**Abstracts Volume**

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# Urban Archaeology and Data

**Re-use and Repurposing of Archaeological and Historical Material and Data**

Ever increasing understanding of our primary sources and technological progress have led to higher and higher standards of recording and analysis in archaeological and historical research.
The corollary is an exponentially growing volume of archives about the past, including written and graphic documentation – both analogue and digital – as well as archaeological finds and samples and historical objects and documents of great scientific value. This heterogeneous collection is extremely precious, often being the only testimony left to witness research and scholarly activity. This data and material must be both securely stored and properly curated to ensure that it remains valid and accessible for reuse, repurposing and new research for both present and future generations. This year's CHNT will examine ways of achieving these goals.
(David BIBBY + Scientific Committee)

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# Advanced Archaeological Trainings

## Unknown Objects

Anthropological Workshop (associated with the Session "(INTER)RELATING TO THE DEAD")
Organiser: Michaela BINDER | Karin WILTSCHKE-SCHROTTA, Austria
Location: Naturhistorisches Museum Wien, 1., Burgring 7

On site sampling and sampling strategies when working with human remains

This workshop will cover two aspects:

- To show unusual biological objects one could find excavating skeletal human remains; the aim is to raise awareness to the variety of possible objects related to the corpse and

- To give an introduction of the state of art of invasive sampling techniques, discuss the connected problems and to find strategies to minimize the damage.

# SESSIONS

# Preservation and Re-Use of Digital Archaeological Research Data with Open Archival Information Systems

Chairs: Valentijn GILISSEN, The Netherlands | Reiner GÖLDNER, Germany | Hella HOLLANDER, The Netherlands | Maurice HEINRICH, Germany | Julian RICHARDS, UK | Felix SCHÄFER, Germany

### ARCHES "Archaeological Resources in Cultural Heritage, a European Standard"

**David BIBBY**
(Regierungspräsidium Stuttgart, Esslingen, Germany)

**Keywords:** Archiving, Long Term Curation, Best practice

**Abstract:**
The initial ARCHES-Project of the Archaeological Archives Working Party of the Europae Archaeologiae Consilium ran from June 2012-May 2014. It was financed to 50% by a grant from the European Commission's Education, Audiovisual and Cultural Executive Agency under the Culture Programme 2007-2013. Data on archiving practice was collected in surveys by the participants. Workshops in each of the members' languages were held to encourage bidirectional information on local/national archiving practices and visions. As a result, six principal activity areas in the compilation and preparation of an archaeological archive were identified: collection, analysis, reporting, ordering, packing and transfer. This result is reflected in The ARCHES Guide: The "Standard and Guide to Best Practice in Archaeological Archiving in Europe", which was written both to help institutions with systems in place to refine their techniques as well as to offer initial guidance for setting up archaeological archiving standards where none yet exist. In seven languages "The Guide" sets out project planning, archive standards, collection of data, recording of information, treatment of records, finds and digital data, the analysis and archiving the results, packing of records and finds, the presentation of digital data, ordering and indexing for archive transfer and the long-term curation and management of archaeological archives (sustainability). Especially innovative are the multi language tables of roles and responsibilities and a comprehensive dedicated bibliography on archaeological archiving. After the end of the financing period ARCHES has not come to an end. It

remains up to date on its home page and has an active LinkedIn presence with almost 1000 members. As it becomes better known, institution from around the world are looking to ARCHES to guide their own archiving procedures. This contribution hopes to increase the visibility of ARCHES for the archaeological community and encourage colleagues to take part in the ARCHES dialogue.

**Relevance conference | Relevance session:**
Win win situation: ARCHES offers guidance for correct archaeological archiving, the ARCHES project benefits from input from the international participants of the conference.
**Innovation:**
International guidelines for archaeological archiving published (so far) in seven languages
**References:**
Archiving practice
Long-term curation and management of archaeological archives (sustainability).


## Archiving Archaeological Research Data – Requirements, Objectives and first Experiences

**Reiner GÖLDNER**
(Archaeological Heritage Office Saxony, Dresden, Germany)

**Keywords:** long term preservation, archiving, archaeological research data

**Abstract:**
Preserving digital data over long times is an ambitious task. While most analogue documents are best stored without touching them, digital data need permanent care and curation. Regarding some differences between analogue and digital data – lifecycle, complexity, functionality and so on – it can be realized, that digital archiving is a new challenge.
This paper will deal with requirements and objectives on archiving archaeological research data, as discussed in a working group of the Association of State Archaeologists in Germany (Verband der Landesarchaeologen in Deutschland – VLA). Interesting themes of that discussions were "Archive Objectives", "Worthiness of Archiving", "Suitability of Archiving" and "Future Use Scenarios".
This paper will also deal with first experiences in building up a digital archive for archaeological research data in Saxony. This archive follows principles of "Open Archival Information System" (OAIS). It is based on professional software that has to be adapted to the special requirements of archaeological data like e.g. excavation documentation.
First lessons learned were, that our ideas of archiving were not very professional and that implementation and operation of such archive system is a considerable effort.
The professional system acts very complex, adapting it to our simple workflow ideas was not quite easy. On the other hand, Archive Information Packages are quite simple and it has to be carefully considered, how to ingest complex convolutes of data like excavation documentation.
Don't underestimate all the tasks around your new archiving system. According to OAIS we need a close cooperation of organization, people and systems to operate a digital archive. There are many tasks to do manually, not least to choose archive data formats and to decide, how to preserve them over years and years.
The paper will sum up some of the most important steps to archive digital archaeological research data.

**Relevance conference | Relevance session:**
The paper matches the conference theme in the field of archaeological data that has to be preserved valid and accessible for reuse, and will give some practical experiences about that.
**Innovation:**
There are no other experiences operating an OAIS conformal archive that matches special needs of German State Archaeology.

**References:**
**GÖLDNER, R. et al.:** Ratgeber zur Archivierung digitaler Daten
(http://www.landesarchaeologen.de/fileadmin/Dokumente/Dokumente_Kommissionen/Dokumente
_Archaeologie-Informationssysteme/Dokumente_AIS_Archivierung/Ratgeber_Archivierung_V1.0.pdf

# Twenty years of the ADS: lessons and challenges for the future of data curation

**Tim EVANS | Holly WRIGHT**
(Archaeology Data Service, York, UK)

**Abstract:**
Since its foundation in 1996 the Archaeology Data Service (ADS) has accessioned over 1700 separate collections covering the full breadth of archaeological data generated by UK-based practitioners. At the time of writing the ADS holds over 2,000,000 files, representing over 350,000 distinct objects, curated in an OAIS compliant digital archive.
This paper presents insights from the practical experience of undertaking digital archiving. Taking a typical example of a fieldwork archive produced through development-led work it will examine the key stages of OAIS in operation, with specific emphasis on the long-term preservation of text-based documents. Unpublished documents, often referred to as 'grey literature', are one of the most common forms of 'data' deposited at the ADS and in many ways – such as a lack of any in-depth technical file-level metadata – present a relatively straightforward corpus of material for those beginning their own archives and an information-rich resource for the wider community.
The paper will also offer a perspective on the difficulties of being a successful archive, particularly in a commercial (i.e. development-led) framework. It will discuss the constant need to balance the technical requirements of the archive (file formats, metadata) with the priorities of a depositor, as well as the often differing perceptions on the nature of, and what constitutes archives and data.

**Relevance conference | Relevance session:**
Examines the fundamental role that digital archives now play in archaeological information flow: with a focus on preservation and re-use.
**Innovation:**
Through use of a digital archive, previously unavailable data is now freely available for re-use.
**References:**
**EVANS, T. / MOORE, R. (2014):** The Use of PDF/A in Digital Archives: A Case Study from Archaeology. IJDC 9(2) doi:10.2218/ijdc.v9i2.267
**MITCHAM, J. / RICHARDS, J.D. (2010):** Digital archiving at the Archaeology Data Service: a quest for OAIS compliance. Proc. 36th CAA Conf. Budapest 2008.

# Data Curation: How and why. A showcase with re-use scenarios

**Philipp GERTH | Anne SIEVERLING | Martina TROGNITZ**
(German Archaeological Institue (DAI), Berlin, Germany)

**Abstract:**
IANUS is funded by the German Research Foundation (DFG) with the objective to build up a digital archive for archaeology and ancient studies in Germany. A first three year phase of conceptual work is now being followed by a second, in which the concepts get implemented and the data centre begins its operational work.
Data curation is essential for preservation of digital data and helps to detect errors, aggregate

documentation, ensure the re-usability of data and in some cases even add further functionality and additional files. This paper will present the workflow of data curation based on a data collection about European vertebrate fauna and will exemplify the different data processing stages at IANUS according to the OAIS model – from its initial submission until its final presentation on the recently established data portal. One aspect of this will be the discussion of the archival information package. The research data stored in the IANUS repository offers many different options for data re-use. Some possibilities will be showcased on the basis of the datasets already ingested in IANUS. They include the visualisation of geographic information with GIS, statistical analysis, reutilisation of bibliography, image processing, and subsequent use of 3D models. A reuse of these data can provide additional benefits to the scientist, e.g. the possibility to examine the topography of findspots or the distribution of archaeological finds and the enlargement as well as regulation of sources.

**Relevance conference | Relevance session:**
The talk highlights the high re-use potential of archaeological data and the preparation for long term preservation in digital archives.
**Innovation:**
The new data portal of the data centre IANUS with their latest available datasets and potential re-use scenarios will get introduced.
**References:**
http://dx.doi.org/10.13149/001.mcus7z-2
http://www.ianus-fdz.de/


# Archiving the past while keeping up with the times

**Valentijn GILISSEN | Hella HOLLANDER**
(Data Archiving and Networked Services (DANS), Den Haag, The Netherlands)

**Keywords:** data-enrichment; expertise; preservation; collaboration; community

**Abstract:**
The e-depot for Dutch archaeology started as a project at Data Archiving and Networked Services (DANS) in 2004 and developed into a successful service, which has ever since been part of the national archaeological data workflow of the Netherlands.
While continuously processing archaeological datasets and publications and developing expertise regarding data preservation, various developments are taking place in the data landscape and direct involvement is necessary to ensure that the needs of the designated community are best met. Standard protocols must be defined for the processing of data with the best guarantees for long-term preservation and accessibility. Monitoring the actual use of file formats and the use of their significant characteristics within specific scientific disciplines is needed to keep strategies up-to-date. National developments includes the definition of a national metadata exchange protocol, its accommodation in the DANS EASY self-deposit archive and its role in the central channelling of information submission. In international context, projects such as ARIADNE and PARTHENOS enable further developments regarding data preservation and dissemination. The opportunities provided by such international projects enriched the data by improving options for data reuse, including allowing for the implementation of a map-based search facility on DANS EASY. The projects also provide a platform for sharing of expertise via international collaboration.
This paper will detail the positioning of the data archive in the research data cycle and show examples of the data enrichment enabled by collaboration within international projects.

**Relevance conference | Relevance session:**
Presenting the processes of a successful archaeological data-archive and the means by which it disseminates data to the designated community.
**Innovation:**
Enriching data reuse via features enabled by (inter)national projects.

**References:**
http://www.chnt.at/wp-content/uploads/Hollander_2014.pdf
http://mappaproject.arch.unipi.it/wp-content/uploads/2012/12/OP2013_pre_atti_rid.pdf

# SIKB0102: Synchronising excavation data for preservation and re-use

**Wouter BOASSON| Ronald M. VISSER**
(RAAP, Boaedificat, Saxion, Weesp, The Netherlands)

**Keywords:** exchange, archival, excavation, harmonisation, XML

**Abstract:**
Key issue in re-using data from excavations is the need to understand the meaning of the contents. Integrating studies have a hard time using old datasets, for obvious reasons like finding the right data in the first place, understanding unknown codes, and the inherent difficulty of combining data from different excavations. These problems are commonly addressed by archiving and publishing harmonized data, which enables searching through combined datasets, but at the price of losing important detail.

Despite hesitation, an interchange format for digital archaeological data was needed. We played a major role in the drafting group for what would later become the 'SIKB0102' interchange standard, where we ultimately focused on: 1) keeping the original level of detail while providing a harmonized view; 2) serving archiving as well as data interchange in active projects; 3) control of versions and 4) making sure that relations, key to solving archaeological mysteries, are central. An unusually flexible interchange format was created, that can hold detailed data together with, and linked to, harmonized data. Having the harmonized data makes it easy to search and combine datasets, while having the related detailed data makes it possible to drill down to the original level of detail. Archaeological data is all about structure and location, so we took care of including the vector geo-location data in the specification as well. Combining all these aspects in one interchange format make the SIKB0102 specification stands out.

In The Netherlands the archaeological research data must be provided to the national archival institute (DANS), and the KNA (quality standard for the Dutch archaeology) demands submitting the data to the national archive. Today the KNA requires to provide archaeological excavation data according the SIKB0102 specification, which is a big step forward in re-using archaeological excavation data.

**Relevance conference | Relevance session:**
We provide a solution for interchanging archaeological excavation data, suited for archiving and re-use, reducing the conflict of interest between standardization and keeping the original detail.
**Innovation:**
The SIKB0102 protocol offers a unique standardized protocol for structured data exchange based on harmonized data, but yet with room for accompanying detailed data, metadata, geodata and versions.
**References:**
DANS
SIKB0102
KNA

# Developing an archive for archaeological data: the 'A puzzle in 4D' project

**Edeltraud ASPÖCK[1] | Gerald HIEBEL[2] | Matej DURCO[1]**
([1]Austrian Academy of Sciences, Vienna, Austria | [2]University of Innsbruck, Innsbruck, Austria)

**Keywords:** excavation data, data archiving, long-term preservation, data re-use

**Abstract:**
'A puzzle in 4D' is a project dealing with the problem of integration of heterogeneous and incomplete digital and non-digital records of archaeological long-term excavations to prepare them for spatio-temporal analysis, long-term archiving based on national and international standards and open-access online publication for specialists and the general public. The project will be a case study to develop an archive for archaeology data at the ÖAW ACDH.

Fieldwork has taken place at Tell el Daba (TED) in Egypt since 1966 and during this time, the archaeological discipline has seen major changes, most notably developments in information technology have caused a shift from analogue to digitally-born data. As a result, the TED archive at the Institute for Oriental and European Archaeology OREA contains a huge and heterogeneous resource of digital and non-digital sources like documents, photographs, plans and drawings.

In our paper we will present work we have carried out so far and discuss the current challenges of the project. We are establishing a metadata model and map it to the CIDOC CRM, an ISO certified standard for heritage documentation and CRMarchaeo, an extension for archaeological excavations. For the types of archive sources that we started digitizing like field drawings we will present the mappings and initial RDF and JSON-LD representations. One of the big challenges in integrating the information sources is the creation of identifiers. We will present our approach to differentiate between identifiers for the documentation sources, the archaeological objects and structures as well as the excavation activities and structures created by excavations.

