective, although this project crosses boundaries it is also reversible from both sides of the boundary. The final boundary this project crosses is that the data collected could be used to assist in public enquires, the public are always interested in the composition and conservation of the guns on display. The fact that this project potentially can be used in public enquires means it achieves a big challenge in research of sharing information beyond the heritage science sector with the public, making this project a successful in crossing the all-important social justice and public engagement boundaries something that can be difficult to achieve in any science project.

The XRF database at Fort Nelson is a project to record the elements of the metals in the manufacture of the guns and the coatings used on the guns in the Royal Armouries artillery collection. A set of readings was taken off each gun, and charts created of the readings that will be uploaded to the museum database system for access to the widest possible audience.

Using Practical Projects to Explore and Research the Language and Ethics of Conservation

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This paper will discuss a pioneering research project investigating the art of language used in heritage science within two disciplines of the subject; these are conservation and restoration / modernisation using conservation projects of dynamic objects that are still in use to research and develop the language and ethics used in heritage science during practical conservation projects.

The practical projects used in this research project are two racing sailing boats both in need of major conservation and restoration treatments. The first boat is an international 14 class racing dinghy built in 1948, this boat has been largely unchanged. It was modified after losing the Prince of Wales Cup in 1948; the equipment that was modified at this stage has been kept with the boat and could be refitted if necessary although this might cause problems of safety if the object is to continue in service although the vessel is not race competitive it is still in service. The second boat is a 20 foot in length overall two man racing keelboat a flying fifteen (15ft at waterline length) class yacht built in 1961, this boat has been continually updated and modernised during its racing life to remain competitive, for example it currently has a hi-tec metal mast as to the original wooden mast. This raises interesting questions of ethics in the restoration of this historic craft and the language used in the documentation of answers to these questions during this restoration of this yacht.

This paper and project will go beyond the original statement of research of examining how this interdisciplinary language specifically looks like in heritage science research to other disciplines in the heritage sector, it will also discuss how the wider public and clients perceive heritage science professionals by the complex language used to explain the ethics and techniques involved in these conservation projects.

Exploratory Study of Using Native Plants to Protect Ruins of Ancient Suoyang City

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Ruins of Ancient Suoyang City located in western Hexi Corridor and were an important strategic site on old Silk Road, added to UNESCO's list of World Cultural Heritages in 2014. The border town were built in Han Dynasty(202BC-220AD) and prospered in Tang Dynasty(618-907). Along with close of Jiayuguan Pass of the Ming Dynasty Great Wall in 1524AD, Suoyang City was deserted gradually. Preservation of Suoyang City was suffering from natural corrosion (wind, sand, rain) and anthropogenic damage. It is a crucial to formulate a comprehensive conservation planning involved in alleviating multiple threatens. Geotechnical engineering protection combined with techniques of biological crust and plant protection were preferred methods to deal with that. Plants may have dual effect on earthen site; it can effectively reduce wind and rain erosion damage to the earthen site, but the root wedging also cause shear failure of soil sites. To maximize the protective effect of vegetation and reduce damage effect simultaneously is important for plan implementation. At this stage, based on traditional sample survey method, aerial photo and following analysis, we have a fully understanding of vegetation distribution in this site. And then, local dominant vegetation was determined, such as Alhagi sparsifolia Shap, Nitraria tangutorum Bobrov, Tamarix gansuensis H.Z.Zhang and Halogeton glomeratus (Bieb.) C. A. Mey. The relationships between these vegetation and earthen site were preliminary assessed in this work. Furthermore, long-term monitoring of vegetation from biogeomorphology view, quantitative evaluation of mutual feedback effects, and biological engineering (microorganisms, algae, native plants etc.) realization are great challenge for the scientific protection of the heritage site. This work was funded by Programe of SACH(20140225), NSFC(No.31500430, 31560160), The Royal Society Fund International Exchanges Scheme-2015/R3, Gansu Province Science and Technology Plan(1604WKCA003).

Development of Piezoelectric Quartz Crystals Sensors for the Detection of Organic Acids in Museums

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In the heritage context, there is a need for an affordable, quick and user friendly method to accurately determine the concentration of organic acids inside museums, as these are known to be damaging, even at low concentrations, to a wide range of materials. This multi-disciplinary project, utilising chemistry, electrical engineering, and printing science knowledge, aims to develop a sensing unit capable of detecting low concentrations of organic acids, for use in heritage institutions. This device will be trialled at the Mary Rose Museum to investigate organic acid emissions from PEG treated historic wood. Piezoelectric quartz crystal (PQC) sensors have the capability to provide real time sensing of volatile compounds. They are small electronic components that, when a current is applied, oscillate at a resonance frequency. This frequency is linearly dependent on the mass of the PQC. Lead coatings have previously been applied to PQCs to produce organic acid sensors, however, over time and even in the absence of organic acids, lead converts to lead oxide making calibration of such devices difficult. This project utilises lead oxide nanoparticles, which are more stable to other environmental parameters, whilst maintaining their sensitivity to organic acids, including acetic and formic acid. A key further consideration is the importance of the uniformity of the application of this film. To accomplish fine control over the applied coating, printing technology was employed to deposit a thin and uniform layer of lead oxide particles. This poster highlights initial research of the suitability of PQCs coated in lead oxide nanoparticles to detect organic acids. Good control of the coating dose allowed fine-tuning of the frequency change and increased repeatability compared to direct application with a pipette. Furthermore, preliminary exposure of the sensors to environments polluted with known concentrations of organic acids will be displayed.

