



# *digital cultural heritage : FUTURE VISIONS*

13-15 November 2017 in London, United Kingdom  
Dr Kelly Greenop, Dr Chris Landorf and Peter McLennan



THE UNIVERSITY  
OF QUEENSLAND  
AUSTRALIA



The Bartlett  
Real Estate  
Institute





# ***digital cultural heritage : FUTURE VISIONS***

## **London symposium**

13-15 November 2017  
in London, United Kingdom

Conference convenors  
Dr Kelly Greenop, Dr Chris Landorf and Peter McLennan

## COLOPHON

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# ***digital cultural heritage : FUTURE VISIONS***

13-15 November 2017 in London, United Kingdom

Conference convenors Dr Kelly Greenop, Dr Chris Landorf and Peter McLennan

<b>DAY 1</b> Morning	
<b>Monday, 13 November 2017</b>	
08:30 – 09:30	<b>Conference registration</b> <i>[room tbc]</i>
09:30 – 10:00	<b>Conference opening</b> <i>[room tbc]</i>
10:00 – 11:00	<b>KEYNOTE ADDRESS</b> <b>Professor Sarah Kenderdine</b> , ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE Modelling the World in Experimental Museography <i>[room tbc]</i>
11:00 – 11:30	Morning tea <i>[room tbc]</i>
11:30 – 13:30	<b>SESSION 1 – Breadth</b> <i>[room tbc]</i>  Session Chair: Andong Lu (tbc)  Toby Burrows Cultural Heritage Collections as Research Data  Sally MacLennan and Natalie Vinton Virtual Explorers: Using digital technology to share and celebrate cultural heritage in New South Wales  Bernadette Devilat 3D Laser Scanning Built Heritage: The case of St. Boniface church in London  Sambit Datta, David Beynon and Joshua Hollick Interaction with Architectural Collections using Immersive Stereoscopic Visualisation
13:30 – 14:30	Lunch <i>[room tbc]</i>

Conference registration details can be found at:  
<https://digitalculturalheritageconference.com/registration/>

**DAY 1** Afternoon

**Monday, 13 November 2017**

14:30 – 15:30 **KEYNOTE ADDRESS**

**Tim Williams**, UNIVERSITY COLLEGE LONDON

Archaeological Heritage Along the Silk Roads: Digital futures

*[room tbc]*

15:30 – 16:00

Afternoon tea

*[room tbc]*

16:00 – 18:00

**SESSION 2 – Macro**

*[room tbc]*

Session Chair: Chris Landorf

Dante Abate, M. Faka, S. Hermon,  
N. Bakirtzis, G. Artopoulos, and  
O. Daune-Lebrun

From Analogue to Digital: 40 years of  
archaeological documentation and  
management at the Neolithic UNESCO  
World Heritage site of Choirokitia  
(Cyprus)

**Yang Geng and Huo Dan**

Digital Reconstruction and Interaction  
of Linear Cultural Heritages – Taking  
Ancient Post Roads in Northeast China  
as an Instance

**Tiziana Casaburi**

Rome's Archaeological Area  
Valorization through Multimedia  
Presentations

**Risto Järv**

Estonian Place-Lore on a Digital Map

**SESSION 3 – Modelling**

*[room tbc]*

Session Chair: Kelly Greenop

**Dijana Alic**

Designing Diversity: Capturing culture in  
digital form

**James Ritson**

A Comparative Analysis of Modelling  
Techniques for the Reduction of Energy  
and Carbon Emissions in a Victorian  
Dwelling

**Maria Manuela Leoni**

Web Modern Cultural Heritage in Post-  
1945 Milan

**Patrizia Schettino**

Augmenting Empty Spaces with Content  
from Digital Archives: Pilot study on the  
visitor experience and the Villa Ciani 3D

**DAY 2**

Morning

**Tuesday, 14 November 2017**

08:30 – 09:00

**Conference registration***[room tbc]*

09:00 – 10:00

**KEYNOTE ADDRESS**

Professor Andong Lu, NANJING UNIVERSITY

Digital Agency and Narrative-Augmented Reality

*[room tbc]*

10:00 – 10:30

Morning tea

*[room tbc]*

10:30 – 12:30

**SESSION 4 – Depth***[room name/number tbc]*

Session Chair: Sarah Kenderdine (tbc)

Yehotel Shapira

The Absolut/e's Digital Emblems: Jewish-Messianic alteration of East Jerusalem

Eleni Kotoula, Kiraz Goze Akoglu, Shi Weiqi, Yin Yang, Stefan Simon and  
Holly Rushmeier

CHER-Ob for Cultural Heritage Research: Unsleben Jewish cemetery case study

Dante Abate and Caroline Sturdy Colls

A Multi-Resolution and Multi-Sensor Approach to the Documentation of  
Treblinka Extermination and Labour Camps in Poland

Francisca Sousa, Elia Roldao, Alexandra Encarnacao and Pedro Serra

Conservation Challenges of Contemporary Art: Preservation issues in the digital era

12:30 – 13:30

Lunch

*[room tbc]*



## DAY 2 Afternoon

**Tuesday, 14 November 2017**

13:30 – 14:30	<b>WORKSHOP</b> Joann Russell and Lyn Wilson, HISTORIC ENVIRONMENT SCOTLAND Practical Applications of Digital Technologies by Scotland's National Heritage Body <i>[room tbc]</i>		
14:30 – 15:00	Afternoon tea <i>[room tbc]</i>		
15:00 – 16:30	<table><tr><td><b>SESSION 5 – Participatory heritage</b> <i>[room tbc]</i>  Session Chair: Joann Russell (tbc)  Rosie Brigham Holyrood Castle, Machrie Moor and citizen science  Mehti Ghafouri Digital Cultural Heritage for Participatory Cultural Heritage Conservation  Ahmet Denker From Dipteros to Pseudo-Dipteros: Ionic Temples of Aegean Turkey</td><td><b>SESSION 6 – Digital heritage</b> <i>[room tbc]</i>  Session Chair: Tim Williams (tbc)  Mollie Claypool We Have Never Been Digital: Architectural design and the heritage of building practices  Xu Ding Importance of Digital Strategies in Chinese Traditional Village's Conservation  Eftyhios Savvidis Future Pasts, Past Future: Or material preservation in an Increasingly digital world</td></tr></table>	<b>SESSION 5 – Participatory heritage</b> <i>[room tbc]</i>  Session Chair: Joann Russell (tbc)  Rosie Brigham Holyrood Castle, Machrie Moor and citizen science  Mehti Ghafouri Digital Cultural Heritage for Participatory Cultural Heritage Conservation  Ahmet Denker From Dipteros to Pseudo-Dipteros: Ionic Temples of Aegean Turkey	<b>SESSION 6 – Digital heritage</b> <i>[room tbc]</i>  Session Chair: Tim Williams (tbc)  Mollie Claypool We Have Never Been Digital: Architectural design and the heritage of building practices  Xu Ding Importance of Digital Strategies in Chinese Traditional Village's Conservation  Eftyhios Savvidis Future Pasts, Past Future: Or material preservation in an Increasingly digital world
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16:30 – 17:30	<b>Conference closing panel session</b> <i>[room tbc]</i>		
17:30 – 18:30	<b>Conference closing drinks</b> <i>[room tbc]</i>		

## DAY 3 Morning

**Wednesday, 15 November 2017**

10:00 – 12:00	<b>SITE VISIT</b>  Museum of London 150 London Wall, London EC2Y 5HN <a href="https://www.museumoflondon.org.uk/museum-london">https://www.museumoflondon.org.uk/museum-london</a>
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Welcome to the *digital cultural heritage: FUTURE VISIONS* London Symposium, hosted by the Architecture Theory Criticism History Research Centre in the School of Architecture at The University of Queensland and University College London's Bartlett Real Estate Institute.