We will end our presentation with research questions we came up with during our work and questions related to the architecture of a system that can handle the created metadata structure and relate it to the digital resources creating an implementation that satisfies the project requirements.

**Relevance conference | Relevance session:**
Presentation deals with conference topic of: Re-use and Repurposing of Archaeological and Historical data, in our case excavation data

**Innovation:**
We will develop an archive for excavation data based on international standards – in Austria

**References:**
**ASPÖCK, Edeltraud et al. (2015):** A Puzzle in 4D: Digital Preservation and Reconstruction of an Egyptian Palace. Proceedings of Digital Heritage International Congress 2015, 28.DOI: 10.1109/DigitalHeritage.2015.7419596
**Reference Model** for an Open Archival Information System (OAIS), Recommended Practice, CCSDS 650.0-M-2 (Magenta Book) Issue 2, June 2012.

# Digging for the Digital Dividend: Information Systems and Excavation Data

Chair: Benjamin DUCKE, Germany

## 3D GIS in archaeology – a micro-scale analysis

**Undine LIEBERWIRTH[1] | Axel GERING[2]**
([1]Free University Berlin | [2]EXC Topoi, Berlin, Germany)

**Keywords:** 3D GIS, 4D GIS, voxel, spatio-temporal analysis

**Abstract:**
The micro-scale analysis in this study shows new possibilities for analysing archaeological excavations by using 3D GIS.
The study shows the range of possibilities available for using standardised vector, raster and voxel data formats (OGC) in the open source environments GRASS GIS and ParaView. It allows the creation of a digital model of all documented archaeological information – including legacy data come from laser scan, SfM, AutoCAD drawings and photographs – in a real 3D co-ordinate system.
The addition of 3D geochemical and geophysical research data to the archaeological record allows a comparison of all gathered information, leading to a better understanding of archaeological remains. The course of stratigraphy can be detected throughout 3D space and common tools like filtering and querying can create new thematic 3D models, thereby allowing insight into entire structure and detecting 3D patterns.
The newly created 3D maps not only offer new possibilities for looking at archaeological facts from any perspective, but also allow the re-excavation in a spatio-temporal environment by adding the 4th dimension.
Furthermore, the reconstruction and analysis process has a retroactive effect on documentation. The model holds information everywhere within the 3D scope, and can therefore produce profiles and sections anywhere. Is there a need for their documentation any more?
The spatio-temporal cultural-scapes model not only gives new perspectives in documentation and analysis of archaeological data at the micro-scale; it also provides insight into the most interesting parts of the West Porticus at the Ostia forum, crossing time-scales from the 2nd to the 6th century BC underneath the antique marble stone pavement (which had never been lifted before).

**Relevance conference | Relevance session:**
With the detailed 3D reconstruction of excavation trenches in the heart of Ostia Antica it is now possible to draw detailed conclusion about development and destruction processes of the 4 centuries.
**Innovation:**
The new method of solid 3d modelling allows new statistical perspectives for archaeological, geophysical and geochemical records.
**References:**
**LIEBERWIRTH, U. / NETELER, M. / METZ, M. / KÜHNLE, K. (2015):** Applying low budget equipment and open source software for high resolution documentation of archaeological stratigraphy and features. In Across Space and Time, Papers from the 41st Conference on Computer Applications and Quantitative Methods in Archaeology, Perth, 25-28 March 2013, 104–119. Amsterdam University Press, 2015.

# NormA – Building an Archaeological Information System Around a Normalized Geographic Data Model

**Jörg RÄTHER**
(Archaeological Museum Hamburg, Hamburg, Germany)

**Keywords:** GIS, Geographic Data Model, Data Normalization, Excavation Data

**Abstract:**
The on-site recording, as well as the later storage of simple geometric features like points, lines and polygons as a part of the digital documentation process in archaeology, still involve several not satisfyingly solved problems. One could have well-engineered tools for drawing within CAD and still run into difficulties connecting graphical with attribute data. To avoid this, one could use a GIS, which is, however, not capable of handling and visualizing 3D data. But storage must be regarded the crucial element within the cultural heritage preservation sector. CAD data can only be stored in single files, while using a GIS, one can have file-based as well as database storage of survey data. Since file-based storage means having to migrate data file by file to another format sooner or later, the utilisation of a GIS in combination with a geodatabase seems to be the best solution in regard to the above considerations. But this geodatabase will only be one component of an Archaeological Information System to be implemented, of which a few components, e.g. PostgreSQL/PostGIS or FOSS web- and desktop GIS', already exist but probably need modifications. However, the core component, the geodatabase, as the primary storage of all survey data, should be designed with certain requirements in mind. It should be independent from the applications used to edit or view the data, and its design should be as simple and intuitive as possible. On the basis of these general considerations, the Normalized Archaeological Data Schema ("NormA") has been developed. The modelling of its entities and relations is based on CRMarchaeo as far as concerns the survey data. Excavation data is more complex and cannot be handled easily in a GIS, as it consists of entities with and without spatial representations that have complex relations with each other. Our approach allows the reduction of entities within the database schema to a form that can be represented in a GIS fully and without redundant information. NormA is a high-level archaeological data model that defines a minimum set of entities and relations which can be adapted to suit any archaeological survey or excavation and may be implemented in backends as simple as GIS shapefiles and as complex as geodatabases.

**Relevance conference | Relevance session:**
The NormA project is intended as a component of a FOSS Archeological Information System.
**Innovation:**
The NormA project proposes a normalized geographic data model to suit any archaeological excavation and survey.
**References:**
http://www.ics.forth.gr/isl/index_main.php?l=e&c=711
http://www.academia.edu/173585/Archaeological_Information_Systems_AIS_Adapting_GIS_to_archaeological_contexts

# 3D GIS for building archaeology – combining old and new data in a three-dimensional information system in the case study of Lund Cathedral

**Martina POLIG**
(Lund University, Lund, Sweden)

**Keywords:** 3D GIS, building archaeology, 3D model, information system

**Abstract:**
Traditionally, building archeology is conducted by creating and interpreting 2D documentation, even

though the spatial properties of a building are not fully expressed in 2D. The reason for neglecting the third dimension has been mostly due to technical limitations in data acquisition and creation, as well as visualization. The fast progress in 3D technology puts an end to those limitations even though its full potential is still yet to be explored.

This study shows how a 3D GIS can be applied from the outset of a building archaeological study to create a three-dimensional information system connected to a geometrically accurate 3D model of a structure.

The case study investigates Lund Cathedral (Sweden) and is linked to a larger research project launched in occasion of the cathedral's 900th anniversary in 2023 ("Lund Cathedral 2023"). Within the framework of this project, the cathedral was acquired digitally through laser scanning and georadar. The building is characterized by a complex building history with a multitude of changes and renovations. Gaining an understanding of all interventions, as well as managing the different types of datasets created during two centuries of study is a challenge.

In order to overcome these difficulties, various datasets (from excavations, wall analyses, georadar, etc.) and their relevant metadata were imported into the ArcGIS software and linked to a geometrically accurate 3D model of the church, placing all pieces of information in their correct spatial position. Thus, data that was previously impossible to view simultaneously and in the same space can be displayed together, creating a unique holistic oversight of the available material. Through the flexibility and versatility of the system, information can be displayed and queried at will, as well as updated continuously, greatly facilitating interpretation and making it an important resource throughout the entire building archaeological study.

# The contribution of 3D technologies for a critical reading of the Casa di Octavius Quartio and the Casa del Bracciale d'Oro in Pompeii

**Francesco GABELLONE | Francesco GIURI | Ivan FERRARI | Maria CHIFFI**
(CNR IBAM, Lecce, Italy)

**Keywords:** Pompeii, 3d reconstruction, image-based, ancient garden

**Abstract:**
This paper explains the results achieved in collaboration with the Egyptian Museum of Turin, the Superintendence of Pompeii and Mondadori Electa, in the framework of the temporary exhibition "The Nile in Pompeii-Visions of Egypt in the Roman world" set in the Egyptian Museum of Turin. Virtual reconstructions of two Pompeii's houses were prepared for the exhibition: the House of the Golden Bracelet (Casa del Bracciale d'Oro) and the house of Octavius Quartio (Casa di Octavius Quartio or Loreio Tiburtino). The research allowed to make an accurate representation of gardens, statues, architectural spaces, pools with fountains and frescoed rooms, all virtually reproduced in their original context, using communication methods that combine technology with a synthetic and emotional approach. Particular attention was given to the definition of open spaces, characterized by vegetal species well attested by old studies. Techniques of close range photogrammetry have allowed the 3D survey of sixteen statues and other architectural elements; lost artifacts have been reconstructed and spaces destroyed by the eruption of 79 A.C. have been evoked. The eruption was partially represented, with fluid dynamics simulations and Computer Graphic effects in order to transmit accurate scientific information in simple and immediate language developed by lengthy technical experiments. The synthesis imposed by the short duration of the movie made it possible to match all this information with a self-explanatory approach, which allows the visitor to understand the peculiarities of the archaeological goods displayed in the exhibition in a general view that repeats colors, sounds and suggestions of the environments destroyed two thousand years ago.

**Relevance conference | Relevance session:**
New reconstructive results of two Pompei's sites associated with 3d simulation of fluids and nature fx.

**References:**
**GABELLONE, F.: (2009):** Ancient contexts and Virtual Reality: From reconstructive study to the construction of knowledge models, in Journal of Cultural Heritage, vol. 10, Suppl. 1, December 2009, 112-117. ISSN: 1296-2074.
**GABELLONE, F. / FERRARI, I. / GIURI, F. (2015):** Digital restoration using Image-Based 3D models. In: Proceedings of the 1st International Conference on Metrology for Archaeology, Benevento – Italy.

# How much of a historic town can be mapped by a terrestrial laser scanner within a working day?

**Nikolaus STUDNICKA | Christoph FÜRST | Martin PFENNIGBAUER**
(RIEGL Laser Measurement Systems GmbH, Vienna, Austria)

**Keywords:** terrestrial laser scanning, high speed mapping, historic urban area

**Abstract:**
We are all aware that in some respect it's undoubted that cultured heritage must be conserved. As an example, downtown Vienna is one of the most famous cultural sites in central Europe and most complex structures which are not easily captured with 3D mapping. One possibility to survey such an environment is new sensor equipment as a 3D laser scanner from tripod which is available and capable doing this with tremendous speed.
So we performed a test with the new RIEGL VZ-400i terrestrial laser scanner. In the night from 2nd to 3rd of June 2016 for eight working hours, one single operator has used the scanner through the city centre of Vienna. He managed to take 514 high resolution laser scans approximately every 10 meters covering various historical monuments along this path like "Stephansdom", "Peterskirche" and the "Hofburg" to name a few. Using the data acquired in the course of this project the authors want to show the potential of state-of-the-art terrestrial scanning to preserve very detailed 3D-information of various sites within very limited amounts of time. This paper describes the complete workflow from the one touch operation in the field up to the automatic registration process of the laser scans which were collected within this urban area.

**Relevance conference | Relevance session:**
This case study should show the auditorium how to select a terrestrial laser scanner in order to scan and register scan data of large historic urban sites as efficient and well-proven as possible.
**Innovation:**
The shown „high speed collection and automatic registration workflow" for static terrestrial outdoor scans of urban areas will be published for the first time.

# An Urban Archaeological Database in Tarsus, a Multi-layered Historic City Centre in Turkey

**Burak BELGE**
(Mersin University, Faculty of Architecture, Department of City and Regional Planning)

**Keywords:** Tarsus, Urban Archaeological Database, QuantumGIS

**Abstract:**
Research project in Tarsus, which has been settled since Neolithic ages in the course of Cydnus River in Cilicia (Turkey), is supported by "The Scientific and Technological Research Council of Turkey (TUBITAK-Project No: 113K132)", primarily aims to develop a method to handle urban archaeological

– especially sub-soil archaeological- resources into planning process of multi-layered historic city centres. However, there is no urban archaeological database to evaluate archaeological potential with spatial references in Tarsus similarly many cases in Turkey, where archaeological data are authentically stored in the archives of local museums, local conservation councils, archaeological excavations teams, universities or municipalities. But, in any case, these varying institutions and archaeological teams could not work together to set a synergy to understand overall context of archaeological potential. Archaeological teams have only focused on their specific sites even they have studied in same city. Therefore, research team established an Urban Archaeological Database allowing spatial queries, assessments and visual inspections instead of a static databank, inventory, or archive to evaluate archaeological potential in Tarsus to develop a general national strategy for similar issues. Research team prefer to use Free and Open Source GIS software, QuantumGIS (QGIS), because of widening use and flexibility that allow creating a multiplier effect. Preliminary, varying archaeological, historical and visual datasets in aforementioned institutions are assessed with spatial references by means of GIS supported processes. In details, spatialization of urban archaeological datasets is possible by determination of primary and interpreted secondary data together to evaluate limited field investigations with ongoing or complete archaeological studies and ad hoc findings. Consequently, urban archaeological database allows evaluating geographical changes, archaeological datasets and recent townscape together to define dia-chronic map of each unique period in the historical development of Tarsus and to determine urban archaeological character zones. Recently, the project is seen as a pioneer research to develop an overall strategy by local authorities and forthcoming publications will let to develop a national model for multi-layered cities.

**Relevance conference:**
Research project is a pioneer for using open source GIS as a tool to evaluate urban archaeological heritage in planning process in Turkey.

**Relevance session:**
Urban Archaeological Database (Tarsus) is established by varying authentic primary and secondary datasets from differenet archaeological researches. By the way, physical and digital datasets were combined by archaeological traces in modern Tarsus.

**Innovation:**
Research Method bases on handling urban archaeological heritage within planning process by free and open source GIS tools and Urban Archaeological Database.

**References:**
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WILLIAMS, T. (2015): Archaeology: Reading the City through Time. In: F. Bandarin & R. van Oers, eds. Reconnecting the City, The Historic Urban Landscape Approach and the Future of Urban Heritage. Wiley-Blackwell, 19-44


# Systematic Charting of Archaeological Finds and Sites in the Canton Aargau for more than 100 Years

Yvonne GERBER
(Kantonsarchäologie, Kanton Aargau, Departement Bildung, Kultur und Sport, Brugg, Switzerland)

**Keywords:** Maps, GIS, Landscape, Geology, LiDAR, Building activity, "Archäologischer Verdachtsflächenkataster", sites, information sources

**Abstract:**
Archaeology on the run: The Archaeological Department of the canton Aargau (Switzerland) has always been condemned to "react": to perform salvage excavations under extreme pressure, as relentless building activity revealed new archaeological sites while threatening to unravel them. We are trying to turn the tables: Advancing understanding of our landscape and its settlement

patterns is allowing the Department to produce a *Prospective Action Cadastre* ("Archäologischer Verdachtsflächenkataster", in our jargon). Known or suspected archaeological sites are marked for prospective action in this Cadastre.