Building Pathology; an emergent phenomenon of buildings and the built environment acting as evolving complex systems, similar to living organisms, rather than as designed or engineered systems

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There is an extensive body of knowledge covering the art and science of the construction, investigation, remediation, conservation, and refurbishment of buildings and the built environment. Similarly, there is an increasing body of academic and practical knowledge on the interaction between buildings, the built environment and building occupants; and on perceived failures in these interactions. However, coming from a medical training, it became clear to the author that buildings and built environments were complex evolved systems. The author therefor proposed the concept of Building Pathology about twenty five years ago; so as to allow the study, application and development of methodologies for 'diagnosis', 'epidemiology', 'treatment' and 'prognosis' in this multidisciplinary area. Since that time, there has been much progress in the related subjects, and much knowledge and practical experience has been gathered on its application. Similarly, the term 'Building Pathology' and the description 'Building Pathologist' has gained some currency among academics and professionals involved in the investigation of building defects. However, in the author's experience as a practitioner, the subject is not generally well understood or effectively applied; despite having been a recognized subject for over 20 years, despite having become a core discipline in the training of many building professionals, and despite a number of text books having been published. This may be because of a failure to properly understand the higher-level philosophical and scientific 'roots' of Building Pathology; or how this can be usefully applied. It is intended that the results of the authors current research project will allow the development of methodologies and protocols for a more effective and general understanding and application of Building Pathology, and allow its further development. A brief introduction to the subject and a review of the current research project will be presented

Use of Metal Nanoinks for Surface Enhanced Raman Spectroscopy (SERS) Investigation of Dyes in Felt-tip Pens

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Since their initial fabrication, felt-tip pens have been increasingly used for original and creative artworks. However, there is an increasing concern about the preservation of these artworks due to their lightfastness. Still few research works have been carried out in order to address these issues and identify inks components, and most of them include chromatographic methods often coupled with standard spectroscopic techniques. In this frame, Surface Enhanced Raman Spectroscopy (SERS) can represent a valuable alternative when mass-limited samples, in situ applications and locally selective dyes identification are required. In particular, SERS can be very efficient if the emerging use of plasmonic nanostructured inks is considered.

In this work we present the use of gold nanorods and silver nanoparticles based nanoinks as metal substrates for the SERS analysis of felt-tip pens on paper samples. Marker pens of different color and brand have been applied on commercial A4 paper and analyzed at 514 nm wavelength. Microscopically amounts of metal nanoinks have been put on the colored samples in order to get the SERS effect, allowing the collection of useful information on dyes identification. Comparison between Normal Raman and SERS spectra showed high enhancement factors attributed to an electromagnetic effect generated by the use of metal nanostructures. Gold and silver nanoinks resulted differently effective in the identification of specific dyes. Phthalocyanine-based dyes have been identified in blue and green markers while Rhodamine-based dye in red and pink ones.

Moreover, original markers used by the famous film director Federico Fellini, who realized in his life numerous drawings between 1960 and 1990, have been analyzed. The analysis of the brand-new reference marker pens helped in the identification of dyes in Fellinis original markers and gave some indications on their conservation state.

Smelling Change: Measuring Volatile Organic Compound Emissions from Historic Polymers in Laboratory and In-Situ Settings

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This research focused on using solid phase micro extraction gas chromatography mass spectrometry (SPME-GC/MS) to examine volatile organic compound (VOC) emissions from three-dimensional plastic objects at room temperature. Monitoring the types of VOCs emitted from an object or present in its vicinity is a very novel way to understand decay mechanisms, or identify the object. Two novel methodologies were used - the first allowed for VOCs to accumulate within sealed Tedlar bags for 1-week before being analysed via SPME-GC/MS. Two types of objects were analysed in this way: naturally aged objects and objects that had been aged in an oven at 80° C and 62% RH. In total eight different polymer family types were analysed using this methodology, including cellulose acetate (CA) and cellulose nitrate (CN). The second methodology was performed in-situ within a heritage environment storage area at Tate Britain where the background VOCs and VOCs emitted from a heavily decayed CA sculpture were monitored.

Results showed that the DVB/CAR/PDMS SPME fibre had the capabilities to collect a broad range of relevant VOCs from the different polymer family types analysed. Our analysis showed the presence of oxidation decay markers such as aldehydes, ketones, and carboxylic acids from a number of the polymers we studied. The presence of furfural in the chromatogram of certain objects indicated the active hydrolysis of cellulose. Identification of CN and CA was also possible via the presence of characteristic plasticisers and decay markers. In-situ experiments at Tate successfully demonstrated real world applicability of the methodology by collecting and identifying decay markers such as acetic acid, and dimethyl phthalate. Results from in-situ analysis has also led to further work in order to confirm our initial finding that the location of the fibre is critical for identifying any potential areas at high-risk of VOC build up due to surface geometry.

The Diverse Fading Patterns of Historic Silk Velours Dyed With Natural Indigo Presented in Royal Apartments in Museum Palace at Wilanów.

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The aim of this study was to analyze the unpredictable changes in color of silk textiles placed in two Royal Apartments – Kings Bedroom and Kings Antechamber in Museum of King Jan III's Palace at Wilanów. Decorations velvets in both rooms currently presents shades of deep dark green or pale aquamarine although in historical documentation clearly appeared information of previously noted the same color of both textiles, as well as usage of the same blue dye – indigo in both cases.

The aim of these analyses was identification of the chemical composition of historical dyes used in the past and the recognition of kind of metal, which was presented in fabrics threads. An important objective was to confirm the possible differences in the composition of dyes and metal threads in both fabrics in terms of research the significant differentiation of fading patterns of silk textiles from those two chambers during the past 300 years.

High performance liquid chromatography with tandem mass spectrometry (LC / MS / MS) was applied for the analysis of natural dyes used to dye the test fabrics. Identification of indigo, which is the main chemical component responsible for the blue color was led by comparing the results obtained for samples of ancient fabrics and standard solutions. Prior to chromatographic analysis the dyes extraction from the tiny samples of fabrics was performed. Dimethyl sulfoxide (DMSO) was used as a solvent commonly used to extract vat dyes, such as indigo. To identify the composition of the metal threads woven into the analyzed samples of fabrics, X-ray fluorescence (XRF) and a scanning electron microscope (SEM) were introduced.