This symposium aims to explore the boundary between the emerging discipline of digital cultural heritage and the established practices of heritage interpretation and management. It provides a platform for critical debate between those developing and applying innovative digital technology, and those seeking to integrate best practice into the preservation, presentation and sustainable management of cultural heritage. The diverse range of research being presented at the symposium highlights the breadth and multi-disciplinary nature of the field, as well as the potential for greater collaboration between academia, practice and industry.

We welcome the opportunity to host this inaugural collaborative event between the Architecture Theory Criticism History Research Centre and the Bartlett Real Estate Institute at University College London's new Stratford campus.

The symposium brings together delegates from the Australia, Canada, China, Estonia, Israel, Italy, Portugal, the United Kingdom and the United States, demonstrating the international appeal of this growing field of research.

The Symposium Convenors received a total of 33 abstracts. All abstracts underwent a double-blind peer review by two members of the Symposium Organising Committee. Authors of accepted abstracts (24) were invited to submit a full paper following presentation of their draft papers at the symposium. All submitted full papers will be double-blind peer reviewed by two anonymous reviewers and given the opportunity to address reviewer comments. Revised papers will undergo a final post-conference review before notification of acceptance for publication in the conference proceedings by June 2018.



## KEYNOTE ADDRESS

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Professor Sarah Kenderdine,  
ECOLE POLYTECHNIQUE FEDERALE  
DE LAUSANNE

### Modelling the World in Experimental Museography

This presentation explores issues related to the use of digital facsimiles of cultural heritage, in museums. In an era of 'heritage at risk', digital reproduction provides us with access to cultural sites and objects that may otherwise be irrevocably lost. Recent debates also describe how digital copies form part of the trajectory of any object's cultural career. Analogously, documentation of intangible heritage practices gives us opportunities to examine embodied knowledge systems and to explore their transmission through time. Nonetheless, digital facsimiles continue to occupy an uneasy space within museums whereby their artful materialities—intangible, reproducible and transmissible—pose a threat to institutionalized claims of uniqueness and authenticity. By focusing on a series of experimental new media installations for museums, this talk re-examines the possible futures for digital modelling of intangible and tangible heritage in exhibitions, where issues of authenticity and interpretation are at stake.

#### Biography

Professor Sarah Kenderdine researches at the forefront of interactive and immersive experiences for galleries, libraries, archives and museums. In widely exhibited installation works, she has amalgamated cultural heritage with new media art practice, especially in the realms of interactive cinema, augmented reality and embodied narrative.

## KEYNOTE ADDRESS

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Tim Williams,  
UNIVERSITY COLLEGE LONDON

### Archaeological Heritage Along the Silk Roads: Digital futures

From place to region; from site-based digital strategies to trans-national digital research and access. The long-running UCL Ancient Merv Project in Turkmenistan has been using a range of digital techniques - such as structure through motion; 3d laser scanning; UAV photography, video and DTM; GPS survey; digital field recording - to document, research and communicate the complexity this World Heritage Silk Road city. This work has raised many issues with data standards, data sharing, metadata, and long-term data security. But it has also raised questions about what we are trying to achieve:

- Are we just doing the things we used to do 'on paper', but better (more accurate? more detailed?) or quicker?
- Or are digital approaches enabling us to do the things we dreamed of doing 'on paper', but seldom actually realised?
- Or, perhaps, are we doing things we could not dream of achieving through non-digital means? Will deploying new techniques, such as cost-effective airborne multi-spectral imagery, transform the heritage documentation of landscapes.

More broadly, along the Silk Roads, how can we use digital data strategies to create an open, collaborative and trans-national environment? Can we utilise crowd-sourced participation to engage different audiences, enable local communities, and advance alternative meanings? How will this impact upon authorship and senses of ownership?

#### Biography

Tim Williams is Reader in Silk Roads Archaeology at the Institute of Archaeology, University College London. He is also Degree Programme coordinator for the MA Managing Archaeological Sites & the MA Urban Archaeology, Director of the Ancient Merv Project (Turkmenistan), Member of ICOMOS and the International Scientific Committee on Archaeological Heritage Management (ICAHM), Academic Board member of the Institute for Field Research.



Mr Williams' background is in urban archaeology, especially Roman, Islamic & Central Asian; approaches to complex stratigraphy; and archaeological site management. He worked for the Department of Urban Archaeology (Museum of London), between 1981-1991, and then was Head of Archaeology Commissions at English Heritage, before joining UCL in 2002, and has undertaken long running projects in Beirut, Lebanon & Merv, Turkmenistan.

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His current research focuses on the development of urbanism along the Silk Roads. He is an ICOMOS expert member on advisory missions and panels, and undertook the ICOMOS thematic study of the Silk Roads, which moved away from the emphasis on east-west interaction by exploring the complexity and dynamics of cultural exchange. It provided the basis for the UNESCO World Heritage nomination strategy for the Silk Roads. He is now working on the South Asian Silk Roads project, and assisting the Kingdom of Bhutan to develop its national heritage inventory using the Getty Conservation Institute's open source system ARCHES.

## KEYNOTE ADDRESS

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Andong Lu

NANJING UNIVERSITY

### Digital Agency and Narrative-Augmented Reality

This talk will ponder on architecture as form of agency of memory. For the long run, architectural explorations on the issue of memory have been obsessed with a symbolic understanding of monument. However, digital technologies today allow us to freely engage with multiple agencies of 'object', 'monument' and 'milieu', enabling emerging connections and allowing the creation of innovative spatial narrative forms. New digital agency has profoundly changed the way memories are experienced, communicated and reinvented. Based on this hypothesis, this talk will introduce a series of recent design-research practices conducted by the LanD Studio towards narrative-augmented reality. The *Ephemera* (2013) project fabricated a network of everyday objects to revitalize a dilapidated village. The *Inter-place* (2016) project investigated in the potential amalgamation between urban and rural places. The *Wiki-memory* (2017) project uses collective memory as medium of contemporary place-making.