As soon as building activities are planned in the neighbourhood of such areas (ominously named "Verdachtsflächen"), soundings take place. This enables us to get ready to act: to excavate, to apply for special cantonal credits if necessary etc. Starting in 1898 all finds and sites in the canton Aargau have been charted (location as precise as possible, site specifics, dating). The charting was marked by hand on maps, the corresponding information was written on paper. A comprehensive computer database, introduced in 2000, was revolutionary for the recording of all cantonal archaeological sites (in GIS), as well as of all excavations and inventory data. An even more powerful database in 2010 (*imdas pro*) allows all these sections to be combined and will be the main tool for archiving all archaeological documents and recordings of the canton.

In combination with maps giving detailed information about landscape, geology, water sources, agriculture, orography, exposition etc., the pattern of the ancient settlements can be identified, relevant for the Prospective Action Cadastre.

**Innovation:**
With the systematic charting of archaeological sites in combination with the understanding of the landscape and settling of the aboriginal inhabitants, it is possible to foresee future excavation projects.

**References:**
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# PhD / Master Session

Chair: Benjamin STANGL, Austria


## Geoarchaeology and ritual – a methodological approach for the study of prehistoric ceremonial contexts

**Susanna CEREDA**
(University of Vienna, Vienna, Austria)

**Keywords:** geoarchaeology; spatial analysis; ritual behaviours; prehistory

**Abstract:**
Temples, shrines and other ceremonial spaces have always been fascinating research contexts in archaeology, because of their high symbolic and cultural values. Though, while architectural structures and liturgical furniture are more easily recognisable and are therefore better studied, the understanding of what was happening inside these spaces, the ritual practice, is more evanescent, and this is especially true when there are no written sources that come in our help.

In this paper the author will discuss the approach adopted in her PhD project for the study of ritual behaviours, which is based on the analysis of sediments through the implementation of scientific methods adopted from the field of geoarchaeology. Rituals, in fact, are first of all human actions and as such they leave more or less visible traces. According to this deposit- oriented approach, ritual events will be identified and reconstructed from the material traces they left within mud-floors and, possibly, walls. The case study for this research is the so-called "Temple D", unearthed in the pre-

and protohistoric site of Arslantepe (Malatya, Turkey) and dated to the 3750-3300 BCE. The goal of this study is to show how such a methodological approach can help to overcome inherent visibility problems of ritual events, in order to gain a better understanding on the way a ceremonial space was used (nature of actions, cyclicity, spatial variations, etc.), and to ultimately reconstruct behavioural patterns.

## Digital visualisation and interpretation of archaeological sites. A case study from Middle Bronze Age Cyprus

**Francesca DOLCETTI**
(University of York, York, United Kingdom)

**Keywords:** digital visualisation-3D modelling-cypriot archaeology

**Abstract:**
The research project I present aims to assess and monitor the impact of 3D modelling upon research, academic dissemination and public engagement. A triangulation approach, combining both qualitative and quantitative analyses, will be applied in order to compare data coming from different methods and obtain a better understanding of the subject (Economou and Pujol Tost 2011).
Using the case study of the Middle Bronze Age settlement at Erimi- Laonin tou Porakou (Limassol, Cyprus), the research will consider each stage of the visualisation process, from the creation of interactive three-dimensional models, to their presentation to varying audiences in a range of settings, to the evaluation of their effectiveness and the subsequent improvement using users' feedback.
The methodology proposed for this project is defined by different stages along the following workflow:

1. Data acquisition and recording: gather all the available data through a multidisciplinary approach, including material evidence and micromorphological analyses. Record all the information related to metadata and paradata in a comprehensive metadata schema;

2. 3D modelling: create an interactive 3D model that shows the site at its actual state and the interpretive visualisation of the settlement;

3. Evaluation: present the 3D visualisation to different user groups, composed by specialists and non-specialists, and use both qualitative and quantitative approaches (interviews and questionnaires) to collect their feedback;

4. Implementation: use the audience feedback in order to define guidelines to improve the 3D model comprehensibility.

Through this methodological approach, I aim to assess how people perceive digital visualisations and to what extent 3D models can broaden the understanding of an archaeological site to groups of both specialists and non-specialists unfamiliar with the specific case study's context.

## The historical landscape of Scharfeneck – a combination of written sources and archaeological prospection data

**Roland FILZWIESER**
(University of Vienna, Vienna, Austria)

**Keywords:** historical archaeology, ALS, historical maps, database

**Abstract:**
In recent years, there has been an increasing interest in the use of airborne laser scanning (ALS) and geophysical prospection within archaeological research. Likewise, the use of geographical

information systems (GIS) for the documentation and mapping of archaeological remains has become commonplace. In the field of digital humanities and historical research, the development of tools for automated text recognition and the collection of large, open-source historical databases, are contributing to the advancement of the methodology. The here presented work deals with the study of the historical landscape of the Leithagebirge southeast of Vienna, based on written sources in combination with archaeological prospection data. The guiding questions are directed to illuminate how these latest methodological and technical advancements can be jointly exploited in order to benefit the disciplines of archaeological and historical research. For this purpose, an Urbarium of the Herrschaft Scharfeneck in Lower Austria dating to the 16th Century was transcribed and recorded in a historical database. In a second step, the database was combined with an interpretation of the ALS data of the area, which had been obtained in the framework of an FWF project run by the Institute of Prehistoric and Historical Archaeology of the University of Vienna, as well as several historical maps. The integrated spatial analysis of these combined sources aims to address specific questions concerning the perception of castle Scharfeneck within the surrounding historical landscape, the investigation of the network of hollow ways in the region, the development of agricultural land use, as well as historical borders and desertification processes during the late medieval period. In addition, a best practice model for the combination of written sources and archaeological prospection data is being developed.

**Relevance conference | Relevance session:**
The paper addresses problems regarding the integration of historical research and new technologies that are relevant to a number of topics covered in the conference.

**Innovation:**
The paper aims to further promote the linkage between historical and archaeological research by taking into account latest methodological as well as technological developments.

**References:**
**DONEUS, M. et al. (2008):** 'Flugzeuggetragenes Laserscanning als Werkzeug der archäologischen Kulturlandschaftsforschung: Das Fallbeispiel "Wüste" bei Mannersdorf am Leithagebirge, Niederösterreich', Archaologisches Korrespondenzblatt 38.
**EICHERT, St. (2014):** 'OpenATLAS – An Open Source Database Application for Archaeological, Historical, and Spatial Data', Proceedings of the CHNT 18.


# Leipzig 1015 – A multiproxy study to reconstruct the palaeorelief of Leipzig's centre

**Ulrike GRIMM**
(University of Leipzig, Institute of Geography, Leipzig, Germany)

**Keywords:** DEM, GIS, Geoarcheology, Leipzig, Palaeorelief

**Abstract:**
2015 marked the millennium of the first documentary evidence of the city of Leipzig as "urbs Libzi". Inspired by this event a digital elevation model from the palaeorelief (palaeo-DEM) of the first settlers will be modelled in 2/3 Dimensions by applying a geographic information system (GIS). The topic of the ongoing PhD-project combines various geographical disciplines such as geomorphology and statistics. Qualitative data, mainly from archaeological excavations and geological drills, are linked by using GIS through surveying techniques. By applying the same method as for the palaeo-DEM a recent-DEM is created. Furthermore, a comparison is conducted between this recent-DEM and another recent DEM, which was generated with LiDAR data from the »State Operation Geobasisinformation and Surveying Saxony«. A correlation analysis and the descriptive comparison validate a close connection between the two recent DEMs. This supports the proposed methodology as being well suited to generate a visualization of the palaeorelief. However, models represent only a limited picture of reality. Undoubtedly, strong anthropogenic influences in the entire study area

represent limiting factors which are hard to quantify. Therefore, the palaeo-DEM shows the minimum extent of the palaeorelief for the founding of the city of Leipzig. Nevertheless, the ongoing PhD-project supports further research on the landscape and settlement genesis at the study area. The palaeo-DEM allows the exploration of the palaeorelief and specific natural conditions during the Holocene. Furthermore, it´s possible to draw inferences about how the environment has been shaped and structured by humans in this area over the last 1000 years. The research has the character of a case study that subsequently will open up opportunities to other regions.

**Relevance conference:**
My interdisciplinary multiproxy-solution to model the ancient surface for landscape reconstruction in Leipzig's centre with GIS-Technology, fits perfectly into the conference's overarching topic. ("Cultural Heritage and New Technologies")
**Relevance session:**
The presentation of my ongoing PhD-project shares innovative multiproxy ideas to reconstruct the palaeosurface for a city centre with GIS-Technology.
**Innovation:**
Strong anthropogenic influences in the study area result in limiting factors which are hard to quantify. Nevertheless, it is possible to visualize the surface for the founding of the city of Leipzig.
**References:**
At the moment no publication is available.
My supervisors are:
Prof. Dr. Jürgen **HEINRICH**, Institute of Geography, Faculty of Physics and Earth Science, University of Leipzig, Johannisallee, 19a, 04103 Leipzig, Germany
Dr. Thomas **WESTPHALEN**, Archaeological Heritage Office Saxony, Zur Wetterwarte 7, 01109 Dresden, Germany

# New Technologies in the preservation, development, and visualization of design in the cultural practice of Trinidad Carnival

**Vernelle A. A. NOEL**
(The Pennsylvania State University, University Park, USA)

**Keywords:** Digital heritage, Trinidad Carnival, computer interaction, preservation, development

**Abstract:**
French planters introduced carnival to Trinidad in the 1780s. In 1834, newly emancipated slaves reinvented the celebration to create what is known today as the Trinidad Carnival. Through this carnival people express their freedom, their creativity, and their aesthetic sensibilities. One of the main elements of this carnival is the creation of "meticulously detailed construction and brilliant costuming." The first methodical studies of the Trinidad Carnival took place in the 1950s, where scholars attempted to document existing and extinct figures in the carnival through text, photos, and drawings, to "serve as a basis for future documentation." In 1985, another scholar called for the preservation and development of traditional figures through literature; photos; dolls; and museums. Despite this carnival's rich design history, its spawning of more than 70 carnivals around the globe, and it being one of the "most copied major carnivals in the world," there is currently no established system for preserving or exhibiting the history and development of design in this culturally-significant practice. Additionally, there is a current lack of comprehensive understanding of the activities, knowledge, and processes in design in the carnival. This project seeks to answer the question: How can we use new technologies in the preservation of cultural heritage, and comprehensive understanding of activities, knowledge, and processes in design in carnival? I present three pilot studies which illustrate three novel approaches – Interactive Data Visualization; Computer Interaction using the Kinect; and Virtual Reality using a camera and Unity 3D – to aid in the

preservation, development, and comprehensive understanding of design in Trinidad Carnival, using new technologies.

**Relevance conference | Relevance session:**
Three novel approaches to aid in the preservation, development, and comprehensive understanding of design in the cultural practice of Trinidad Carnival, using new technologies.
**Innovation:**
The development of three novel approaches to preservation, and development of design in the non-western cultural practice of Trinidad Carnival, using new technologies.
**References:**
CROWLEY, Daniel J. (1956): "The Traditional Masques of Carnival." Caribbean Quarterly 4 (3/4): 194–223.
HILL, Errol (1985): "Traditional Figures In Carnival: Their Preservation, Development And Interpretation." Caribbean Quarterly 31 (2): 14–34.

# Destruction of Cultural Heritage in Conflict Areas at Iraq

**Omar JASSAM | Ali Kazim OZ**
(Dokuz Eylul University, İzmir, Turkey)

**Keywords:** Iraq, Mosul, Conflict, Destruction

**Abstract:**
Iraq has the oldest civilizations such as Sumerian, Akkadian, Assyrian, Babylonian, Hatra and the Islamic culture. After April 2003, all archaeological sites and museums were affected by military disasters. In addition, the armed militias commonly known as ISIS / DAIS occupies from Syria to Iraq. These militias entered to the city of Mosul in northern Iraq in order to establish a religious state in June 2014. Especially archaeological sites were affected by this destruction such as Nimrud (1300 BC), Nineveh (700 BC), Khorsabad (700 BC), Hatra (AD 100) and Mosul Museum. Finally, more than 50 historical sites, mosques, religious tombs, churches, monasteries, library, ancient buildings etc. shared the same fate.
This study aims to clarify the areas under conflict and exposed to destruction by terrorist operations. For this purpose, the latest situation of the monuments will be made in comparison with the available data of museums and historical sites. In this way, it can also be carried out to determine the artifacts which are taken abroad by illegal ways as well as the physical destruction. Other purpose is to determine the size of cultural destruction and the amount of affected neighboring areas such as Syria and southeastern Turkey. The organization scheme of the illicit traffic is uncovered due to the confidential documents that can be taken out of the region with a limited edition. Finally, it needs to proposal important solutions opposed to regional devastations and to protect remains of the cultural heritage as in-situ.

**Relevance conference | Relevance session:**
Uncover the lost cultural heritage using new technologies.
**Innovation:**
A comparative analysis of the cultural destruction in the recent period.
**References:**
MESKELL, L. (Ed.) (1998): Archaeology Under Fire: Nationalism, Politics and Heritage in the Eastern Mediterranean and Middle East, Routledge: Taylor & Francis, 1998. Stone, P. G. / Bajjaly, J. F. (Ed.) (2008): The Destruction of Cultural Heritage in Iraq, Suffolk: Boydell & Brewer Ltd. 2008.

# Combining 'physical' and 'digital' in archaeological practice: collaborative visualisation during excavation

Chairs: Fabrizio GALEAZZI, UK | Peter JENSEN, Denmark

## Must Farm: An Integrated 3D Workflow

**Donald HORNE**
(Cambridge Archaeological Unit, University of Cambridge, Cambridge, United Kingdom)

**Keywords:** Bronze Age, Workflow, SfM, 3D, Photogrammetry

**Abstract:**
The discovery of at least five Bronze Age structures and their contents at an almost forensic level of preservation has made Must Farm one of the most exciting excavations of 2015/16. To achieve this excavation, both the budget and time-frame had to be viable to our partners of Forterra and Historic England. It is these constraints that led to the development of an integrated workflow utilising Surface from Motion (SfM) as the primary recording methodology.
Too often on working excavations, 3-D technologies are used only as an additional methodology to capture the most aesthetically exciting items and do not feedback into the analytical recording process of the site. This paper will explore how the workflow system employed at Must Farm which has allowed the integration of 3D technologies into the onsite recording. In addition to this how the 3D models have had the an extra value employed both with regards to public dissemination but also analytical use by other archaeologists; how this methodology has coped with the complexity of data as discovered and how it copes as our interpretations change and grow; where the workflow can be improved and whether it is possible, or even useful, to employ such technologies and workflows on more mainstream sites.