The research showed that the color intensity of the fabric is dependent on the indigo content and could present different fading pattern due to differences in metals, which were woven into fabrics.

Analytical Robustness of Quantitative NIR Chemical Imaging for Historic Cellulosic Materials Characterization

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Spectral imaging techniques have gained importance in the field of heritage conservation. Such techniques have widened the possibilities of imaging and material characterization by expanding spectroscopy to examination of an entire surface of an object which consequently improved the knowledge of distribution of material properties.

However, most applications of hyperspectral imaging have focussed on qualitative investigations due to the complexity of objects and lack of standard materials for calibration. Calibration is crucial for the performance of hyperspectral imaging systems as it significantly influences the analytical outcome as well as the stability of calibration over time.

This study will explore the analytical robustness of quantitative chemical imaging for historic cellulosic materials characterization such as Islamic paper and painting canvases by focussing on the effect of different measurement and acquisition parameters on the accuracy of the collected spectral data. This will provide a better understanding of the technique which will then provide a measure of change in collections through imaging.

For the quantitative model, special well-characterized reference collections were gathered and analysed. Several material properties were of interest: starch sizing (Islamic Paper), acidity and degree of polymerization (DP). Multivariate data analysis methods were used to develop discrimination and regression models which were used as an evaluation methodology for the metrology of quantitative NIR chemical imaging.

Spectral data were collected using a pushbroom HSI scanner (Gilden Photonics Ltd) in the 1000 – 2500 nm range with a spectral resolution of 6.3 nm using a mirror scanning setup. The scanner is based on a line-spectrograph (Specim, ImSpector N25E) with a 30μm slit connected to a Mercury Cadmium Telluride (MCT) camera. The object is illuminated by a line of halogen lamps (500 W).

Novel Retrofit Technology Incorporating Robots for Lower Energy Healthy Buildings

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More than 19 million homes in the UK have been built pre 1990, when dwellings in the UK were not required to have any insulation in the walls and floors. In order for the UK to reach its commitment of 80% reduction of greenhouse gas emissions by 2050, an urgent overhaul of retrofitting the existing building stock is required. A novel way of retrofitting suspended timber floors has been developed by inserting a robot into the floor void, which sprays foam insulation to the underside of the floor boards. This keeps the appearance of the on the warm dry side, while maintaining ventilation within the void. However, an important question needs to be addressed: the PU foam itself and its impact on the indoor environment and occupants during the installation and afterwards

The volatile organic compounds (VOCs) emitted from the insulation materials could impact indoor air quality (IAQ), residents health and building materials. The particles are emitted during the curing process of the material and off-gassing is usually expected to decrease during its lifecycle.

To address this lack of knowledge, a six month experiment (February 2017 – August 2017) is being conducted involving 1–3 dwellings as case studies. In-situ VOC emissions from spray foams pre, during and post installation will be recorded in order to analyse off-gassing rates of the insulation material. We will be collecting weekly samples by using glass cylinder tubes with hollow bottoms, air pumps and tenax sorbent tubes. The collected data would provide new knowledge on VOC rates of novel retrofitting measures. The analytical technique we are using is automated thermal desorption-gas chromatography-mass spectrometry (ATD-GCMS), which will determine the intensity of the emissions and allow for the rates to be calculated.

The expected outcomes aim to provide a clearer understanding of the interrelationship between IAQ, human health and novel retrofitting measures.

Development and Research Laboratories in National Library of the Czech Republic – Special Technology

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Technological laboratory significantly participates to protection and care of ancient to modern library documents in the library collections of the National Library of the Czech Republic (NK CR). Research and development focuses on all aspects of bookbinding, material composition, survey the damage, damage prediction based on the chemical and physical properties of materials and verification of the effects of restoration-conservation interventions. The laboratory also focuses on the issue of mass de-acidification of paper and lightfastness of bookbinding materials. Facilities include system Microfadometer for measuring the light fastness of materials, eg. at exhibitions and in study rooms, for controlling material for restoration, preservation and bookbinding operations. The laboratory includes SurveNIR, device for non-destructive analysis of paper and plastics, based on near infrared spectroscopy (NIR). The device is used for the survey of the physical condition of library collections. Based on the chemometric method are determined chemical and physico-mechanical properties of paper and the type of paper or is identified type of synthetic material. Using the system SurveNIR can statistically evaluate the physical condition of the paper in the large book collections and select the appropriate procedure for preventive care. A significant part of survey of bookbinding materials is performed by microscopic examination. A great benefit in survey of state and composition of the materials is a 3D digital microscope HIROX. With this device you can observe and analyze material or its damage in detail otherwise inaccessible to naked eye, including 3D display of surface. With the 3D microscope you can identify bookbinding material, colored layers, performing microscopic analysis of the physical condition of material, identify the damaging pollution, control the effects of conservation and restoration work on the material microstructure and microbiological survey.

Responsive heritage. Towards the integration and visualization of Historic Indoor Environments Sensors Data with BIM

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By bringing data about Historic buildings, environments and users together through the creation of a BIM digital prototype, the project will open new opportunities to extract meaning and connect otherwise spatially and/or temporally disconnected information, fostering novel interpretations to inform preventive conservation strategies whilst improving the end-user interaction with science and heritage.

Through Building Information Modelling and data mining capabilities we will be able to process large amounts of information that will facilitate the visualization, interpretation and extract new meaning from data collected during the monitoring campaigns.

The case study for this project takes the context of display of textiles and tapestries in historic houses. We explore the correlations between light incidence data on textiles and tapestries and changes in temperature and relative humidity within the material. The research models future environments based on climate scenarios developed using transfer functions that relate outdoor conditions with the recorded indoor data.