### Biography

Andong Lu is Professor in Architecture and Urbanism, Nanjing University and Executive Chief-editor of the *Architectural Journal* (International Edition), *China*. He completed PhD at Darwin College, University of Cambridge, and was a Fellow of Wolfson College. He has published widely in academic journals, including the *Journal of Architecture*, *arq: Architectural Research Quarterly*, *Time + Architecture* and *World Architecture*, etc.. He co-edited with François Penz the *Urban Cinematics* (University of Chicago Press, 2011) and with Wowo Ding and Arie Graafland the *Cities in Transition* (NAi010 Press, 2015). He is working on *Steady Steps Forwards: Reflective Architectural Practice in China*, a special issue of *Architecture Design* (forthcoming 2018). He is an architect, curator and filmmaker. His current research focuses on modern vernacular heritages in China, including early- 20th century cocoonery architecture and the wetland settlements in the Yangtze Delta region.

As early adopters, Historic Environment Scotland continue to pioneer practical applications of digital technologies in conservation management and education. Applications for educational purposes are illustrated via Scotland's new building conservation centre for research and education, and in estate management. An innovative digital national asset management system is outlined.

## WORKSHOP

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Joann Russell,  
HISTORIC ENVIRONMENT SCOTLAND

Lyn Wilson,  
HISTORIC ENVIRONMENT SCOTLAND

Practical Applications of  
Digital Technologies  
by Scotland's National  
Heritage Body

## ABSTRACT

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Dante Abate,  
STAFFORDSHIRE UNIVERSITY  
Caroline Sturdy Colls,  
STAFFORDSHIRE UNIVERSITY

### A Multi-Resolution and Multi-Sensor Approach to the Documentation of Treblinka Extermination and Labour Camps in Poland

In 1941, a labour camp which came to be known as Treblinka I was constructed in a remote area of forest, north-east of Warsaw. Initially, mainly Polish political prisoners were sent there and this was then followed by the deportation of Jews. Some of the workers interred in the camp were also forced to construct the extermination camp that was built 2 km to the north in 1942 (known as Treblinka II). The current landscape of Treblinka reveals little of its former function as the location where over 800,000 people were murdered. Visitors to the site are faced with limited information about the events that occurred, and about the extent and nature of the extermination and labour camps which operated there.

This study reports on a multi-resolution and multi-sensor approach developed for the accurate and detailed 3D documentation of the archaeological structures and remains of the Treblinka camps. Data capture was planned according to a top-down strategy, aiming to achieve a resolution spanning from a few centimetres down to few millimetres. The interdisciplinary 3D modelling work consisted of a multi-scale image- and range-based digital documentation method developed to fulfil all the surveying and archaeological needs of the project, and to exploit all the intrinsic potentialities of the actual 3D modelling techniques. The first layer of information is represented by LiDAR data acquired from an aerial platform covering the entire area of the historic site. From the Digital Surface Model (DSM), a Digital Elevation Model (DEM) was subsequently extracted. Geometrical features were enhanced through the application of specific algorithms with the main aim to improve the archaeological interpretation. At ground level, the visible structures were digitized through photogrammetric techniques and georeferenced with GPS data. Where test trenches were opened, a layer to layer image-based 3D documentation was carried out to assess the volume and the morphology of the excavation, extract vertical and horizontal sections, and create an interactive 3D excavation diary. All the value-data were eventually collected in a WebGL system for online visualization.

## ABSTRACT

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This paper introduces the research challenges of a collaborative project aiming at the integration of the recent 3D documentation of archaeological remains at the UNESCO World Heritage site of prehistoric Choirokoitia (Cyprus) with earlier, analogue and digital data obtained during the site's more than 40 years history of excavations and multi-disciplinary research (archaeology, bioarchaeology, geology). The project, led by The Cyprus Institute in collaboration with the Centre National de la Recherche Scientifique (CNRS) archaeological team, the Department of Antiquities of Cyprus and the National Center for Supercomputing Applications of the University of Illinois, aims at creating a virtual environment for the visual representation of diachronic and temporal events at Choirokoitia based on the vast volume of multi-disciplinary data collected at the site. The final result is expected to be effectively integrated in the UNESCO site's management plan.

The site has been first investigated between 1936 - 1946 by P. Dikaios (Curator of the Cyprus Museum) and later between 1976 - 2009 by the French Archaeological Mission at Choirokoitia. Its extensive excavations and consequent multi-disciplinary research revealed a complex and dynamic history. Due to its exceptional preservation and contribution to the knowledge on the Neolithic period, its culture and people, the site was included to the UNESCO World Heritage Sites List in 1998.

Beyond the complexity of 3D data acquisition, due to the density of the layered archaeological record at the site, a major challenge is the digital data fusion process. This method corroborates digital with analogue material and is crucial for the presentation of the development of excavations and the gradual exposure of remains. The final 3D model will be subdivided in blocks according to types of processed data, details of geometric and geodetic information and richness of metadata.

Dante Abate,

THE CYPRUS INSTITUTE

M. Faka, S. Hermon, N. Bakirtzis,  
G. Artopoulos,

THE CYPRUS INSTITUTE

O. Daune-Lebrun,

CENTRE NATIONAL DE LA RECHERCHE  
SCIENTIFIQUE

From Analogue to Digital:  
40 years of archaeological  
documentation and  
management at the  
Neolithic UNESCO World  
Heritage site of  
Choirokitia (Cyprus)

## ABSTRACT

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Dijana Alic,  
UNIVERSITY OF NEW SOUTH WALES

### Designing Diversity: Capturing culture in digital form

In conducting research for design studio projects, architecture students commonly focus on the measurable aspects of a site – including physical qualities, site constraints and regulatory practices. The conventionally used research tools often become reductive and unable to deal with the social and cultural realities in which design productions take place. The actualities can often be neglected on account of their resistance to being distilled into clear and simple representations and bodies of information/data.

This paper discusses the specific approaches to data collection and digital visualization techniques in generating information about cultural diversity. For a group of postgraduate architecture students, Sydney provided the primary site for their deliberations; its multicultural character offering a rich milieu for the exploration of the relationship between architecture and culture. The course considered a number of distinct spaces, such as religious and community spaces for migrant and minority groups, due to capacity to spatially represent beliefs and practices. Diverse community and public spaces, as well as places of consumption, were contextualized to show the engagement of these spaces with popular and daily aspects of culture, as well as the ability of architecture to negotiate the representation of dominant and marginal groups.

The research undertaken was presented in three distinct forms of representation; namely visual, descriptive, and narrated. The research demonstrated interrelationships between digital mapping, historical research, the analysis of urban and suburban locations, and oral history narrated in multimedia formats. These connections allowed the students to form an understanding of the ways in which architectural heritage connects a cultural and historical past and present, as well as to visually represent frameworks of diversity and their impact on urban context. Students came to understand the manner in which social and cultural heritage is a product of its place within the broader assemblages of culture, practices, and people.