**Relevance conference | Relevance session:**
The recording methodology created for Must Farm attempts to integrate the digital and analogue record allowing a much more accessible and integrated achieve overall.
**Innovation:**
The use of Surface from Motion within the recording methodology of Must Farm is one of the first commercial sites to rely on this technology and workflow.
**References:**
**Verhoeven, G. J. J. (2009):** Providing an archaeological bird's-eye view – an overall picture of ground-based means to execute low-altitude aerial photography (LAAP) in Archaeology. Archaeol. Prospect., 16: 233–249.
**De Reua, J. et al (2013):** Towards a three-dimensional cost-effective registration of the archaeological heritage. Journal of Archaeological Science Volume 40: 1108-1121

## A critical evaluation of the use of hybrid digital / analogue recording and 3D modelling at the Early Mesolithic site of Star Carr, UK

**Michael BAMFORTH**
(University of York, Department of Archaeology, York, United Kingdom)

**Keywords:** Photogrammetry 3D digital recording Mesolithic

**Abstract:**
Archaeological excavations have long relied on three pillars of recording – the written, drawn and photographic record – to generate preservation-by-record of contextual information that is destroyed through the dynamic process of excavation. The recorded information sits alongside the

physical remains of excavated artefacts and ecofacts to form the site archive. However, the increasing availability of digital technologies capable of providing high resolution 3D digital imaging in the field is opening up a new arena of archaeological recording.

Waterlogged sites with a high prevalence of organic remains – such as Star Carr – have presented particular challenges in terms of (1) the richness and density of contextual information that can often be difficult to articulate within a standard analogue recording framework, and (2) the difficulty and often high cost not only of excavation but also of preservation and long term storage of waterlogged remains.

A hybrid digital / analogue recording system can help to address some of these challenges. This paper critically appraises the implementation of such an approach at the Early Mesolithic site of Star Carr in terms of workflow, deliverability, speed and ease of use. Using Agisoft Photoscan Pro, an enhanced 3D archive of timber structures and other associated finds scatters was produced, enabling an increased speed of on-site recording during a high-tempo, time-limited excavation.

**Relevance conference | Relevance session:**
Critical appraisal of a real world case study utilising 3D digital data collection in field archaeology
**Innovation:**
Bringing together digital photogrammetric resources with manual analogue recording to increase throughput and ease workflow in a dynamic excavation environment
**References:**
**MILNER, N. / TAYLOR, B./ CONNELLER, C. / SCHADLA-HALL, R. T. (2013):** Star Carr: Life in Britain after the Ice Age. Council for British Archaeology. 10.11141/AfA1.
**CONNELLER, C./ MILNER, N. / TAYLOR, B. / TAYLOR, M. (2012):** Substantial settlement in the European Early Mesolithic: new research at Star Carr. Antiquity, 86(334), 1004-1020

# Integrating 2D and 3D GIS in Archaeological Excavation Documentation

**Peter JENSEN**
(Aarhus University / University of York, Aarhus, Denmark)

**Keywords:** Workflow, SfM, 3D, Online, Database

**Abstract:**
For years, archaeological excavation documentation has been faced with a methodical challenge strongly related to the general digital and technical development. The acceptance and implementation of GPS, total station, CAD and GIS as a new documentation tradition, mirroring analogue documentation principles, is a perfect example of this. However, an actual seamless integration of digital, spatial data is still proving to be a challenge, especially in the light of the increasing use of 3D-documentation. GIS and CAD only partly address the needs of archaeological documentation, and file based storage imposes very high demands to the structuring and organisation of data.

By example of several Danish research excavations where different photogrammetric and 3D visualisation documentation principles were applied, this paper presents a new, browser-based, object-oriented archaeological excavation database, seeking to complement existing solutions by integrating digital spatial data. By collecting, presenting and scientifically augmenting the data quality and integrity, existing and new excavation data become far more searchable across sites. The solution integrates numerous archaeological classification systems with GIS and 3D-documentation, and include existing excavation data from national web services. In addition, the 3D-module allows for administering vertical excavation profiles and sections, and increases the value of 3D-documentation by providing automated tools for the embedding of semantic, archaeological classification within 3D models, whereby 3D-models become more dynamic information carriers, compared to static surface models.

**Innovation:**
Classification of 3D models and integrating in online object oriented database.
**References:**
www.archaeo.dk

# Digitizing the excavation. Toward a real-time documentation and analysis of the archaeological record

**Luca BEZZI | Alessandro BEZZI | Rupert GIETL | Gianluca FONDRIEST | Giuseppe NAPONIELLO | Mattia SEGATA**
(Arc-Team, Cles, Italy)

**Keywords:** Real-Time, 3D, Archaeometry, WebGIS, Archaeorobotics

**Abstract:**
Since the excavation is considered as the most destructive process in the methodology of the discipline, the last decade has seen a growing commitment in developing systems able to document and analyze the archaeological record in real time, or at least to reduce the phase of data post-processing. Due to the lack of reproducibility of the excavation, which is one of the stronger distances between archeology itself and the main principle of the scientific method, the strategy applied to the field-work represents the most sensible point for the cognitive processes, being subject to possible influence of fatal (not reversible) errors. To avoid this negative impact, often connected with wrong or too fast interpretations, many solutions has been developed, especially in the field of professional archeology, in which the lack of budget and time can increase stress conditions and reduce the options during the decision making stages.
Considering the issues described above, this contributions intends to present the experience of Arc-Team in dealing the problems connected with the archaeological excavation, through a range of different solutions which can be summarize, on one hand, in the attempt to increase the amount of information collected on the field, while decreasing the time-consumption operations in data acquisition, on the other, in the effort to reach analytical results directly on the field, at least for those knowledge which can reduce the risk of error in decision making. This approach allows to postpone on a later stage the sensible data interpretation, to avoid a risky data selection during the excavation, and to perform a better data-driven choice in defining a digging strategy. Practically Arc-Team research focuses on several targets: a partial migration from a open software based 3D documentation, which needs post-processing, to an open hardware based real-time 3D mapping (improving robotics technologies in archeology); a real-time data interpretation on the field via GIS and WebGIS, reducing the gap with traditional documentation in this field (archaeological drawing); some real-time basic chemical and physical analysis (sedimentation test, phosphates, etc…), following the concept of moving primary investigations from laboratory to the field.

**Relevance conference | Relevance session:**
Combining physical and chemical primary analysis on the field with data acquisition, management and processing with GIS and WebGIS.
**Innovation:**
The use of open source software technologies (based on the Linux system ArcheOS) and open hardware robotics (based on the system ROS) to improve the data acquisition, management and analysis processes.
**References:**
Some references about the use of chemical and physical analysis and open hardware robotics (UAV) to the archaeological excavation:http://arc-team-open-research.blogspot.it/2015/07/the-archaeometric-excavation.html
article (IT):

## Resin Analysis and Characterization in the Yenikapı Byzantine-Era Shipwrecks

**Recep KARADAĞ**
(Marmara University, Üsküdar, Turkey)

**Keywords:** Resin, analysis, horsehair, SEM-EDX

**Abstract:**
Salvage excavations conducted in the Yenikapı quarter of the historic peninsula of Istanbul by the Istanbul Archaeological Museums 2004–2013 have brought to light the Theodosian Harbour on the Sea of Marmara. In addition to thousands of archaeological artefacts, a total of 37 shipwrecks dating from the 5th to the 11th centuries AD were uncovered, constituting the biggest collection of medieval ships uncovered at a single excavation site. One of them is very important. The wreck (YK 12) was excavated together with its cargo of amphora. A separate compartment at the stern contained personal belongings, probably of the captain.

The wrecks contain different natural resins. Six resin samples were taken from different areas of the wrecks. The samples were analysed by FTIR. In the spectra of these natural resins the broad absorption bands at around 3500-3200 cm-1 can be attributed to the hydroxyl functional groups (OH stretching). Methyl and methylene stretches occur in the region of 2800-3200 cm-1. The peak at 1791 cm-1 in Sample 1 can be ascribed to the carbonyl group of anhydride or carbonate functional groups. On the other hand the absorption band at 1715 cm-1 is due to the carbonyl groups of ketone or carboxylic acid groups. The peak at 1640 cm-1 can be due to the double bond of the terpenes found in these natural resins. The strong peaks at around 1200 and 1200 cm-1 are due to C-O ether bonds. The peaks at around 1600, 1500, 1450 and 1410 cm-1 in Sample 5 shows the presence of aromatic units.

In addition to, the resins were analysed by SEM-EDX and optical microscopy. Horsehair was identified in the resins.

**References:**
**Kocabaş, U. (2015):** The International Journal of Nautical Archaeology (2015) 44.1: 5–38.

## familia gladiatoria

**Marion GROSSMANN**
(Archäologischer Park Carnuntum – Römerstadt Carnuntum, Petronell-Carnuntum, Austria)

**Keywords:** fighting and training of the Gladiators in Carnuntum

**Abstract:**
Ever since the sensational discovery of the gladiator school (ludus) in 2011, Carnuntum has placed a major emphasis on the phenomenon of gladiator fights, reflected both in scientific activities and as well as in cultural mediation. In this process, different aspects vital to the life of gladiators continue to be explored: everyday life of members of a familia gladiatoria, training and nutrition, living situation and, finally, the combats (munera) themselves in which fighters had to prove their courage. Similar to other ancient sites, a considerable number of findings from different archaeological features has surfaced near the remains of both amphitheatres and the above-mentioned ludus which clearly indicate gladiator activities in the Pannonian metropolis of 50.000 inhabitants: everyday objects, equipment, remains of equipment of arms, souvenirs and memorabilia. These objects all contribute to our idea of Carnuntum's gladiator troop living in the environment of the amphitheatre. In 2014, both coincidence and great enthusiasm shown by a small group of individuals brought forth the idea of establishing an own gladiator re-enactment troop. Only a few months later, our Familia

Gladiatoria Carnuntina already consisted of 20 members. Contrary to other troops such as Armor Mortis from Xanten or the Familia Pulli Cornicinis founded by Marcus Junkelmann, female gladiatrices also stand their ground in the arena.

The troop boasts all combat genres, regular trainings during the winter months ensure physical fitness. The owner and trainer of the gladiator troop (lanista) monitors the fighters and keeps an eye on each gladiator's gear while the mater castrorum provides meals during the competitions.

A public training in May 2015 served as a launchpad for our gladiators' first combats before spectators. Later that same year, the Gladiator Festival hosted the first professional munus. Meanwhile, the troop has become increasingly in demand on a national and international level alike. Which impact has the historic evidence of a familia gladiatoria in Carnuntum had on the foundation of our own troop and which insights have we reaped from the first seasons?

**Relevance conference | Relevance session:**
Reusing the scientific data about Gladiators in Carnuntum and try to reenact nowadays.
**Innovation:**
Lifing history based on the archaeological and geophysical data in Carnuntum.
**References:**

**Neubauer, W. / Seren, S. (2012):** Die Entdeckung der Gladiatorenschule in Carnuntum, Acta Carnuntina 2/1/2012, 4-1.
**Scholz M. (2012):** Eine Sensationelle Neuentdeckung, Acta Carnuntina 2/1/2012, 14-21.

# Amphitheater of Volterra: case study for the representation of the excavation data

**Carlo BATTINI | Elena SORGE**
(University of Genoa, Genova, Italy)

**Keywords:** Mobile App, Virtual, Amphitheater, 3D models

**Abstract:**
The continuous development of techniques of relief allows today to acquire countless information in a very short time. Data produced by the procedures for different relief, which can interact with each other to create a data bank increasingly rich, indispensable for the study of the well investigated.

The work presented wants to show how different techniques of expeditious relief can be combined together in order to better describe the subject studied. Techniques of digital projection as laser scanner, topography and structure from motion can in fact be used simultaneously and interact with each other to create a rich database of colorimetric information and metrics. Methodologies that, at the same time, present the peculiarities and errors of peculiar relief of the technology employed.

The documentation of the excavation was then addressed by employing more detection systems, trying not to interfere with the timing of the archaeologists.

The case study examined in this type of research is the discovery of the amphitheater of Volterra. Discovered in July 2015 during the phases of reclamation of a stream, is located close to Porta Diana and a few hundred meters from the Roman Theater discovered in the last century. Between October and November 2015 was undertaken an excavation campaign that has allowed us to bring to light the crests of the supporting walls of the structure, revealing the presence of the three orders and a depth of about ten meters.

The step of post processing has finally seen the use of three-dimensional models acquired both for the creation of images metrics necessary to the study of the stratigraphic units, both for studying a multimedia system easy to use for transmitting the information collected. Precisely this second point has allowed us to realize a prototype for a mobile application, inside which it is possible to display the 3D models and data of the excavation carried out.

**Relevance conference | Relevance session:**
As declared from the platform "Discovery News" one of the most promising discoveries last year is the amphitheater of Volterra.

# Museum Glass Beacon at Museum of the Imperial Forums in Rome

**Adele MAGNELLI | Davide PANTILE**
(ETT SPA, Rome, Italy)

**Keywords:** augmented reality visor – beacons – ancient Rome

**Abstract:**
The project "Beacon Glass Museum: the Museum of the Future", that involved the Trajan's Markets – Museum of the Imperial Forums in Rome, has been developed to experiment the hight narrative potential of augmented reality at the service of archeology.
In the two-month trial the museum offered an extra virtual path of augmented reality that includes fourteen points of interest about the major attractions of the archaeological complex, telling the story of Trajan's Markets and its protagonists.
Equipped with the latest generation of augmented reality viewers, when approaching the works, visitors – thanks to beacons- discovered the stories of the Museum and its characters getting information, text, images, video directly before their eyes. An empathetic and emotional journey, thanks to the use of images, holographic projections, 3D animations – that offered a funny, educational and long-lasting experience, all at the same time. The result is a unique and highly technological visit in which everyone was able to move freely, exploring the attractions and the related multimedia contents, without using additional headphones as the glasses are equipped with their own audio system.
The conference will be an occasion to display the results of this trial, monitored through questionnaires relating to user satisfaction.
The project was developed by ETT S.p.A., the Genoa-based company leader in the production of multimedia, interactive and immersive installations, in collaboration with a young creative selected in the Italian Youth Guarantee Plan. The experimentation was sponsored by the Department of Culture and Sport of Rome – Cultural Heritage Capitoline Superintendence that, together with the Scientific Director of the Museum, has supported the project.