Interpretive Conservation: A New Approach for the Heritage Sector

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Within the heritage sector there are areas of specialism that have to interact in order to manage the process of conserving and understanding our material culture and interpreting that material for the visitor. I have identified these three areas as being conservation, heritage science and interpretation. Conservation is deeply involved in conserving the material and physical aspects of our material culture. Heritage science's focus is in the investigation and understanding of our material culture. It will use many scientific techniques; my research will focus on scientific imaging. It will seek to employ the power of this imaging to engage visitors by using it to enrich exhibition and interpretation. It is worth noting that practical conservation's engagement of scientific imaging into its practice and pedagogy has been slower than in other disciplines. My research has the potential to develop this pedagogy.

The research will undertake a critical review of the relationship between the three areas and proposes that they would integrate better if a role was defined that understood their individual aspects and could communicate and mediate between them. This approach is given the working title of 'interpretive conservation'. I believe that once defined, this approach has the potential to create mutually beneficial effects for all three defined areas, raising the profile and significance of conservation and developing the potential for public engagement and impact in all of them.

Study on Action Mechanism of Sticky Rice Paste Modified Site Soil – A Traditional Chinese Cementitious Material

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Sticky rice paste is one of the cementitious materials commonly used in traditional Chinese construction that has the characteristics of high thickness and viscoelasticity, good corrosion resistance, weather resistance and small expansion. It is added into site soils with different methods to modify their basic physical and mechanical properties. The study finds gelatinized sticky rice paste modified site soil has an obvious improvement on physical and mechanical properties compared to 20°C water modified and 100°C water modified soil when 1%(mass percentage) sticky rice paste is added to modify the site soils. Its liquid and plastic limit and plastic index show a whole rise than before, the three indicators respectively reach 27.4%, 17.7% and 9.7%. There has a threefold increase in unconfined compressive strength and a two orders of magnitude decrease in permeability coefficient as well as more slowly water-destruction rate and better water resistance. Study of XRD, FT-IR and TG/DSC manifests the action between sticky rice paste and soil is a physical process. It is observed by SEM that dispersive branched chain molecules of nanoscale sticky rice paste highly infiltrate into the surface of soil particles and attach to them forming good adhesive colloid, and it solidify soil particles after water evaporating and makes the structure more compact. Because gelatinized sticky rice paste has the fluidity property of colloid and solution and contains amounts of hydroxyl, adhesive forces of wettability, Van der Waals force, hydrogen bond, crosslinking wrapping make surface of soil particles and molecules of rice paste interlocked to improve the property. Citation: PEI Q Q, WANG X D, GUO Q L et al. Study on Action Mechanism of Sticky Rice Paste Modified Site Soil – A Traditional Chinese Cementitious Material. Sci China Tech Sci,.

Investigating the Impact of Texture on Microfading Data

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Microfading tests are widely used to assess the light sensitivity of heritage objects: A sub-millimeter area of an object is exposed to light of high intensity and the change of reflectance measured simultaneously by a spectrophotometer. The test is virtually non-destructive and relatively quick, and is used on diverse materials such as graphic media, textiles, photographs etc. However, the technique has not been standardized and there are no generally agreed test protocols to ensure reproducibility and comparability.

In this project, the impact of the material characteristics texture and roughness – as found in textiles - on microfading data are investigated. Practical aspects such as directionality and the measuring background are taken into consideration. The tests are carried out with a retro-reflective system by Townshend & Thomas LLP, which allows to vary the probe head position and hence the measuring angle. Two different light sources (xenon and LED) are used for reciprocity tests.

The aim is to develop a test protocol with the view to achieve reproducible and comparative data, which may facilitate inter-laboratory exchange of fading data in the future.

Contributions of Instrumental Analysis for the Conservation and Restoration of a Glazed 18th Century Ceramics from the Dirmstein Manufactory

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One of the rarities of 18th century ceramics manufacturer Kurfürstlich-Mainzische Ofen-Steingut- und Fayence Dirmstein is an earthenware object, measuring 19.2 cm height and 7.3 cm width. Now it belongs to the Museum Angewandte Kunst, Frankfurt am Main. The white, glazed figurine portrays Zeus with his attributes. It was covered with various deposits, and showed discolored, partially displaced restoration treatments, all leading to a poor appearance. Information on previous treatments are missing. Therefore, the project focused on saving the authentic material, and sampling information in general, like traces of use and the state of conservation.

Scientific investigations defined previous conservation treatment. A variety of obsolete adhesives such as nitrocellulose lacquer and shellac, refills and oil retouches could be revealed using UV-radiation and FTIR. Integrated pigments in large numbers were measured by XRF. The results were confirmed by micro-analysis. Finally, inner metal rivets were detected using X-ray radiation.

Conservation and restoration ethics demand minimalism and authenticity. Equally, conservation treatment should correlate the institutions requirements of aesthetics and safety on display. Therefor the conservation concept incorporated a reduction of degraded materials to the original state and a coherent overall pattern. To avoid moisture penetration into the ceramic, surface cleaning was performed using highly volatile solutions. Likewise, the retouches and fillings were released. Old adhesives were replaced with stable, and correctly positioned ones. Gaps were filled plaster based and concluded with a minimum of retouches and glazes. As the project outcomes, the well secured figurine has achieved its actual form, and detailed surface properties are visible again.

Radio-Monitoring Says that Microclimate is Superb. Do Historical Objects Share this Same Opinion?

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In one of our historical buildings we found many signs of exceeded humidity visible on objects, such as looses of the paint layer, focuses of mould contamination, etc. Also people complained for some time about the unpleasant smell of fustiness. How it is possible, that for several past years, based on the well-developed radio-monitoring system data, microclimate there has been ranked an A class, according to the ASHRAE categorization?

An interdisciplinary team has been set up for solving this issue. As an instant result the following tasks were pointed out to accomplish. Careful analysis of potential damage of objects. A detailed analysis of indoor microclimate conditions in regard to historical and outdoor conditions. Isolation of microorganisms from places where some visible changes of microbial contamination were recognized and estimation their ability to biodeterioration. Estimation of levels of moisture in drillings took out of the building partitions. Computer simulations of the microclimate forming in indoors of the historical building including temperature-humidity simulations of the building partitions and microbiological hazards.