## ABSTRACT

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Rosie Brigham,  
UNIVERSITY COLLEGE LONDON

### Holyrood Castle, Machrie Moor and citizen science

Citizen science has the potential to change the way heritage is managed. The use of data contributed by members of the public could improve the monitoring of isolated heritage sites. This study set out to establish the usefulness of crowdsourced image data as a tool to monitor built heritage at two Scottish sites – Holyrood Castle and Machrie Moor.

The feasibility and quality of data collection was first determined using controlled lab experiments. The ability of various consumer grade digital cameras to accurately capture colour, particularly shades of red, brown and green, (colours implicated in important facets of heritage conservation, such as salt efflorescence or biological growth), was assessed following the sequential imaging of test colour swatches. Cameras tested included those found in popular mobile phones such as the Apple iPhone and Samsung Galaxy. By measuring LAB colour values, we established that all cameras tested were able to accurately record levels of colour without prior calibration. Furthermore, by measuring the total area of colour captured, we were able to determine that these cameras could survey colour variations in areas as small as 600 mm<sup>2</sup>.

Images submitted by the general public via Twitter and Instagram and email. While social media was an effective tool for engaging audiences, images submitted through such sites were compressed to an extent that made them unsuitable for accurate monitoring of colour, as determined by comparative LAB measurements. It was also established that without methods of calibration between images, it is not possible to obtain reliable quantitative measurements of colour. However, the collected data was useful to track changes to the heritage sites in a qualitative fashion, with regards to plant growth and waterlogging. Future developments of crowdsourced heritage monitoring should address an effective way to calibrate images, that does not detract from the heritage sites themselves.

## ABSTRACT

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Toby Burrows,  
UNIVERSITY OF OXFORD

### Cultural Heritage Collections as Research Data

This presentation will focus on the re-use of data relating to collections in libraries, museums and archives to address research questions in the humanities. Large-scale research into the history and characteristics of cultural heritage materials is heavily dependent on the availability of collections data in appropriate formats and on a suitable scale. Until recently, this kind of research has been seriously limited by lack of access to curatorial data. Collection databases have not been available for downloading in their entirety, or have not been made fully available on the Web. There has been a disconnect between curatorial databases and researchers, who have been generally unable to contribute their findings to institutional databases.

Some recent “collections as data” initiatives (such as [collectionsasdata.github.io](https://collectionsasdata.github.io)) have started to explore approaches to best practice for “computationally amenable collections”, with the aim of “encouraging cultural heritage organizations to develop collections and systems that are more amenable to emerging computational methods and tools”.

In this presentation, I will look at three projects which are addressing these issues. The first project is “Collecting the West”, in which Western Australian researchers are working with the British Museum to deploy and evaluate the ResearchSpace software, which is designed to integrate heterogeneous collections data into a cultural heritage knowledge graph. The second project is HuNI – the Humanities Networked Infrastructure – which is building a “virtual laboratory” for the humanities by reshaping collections data into semantic information networks. The third project – “Mapping Manuscript Migrations”, funded by the Digging into Data programme – involves combining collections data from a range of digital and sources to reconstruct the histories of large numbers of medieval and Renaissance manuscripts.

Tiziana Casaburi,  
UNIVERSITÀ DEGLI STUDI ROMA TRE

### Rome's Archaeological Area Valorization through Multimedia Presentations

This research focuses on the valorization of the archeological landscape in urban contexts and analyses the case of Rome's archaeological area. The aim is to understand how the concept of purpose of the Cultural Heritage, which from being a characterizing sign of the *elite*, became a resource on large-scale tourism. However, what could be done in order to make the share of archaeological evidence more accessible without decreasing the scientific quality of the cultural offer?

The use of the Augmented Reality as a guide on the site has been experimented in multiple forms throughout the Archaeological Area of Rome and has increased even the visits among the citizens.

From the analysis of the current cultural offer and the comparison with other international realities, it has been possible to trace some guiding lines, which should combine this type of representations and ensure a balance between the real and virtual world.

Although, from the study, it emerged that the use of AR as narrative tool of the ancient events seems to be leading the citizen to "wear" the garment of the tourist in his own city, rather than bringing the urban reality into the archaeological context. Indeed, in Rome's case the urban context is assuming features aiming to touristic exploitation. Banal souvenir shops and mediocre restaurants have replaced artisan workshops, once highly frequented and characterizing the landscape around the archaeological area. To integrate urban archaeology in everyday life as a space in the city and valorize the Cultural Heritage, the simple image of the elements constituting the original archaeological landscape is not enough. In order to save the cultural identity of this heritage, it is necessary to preserve even its context and respect the authenticity of the locations, not to fall in the mere (though didactic) spectacle of the Cultural Heritage.

## ABSTRACT

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Mollie Claypool,  
UNIVERSITY COLLEGE LONDON

### We Have Never Been Digital: Architectural design and the heritage of building practices

The way in which contemporary architects use digital technologies has, without a doubt, transformed the way in which the creative production of the discipline is disseminated. More information about artefacts, objects, places and buildings can be collected and utilised in the design process than ever before, at a scale and detail unimaginable in previous decades. However, when it comes to building practices, digital technologies have so far been used most commonly as mere representational devices; of pasts and presents.

The work of the Design Computation Lab at the Bartlett School of Architecture at UCL, challenges this notion as we look to promote and protect the future of the discipline of architecture: its future heritage. We believe architecture should be wholly digital – from the scale of the micron and particle to the brick, beam and building. This embodies a fundamental shift in architecture and design thinking that is unique to our research and projects. We argue in this paper that architecture that is wholly digital is one which would radically rethink the heritage of building practices within the discipline. Instead of designing buildings with advanced digital tools and techniques, but utilising building practices dating back decades or centuries that are extremely wasteful and inefficient in terms of impact on the environment, time and resources, we aim to think about architecture as being digital in both process and artefact. The paper will explore this both at the scale of a part; the brick or beam, and the whole; the building. This, we argue, has major implications for how we think about design, composition, authorship and process and the heritage of building practices in contemporary architectural design.

## ABSTRACT

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We present our research on the use of immersive stereoscopic visualisation in interaction with collections of architectural representations. Immersive environments such as large interactive touch surfaces, head mounted displays, dome projection systems, and Cylindrical panoramas provide a new dimension to the ways in which abstract architectural collections can be perceived, studied and analysed. The majority of virtual immersive environments attempt to create a realistic representation of their subject. Non-realistic virtual representations of artefacts and abstractions have received little attention. In our research, we combine the characteristics of virtual environments to explore and interact with a collection of architectural abstractions.

We present the processing and visualisation of multiple model representations from architectural datasets of Asian temples. Physical artefacts are digitally represented as abstract 3D models through representations comprising point clouds, boundaries, wireframes, meshes, voxels and solids. Utilising different methods of data analysis and visualisation, we show different representations of data that have been collected from photogrammetric and manual modelling. Specifically, we present a voxelisation strategy that allows generation of solid abstracted shapes closer to those generated from manual modelling.