**Relevance conference | Relevance session:**
Results of a technological experimentation on augmented reality applied to the Imperial Forums in Rome.
**Innovation:**
New narration format: the most important archaeological relics narrated in the first person the story of the Imperial Forums in Rome, thanks to beacon and augmented reality viewers technologies.
**References:**
http://www.mercatiditraiano.it/mostre_ed_eventi/eventi/museo_glass_beacon_il_museo_del_futuro
http://www.ettsolutions.com/News.aspx?id=824
http://www.archeomatica.it/musei/glass-e-beacon-per-una-fruizione-innovativa-dei-mercati-di-traiano
https://pixarcinfo.hypotheses.org/323

# New realities2: virtual, augmented reality and other techniques in Cultural Heritage for the general public

Chairs: Willem BEEX, The Netherlands | Giorgio VERDIANI, Italy | Bernard FRISCHER, USA | Peter FERSCHIN, Austria

## Introducing NOaA 2.0: a web-based research agenda for Dutch archaeology for the benefit of heritage management, science and society

**Bert GROENEWOUDT**
(Cultural Heritage Agency of the Netherlands (RCE), Amersfoort, The Netherlands)

**Keywords:** research agenda, question-driven research, decision-making, public participation

 **Abstract:**
Recently a new research agenda for Dutch archaeology went online: NOaA 2.0. It replaced an earlier, analogue, research agenda (NOaA) that originates from the early days of commercial archaeology in the Netherlands. NOaA was created between 2005 en 2008 to ensure that field archaeology remained to be guided by relevant research questions. This was a joint enterprise bringing together universities, commercial companies, heritage agencies etc.
This paper focusses on the transformation of the NOaA from an exhaustive overview of archaeological knowledge and remaining questions, into a selective, web-based and highly accessible research agenda meant not only to be used by archaeologists, but also policy makers and interested members of the general public. It was specifically designed to facilitate decision making related to archaeology/archaeological heritage and for outlining archaeological research plans.
The user-friendly NOaA 2.0 search engine is based on faceted browsing. Relevant research questions can be selected by choosing five different parameters: place name, archaeological region, period, site type and/or research subject. The more detailed the query, the more specific the search result: the selected set of research questions. Each NOaA 2.0 question is briefly explained and contextualized. Also suggestions are provided how to put questions into practice in order to create building blocks that in due time will help answering them. All NOaA 2.0 question can be translated into archaeological fieldwork: in the selection process scientific ambition was carefully balanced with practical realities and opportunities. Only 'national' (supra-regional) questions are included. Different groups of NOaA users not only participated in creating NOaA 2.0 but also contribute to continuously improve the system: shape as well as content. Feed-back has been positive. The NOaA 2.0 facilitates decision-making and public participation because it makes archaeology more accessible to non-specialists, and archaeological priorities transparent.

**Relevance conference | Relevance session:**
NOaA 2.0, probably the first web-based and user-friendly archaeological research agenda in the world, facilitates archaeological decision-making and makes the process more transparent.
**Innovation:**
Based of faceted browsing: selecting (and checking) what research questions are relevant – and how to put them into practice – is a matter of seconds.

**References:**
GROENEWOUDT, B. (2015): Valletta Harvest: value for money. Dutch initiatives to make 'Malta' excavation results relevant to heritage management, science and society. Contribution EAC Occasional Paper No. 10 Amersfoort.
THEUNISSEN, L. /. GROENEWOUDT, B. / GROOT, T. de, / EERDEN, M. (2015): Wat willen we weten over het verleden? Naar een Nationale Onderzoeksagenda Archeologie 2.0, Archeobief 19-2, 7-13.

# Presentation of a complex project on a virtual and interactive museum involving institutions of Florence, Rome and Hiraklion, addressed to scientific and general public

**Anna Margherita JASINK | Cristian FARALLI | Panaiotis KRUKLIDIS**
(University Florence, Italy)

**Keywords:** interactive museum, new technologies, cultural heritage

**Abstract:**
MUSINT II is part of a bigger project involving a series of virtual and interactive museums, using traditional and new technologies with the aim to reach an enlarged public. The presence of Archaeologists, Architects/designers and Informatics assures an interdisciplinary methodology that makes our project rich of solutions and attractive to different visitors. MUSINT II uses a sophisticated structure, a series of 3 dimensional models produced both with photogrammetry and laser scanner. A complex database with numerous interconnected queries is implemented in order to enhance the study of a large number of objects giving really innovatory answers and effortless data process. New hyperrealistic techniques are used to best illustrate the reconstruction of buildings, objects and scenes of life. A specific educational section is directed to young people where all these new techniques are applied in a winning way. The main object of MUSINT II consists in a specific category of small objects: sealings and seals coming from the excavations at Haghia Triada carried out by the Italian Archaeological expedition in Crete during the first years of 1900. Our purpose is to offer a new analytic and, at the same time, a synthetic vision opened to a large audience of the historical-archaeological representation of one of the most important sites of Minoan Crete.

**Relevance conference | Relevance session:**
interdisciplinary methodology for a virtual museum
**Innovation:**
Example of Cultural Heritage for scientific and general public
**References:**
**MUSINT –** Museo interattivo delle Collezioni egee e cipriote in Toscana. Ricerche ed esperienze di museologia interattiva (A.M.Jasink, G.Tucci, L.Bombarbieri eds.), University Press, Firenze 2011 (= Periploi 3)
The use of new technologies in the presentation and analysis of ceramics of the Aegean Collection in the National Archaeological Museum of Florence

# Photogrammetry and macrophotography. The experience of the MUSINT II Project in the 3D digitizing process of small size archaeological artifacts

**Stefano MARZIALI[1] | Giulia DIONISIO[2]**
([1]Accademia di Belle Arti di Verona, Italy | [2]University of Florence, Italy)

**Keywords:** photogrammetry, macrophotography, glyptic, interactive museum, workflow

**Abstract:**
The MUSINT II project was created to publicize and promote the minoan glyptic, a little-known archaeological heritage. Its contents were designed to involve both specialists and a general public (adults and children).
The project assembles a single tipology of objects, the whole of the sealed administrative documents discovered at Haghia Triada in Crete and collected in two italian museums, in Rome and Florence (see the contribution by Jasink et alii for a general view). Particularly, this interactive museum focuses on the 3D digitalization of 18 very small (about 2 cm diameter) minoan seals, stored in the archives of the National Archaeological Museum of Florence and not visible to the public.
The digitalization of these artifacts requires a high quality resolution technique capable of capturing

their morphology and decorative motives and, at the same time, appeals to the aforementioned educational targets.

For this reason, the Structure from Motion (SfM) Photogrammetry was chosen. This technology makes it possible to obtain three-dimensional reproductions from random photographs made by non-dedicated devices, but the tiny-object survey required specific instruments and skills.

A macrophotography technique was applied together with a specific workflow to obtain high quality photogrammetric models and to save time in acquiring and processing images. With this methodology we obtained 3D models of high metric precision mesh and maximum color fidelity textures. This process delivers results of high level detail for low capital costs and minimal acquisition and processing time (4 hours).

**Relevance conference | Relevance session:**
The photogrammetric technique is applied to very small size archaeological artifacts.
**Innovation:**
Development of a specific workflow for SfM photogrammetry applied to an interactive museum for the disclosure of little-known archaeological artifacts.
**References:**

ALBERTINI, N. / JASINK, A.M. / MONTECCHI, B. (2014): Digital acquisition and modeling of the Minoan seals and sealings kept in two italian Museums, Proceedings of the CHNT 18, 1-22.
JASINK, A.M. (2009): La collezione di sigilli e cretule egee, in (A.M. Jasink and L. Bombardieri eds.), Le Collezioni egee del Museo Archeologico Nazionale di Firenze, 77-88.

# GIS-based reconstruction of Vienna's historical landscape since the 16th century

**Severin HOHENSINNER**
(University of Natural Resources & Life Sciences Vienna (BOKU), Vienna, Austria)

**Keywords:** GIS, environmental history, landscape, historical sources, urban development

**Abstract:**
In a radical departure from usual historical accounts, we traced the natural and human-induced transformation processes of the Viennese landscape from the early 16th century to the present based on GIS reconstructions. The study was conducted in the two interdisciplinary research projects ENVIEDAN and URBWATER on the environmental history of the Viennese Danube and its tributaries. This paper describes the different types of data sources used for the GIS-based reconstructions, the underlying methodological approach and its limitations.

Several cornerstones provided the basis for reconstructing the historical landscape: (1) more than 1,000 historical maps and topographical views, of which ca. 220 were georeferenced; (2) numerous written sources from the 16th century onwards and a multitude of historical literature; (3) archaeological findings from the late 19th century onwards; (4) geological borehole data and hydrogeological information; and (5) the knowledge about morphological processes typical for the Danube River and its tributaries prior to regulation. We compiled the historical states of the Viennese landscape step-by-step going backwards in time. After one historical situation had been completed, we evaluated its relevance for the temporally younger situations and whether corrections would have to be made. This "regressive-iterative" approach allows for permanent critical revision of the reconstructed time segments already processed. The resulting 14 maps of the historical landscape from 1529 to 2010 provide a solid basis for interpreting the environmental conditions for Vienna's urban development. In addition, the data are provided on the web-based GIS platform "Wien Kulturgut" for the general public.
(see https://www.wien.gv.at/kultur/kulturgut/geschichte/landschaftsentwicklung.html)

**Relevance conference | Relevance session:**
importance of interdiscplinary research and potential for informing the general public

**Innovation:**
The applied regressive-iterative GIS method based on different data sources and online access for the general public.

**References:**

**HOHENSINNER S. et al. (2013):** Two steps back, one step forward: Reconstructing the dynamic Danube riverscape under human influence in Vienna. Water History, 5 (2), 121-143.
**HOHENSINNER S. et al. (2013):** Changes in water and land: the reconstructed Viennese riverscape 1500 to the present. Water History,
5 (2), 145-172.

## Combining data acquisition technologies to support heritage protection and interactive presentation

**Reka LOVAS | Katalin TOLNAI**
(Mensor3D Kft., Budapest, Hungary)

**Keywords:** laser scanning, point cloud, 3D model, virtual presentation, heritage protection

**Abstract:**
Current paper discusses how cutting edge remote sensing technologies can be used for cultural and archeological heritage protection.
The goal is to support many application areas from work on site, through documentation, to virtual reconstruction and virtual presentation in case of the Roman watchtower at Visegrad-Lepence, Solomon-tower and Visegrad-Sibrik watchtower.
Several technologies were combined during the data acquisition procedure, such as terrestrial laser scanning, structured light scanning, UAV photogrammetry, photo, video, geodesy and ground penetrating radar.
The main objective was to create a dataset that enables deriving a colored point cloud with millions of points, then a high quality and high resolution surface model with texture, set of panoramic images, video, CAD models, 3D prints and interactive presentation animations.
To support heritage protection, in case of the Solomon-tower, the building has been surveyed outside and indoor to create the architectural documentations.
At Sibrik-hill a late Roman fortification was recorded during former excavations. Documentation was created manually then transformed and imported into a GIS database. During the survey the inner part of the castle area was measured with magnetometer as well as with ground penetrating radar. The result of this survey was first interpreted in the same GIS environment showing the anomalies in 3D.   A tin chalice artifact was found, the main body's geometry was captured by scanner, and was reconstructed as CAD model.
The reconstruction of the watchtower at Visegrad-Lepence was supported by laser scanned pointcloud. Three Roman age statue heads, and a building construction plate were excavated, scanned with structured light scanner, and the detailed 3D model was created for virtual reality museum presentation. The artifacts are stored and presented in the Solomon-tower's exhibition, the animated video of the virtually joined sculpture head and the female torso can be seen in the Budapest History Museum – Aquincum Museum.

**Relevance conference | Relevance session:**
The goal of this project was to survey, model and document historical sites and artifacts to support historical architecture, art historian research and virtual reality museum presentations.

**Innovation:**
Virtual presentations, animations based on the scanned data can offer not just the sense of presence but also give a touch of time travel back to imaginary but historically correct scenes.

**References:**
http://www.asprs.org/a/publications/proceedings/IGTF2016/IGTF2016-000101_paper.pdf
http://archeologia.hu/content/archeologia/179/sibrik-tolnai.pdf

## Using digital techniques for the communication of the history of the Thessaloniki Islahhane

**Anastasia VALAVANIDOU | Areti KONDYLIDOY | Nikolaos PACHTAS**
(Ministry of Culture, Thessaloniki, Greece)

**Keywords:** ottoman monument, ottoman archives, oral history, digital techniques

**Abstract:**
This paper presents the museological study of the permanent exhibition of the Thessaloniki Islahhane and the ways IT technologies are implemented. The Islahhane of Thessaloniki is an ottoman complex (orphanage and technical school), later a foundry that is enlisted and protected from the Ministry of Culture and Sports of Greece.The Unit of Modern Monuments and Technical Works of Central Macedonia aims at restoring and reusing the Islahhane complex.
Historical information from the BOA archives in Ankara combined with oral history are used in an immersing reality system, where two digitized actors, "Ziya" an early 20th century pupil from Serbia that studied in Islahhane and "Sultana" a woman worker at the 1960's foundry, are acting as multimedia guides to the infrastructure's history. Additionally, a series of interviews with former foundry workers were filmed, based on a predefined questionnaire. All the produced material was properly implemented – through digital technology – in the creation of an interactive application that depicts an essential part of the history of metal-workers in the foundry.
The project team presents the procedure from the initial designing steps to the final products-museum objects, showing the difficulties, the modifications and the alternations that were necessary during the evolving of the digital applications.

**Relevance conference | Relevance session:**
This paper presents the digital applications used on the presentation to the general public of a new cultural heritage monument, the Islahhane of Thessaloniki.
**Innovation:**
Immersing reality and digital actors.
**References:**
**IOANNIDIS, Yannis, et al.(2013):** "One object many stories: Introducing ICT in museums and collections through digital storytelling." Digital Heritage International Congress (DigitalHeritage), 2013. Vol. 1. IEEE, 2013.
**LAROCHE, Florent (2008):** "Advanced Industrial Archaeology and Techno-Museology: A new virtual life for industrial heritage." TICCIH Bulletin 41 (2008): pp-3.