First results of studies shows that some fungal strains were isolated from contaminated places and most of them would be active in biodeterioration process. The occurrence of the most powerful cellulose-destroying filamentous fungi like Aspergillus fumigatus or Alternaria alternata was confirmed in laboratory tests. These species belong to slightly xerophilic moulds with minimal aw 0.80-0.89 (at 25°C) required for their growth so it is crucial to confirm if such favorable conditions took place in the analyzed museum environment. After microclimate studies some laboratory tests of fungal activity in simulated conditions were conducted. These results will be also helpful to verify a computer simulation model.

Low-Cost Wood Tar Analysis: a Citizen Science Method

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Wood tar coatings were traditionally applied to sacred and secular wooden structures and structural elements for protective and decorative purposes in Sweden and much of Northern Europe. To be better able to conserve, preserve and restore these structures the properties of both the per-existing tar and the tar to be applied should be understood to ensure compatibility (chemically and otherwise). Heritage boards in Scandinavia often have regulations or recommendations as to what type and quality of tars can be used on listed buildings, however, not all wood tars are equivalent.

Wood tar is a complex mixture of organic compounds produced by the pyrolysis and subsequent distillation of resinous wood. When pine is used, the tars are derivatives of resin diterpenoids with acids from the abietane series being predominant. However, due to the complexity of the tar burning process (whether in a traditionally fired kiln or in a modern kiln) there is variation in the composition and quality of wood tars between batches as well as differences in the composition of early and late tar fractions.

Several analytical techniques, e.g. FTIR, GC-MS, are suitable to characterize tars, but these techniques are not readily accessible for most building officers, and there is a need for a simple and low cost method to evaluate and categorize tars.

This poster presents a pilot study to develop citizen science methods based on thin layer chromatography and laser induced fluorescence using open access software, easily available solvents for TLC and a homemade origami laser pointer fluorimeter from Public Lab. While data quality suffers, the low cost, simple methods are able to discriminate between tars, and they can be used with little training by practitioners.

Multi-Disciplinary Information System Covering Prague's Collection of Cuneiform Tablets

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Assyrian cuneiforms tablets represent earliest forms of written documents and witness a direct communication between members of ancient society. Due to its resilient material, fired or unfired clay, they are preserved in large quantities and scattered around the world museums as findings discovered during archaeological excavations. However the cuneiforms can speak for themselves due to legibility of their written content, a valuable context given by known location of the finding is often lost. From this point of view Prague's collection, uncovered by prof. Hrozný at the beginning of twentieth century is exceptional as detailed and methodical documentation of the site and the whole set of discovered tablets is available, thus it can play a role of example and reference for other objects of this kind. Having this in mind, the current project aims at development of a complex database containing multidisciplinary data combining physical measurement, digital models and historical and linguistics information allowing new insights, e.g. to track trade routes, etc. The database contains data on material content of the tablets based on spectrometric data and data obtained by x-ray fluorescence enabling to analyze tablet's composition. The record also contains transcription of the text and data known from archeological records. The database is intended to be available on-line for everyone, allowing observation of the 3D digital model of tablet on user interface in simulated illumination, locate the tablet origin and other important contextual data. The rendered light throws shadows on the surface of the tablet, enhancing scripts shape, a process essential for recognizing the text. The manipulation with a virtual replica would be possible on computer screen and in virtual reality. This way linguistics, physics and computer science in databases and digitalization can give rise new synergies in discoveries of unknown relations between objects in collections.

Hyperspectral and Multispectral Imaging of Historic Building Materials

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Multispectral and hyperspectral imaging are non-invasive analytical techniques which combine spectroscopic and spatial information. Spectral imaging has been used for over 50 years, and as time has progressed, so has its applications. Initially used in remote sensing and satellite imaging, the popularity of the technique built momentum within applications such as medicine, food science, pharmacology and agriculture. Its ability to provide accurate and substantial spectroscopic information, while having no physical impact on an object, made it desirable to conservation and its delicate and treasured artefacts. Used for the isolation and determination of inks, paints and dyes on different types of media, spectral imaging became a quick and valuable tool to assess a samples chemical composition as well as its condition, previous repairs, and the types of materials used. This type of data can be used to assess the best path for conservation to take, as well as dating an object and confirming its provenance. As equipment advanced, spectral imaging was able to be taken out to the field, and research began to be focused on building materials and their defects. It has been shown that it can provide useful information in the characterisation of mould growth, timber decay and timber species identification, presence of liquid water within porous building materials, and also salt and mineral contents within masonry and concrete. As well as providing millions of spectra on chemical composition, the data from spectral imaging is multivariate by nature, and through manipulation by data analyses can be displayed visually. This gives the viewer either a glimpse of what was not previously visible to the naked eye, or make features more apparent to the less-trained eye

Characterization of Modified Digital Camera: Spectral Imaging for Cultural Heritage Documentation

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Spectral imaging includes ultraviolet, infrared and multispectral imaging, techniques that record the varying reflection, absorption, and fluorescence of radiation by the materials present in a cultural heritage object. These techniques are used to reveal underdrawings, observe compositional changes, detect conservation treatment, differentiate materials, and enhance obscured or faded features.

Spectral imaging includes ultraviolet, infrared and multispectral imaging, techniques that record the varying reflection, absorption, and fluorescence of radiation by the materials present in a cultural heritage object. These techniques are used to reveal underdrawings, observe compositional changes, detect conservation treatment, differentiate materials, and enhance obscured or faded features.