Using the representations described above inside virtual environments, which the viewer can immerse themselves within to explore the temple structure. This immersion may take the form of large scale displays, smaller displays such as desktop monitors or various head mounted displays. The different representations of the structures allow the viewer to focus on different aspects revealing otherwise non-obvious features.

To study interaction, we develop two contextual environment models for curating our collections, a realistic interior gallery and a synthetic landscape. We evaluate the qualitative interactive experience within each context using stereoscopic immersive visualisation environment. Our findings show that the use of this visualisation conveys aspects and dimensions of the collections that are enhanced by contextual interaction. The characteristics, benefits and weaknesses of the interaction parameters are summarized and presented.

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Sambit Datta,  
CURTIN UNIVERSITY

David Beynon,  
DEAKIN UNIVERSITY

Joshua Hollick,  
CURTIN UNIVERSITY

## Interaction with Architectural Collections using Immersive Stereoscopic Visualisation

## ABSTRACT

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Ahmet Denker,  
ISTANBUL BILGI UNIVERSITY

### From Dipteros to Pseudo-Dipteros: Ionic Temples of Aegean Turkey

Eight of the greatest Ionic temples of the ancient world were built on or near the Aegean coast of Turkey, from the *dipteros* of Chersiphron in Ephesos to the pseudo-dipteros of *Hermogenes* in Magnesia on the Meander. The temples were the epitome of elegance and splendor, difficult to surpass in terms of architectural achievement for the period. All of these edifices now lie in ruins. As various empires in the region rose and fell, the temples suffered looting and destruction. Nature also played a part with rivers inundating the temenoses and silting up the archaeological remains, and earthquakes toppling columns and reducing the cellas to rubble. Despite this, tens of hundreds of years after they were built, these marble buildings still tantalize the human imagination.

The objective of this paper is to present a visualization these monuments of the ancient cities of classical antiquity. The virtual reconstruction of the original temples constituted a challenging task and called for an integrated approach to the subject, bringing together 3D digital technologies, materials and methods. While the archaeological remains provided some evidence, missing elements required the development of reconstruction hypotheses based on architectural similarities between the various Temples of Ionia. The paper will describe the four-stage reconstruction process:

- i) Detailed survey of the temple remnants,
- ii) Compilation of information from ancient texts, lithographs and architectural drawings,
- iii) 3D reconstruction of the missing parts,
- iv) Integration of the results of the preceding three stages.

The virtual 'rediscovery' and visual recovery can never replace or remedy the loss of the temples. It can, however, visually awaken the imagination and provide an hypothesised experience of the temples and restore a sense of the architecture and the place.



Bernadette Devilat,  
UNIVERSITY COLLEGE LONDON

### 3D Laser Scanning Built Heritage: The case of St. Boniface church in London

The use of new technologies to record existing architectures is increasing as they become cheaper and more accessible than ever before. Among them, 3D laser scanning is of particular relevance since it can provide full documentation of the built reality in the form of a three-dimensional coloured point cloud, measurable and with a precision of millimetres. Besides digital navigation, the resultant 3D point cloud can be used to generate a series of sub-products such as images, videos, technical drawings, virtual reality environments and 3D printed models. This essay will present some of these products from the 3D laser scanning data obtained in the St. Boniface church in London, done in the context of the BScan 3D laser scanning open classes that the author teaches at the Bartlett School of Architecture UCL.

The objective is to dimension the amount of data obtainable in just one day of data capture on-site to speculate over the importance of such a comprehensive and accurate record for built heritage documentation and intervention. When compared with previous forms of recording, accuracy is relative to the period: from words to drawings, to photographs, to photogrammetry: each one of these was seen as the most precise at the time—and they were. But the 3D laser scanning can even serve as a basis to rectify those previous methods of documentation. With the availability of having a measurable 3D model of the reality, it is tougher to decide the value of heritage and what should be physically preserved. Its convenience is certainly changing the way we intervene and preserve historic buildings, since never before such an accurate record was available as a relatively fast method, with direct consequences for its replication and intervention.”

## ABSTRACT

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Ding Xu,

UCL INSTITUTE FOR SUSTAINABLE HERITAGE

Dr Kalliopi Fouseki,

UCL INSTITUTE FOR SUSTAINABLE HERITAGE

The significance of digital technologies in developing heritage conservation strategies for Chinese traditional villages

This paper aims to advocate for the significance of employing digital technologies in the development of heritage conservation strategies in the context of historic places. The focus is placed on the case of traditional Chinese villages where ethnographic fieldwork was undertaken in 2014 and 2015. The aim of the fieldwork was to critically explore current protection strategies and actions at the traditional village of Zhujiadian, which is located in Kunshan City of Jiangsu Province, China. Situated in the radiation area of large cities of Shanghai and Suzhou, the village is experiencing gradual decay, depopulation, decline of traditional industries, deruralization and loss of rural identity, a typical problem for traditional villages around the suburbs during the urbanization in the Yangtze River Delta. Despite attempts to revive the area though the revival of craft industries, the decay of traditional buildings is an obstacle such attempts.

The fieldwork comprised of interviews with home owners who also participated in mapping the traditional houses of the village as well as participant observation. The results unveil current challenges and actions related to the protection and conservation in traditional Chinese villages. In addition, the paper further explores the potential of digital technologies for facilitating preservation decision-making in China *using visual programming software (grosshopper)*. Having established the significance of the Zhujiadian villages in partnership with the residents, a future plan for the area was co-designed with the community using digital media. The digital mapping that took place in Zhujiadian is a first attempt to map the interactions of the heritage dimensions of a space with people. More is needed in digitizing the physical dimensions of the built environment especially as it is currently in the process of decay.

## ABSTRACT

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Yang Geng,  
DALIAN UNIVERSITY OF TECHNOLOGY

Huo Dan,  
DALIAN UNIVERSITY OF TECHNOLOGY

Digital Reconstruction and  
Interaction of Linear Cultural  
Heritages – Taking Ancient  
Post Roads in Northeast  
China as an instance

In recent years, worldwide attention has been paid to the overall protection of “cultural routes”, “heritage routes” and other linear cultural heritages and the sustainable development of cross-regional culture. As the tangible and intangible cultural heritage groups in the linear or striped areas with a collection of special cultural resources, they constitute the chainlike cultural remains state, truly re-presenting human cultural, political, and economic interaction, but at the same time, the cross-regional cross-scale and geographical spatial decentralization characteristics have resulted in a variety of protection problems. This ongoing project mainly focuses on the research on digital reconstruction and interaction of linear cultural heritages. Specifically, taking the millennium ancient post roads as in Northeast China an instance, the research comprehensively uses UAV mapping, laser data scanning 3D modelling, information visualization and other technologies to reshape the route remains. Therefore, the digital map and interactive virtual environment of heritage routes will be established, so as to strengthen the links between heritages along the routes and shape the overall image of linear cultural heritages. The research provides the overall strategy and new ideas of the digital reconstruction for the cross-regional cross-cultural linear cultural heritages from macroscopic to microcosmic perspective.