## Augmented, virtual, and actual soundscapes as cultural heritage

**Aaron LIU-ROSENBAUM**
(Laval University, Quebec, Canada)

**Keywords:** soundscape, immersion, spatialization, augmented reality

**Abstract:**
In discussions of cultural heritage, the focus is often on the visual and the material. The important role of sound in cultural heritage—even tangible cultural heritage—is therefore often overlooked or underrepresented. In this presentation, I will discuss two projects that use and adapt field recordings to both promote and preserve the cultural heritage of sites. These recordings are composed into soundscapes that may be modified according to artistic or other goals. In the first project, various

recordings of Quebec City were altered to simulate physiological hearing patterns in order to raise awareness of hearing loss, thus drawing in social elements to the visitor experience. For the second project, field recordings of bird calls taken at a historic site valued for its diverse bird population enable the archiving and transposition of the sonic experience of the site to both online as well as other geographic locations, in order to promote the site and its heritage through "real", "augmented", and "virtual" recreations of its soundscape. Once the sounds of a site are recorded, there are thus many modalities for their preservation and promotion, and for designing interactions with visitors. I will discuss these modalities as they pertain to these two cases.

**Relevance conference | Relevance session:**
This paper addresses how to treat and present digital information—in this case, soundfiles—of cultural and scientific value, which is one of the conference's stated goals.
**Innovation:**
The innovative aspect of this paper is the integration of immersive sound as a complement to the visual appreciation of tangible cultural heritage.
**References:**
Professeur Alain **VIAU**
Département des sciences géomatiques
Université Laval

Mathieu **VIAU-COURVILLE**
Chargé de recherche, rayonnement scientifique
Direction des expositions
Musée de la civilisation, Québec

# Chronicles of a House – An Immersive Journey from the Middle Ages to the Present

**Sandro LOCHAU**
(Züricher Hochschule der Künste, Zürich, Switzerland)

**Keywords:** interactive simulation, looking into the past, storytelling

**Abstract:**
For my bachelor's degree in Scientific Visualization I created an interactive archaeological reconstruction telling the story of a medieval secular building, the «Papenhof», located in the town of Barth, in Mecklenburg-Vorpommern, Germany. The goal was to allow the viewer to immerse into a time travel simulation with the help of virtual reality and to present the exciting history of the Papenhof in a five-minute experience with simple interactions, voice-over, environmental sounds and a concise plot.
Using the head-mounted display, the challenge was to work with different aspects of virtual reality such as immersion, realism, and sound and to merge everything into a stand-alone application for both experienced and non-experienced VR users. Some of the questions were: How can the user gently be introduced into the virtual world without confusion and discomfort? Which navigation technique (keyboard/mouse/controller/gaze) should be used? How can the learning phase of controlling the simulation be kept as short as possible? What should be the storyline and how can it be told interesting enough to keep the viewer focused?
Because of their realism, digital reconstructions often tend to give the impression of absolute certainty. As virtual reality is still a very young medium, there was an opportunity to investigate new standards of the depiction of hypotheses. Thanks to new narrative structures it was possible to clearly state what was certain and what not.

**Relevance conference | Relevance session:**
Aiming to catch the digital natives attention in archeology by making use of "their" technologies.

**References:**
https://www.youtube.com/watch?v=Q_8rJq-WPSw


# Panoramic Media: Recording and Representing Digital Heritage Experience

**Takehiko NAGAKURA | Joshua CHOI**
(Massachusetts Institute of Technology, Cambridge, USA)

**Keywords:** Panorama, Video, Architectural History, Digital Heritage

**Abstract:**
In an essay on architectural representation, Stan Allen (2000) wrote about a paradoxical nature of built forms. "Buildings are presumably more tangible and physically present than drawings, yet it is only in the experience of the building that the most intangible aspects of reality can be made visible." Documenting a heritage site is difficult since no representation method can make an exact copy without loss. This paper specifically examines panoramic recording media and related technologies as new means to archive, and represent architectural heritage. It looks at cost effective and widely available platforms such as 360 video camera systems, YouTube, and immersive HMD equipment. Subject tests are conducted to see how the experience of recorded panoramic sequence compares to spatial and temporal experience in the physical space. For instance, the subjects with HMD are tested for the ability of sensing the correct scale of spatial forms in the playback. And through analysis of the test results, discussions are made as to the roles such systems can play in conveying the spatial environment, especially in representing what Allen wrote as its intangible aspects: the play of light, shadow, and atmosphere as well as the parallax effects produced by the movement of the spectator. As examples, the paper then demonstrates prototype exhibit designs that processed panoramically recorded footage into derivative forms. With recordings on sites such as Palladio's villas, Acropolis in Athens, and Japanese historic temples, it shows spatial and temporal editing of raw footage, its superimposition with drawings, interactive display combining a panoramic walk-through with a map, and a framed video narrative produced from panoramic videos. These methods illustrate a range of curatorial possibilities that put each dislocated recording back into context, and shed a light to what is often difficult to achieve by 3D models.

**Relevance conference:**
As a new form of data archive, panoramic recordings can potentially play a unique, cost effective role in capturing intangible sense of heritage space, and conveying the way visitors perceive it.
**Relevance session:**
360 video is explosively marketed during this past year as new format distributable on YouTube and promoted with emerging 360 cameras and HMD products from Samsung, HTC, Oculus, Nikon, LG and Google.
**Innovation:**
For architectural heritage, this paper discusses and illustrates use of panoramic media as a tool for representation of spatial and temporal experience, instead of just documenting the form itself.
**References:**
**ALLEN, Stan (2000):** Practice, Architecture, Technique and Representation (Critical Voices in Art, Theory, and Culture), The Gordon and Breach Publishing Company.
**CUMMINGS, James J. / BAILENSON, Jeremy N. (2015):** How Immersive Is Enough? A Meta-Analysis of the Effect of Immersive Technology on User Presence. Media Psychology. 1-38

# From micro-survey to virtual reality: an attempt of immersive virtual reconstruction

**Andrea PASQUALI | Angela MANCUSO**
(University of Florence – Dipartimento di Architettura, Florence, Italy)

**Keywords:** digital survey, micro-photogrammetry, HMD system, 3D printing, Cappadocia

**Abstract:**
The study concerns of the possible applications of augmented reality in relation to immersive systems for virtual simulation. The study brings together the products of two possible ways of digital survey, laser-scanners and photogrammetry, and their DSM development and software prototyping of portions to propose scenarios useful for cognitive and sensorial immersive experiences.
The example is developed on the rupestrian architectural system of Göreme in Cappadocia, Turkey; the laser-scanner survey operations allow the processing of point clouds of architectural environments: selecting between these environments on which they were carried out more detailed studies, is possible to create software platforms executable by HMD device immersive virtual simulation. The thus created environments then become useful for direct cognitive experience, being able to get into them and feel the size and recognize the functional destination within the architectural system that contains them.
Parallel to this process, the in-depth studies develops the data obtained from relevant micro-photogrammetric operations performed on the wall surface portions with SFM processes; obtaining first virtual models and later as digital 3D printing product life-size reproductions with a high level of detail. By relating environments with hand tracking and space location tracking is possible to get in augmented reality broader experience, which also includes the tactile component that allows an extension of the cognitive framework of the cultural property.
The research does not claim to be conclusive but provides an input to a new path of development of possible relationships between the results of complex measurement campaigns and the use of physical and virtual environments reproduced; all to provide the means of study or archive components evolved and some more next to the total reproduction of reality.

**Relevance conference | Relevance session:**
The paper is an attempt of new ways of relationship between different survey methods.
**Innovation:**
The relationship between the tactile component and the augmented reality
**References:**

**MANCUSO, A. / PASQUALI, A. (2015):** Digital Micro-Photogrammetry: new ways to dialogue with future researchers – Poster Session CHNT 20
**VERDIANI, G. / PUCCI, M. / GIRA, C. (2016):** A special eyesight to a lost past: Oculus Rift, Google Cardboard and SketchFab to support the digital reconstruction of the St. Donato cathedral in Arezzo, Italy – Proceeding of the Kultur und Informatik Conference-Berlin

# As abandoned as full of historical strenght: the case of the Marconi's station in Coltano, Pisa

**Giorgio VERDIANI | Carlo GIRA | Andrea PISANI**
(Dipartimento di Architettura, Florence University, Florence, Italy)

**Keywords:** Guglielmo Marconi; Digital Survey; Radio station; Coltano; augmented reality;

**Abstract:**
In the campaigns around Pisa, in the area named Coltano, there are the modern ruins of an important site, not a simple house with the roof fallen inside, but the headquarters of past scientific activities and the base of a radio station. Once more, not a common radio station, but the very first

radio station, where Guglielmo Marconi (Nobel in Physic in 1909), made the first radio transmissions and the first significant steps in our technological age. The radio station was opened in 1911 and continued its activities until the World War two.

The buildings on the area and the great antennas are now destroyed or in ruins, the house of the Marconi's headquarters is left to itself by general negligence and is reduced to poor walls, while the antennas were destroyed during the war, but their massive concrete bases are still in place.

After a first general survey of the area with the 3D laser scanner documentation of the ruins and the georeferencing of the antenna basements, this personal research started to develop reconstructed 3D digital models from the on site data and from the historical archives. The aim of the project is the development of a working augmented reality model of the place, capable to give at least an image in place of what is lost and what should be worth of some recovery. In this contribution it will be presented the state of development of the project, the procedures and methods adopted to produce a shareble documentation of this neglected mile stone of our age.

**Relevance conference | Relevance session:**
A case study on a modern ruin with a very high historical (and tecnology history) value.
**Innovation:**
A try to avoid to recover what's remained in place and extend the perception in abandoned place is still an innovation.

**References:**
VARIOUS AUTHORS (2004): La stazione Radiotelegrafica Guglielmo Marconi di Coltano, Lions Club Livorno, Pisa 2004
CIABATTINI P. (1995): Coltano 1945, Mursia, Milano 1995

# Apps under the Surface: Problems with Cultural Heritage apps

Daniel STILLER[1] | Willem BEEX[2]
([1]Omgevingsdienst Midden Holland, Amsterdam, The Netherlands | [2]BEEX, Amsterdam, The Netherlands)

**Keywords:** Apps, Municipalities, goals, general public, Cultural Heritage

**Abstract:**
More and more apps for mobile devices are being made with the goal of telling the story of our cultural heritage to the general public. Whether they actually reach the targetaudience or if the apps are being used a lot, is often a mystery.

In the Netherlands most apps are financed with public money by local government-organisations. When we were asked by a Dutch city to advise them about cultural heritage apps for the general public, we noticed and encountered several issues. In the Netherlands there aren't that many apps solely for cultural heritage. And those that exist are often far from perfect and could easily be improved. Most apps, especially those with an archaeological subject, are also rather static. After the original development, new content is almost never added. The download-data show that many apps are not very often downloaded.

From the local governments-side there seems to be a lack of understanding of what could or should be achieved. Often one gets the impression that the only goal was simply to build or have an app. Often an development company gets a set of parameters (subject, a 3d model, etcetera) and the mission to build the app. Another known problem is limited funding, so the optimal system development cannot be reached. Lastly the promotion of apps is relatively sparse after the initial presentation. This results in a initial burst of downloads, followed by a very slow trickle of new downloads afterwards.

Not every problem mentioned above can be easily solved, but a better understanding of the possibilities, combined with a better promotion, will lead to better apps and a better use of them by the general public. As a result the same amount of (public) money will give a better return-rate, while the awareness of Cultural Heritage will improve.

# Digital reconstruction in university teaching and outreach

**Matthew NICHOLLS**
(University of Reading, Reading, UK)

**Keywords:** 3D Rome model digital visualisation reconstruction

**Abstract:**
I have made a large-scale digital model of ancient Rome which I use extensively in teaching and research, and which has also been adapted for broadcast, is being used as the setting for a computer game, and is now the centrepiece of a massive online open course (MOOC) on ancient Rome which will be released on the FutureLearn platform later this year.
If accepted for the New Realities session, I would like to talk in particular about the MOOC., which will be releasd in 2016 and should attract cohorts of c.10,000 students in each of its runs. This will use my digital reconstruction, released in a variety of formats and combined with real world 'documetnary' footage recently filmed in Rome, to introduce learners to ancient Rome. As far I know this will be the first attempt to create a massive online public course using city-scale digital reconstruction. The slide format for this session is prescribed, and my proposals are as follows:

- Summary of the project:
  ancient Rome (5 themed weeks of online course looking at infrastructure, residential and commercial buildings, political buildings and monuments, religious buildings, and entertainment structures). Public global audience of several thousand learners per course run.

- Technical solution (short and clear, stressing the innovations, if any)
  Generation of high quality rendered animations and stills from my city-scale reconstruction of Rome, plus interactive 3D elements inc. Unity-generated 360s for mobile phone and Google Cardboard deployment; combination with real world and studio footage.

- How the technical solution contributes toward reaching the project's goal
  Integration with FutureLearn platform and traditional MOOC content such as high-quality video and discussions. Online deployment of dynamic elements like 360 panoramas within a MOOC platform. Use of visualisation as a teaching tool.

- Results: success, failure, something in between?
  TBC: we have not yet released it but will have done by the time of the conference!

- Where do we go from here?
  Unity-generated complete walk-around model of ancient Rome

**References:**
https://www.academia.edu/25631423/Digital_Visualisation_in_Classics_Teaching_and_Beyond
**NICHOLLS M. 2016:** 'Digital Visualisation in Classics Teaching and Beyond' in Journal of Classical

Teaching, 2016.
Article about my work in British Academy review.

# (Inter)relating to the Dead

Chairs: David BIBBY, Germany | Ann DEGRAEVE, Belgium | Raphael PANHUYSEN, The Netherlands | Karin WILTSCKE-SCHROTTA

## Harris-Matrix as key for understanding time in cemeteries

**Claudia Maria MELISCH | Peter RAUXLOH | Natasha POWERS**
(Humboldt-University, Berlin, Germany)

**Keywords:** cemetery, Harris Matrix, relative chronology of archaeological contexts

**Abstract:**
The beauty of the Harris-Matrix for the understanding of the relative/ real chronology in cemetery excavations was up to now not really exploited. Such a statement might sound arrogant and exaggerated in the ears of experienced archaeologists, but it's nevertheless true. The reason for this is the lack of a common tool that enables the archaeologist to join partial matrices and to implant additional data into the matrix. The importance of the Harris-Matrix was first and foremost seen in the graphical display of the relative chronology – but the Harris-Matrix is much more powerful than that. In fact, the graphical display of the relative chronology of contexts is only the surface. If the amount of contexts from an excavation exceeds a certain number, the conventional graphical display of the Harris-Matrix becomes useless. But the math behind the Harris-Matrix doesn't! By using an interactive graphic format for displaying the relative chronology of archaeological contexts, we created a surprisingly mighty tool that unveils the capacity of this kind of information for the first time and revealed a great potential for further analysis and dating, especially for graves. We have introduced certain aspects of the project "Medieval Space and Population" before in CHNT, but now we can harvest from the previous developments and our interactive Harris-Matrix is the key tool to for choosing radiocarbon-samples, for understanding and correcting the map of the cemetery and for applying a time-component onto the succeeding burials, based on scientific dating.