Heritage professional are already using high-resolution consumer digital cameras for visible light cultural heritage documentation. These off-the-shelf cameras can be modified to provide heritage professionals with a less expensive, high-resolution option for spectral imaging of cultural heritage objects. Silicon sensors at the heart of consumer digital cameras are inherently sensitive to near ultraviolet and near infrared radiation but are optimized for colour photography by incorporating an infrared blocking filter and a colour filter [Bayer] array on the sensor. By removing these filters, the cameras can provide capabilities for spectral imaging while retaining the same handling properties and user interfaces and the ability to connect with previously purchased camera accessories and software.

The question then arises if the camera was produced for visible light, colour photography does the modification impact the resulting radiometric and geometric image quality? The aims of this presentation are to demonstrate the characterisation of a modified camera including spectral characterisation and image quality assessment and to provide a better understanding of modified cameras being used for cultural heritage documentation. This research is a component of a larger project investigating an integrated approach to spectral and 3D imaging for monitoring of cultural heritage objects.

Anchoring the Archive – Physical Space as a Digital Access Point to Research Documentation

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Drawing from a multi-spectral documentation of the choir of Hammarö Kyrka, a medieval wooden church built in the 14th century, this article describes the process and gains of using both Virtual Reality (VR) and Augmented Reality (AR) to digitally dress a space in material obtained through UV and IR photography. By mapping visual data gathered through historical archive research and multi-spectral photography back on to the physical space of origin, VR and AR are framed as contextualised windows through which both to organise and to access and analyse documentation. In this physical-digital hybrid space, the digital visual data of the documentation is given a physical context and the physical space is given a depth beyond visible light and current conditions. Rather than organising the material according to topic, archival and research data is mapped in relation to place in a three dimensional space. The material is thus resituated as a place-centric analytical layer accessible to care takers, conservation scientists, and the public alike, all while leaving the current state of the physical space free from markings.

Jack of all Trades: The Interdisciplinary Individual

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There is much talk at the moment of the need for interdisciplinary teams both in research and in practice. What is perhaps less often discussed is the benefit of the interdisciplinary individual, one whose knowledge spans the boundary of disciplines. The 'Jack of all trades' is today assumed to be a 'master of none', however, at times being able to consider a problem from multiple perspectives is essential. One such case is the energy retrofit of historic buildings. Issues involving history, architectural theory, conservation philosophy, construction, biology, building physics, human comfort and socio-economic factors must all be considered to ensure that the best balance is achieved between user, building and planet. Using my own experience as an architect and my research into the low energy retrofit of historic timber-framed buildings, I will hope to demonstrate that a wide knowledge base is advantageous for the tackling of the issues raised in this field. In the full words of the now commonly shortened phrase, perhaps the 'Jack of all trades, master of none, is oftentimes better than master of one.'

Natural and Human Impact on Airborne Microbes and Microenvironment Parameters at the Mogao Grottoes of Dunhuang, China

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The pollution of dust particles and bioaerosols is a big threat for the preservation and exhibition of the Mogao Grottoes. With the extreme weather and increasing number of tourists, frequent disturbance of microenvironment parameters (MP) in show caves that had poor ventilation is harmful to the heritage and visitors. In this study, the culture-based method and real-time bioaerosols monitor, particle counter, temperature (T) & relative humidity (RH) recorder and CO_2 sensor were used for airborne microbes monitoring and MP record. The number of visitors and residence time were also recorded. Results shown that concentration of microbes and MP changed dramatically after tourists entering, with normal distribution in general, and the peak value appeared around 1 h before cave closed, but it takes at least 6 h when the microbes, particulate matters (PM), and CO_2 concentration back to the initial state of caves. Outside microbial concentrations of were 1 to 3 orders of magnitude lower than inside caves, which fluctuated with visitors entering. Data of PM indicated that the effects of visitors disturbance on PM of different particle sizes was varied, larger particles are more likely to be suspended due to tourist disturbance. The fluctuation of T, RH and CO_2 is higher than that of the outside, while CO_2 accumulated significantly during the opening hours. We also found that the airborne microbes and MP changed greatly in sand-dust weather that is an inherent problem in Mogao Grottoes. The managers had taken measures, such as appointment visit, route optimization, and carrying capacity control to alleviate the impact of tourists. How to respond to extreme weather, deposition and resuspension of airborne PM, and MP fluctuation is still a challenge for preventive protection.

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The Application of Non-destructive Testing Techniques on Assessment for Consolidation Effects of Earthen Sites in Drought Environment of Northwest China

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There are a large number of earthen sites preserved in northwest of China that are suffered from different types of diseases like weathering, fissure and root erosion under the external force for a long time. At present, a set of mature technology have been used to consolidate these diseases, but the assessment for consolidation effects has taken much less.

The deteriorations of two typical dry-weathering earthen sites were taken as study objects for this paper that were from Jiaohe Ruins (Turpan, Xinjiang Uyghur Autonomous Region) and Western Xia Imperial Tomb (Yinchuan, Ningxia Hui Autonomous Region). Color Difference Meter(CDM), Electrical Resistivity Tomography(ERT) and Ground Penetrating Radar(GPR) were used to take non-destructive testing for these two sitesin order to detect the feasibility and consolidation effect evaluation for these instruments in assessing surface chromaticity, fissure grouting reinforcement and roof-propping reinforcement after weathering reinforcement. The results demonstrated CDM could be used to assess the effect of weathering consolidation for earthen sites. If the color difference between reinforced wall and original wall is less than 4, the surface color different can meet requirements. GPR could be used to evaluate consolidation effect of roof-propping reinforcement. If an obvious crack between reinforced wall and original wall can be check out by GPR, the reinforcement is disqualified. ERT and GPR could be used to test the effect of grouting reinforcement for fissure. If the test result shows the resistivity distributes evenly without visible cracks, the effect of consolidation for fissure is good. These methods can enrich the methods of reinforcement effect assessment for earthen sites and improve the reliability for earthen sites consolidation.