## ABSTRACT

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Mehdi Ghafouri,  
VANIER COLLEGE

### Digital Cultural Heritage for Participatory Cultural Heritage Conservation

The level of citizens' participation and their engagement in participatory based cultural heritage conservation process, is an indicator of the pertinence of the past to today's societies, as well as, a crucial component in identification, recognition, conservation and presentation of heritage. Departing from this premise, the principal question that this paper will attempt to suggest some answers is: how and to what degree digital heritage has had an impact and contributed to citizens' participation? This paper, based on our research on the levels of citizens' participation and engagements in consultations process, will offer some insight on the role of digital heritage in cultural heritage and FUTURE VISIONS for participatory heritage development.

The past, tangible and intangible heritage, is one of the foundations for construction of collective identity, well-being and sustainability; but the challenge remains is how to identify and conserve the past that matters and is relevant to the world views of each society. Therefore, the local population plays an important role and ideally will participate in both identification of heritage values and their transmission. Furthermore, as the level and effectiveness citizens' participation is based on the objectives and modalities of consultation process, which in turns depends on providing pertinent and crucial information to citizens and offering alternative means of participation; digital heritage is increasing becoming an important element in heritage practice. Digital heritage has become more effective, even crucial, in providing information; forming "informed citizens", and making their participation both more effective and facilitated.

This paper will present the results of a research on the impact of digital heritage in consultation process on interventions, by public and private sectors, in heritage sites and policies in Montreal by Montreal Consultation Offices, a para-municipal organization, since its creation in 2002. The paper will present both the process, the technological means and the level of participation of Montrealers in the conservation of their heritage.

## ABSTRACT

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Risto Järv,  
ESTONIAN LITERARY MUSEUM

### Estonian Place-Lore on a Digital Map

Estonian Folklore Archives of the Estonian Literary Museum has collected cultural heritage from different parts of Estonia for 90 years. For the last decade, it has become possible to represent our collections not only in text publications but in various databases that are linked to specific places in Estonia.

Our original audio guide book Linda kivist Lilla Daamini, 2014 ("From the Linda's Stone to the Lilac Lady") covers the journey from the capital Tallinn to the second largest town Tartu with legends and other place lore; the booklet accompanying the CD includes QR codes referring to the relevant texts in the place-lore of folklore archives of the Estonian Literary Museum. Such editions help change the image of archives as a collection of dusty manuscripts and show that when presented in a contemporary way, the collections of archives and museums can also be of interest to today's people. In projects like this, digitisation serves one purpose of memory institutions – to "give back" the material to people.

In the last ten years, the Estonian Environmental Board has been developing a portal called *Memoryscapes* in cooperation with Estonian Literary Museum. This links specific locations on the digital map with the place lore – text, video, photo and audio files that are stored in the digital archives of the Estonian Literary Museum. The data from this portal have now been incorporated in the Place-lore map application hosted by Estonian Land Board's Geoportal (geoportaal.maaamet.ee). At the moment, the application includes heritage from only a small part of Estonia – five Estonian national parks (Soomaa, Karula, Lahemaa, Matsalu and Vilsandi National Parks). For additional value, the users of the geoportal can choose between several layers: heritage conservation, heritage objects, place-names, and use the historical maps as base maps instead of contemporary ones.

## ABSTRACT

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Eleni Kotoula,

YALE UNIVERSITY

Kiraz Goze Akoglu,

YALE UNIVERSITY

Shi Weiqi,

YALE UNIVERSITY

Yin Yang,

YALE UNIVERSITY

Stefan Simon,

YALE UNIVERSITY

Holly *Rushmeier*,

YALE UNIVERSITY

### CHER-Ob for Cultural Heritage Research: Unsleben Jewish cemetery case study

Cultural heritage studies cover a broad area of research and their different aspects and dimensions can be explored only in a multidisciplinary research environment. The diverse nature of the data collected using rapidly developed technologies influence the way experts from different fields access and interact with the heritage record. Systems that provide holistic approaches to data interpretation, easy retrieval of information, tracking of the development of projects and sharing of their results are prerequisites for the success of any cultural heritage project. Nevertheless, specific software that meet the needs of cultural heritage professionals is still at an early stage of development. As a result, highly specialized or generic image viewing and analysis software is being used in combination with databases and data management systems.

CHER-Ob (Cultural HERitage-Object), a new open source integrated platform, was developed in an attempt to encourage cooperative research and enhance the interaction between cultural heritage professionals and digital technologies. It proposes a new methodology for managing 3D and 2D visualizations as well as textual and conservation science data, analysis and evaluation, documentation and sharing of information. The conceptual design of CHER-Ob, its compatibility with commonly used imaging data types (2D and 3D images, Reflectance Transformation Images, Computed Tomography) and textual information and its main features, such as the different annotation modes, the automatic report generation, the metadata schema, the bookmark, screenshot, searching, sorting and filtering options are discussed.

As a case study, a dataset from the historic Unsleben Jewish cemetery in Bavaria, Germany, derived from the 'Unfolding Communities' project was analysed. Considering the different stakeholders, the complex and diverse dataset of historical/archival information and imaging data, the intangible aspects of the cemetery and its connections to the lost Jewish community, the Unsleben Jewish cemetery case study is ideal to demonstrate the features of CHER-Ob.



## ABSTRACT

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Maria Manuela Leoni,  
POLITECNICO DI MILANO

### Web Modern Cultural heritage in Post-1945 Milan

The increasingly capillary diffusion of the web and new digital technologies is slowly redefining a broad range of experiences in the cultural heritage sector, thanks to continuous innovations which allow not only the amplification of the user base to which the historical-artistic contents may be oriented, but also the development of innovative methods for the protection, value enhancement and fruition of such heritage assets. This means that even in the case of architectural history, we are increasingly witnessing experiences oriented towards digital curation. This vision implies that the preservation of heritage assets is no longer a unique and sufficient moment, albeit indispensable, but rather must be integrated by actions capable of offering the new public tools which are suited to the dynamics of digital information.

These observations are the theoretical basis for the prototype "Web modern cultural heritage". Developed by LADA (Laboratorio Archivi Design e Architettura, Design Department, Politecnico di Milano) it is a website designed to enhance the modern Milanese architectural landscape, by selecting iconic constructions realized from 1945 on the basis of studies already performed by the Politecnico di Milano which led to mappings, registrations and descriptions of the project's architecture and archives. The objective is the integration, in a unique virtual space, of information about buildings (construction techniques, materials, transformations, etc.) and their design instances, retraceable through a variety of archive materials preserved in different types of institutions (specially, private archives), spread throughout the entire national territory and beyond. The prototype, designed for different user profiles (from architectural scholars to casual users), adopts an open search, flexible interface which seeks to overcome the limitations of models based on the keyword search system, in favour of a plurality of approaches to its content."