**Relevance conference | Relevance session:**
New international research
**Innovation:**
The transformation of the Harris-Matrix into an interactiv graphic format revealed a mindblowing capacity.
**References:**
Harris Matrix – new format=new potential
Dating graves, safely separating medieval and early modern period graves by sampling according to the Matrix

## Construction of a Geophysical Signature Archive for the Investigation of Bronze Age sites. The Case of Békés 103 (Jégvermi-kert) in Eastern Hungary

**Apostolos SARRIS[1] | Paweł DZIECHCIARZ[2] | Dylan KELLY[3] | Paul R. DUFFY[4] | Györgyi PARDITKA[5] | Julia GIBLIN[6]**
([1]GeoSat ReSeArch Lab, FORTH, Rethymno, Crete, Greece | [2]University of Warsaw, Poland |

[3]University of New Hampshire, USA | [4]University of Toronto, Canada | [5]University of Michigan, USA | [6]Quinnipiac University, USA)

**Keywords:** Geophysical Prospection, cemetery, Bronze Age, Hungary

**Abstract:**
Geophysical exploration has been an integral part of the BAKOTA (Bronze Age Körös Off-Tell Archaeology) project which is focusing on the archaeological investigations at the Békés 103 (Jégvermi-kert) site located on an old meander of the Kettős Körös in E. Hungary. The site comprises a flat Bronze Age settlement and an urn cremation cemetery. The small size of the graves, the shallow and disturbed deposits and the intensity of agricultural practices have affected the preservation of the archaeological record and provided challenging conditions for the prospection of the site. Investigations were carried out through the combined employment of magnetic gradiometry, EMI techniques, soil resistance and geochemical coring coupled with shovel testing followed by excavation. In order to enhance the interpretation of the fuzzy geophysical signals, the geophysical signatures of the detected features were cross-correlated to the excavation results and the attributes of the excavated features. The statistical analysis indicated the superiority of the magnetic techniques over electrical resistance methods in terms of correlating the magnetic anomalies with the number of ceramic vessels and their dimensions. The study signifies the importance of the construction of geophysical signature libraries that can be used as an archive to establish a framework for future investigations of similar sites.

**Relevance conference | Relevance session:**
Fusion of Geophysical and Excavation Data
**Innovation:**
Towards the construction of geophysical signatures
**References:**
DUFFY, Paul R. / GYÖRGYI PARDITKA, Julia I. / GIBLIN, László Paja / RODERICK B. Salisbury (2014): "Discovering Mortuary Practices in the Körös River Basin, Hungary." Hungarian Archaeology Autumn (2014).
SARRIS, Apostolos A. (2013): Technical Report: Bronze Age Körös Off-Tell Archaeology (BAKOTA): Geophysical Investigations at Békés Koldus-Zug, Hungary (Phase II:2013).

# Life and death in the Napoleonic wars – A bioarchaeological investigation of skeletal remains from the Battle of Aspern 1809

**Michaela BINDER | Leslie QUADE**
(Österreichisches Archäologisches Institut, Vienna, Austria)

**Keywords:** bioarchaeology, paleopathology, Vienna, battlefield archaeology

**Abstract:**
From the 21st to the 22nd of May, 1809, Napoleon met his first defeat on land in a major battle near the villages of Aspern and Essling on the outskirts of Vienna. An estimated 55 000 French and Austrian soldiers died as a direct result. In recent years, large scale building projects due to the expansion of the city brought about several salvage excavations in the area of the battlefield, carried out by the Stadtarchäologie Wien. In addition to a number of prehistoric site, several battlefield burial sites were uncovered as well. The presence of textiles, buckles and metal uniform buttons marked with specific regiment numbers has made it possible to identify some of the soldiers as members of the French army.
29 individuals were subject to bioarchaeological analysis and evaluated for demographic data, stature, dental and skeletal pathologies to elucidate the impact of Napoleonic military conditions on health during life and patterns of trauma leading to death on the battlefield. The analysis revealed high mean stature and low prevalences of enamel hypoplasias, indicating relatively good health

during childhood. This comforms to historical records stipulating that soldiers were required to meet certain height and health requirements to enlist in military service. The high percentage of individuals under the age of 20 (18.5%) supports documentation of Napoleon's increased need for new recruits during this time period. Carious lesions, dental calculus, sinusitis and indicators of infectious diseaas were very common, attesting to the effects of military life on health. Perimortem projectile gunshot wounds to the cranium, thorax and femora were the most frequently identified trauma, with little clear evidence of sharp force trauma.

**Relevance conference | Relevance session:**
This presentation showcases contextualised bioarchaeological work in Vienna.

## „Aim and shoot" – A bioarchaeological contribution to the reconstruction of military strategies in the Thirty Years' War

**Nicole NICKLISCH | Oliver PESCHEL | Axel MANTHEI | Frank RAMSTHALER | Kurt W. ALT | Susanne FRIEDERICH**
(The State Office for Heritage Management and Archaeology – State Museum for Prehistory Saxony-Anhalt, Halle (Saale), Germany)

**Keywords:** battlefield archaeology, ballistic analysis, forensic gunshot reconstruction

**Abstract:**
In 2011 a mass grave from the Thirty Years' War was discovered near the small town of Lützen in Saxony-Anhalt, Germany. The whole grave was recovered "en bloc" and analysed at the State Museum of Prehistory in Halle (Saale). The grave contained the skeletal remains of 47 men with an age at death range of 15-45 years. Due to the geographical location of the grave, along with material findings around and within the pit, the ensemble can be dated back to the 17th century: the skeletal remains belonged to soldiers, which died in the great Battle of Lützen in November 1632. According to the trauma analysis numerous individuals revealed gunshots wounds – mainly to the head. It was speculated that these soldiers might have been executed on the battlefield. But from the historical point of view and military reconstruction of the battle there is no need for such an explanation. In fact, the forensic examinations of the shape of the wounds as well as the ballistic properties of the retrieved ammunition indicated short- to mid-range gunshot discharges of firearms from light and heavy cavalry in close combats. To receive more information about the ongoing on the battlefield, gunshot experiments were performed with replica of three historical weapons (pistol, carbine, and musket). For this reason hollow spheres filled with ballistic gelatine as well as blocks of gelatine and ballistic soap were used to simulate the human skull and soft tissue. The experiments were conducted in order to reconstruct the situation in which the soldiers died by exemplifying questions of target distance, load or possible influences by environmental parameters (e.g. climatic conditions). At the conference we would like to present methods and results of the investigations and to discuss technical approaches.

**References:**
**NICKLISCH, N. / KNIPPER, C. / HELD, P./ PICKARD, L. / RAMSTHALER, F. / FRIEDERICH, S. / ALT, K. (2015):** Die 47 Soldaten aus dem Massengrab – Ergebnisse der bioarchäologischen Untersuchungen. In: Meller H, Schefzik M (Eds.) Krieg. Eine Archäologische Spurensuche. Begleitband zur Sonderausstellung im Landesmuseum für Vorgeschichte Halle (Saale), Theiss-Verlag, S. 405-420.

## Interrelating realities: historical and archeological sources for burials in post-medieval Amsterdam (1553- ca. 1865)

**Erik SCHMITZ**
(Amsterdam City Archives, Amsterdam, The Netherlands)

**Keywords:** burial history archeology sources

**Abstract:**
In 1991, the former Dutch Reformed Olof Chapel (Olofskapel) in Amsterdam was transformed into a congress centre. Building activities included digging a large basement, destroying all five still intact layers of burials, dating from 1619 onwards, and the underlying late medieval traces. In advance, the municipal Amsterdam archeologists were able to investigate the medieval phases of the chapel. As for the later periods, the former tombstone floor was documented and – due to lack of time and money – only a part of the deepest burials was properly excavated. Although these were expected to date from the early 17th century, they turned out to be from an much later date: the late 18th and 19th century. In retrospect, this can be corroborated by the grave books of the chapel, that show that burial was common until the 1860's. The grave books also mention the removal of older burials, depositing the remaining bones in a deeper, sixth layer of 'charnel'coffins. In 1991, this layer of bone deposits was a surprise as well.

The Olof Chapel might serve as an example of two intertwined realities. On the one hand the historical data stored at the archives. The on-line index of burials (1553-1811) on the website of the Amsterdam City Archive contains 1,1 million records, mentioning the date of funeral and the name of the deceased, leading to the original historical sources that also mention family relations, the street where the deceased lived, and costs of the burial. These records are an important historical source in itself. But they can, as can the church archives, also help in predicting the archeological potential remaining under the old church floors. This paper seeks to highlight and map this aspect.

Archeology, on the other hand, is depending on the state of the soil archive. But modern church restauarations, including constructing floor heating systems, have left their scars in the archeological data that still remain in the ground. This paper seeks to highlight and map this aspect too.

**Relevance conference | Relevance session:**
Reuse of archival data in understanding archeological data
**Innovation:**
Predicting archeological remains by using historical sources in an new way
**References:**
https://archief.amsterdam/indexen/begraafregisters_1553-1811/zoek/index.nl.html
https://www.amsterdam.nl/publish/pages/463724/aar_7.pdf

# The Black Church Project: interdisciplinary approaches to the study of a medieval urban cemetery

**Daniela ISTRATE | Annamaria DIANA**
("VasileParvan"Institute of Archaeology, Bucharest, Romania)

**Keywords:** medieval and modern burials; urban archaeology; human osteoarchaeology; German colonists in East Europe

**Abstract:**
Between 2012 and 2013, extensive rescue excavations were conducted in the area overlying the old parish cemetery of Braşov, in Transylvania (Romania). Braşov was a flourishing urban centre founded in the 12th century by Central European colonists, under the protection of the Hungarian King. Over the following centuries, the settlement became a crossroad for travellers, merchants and diplomats from all over Europe and the Middle East, as witnessed by documentary sources. Braşov was in fact a multi-ethnic and multi-cultural city, where communities of German, Romanian, Hungarian and Jewish ancestry lived.

The recent excavations unearthed a complex and challenging stratigraphy formed by centuries of uninterrupted human habitat, and an archaeological site of inestimable value for the reconstitution of the urban life in medieval and modern Eastern Europe. Dwellings dating back to the 12th century were overlapped by the structure of a Premonstratensian monastery and a Cistercian abbey. Around

the year 1200 the area was occupied by the parish churchand its burial site, which would have been used as the urban community's main cemetery until the 18th century. The investigation of the burial ground revealed over 1,400 tombs.

Our paper will focus on the analysis of the cemetery by means of an interdisciplinary approach. The study and interpretation of burial practices, grave goods and funerary topography, cross-referenced with the demographic and pathological profile reconstructed from human skeletal remains, are shedding new light on this population's history. The paper will pay particular attention to the interpretation of the burial context in a broader historical framework, emphasising the implications for understanding the process of urbanisation in this area.

**Relevance conference | Relevance session:**
The paper will discuss the main features of the burial ground in a broader historical, archaeological and anthropological context.

**Innovation:**
Archaeological and human osteoarchaeological investigations allow a unique insight into the living conditions of a medieval diaspora from East Europe.

**References:**
**MARCUISTRATE D. (ed.) 2015:** Redescoperiretrecutului medieval al Braşovului – Unearthing the medieval past of Braşov, Mega Publishing House, Cluj Napoca.
**MARCUISTRATE, D./ CONSTANTINESCU, M./ SOFICARU, A. (2015):** The medieval cemetery of Sibiu (Hermannstadt) – Huet Square, Dr. Faustus Verlag, Tübingen.

# Lauchheim 1986 – 2016. The Interdisciplinary analysis and GIS-Mapping of a prominent early medieval necropolis in Eastern Swabia

David BIBBY | Benjamin HÖKE
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**Keywords:** Necropolis, computer tomography, anthropology, GIS

**Abstract:**
One of the most well-known and largest early medieval necropoles in Western Europe lies near the small town of Lauchheim in Baden-Württemberg, South West Germany. Totaling round 1400 inhumations dating from 5th – 7th Century AD, it was completely excavated between 1986 – 1996. Due to the high frequency of finds and the fragility of some of the bone material, much use was made of block lifting. Some blocks remain unopened till today. The good state of preservation and the juxtaposition of the necropolis with a contemporary settlement, which was also extensively excavated, set the stage for an extensive social-historical analysis of a local early medieval community over two centuries. Analysis of the grave good and anthropological appraisal have been combined and structured in a specially designed Database containing over 30,000 individual entries. A GIS Map of the site, arduously piped from the original hand drawings via vectorization software and CAD into Open Source GIS, allows for perspicuous visualization of any combination of anthropological data and/or finds and contributes greatly to the understanding of the development of the necropolis. Since 2008 the Lauchheim Project has been supported by the German Research Council, allowing innovative conservation and documentation methods including complete anthropological examination, 3D computer tomography of the unopened blocks (with sometimes surprising results) and the extensive examination of organic material and textiles.

This contribution will be the first English language progress report on the development archaeological and anthropological analysis of the Lauchheim findings and, especially their visualization in GIS.

**Relevance conference | Relevance session:**
Innovative project showing the progress from "low tech" conventional Excavation of 1980s-1990s to

"high tech" analysis of the results in 21st century.

**Innovation:**
Use of laboratory conditions for opening the blocks to get maximum information, use of 3D tomography, innovative use of GIS for cememtary analysis.

## Scanning an Early Medieval burial from Domburg (The Netherlands)

**Raphaël PANHUYSEN[1] | Maarten SEPERS[2] | Kim VAN STRATEN[3]**
([1]ACASA-Department of Archaeology, Amsterdam University | [2]Loes Opgenhaffen | [3]Panoptes Heritage, Amsterdam, The Netherlands)

**Keywords:** Domburg, burial coffin, Early Medieval, CT scanning, 3D surface documentation

**Abstract:**
In 1923 the North Sea coast retracted near Domburg leaving traces of an ancient burial exposed. The remains of the grave were recovered by block lifting the wooden bottom of a burial coffin together with human remains embedded in soil on top of the plank. Although the find is curated in the collection of antiquities of the province of Zeeland, it has never been studied in detail. Only recently the initiators, Letty ten Harkel, Robert van Dierendonck and Pieterjan Deckers, of the Investigating the Early Medieval Dead from Domburg project have focused their attention on these remains. Within the framework of this project several burial contexts from the early medieval period from Domburg are being examined. The project combines a wide range of methods starting with traditional archaeological methods and including various dating techniques and element analyses. Since the grave was salvaged in 1923 it represents one of the oldest graves found in Zeeland. Because it is also a suitable object to illustrate the early medieval history of the province it was decided to study this object mainly in a non-destructive way. For this reason, a protocol was designed combining a 3D scan of the surface of the preserved remains with a CT scan. This protocol is aimed at documenting the wooden plank, which is supposed to be a reused fragment of a ship and analysing the human remains. In order to determine the sex and age of the person buried in the grave the bones would normally have to be lifted from the soil adhering to the wooden board. Doing so would result in a complete dismantling of this historical object. The combination of CT scanning and 3D surface documentation will allow us to analyse the remaining skeletal elements in detail and provide the necessary physical anthropological and palaeopathological data. This paper describes the details of the applied techniques and the results of the osteoarchaeological examination. Further it will discuss the advantages and limitations of non-destructive analysis of special archaeological objects.