Construction of a Monitoring and Precaution System at the Mogao Grottoes in Dunhuang

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The monitoring and warning system of the Mogao Grottoes was established based on the concept of risk management and preventive conservation for cultural heritage. The monitoring and warning system could not only identify the small changes in wall paintings, sculptures and the microenvironment of caves early but also provide scientific basis for risk assessment and making emergency measures. It is composed of two parts: the front-end data acquisition system and back-end hardware and software support systems. The main monitoring modules of the system include atmospheric environment, microenvironment of caves, deterioration of wall paintings and sculptures, stability of cliff strata, carrying capacity, natural disasters (flood, earthquake, etc.) and security. The mechanism of risk warning, risk response and information reporting was established depending on the risk assessment. It strengthened the collaboration between departments as well as improved management level of cultural heritage. Various conservation and management goals including monitoring changes at cultural heritage sites, forecasting risks, pre-controlling emergency dangers and conserving in advance could be achieved via the risk monitoring and precaution system.

Breakout Sessions

Session A & B

Multispectral Imaging and the Mobile Heritage Lab Workshop

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The workshop will take place in SEAHA's own Mobile Heritage Lab. Firstly, we will discuss the Mobile Heritage Lab and its uses, and then will explore multispectral imaging, a technique commonly applied to heritage artefacts and easily transported in the Mobile Heritage Lab.

The Mobile Heritage Lab is the first mobile facility for research and public engagement in the UK. It is an initiative of SEAHA and it is funded by EPSRC. The mission of the lab is to tackle the inequality of access to scientific resources: it brings heritage science where it is more needed. In order to achieve this, the lab welcomes applications from any heritage institution. The workshop will involve a description of the techniques the heritage lab can provide and will summarise the main results from previous events led by SEAHA students.

One technique provided by the Mobile Heritage Lab is multispectral imaging. This involves capturing images of an object illuminated across the ultraviolet, visible and infrared regions of the electromagnetic spectrum with the aim to recover hidden features that cannot be seen in the visible region alone. The enhancement of hidden text, underdrawings in paintings and documents watermarks has made it a popular technique to apply to heritage artefacts. We will discuss the science of multispectral imaging, how it works and how the images are processed to produce the desired results. We hope to demonstrate the technique using an inexpensive system comprising a modified digital camera, external filters and broadband light sources.

Computer vision techniques for heritage science workshop

Session A & B

Giles Bergel[1] and Abhishek Dutta[2]
Seebibyte project[1] and Visual Geometry Group (VGG) of the Department of Engineering Science at Oxford University[2]

The University of Oxford's Visual Geometry Grouphas developed a number of search systems, classifiers, annotation and other tools for culture and heritage research: many of them are currently in use in digital collections or funded research projects , while others are being prepared for public release and further development through the SEEBIBYTE project A well-established and rapidly advancing technology, it is a useful addition to the heritage scientist's toolkit.

The session will:

1. Outline the state-of-the-art in image search and classification for heritage science.
2. Demonstrate several applications currently in use (particularly working on documents, visual art and sculpture)
3. Run hands-on exercises in searching and comparing regions of interest in digital images of printed books, paintings and architectural photographs.

Participants will leave the session with a working knowledge of what is possible with current methods, and how they themselves might use it for their own research. Specifically, they will learn how to use Visual Geometry Group tools; understand what hardware, software, support and training is needed; and will be encouraged to think about what adaptations to their current methods might be necessary. They will also be encouraged to feedback feature requests, novel applications and challenging research-cases, thus advancing the state of the art.

About Seebibyte
Seebibyte: Visual Search for the Era of Big Data is a large research project based in the Department of Engineering Science, University of Oxford. It is funded by the EPSRC (Engineering and Physical Sciences Research Council), and will run from 2015 – 2020.
There are two main objectives:

1. To carry out fundamental research to develop next generation computer vision methods that are able to analyse, describe and search image and video content with human-like capabilities.
2. To transfer these methods to industry and to other academic disciplines (such as Archaeology, Art, Geology, Medicine, Plant sciences and Zoology).

About Visual Geometry Group
The Visual Geometry Group is based in the Department of Engineering Science at the University of Oxford, under the direction of Professor Andrew Zisserman.

Session A & B

Micro Light Fastness Testing Workshop

Jacob Thomas[1,2] and Betty Sacher[3]

Department of Conservation, Gothenburg University[1], Townshend and Thomas LLP, London[2] and Institute for Sustainable Heritage, University College London[3]

Micro Light Fastness Testing (MFT) is a technique to evaluate non-destructively the light fastness of materials including, but not limited to, heritage objects. During MFT a light source is focused onto a sub millimetre spot and the resulting reflectance spectra are collected in real time for further processing (often in real time as well) to absorbance spectra and/or colour space parameters. The rate of colour change can be related to that of standard materials, e.g. ISO Blue Wool Standards, or inputted into a lighting policy to model the impact of display conditions on an object. Alternatively, MFT can be combined with other instrumental techniques and be used to probe the photochemistry of a material as an *operando* spectroscopy method.

Three MFT instruments will be presented: two are bespoke instruments for applications where portability and re-configurability are prioritized by expert users and the third is a newly developed instrument optimised for ease of use with automatic operation from data collection to report generation. This new instrument can be operated as a bench-top instrument or on a tripod for *in situ applications*.

Instruction in data collection to exporting and analysis will be given for each instrument. Attendees will have the opportunity for hands on use of the three instruments at the workshop, and they are invited to bring their own samples for measurement, otherwise model materials will be provided.

Design for Research Impact

Session A & B

Alison Heritage[1], Catherine Dillon[2] and Theocharis Katrakazis[1]
ICCROM[1] and University College London, Qatar[2]

Designing research to generate impact is not straightforward; it takes skills, commitment, time and supportive working environment.

We invite participants to join this interactive session and explore the topic of research impact through a variety of perspectives. The workshop is structured in two parts, the first a 40 minute panel discussion, and the second a group-work exercise.