## ABSTRACT

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Sally MacLennan,  
NEW SOUTH WALES OFFICE OF  
ENVIRONMENT AND HERITAGE

Natalie Vinton,  
CURIO PROJECTS

Virtual Explorers: Using digital  
technology to share and  
celebrate cultural heritage in  
New South Wales

Heritage Near Me, an innovative new program within the NSW Government's Office of Environment and Heritage, has been grappling with several 'perception problems' for heritage. Many people, for example, understand heritage narrowly as the bricks and mortar of historic architecture, while others believe that young people have little interest in cultural heritage. Drawing on new social research undertaken by the Office of Environment and Heritage into how the public understand and want to access heritage, the Heritage Near Me program is prototyping new digital projects for celebrating and sharing NSW's diverse cultural heritage.

Using examples of our immersive 360° Virtual Reality films, the Heritage Near Me app, and upcoming virtual, mixed and augmented reality projects, this paper will explore how existing and emerging digital platforms can be used to reach new audiences and challenge preconceived notions of cultural heritage. These projects demonstrate that immersive digital technology is a tool that can activate and reanimate the connections between stories, places and people that allow us to attach meaning and significance to cultural heritage. The growing accessibility of digital platforms like 360° VR imaging and virtual reality also means that communities can be powerful agents in exploring and sharing their own cultural heritage stories, allowing digital cultural heritage to facilitate authentic, multi-voiced and democratised approaches to cultural heritage interpretation. These approaches have multiple benefits in encouraging people to become custodians for cultural heritage, more broadly understand the contribution of cultural heritage in our environment and to challenge authorised discourses on how to manage and interpret cultural heritage.

## ABSTRACT

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James Ritson,  
UNIVERSITY COLLEGE OF ESTATE  
MANAGEMENT

### A Comparative Analysis of Modelling Techniques for the Reduction of Energy and Carbon Emissions in a Victorian Dwelling

There is an increasing acceptance that improving the environmental performance of the existing built environment is critical if carbon reduction and other sustainable goals are to be met. To aid in this process computer modelling has become an important and accepted tool in the assessment of the environmental performance of historic buildings. While the results have been questioned by many it remains an important part of any sustainable strategy for the improvement of historic buildings.

This study focuses on one particular case study that compares three strategies for assessing the improvements of a Victorian urban dwelling. The case study is part of a larger doctoral study into maintenance as a strategy for the sustainable improvements of historic suburban dwellings.

The study compares the computer-modelled results from the computer simulation program NHER against previous datasets of improvements against the real-life actual improvements. It discusses the issue of computer modelling as a method of assessment of environmental improvement in the historic built environment. It will look at the discrepancies and the differences in the results and also how the results can be accurately used. The paper will go on to show the limitations of the software in the decision-making process and the importance of the intangible factors that affect the environmental performance of a historic dwelling. It will show while it is difficult to match the exact energy use of the building it is effective in showing the impact of sustainable improvement interventions.

## ABSTRACT

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Eftychios Savvidis,  
UNIVERSITY COLLEGE LONDON

### Future Pasts, Past Future: Or material preservation in an Increasingly digital world

The rather problematic -yet emblematic- Smithsonian 'streets in the sky', seems to have been proven insufficient, or better inefficient, in putting Robin Hood Gardens on 'the List', joining the ever-growing fleet of English Heritage. Instead, the provocative and influential public housing scheme, designed and completed in 1972 by two of Britain's most important architectural designers and thinkers and also leading protagonists of New Brutalism, was paradoxically given the title of the 'monument' and offered a place in 'PastScapes' – a repository / link in Historic England's online presence for non-listed or non-designated sites. After the failed campaign to save the historic estate and the concurrent approval of the planning application of the second phase of the 'Blackwall Regeneration Project' - which gave a conclusion to this controversial conservation case - local MP Margaret Hodge suggested that a 3D scan of the concrete complex would be enough preservation to legitimize its demolition, raising among other the question of how much a digital replica can really replace a building.

In this increasingly digital world, it seems that we are slowly starting to (if not already doing so) delegate the preservation issue to a new set of evolving technologies, that along with their incredible possibilities and fascinating/interesting capabilities, they bring to the table their own dialectics. Dialectics not quite known and certainly not yet fully determined. Dialectics that will probably once and for all change, shift, disrupt or relocate any relationship with the historical past, unmaking every established idea, notion and concept around cultural heritage, historical monuments and monumentality or even the very own idea of preservation. When everything migrates from the material to the immaterial and ultimately to the digitized computer bank or the cloud, all will be different.

Patrizia Schettino,  
UNIVERSITY OF LUGANO

### Augmenting Empty Spaces with Content from Digital Archives: Pilot study on the visitor experience and the Villa Ciani 3D

This paper shows the results from a pilot study about the visitor experience inside the Villa Ciani, Lugano, augmented with digital storytelling and images from historical archive. Villa Ciani is the house of Ciani brothers, located in Ciani park, the biggest park in the city centre. Ciani brothers played a very important role for the local economy but also the local politics and the politics in Milan and Italy. The study is based on patterns emerging from 22 interviews, collected in two days, for the first re-opening of this house and the first application of augmented reality inside this urban space. The interviews have been fully transcribed and analysed using grounded theory.

The results show from one side the impact of augmented reality in the visitors' interpretation of the space, but also the history of Ciani family and their relationship with the city, but it also shows the limitation to use digital tools not designed to allow collaboration between visitors. Collaboration, as also a way for learning between visitors, is one of the key strategies used by other designers (for example, Sarah Kenderdine, with PLACE Hampi, PLACE Turkey, etc., Kenderdine 2012, Schettino 2013). The challenge is to design augmented experiences that can combine immersion with collaboration.

The augmented reality project for Villa Ciani had the limitation to be designed for one single visitor and for an individual experience, however it reached the goal to offer a new way to visit a space completely empty and to offer to visitors an engaging guide, combining a story (immersion by transportation in a narrative, Schettino 2013) and a layer of images from the past, re-using content from archive. This project is a very good example of augmented reality to combine an empty architecture, with an important past, an iconic space with an important role in the urban landscape, and also to reuse content from digital archives: this can be used as strategy to design more experiences for empty buildings inside and outside the urban space.

## ABSTRACT

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Yehotel Shapira,

TECHNION – ISRAEL INSTITUTE OF  
TECHNOLOGY

### The Absolut/e's Digital Emblems: Jewish-Messianic alteration of East Jerusalem

The proposed paper analyzes the digital cultural heritage initiated by national-religious associations (NRA) in East Jerusalem. Through such digital heritage, the NRA present their current interpretations, which legitimize the new Jewish-Israeli messianic architecture and the NRA political "Judaization" project, ongoing since the late 1970s (Salai, 1992).

The digital heritage sites are analyzed through a non-structural approach developed as a mutation of François Laruelle's non-philosophy (2013) to illuminate how architectural elements and digital image are structured as an intelligible complex mechanism to legitimize "Being there" in the built fabric and its affiliations with the unmediated traumatic experience of the Real (in the Lacanian sense). It also relates to Nancy's concept of "Being with..." which he describes as first philosophy, "a mark of crossover and underlining, drawing apart and drawing together the void between us" (2000:32).

Although these visualizations do not present any iconoclastic sentiments or actual destruction, their digital image of the Temple appears where monuments identified with Islam exist. Moreover, Orthodox Jewish eschatology is utopian, maintaining an aspect of iconoclasm which preserves the tension between a site's holiness and the religious tenets while simultaneously forbidding the making and worshipping of graven images (Flusser, 1975). Such a perception contradicts the NRAs' digital visualizations, which posit concrete emblems of the Absolut basing their projects' legitimization on the supposed Absolut's promise.

In an era when digital imaging without programmatic coherence allows architecture to use every known liked mode (Mitchell, 2015), this paper proposes the creation of a digital architecture heritage which exposes the non-structural, unattainable possibility to prove the validity of one's faith, and the incomplete self-legitimation of "Being there" and the inhabitation of place, in order to promote abilities of "Being with" different heritages in conflictual places such as Jerusalem.

## ABSTRACT

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The valorization of what is 'original' plays a major role in western art history's narratives with frequent support in the materiality of the Thing. The chronology of our civilization follows the concept of materiality up to its fetishization, in diverse ways and diverse areas of the history of culture. Conservation and restoration, after decades of scientific development about the preservation of the physics and chemistry of matter, is now sailing between the danger of *zombification* of art objects and the catastrophe of their disappearing. Therefore, questions such as 'what is the value of certain material, aesthetic or other aspect for this particular artwork / for this particular artist?' are blooming frequently in our museum practice and reveal a fast mutation.

This paper intends to oversee the approaches regarding the idea of authenticity and the role of the museum collections as a vehicle for truth. The perspectives of different conservators from different backgrounds, along with particular conservation intervention examples, allow the argument of a more open awareness towards concepts as materiality, artist's intention and historicity. The digital revolution fundamentally changed how cultural heritage is created, documented, analyzed, and preserved. Managing new media as well as the new approaches regarding conservation must be accompanied by technological advances in storage and data preservation and through interactive and inter-communicative systems for collection management with the aim to preserve intangible aspects of contemporary art collections. Further, this reflection approaches the role of the museum as a mediator between the artwork, the visitor's experience and art history, and mostly, how digital information as well as its preservation must be a priority in contemporary conservation approaches.

Francisca Sousa,  
MUSEU BERARDO

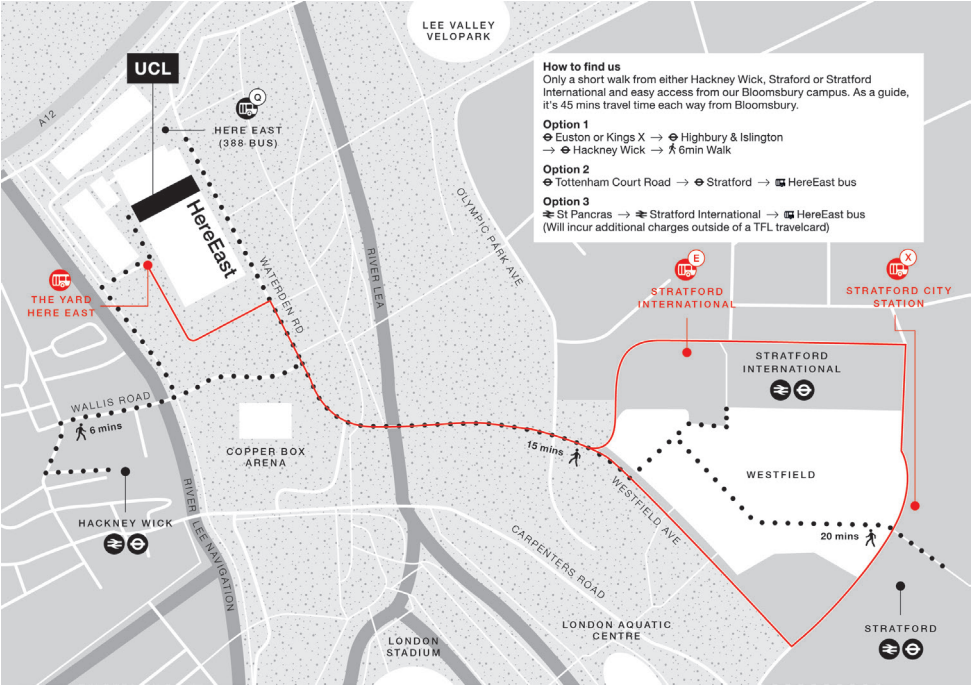
Elia Roldao,  
MUSEU BERARDO

Alexandra Encarnacao,  
MUSEU BERARDO

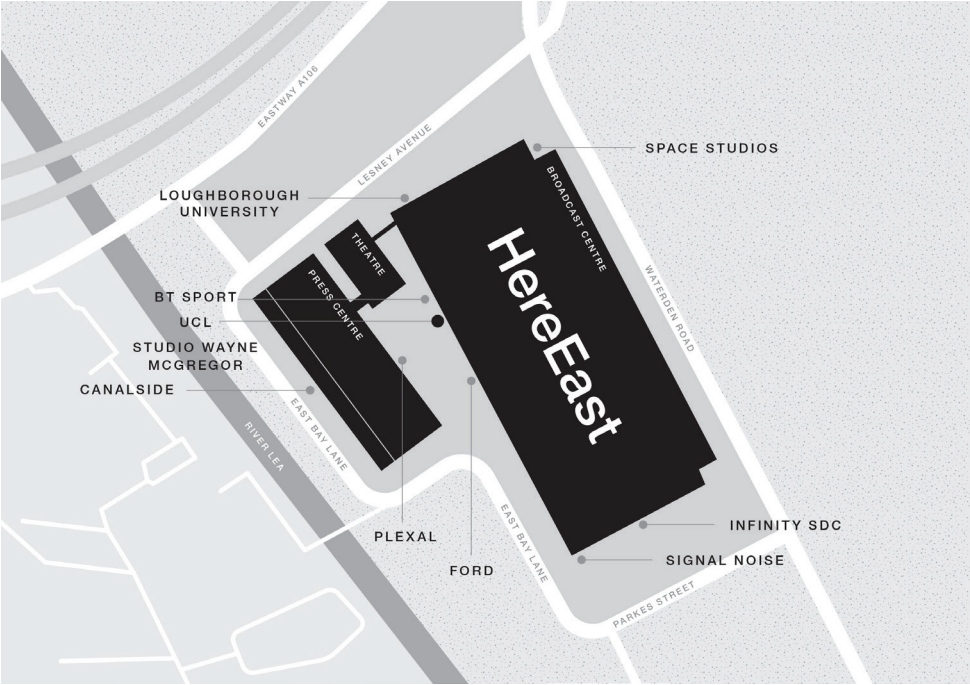
Pedro Serra,  
MUSEU BERARDO

## Conservation Challenges of Contemporary Art: Preservation issues in the digital era

MAP







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