Session A: What is impact and what does it take to achieve it? (Panel Discussion)

The panel will bring together research stakeholders drawn from heritage science and beyond to address the question what makes research impactful and what does it take to achieve it? Panelists will focus on current realities in research landscape and share their vision for the immediate and distant future. The panel will include:

- Dr. Alison Heritage, Conservation Research Specialist, ICCROM (moderator)
- Prof. May Cassar, Director of UCL Institute for Sustainable Heritage and Director of SEAHA CDT
- Ms. Katy Lithgow, Head Conservator, National Trust
- Mr. Tom Feilden, Science Editor, Today Programme, BBC Radio 4
- Dr. Joanna Allen, Research Impact Manager, Research Enterprise & Social Partnerships Department, University of Brighton.
- Mr. Dzhordzhio Naldzhiev, SEAHA Doctoral Student, University College London

Session B: Diversity and impact: who to engage and how? (Group-work exercise)

The session is a group activity aimed at highlighting the benefits of collaboration and diversity in research.

Working in small discussion groups of 4-6 persons, participants will explore issues of diversity and their implications for building strong collaborations for research and preservation (who to involve and how). The session will take as its focus a real life case study – in this particular instance a guerilla art installation.

The activity is based on a session developed for the ICCROM international summer school on Communication and Teaching Skills in Conservation and Science.

Session A & B

HERIe – Assessing the risk of climate-induced physical damage

Arkadiusz Kupczak[1], Marcin Strojecki[1], Leszek Krzemień[1] and Mariusz Jedrychowski[2]

Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Krakow[1] and the National Museum in Krakow, Krakow[2]

During the session, participants will have the chance to get familiar with the use of innovative modelling software – HERIe. It is a web-based tool, which provides a quantitative estimation of the risk of climate-induce physical damage to heritage objects. The risk is assessed using selected damage criterion, by transforming relative humidity data of real-world microclimates into strain-versus-time histories engendered in specific objects. Participants can bring their own computers in order to analyse their own microclimates data or provided tutorial microclimates data. The HERIe tool is available at herie.mnk.pl.

Session A & B

Introduction to white light 3D scanning with hands-on training

Dirk Rieke-Zapp[1] and John Rohde[2]

AICON 3D Systems[1] and Hexagon[2]

After a brief introduction in the theory and practical applications of white light scanning, participants can work hands-on with a different white light/ fringe projection system. For this workshop, we will put emphasis on surface properties of typical cultural heritage materials and their impact on quality of scan results. Participants are encouraged to bring their own samples for scanning (please contact the organizers before the workshop if you plan to bring an object).

Session A & B

Non-conventional photogrammetry

Vladimir Vilde and Pedro Rocha

University College London

MESHeritage: Modeling Endangered and Sustainable Heritage (https://mesheritage.wordpress.com/)

This workshop aims to demonstrate that simple 3D models can be produced using existing footage or images that were not necessarily taken for photogrammetry purposes. We will also introduce ways to share the models from augmented reality to 3D printing. The methods that will be presented in this workshop are most appropriate for lost heritage, for situations tight on time or equipment, and monitoring older or historic states of heritage site, in short, where conventional 3D scanning is not a choice.

Infrared thermography: challenges and opportunities for built cultural heritage assessment and management

Session A & B

Scott A Orr
Oxford University Centre for the Environment

The use of non-destructive infrared (IR) thermography – indirect measurement representing surface temperatures – can be an informative tool for managing and assessing built cultural heritage. It has been employed for many purposes: among others, monitoring air movements through building fabric, locating cracks and voids, and investigating moisture ingress. This session will be a discussion forum to share experiences with IR thermography and exchange views on technological developments, novel applications, and data management techniques. There will also be an opportunity to test a subset of IR camera models.

Brighton Walking Tour

Session A & B

Sue Berry
Expert on Resorts and the History of Brighton

The tour will include a short walk around the centre of the resort exploring the evidence for the growth of this famous resort from the 1750s onwards. We will head down one of the early roads of shops and other facilities towards the Pavilion and explore why the Prince of Wales chose this already fashionable resort and his efforts to build a distinctive seaside home here. Then down on to the front and view a range of projects of different periods such as the pier and head up a street of Georgian houses.

Conservation, Royal Pavilion and Brighton Museum

Session A

Andy Thackray[1] and Anne Sowden[2]
Objects Conservator, Brighton Museum[1] and Decorative Artist and Glass Conservator, Brighton Museum[2]

**Please note that there is a time difference for this session. There will be two groups for this session one starting at 9:30am and the second at 10:00. The group signed up for the 10:00am tour will miss the coffee break, but will still be able to sign up for SESSION B starting at 11:10.

A tour to see progress on the Saloon restoration project at the Royal Pavilion. Anne Sowden will show participants the redecoration work that is underway in the Saloon to restore the decoration to the 1822 scheme by Robert Jones, and Andy Thackray will show the conservation work underway on the cabinet furniture from the room.

Session A

Multispectral Image Acquisition and Analysis with VideometerLab

Adrian Waltho
Analytik Ltd.

Multispectral/Hyperspectral imaging combines spectroscopy and photography, revealing more detailed information than the human eye can perceive in a scene or object. This workshop aims to introduce the concepts and applications of spectral imaging, using the VideometerLab system as a demonstration tool for the acquisition and analysis of multispectral image datacubes. Different image analysis approaches will be shown in relation to image enhancement and material identification for the heritage field. Attendees are welcome to bring small artefacts or objects to be imaged and analysed with the VideometerLab.

Session B

Hyperspectral imaging with push-broom sensors

Adrian Waltho
Analytik Ltd.

Hyperspectral imaging combines spectroscopy and photography, revealing more detailed information than the human eye can perceive in a scene or object. This workshop aims to introduce the concepts and applications of spectral imaging, using a Headwall Photonics hyperspectral linear stage scanning kit as a demonstration tool for the acquisition and analysis of hyperspectral image datacubes.