# 3D reconstruction as an interpretative melting pot of the (art-)historical data

Chairs: Piotr KUROCZYŃSKI, Germany | Fabrizio APOLLONIO, Italy |Krzysztof KOSZEWSKI, Poland | Stephan HOPPE, Germany

## A medieval bishop's palace in Milicz. 3D reconstruction as a method of a research hypotheses presentation

**Justyna KOLENDA | Małgorzata MARKIEWICZ**
(Institute of Archaeology and Ethnology of the Polish Academy of Science, Wrocław, Poland)

**Keywords:** 3D visualization, reconstruction, the bishop's palace in Milicz, the London Charter

**Abstract:**

As a result of the intensive development of multimedia 3D visualizations of various kinds of historically, artistically or scientifically valuable objects became standard at the beginning of the 21st century. What triggered the construction of three-dimensional visualizations was the will to protect the cultural heritage – especially historical monuments which are in ruins and exposed to further destruction – as well as the need to disseminate the information about such objects not only among the small group of specialists. Another reason of that is to verify the existing proposals of reconstructions or research hypotheses. The bishop's palace in Milicz was probably built in the late thirteenth or early fourteenth century. It was a brick building referring to the type of layout of princely buildings known in Silesia. Erection of the building in Milicz was connected with the creation of the Church castellany in this area. Visualisation of the oldest phase of the bishop's palace in Milicz is part of the project: Regni custodiam et clavem – Santok and clavis regni Poloniae – Milicz as an example of two border towns, implemented by the Institute of Archaeology and Ethnology of the Polish Academy of Sciences and financed from the funds of the National Program for the Development of Humanities for the years 2011-2017. Virtual reconstructions were based on the analysis and interpretation of source materials, in accordance with the guidelines contained in the London Charter. The purpose of the visualization is to introduce residents of Milicz and tourists to history of the building and, in the long run, to take steps by local authorities towards preservation and revitalization of the bishop's palace.

**Relevance conference | Relevance session:**
Creating of 3D reconstruction is a form of discussion on the correctness of the applied methods and research hypotheses.

**Innovation:**
This is the first 3D reconstruction of the palace in Milicz.

**References:**
The London Charter for the computer-based visualisation of cultural heritage:
http://www.londoncharter.org/fileadmin/templates/main/docs/london_charter_2_1_en.pdf
CHOROWSKA M./ KUDŁA A. (2005) Architektura i historia średniowiecznego Milicza [In:] Nie tylko zamki, eds. M. Chorowska & all, Wrocław, 83-96.

## Reconstructing Vindonissa as a living document

**Jonas CHRISTEN**
(ikonaut, Brugg, Switzerland)

**Keywords:** visualisation, 3D reconstruction, 3D modelling, Roman legion camp

**Abstract:**
The legion camp "Vindonissa" in Switzerland is considered one of the most important roman sites north of the alps. Research there has been going on for over a century and reconstructive drawings have always been a way to showcase scientific findings of the site, the earliest of them dating back as far as 1909.
In 2015, it was decided to produce a new series of illustrations. The whole camp and its surrounding settlements had to be constructed as hand-generated 3D models, allowing for quick changes during the reconstructive process and flexibility in future adaptations. Topographical data, archaeological plans as well as building profiles provided by experts were the basis for the model.
The main focus was on a general impression of the camp and not on individual buildings but some landmarks as the newly postulated circus were crafted with a higher level of detail as they are the

topic of scientific discourse and it helps the discussion if they have a certain fidelity. The circus also serves as a good example for the value of the imaging process in research: Only after trying to fit it into the topography it was noted that it would overlap with a street that was previously thought to run through this area. In the discussion between archaeologists and illustrators a new path for the street was chosen that fits into the landscape and is scientifically acceptable.

The new series of illustrations is going to be originally published in the annual report of the archaeological society Vindonissa. All buildings are constructed so that they can easily be adapted for real-time use, therefore a planned VR application is the logical next step for its use.

The resulting model represents the current state of research but mainly serves as a starting point for future discussion.

**Relevance conference | Relevance session:**
The newly constructed 3D model contains the results of a century of research about the roman legion camp and aims at conserving it for the future.

# The Reconstruction – Argumentation Method, Proposal for a minimal documentation standard for virtual reconstructions

**Marc GRELLERT | Mieke PFARR-HARFST**

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**Keywords:** documentation, virtual reconstructions, standards

**Abstract:**
Virtual reconstructions exist for around 25 years. A documentation of the process of reconstructions was rarely made – a deficit from a scientific standpoint. One reason was that this was a relatively new discipline and there was a lack of agreement as to standards and methods. Another was that in many cases the client did not provide separate funds for a documentation and also did not require or request them.

In the meantime, many involved parties have become aware of the problem of the lack of documentation and standards. Besides good scientific practice, also the guarantee to have access to knowledge embedded in reconstructions should be realized. However, up to now the proposals orientate themselves rather on extensive maximal solutions, often coupled with complex data bank applications, possibly also with annotations to 3D models, which in reality in most projects would present big challenges as far as usability and available resources are concerned.

Thus it seemed more constructive to develop a minimal standard, which in practice would be manageable. The goal of the proposal presented is to compare images of the reconstruction with the sources and to link them to a written text (argumentation), which explains upon what basis, including sources, analogies etc. the reconstruction was made. The core is therefore the triad – "Reconstruction – Argumentation – Source". In addition there exists the possibility to also depict variants for the different areas of a reconstructed building.

The advantage of such a documentation method is that it would be theoretically useable for every kind of architectural reconstruction and thus also for haptic models, reconstruction drawings or actually built structures. The technical goal is a web-linked database that can serve as a platform for work, publication and discussion. The method can also be implemented as a simple text document with a series of images.

**Relevance conference | Relevance session:**
Standards of documentation should be discussed in the scientific community because up until now they have not been established for virtual reconstructions.

**Innovation:**

Proposal for a minimum feasible documentation which could be used for all kind of reconstructions (haptic models, reconstruction drawings etc).

**References:**

**PFARR, M.(2010):** Dokumentationssystem für digitale Rekonstruktionen am Beispiel der Grabanlage Zhaoling, Provinz Shaanxi, China. TUprints, Darmstadt (2010). http://tuprints.ulb.tu-darmstadt.de/2302/

**GRELLERT, M. / HAAS, F. (2016):** Sharpness Versus Uncertainty in 'Complete Models'. Virtual Reconstructions of the Dresden Castle in 1678, in: Hoppe S., Breitling, S. (ed.): Virtual Palaces, Part II Lost Palace

# The reconstruction of 'drawn' architecture

**Fabrizio Ivan APOLLONIO | F. FALLAVOLLITA | R. FOSCHI | S. CORSO | E.C. GIOVANNINI**
(Dept of Architecture – University of Bologna, Bologna, Italy)

**Keywords:** 3D reconstruction, classical architecture, semantic structure, Palladio, Ledoux

**Abstract:**
Among the many cases that concern the process of digital hypothetical 3D reconstruction a particular case is constituted by never realized projects and plans. They constitute projects thought and remained on paper that, albeit documented by technical drawings, they pose the typical problems that are common to all other cases. From 3D reconstructions of transformed architectures, to destroyed/lost buildings and part of towns.
This case studies start from original old drawings which has to be implemented by different kind of documentary sources, able to provide – by means evidence, induction, deduction, analogy – information characterized by different level of uncertainty and related different level of accuracy.
All methods adopted in a digital hypothetical 3D reconstruction process show us that the goal of all researchers is to be able to make explicit, or at least intelligible, through a graphical system a synthetic/communicative level representative or the value of the reconstructive process that is behind a particular result.
The result of a reconstructive process acts in the definition of three areas intimately related one each other which concur to define the digital consistency of the artifact object of study: Shape (geometry, size, spatial position); Appearance (surface features); Constitutive elements (physical form, stratification of building/manufacturing systems).
The paper, within a general framework aimed to use 3D models as a means to document and communicate the shape and appearance of never built architecture, as well as to depict temporal correspondence and to allow the traceability of uncertainty and accuracy that characterizes each reconstructed element.
Case studies span from Palladio to Ledoux, from Antolini to Jefferson.

**Relevance conference | Relevance session:**
From architecture to archaeology: how to preserve, re-use and repurpose data through the 3D reconstruction process

**Innovation:**
The paper aims to define a general framework able to depict temporal correspondence, as well as levels of uncertainty, index of reliability, grade of accuracy

**References:**
**MÜNSTER, S.(2013):** Workflows and the role of images for virtual 3D reconstruction of no longer extant historic objects. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences, ISPRS II-5/W1, 197-202 (2013)

**KUROCZYŃSKI P. / HAUCK O. B. / DWORAK D. (2014):** Digital Reconstruction of Cultural Heritage –

Questions of documentation and visualisation standards for 3D content. In: In: 5th International Euro-Mediterranean Conference on Cultural Heritage, Lemessos/Cyprus, 03.-08.11.2014

# Interdisciplinary data fusion for diachronic 3D reconstruction of historic sites

**Gabriele GUIDI | Laura MICOLI | Sara GONIZZI BARSANTI**
(Politecnico di Milano, Milan, Italy)

**Keywords:** 3D reconstruction, historical data, knowledge representation, critical analysis

**Abstract:**
In recent decades 3D reconstruction has progressively become a tool to show archaeological and architectural monuments, both in their current state and in their presumed past aspect. The search for historical sources, their proper analysis and interdisciplinary relationship between technological disciplines and the humanities are fundamental for obtaining reliable hypothetical reconstructions. Given these premises, it must be underlined that there are cases in which the three-dimensional diachronic reconstruction is particularly complex for several reasons: the nearly total absence of remains to be surveyed; one or more periods of artefact's time life with historical documentation shortage; uncertainty of sources; difficulty to correlate documents and data to a three-dimensional representation.
This paper presents a methodology based on the case study of Milan's Roman circus, built in the era when the city was the capital of the Western Roman Empire, under Maximian (284-305 A.D.). The circus was the place for celebrating the emperor's greatness and for this reason it was located near the Imperial Palace. Although the circus of Milan was one of the most important of the empire, today there are only few visible traces: a tower of the Carceres reused as a bell tower and some sections of the foundations hidden in buildings of private properties. Historical sources report the existence of the circus until Longobard's era, then, as happened to other monuments in Milan, the materials that formed it were used to build other buildings and the area was densely urbanized. Archaeological studies were conducted mostly at the beginning of the '900 and after World War II, when during the reconstruction of some buildings and public works it was possible to see the remains. Many questions are still open about the the building's development elevation and its relation to the surrounding works: the imperial palace and the town fortification walls. This work shows how how all sources (maps, drawings, archaeological reports, archaeological restrictions decrees, photographs, etc) has been integrated to hypothesize a reconstruction of the area, by georeferencing such documents to that specific location of the city.

**Relevance conference | Relevance session:**
The topic refers to an interesting example of urban archaeology to which this year edition of the conference is dedicated.
**Innovation:**
Progressive knowledge gained from integration of nonuniform sources through georeferencing.
**References:**
**GUIDI, G. / RUSSO, M. / ANGHELEDDU, D. (2014):** 3D Survey and Virtual Reconstruction of archeological sites. Digit. Appl. Archaeol. Cult. Herit. 1, Elsevier, 55–69.
**GUIDI, G. / MICOLI, L.L. / ANGHELEDDU, D. / RUSSO, M. (2013):** A multidisciplinary approach to 3D survey and reconstruction of historical buildings, in: 2013 Digital Heritage International Congress (DigitalHeritage). IEEE, USA, 241–248.

# 3D Reconstruction of Furniture Fragments from the Ancient Town of Karanis

**Eiman ELGEWELY[1] | Willeke WENDRICH[2]**
([1]Faculty of Fine Arts, Alexandria University, Alexandria, Egypt | [2]Dep.of Near Eastern Languages and Cultures, USA)

**Keywords:** Virtual Heritage, 3D Reconstruction, 3D modeling, Photogrammetry, Re-contextualization

**Abstract:**
Furniture is the most personalized component of architectural space. It reflects or even determines the use of space, but also the standard of living, the gender, and age of the user. Heirlooms, furthermore, are retainers of memory and social relationships. The raw materials used and the level of skill and craftsmanship to produce furniture speak to the availability of such items for the community. Import of wood, techniques, or entire pieces of furniture show connectedness with other production centers. Wooden furniture fragments from the ancient Greco-Roman Town of Karanis in the Fayum, Egypt are among the most abundant and versatile of the archaeological finds, from this arid site on the desert edge. Objects include furniture legs, boxes, reading tables, and table tops, etc. The University of Michigan mission which worked on the site for about ten years (1924-1934), had as its main focus the architecture of Karanis. The furnishings of these structure does, however, provide important information and a study of the woodworking and composition of the pieces has now been taken on, together with an attempt to place these remains back in their virtual context. The reconstruction of the Karanis furniture provides a major challenge because the remaining fragments belong to various time periods and combines Egyptian, Greek, and Roman influences and tastes. This research is a next phase of the project "Reviving Karanis in 3D", which we started in 2013. In this research, we aim at using state-of-the-art digital technologies to create multiple interpretations of 3D reconstruction of a selection of furniture pieces based on analysis and photogrammetric models of wood furniture fragments from the Karanis collection of the Kelsey Museum of Archaeology, University of Michigan.

**Relevance conference:**
This research is in the field of Virtual heritage as it enables an exploration of how past communities may have perceived and represented their physical and social environments

**Relevance session:**
This research traces the lost information about ancient Karanis furniture aiming to provide alternatives of interpretations of 3D reconstructions by combining and matching various data resources.

**Innovation:**
providing new assumptions about the use of many archaeological objects which might change how they were documented and listed for long periods of time, and convey different scenarios and stories.

**References:**
**ELGEWELY, E. / WENDRICH, W.Z. ( 2015):** Virtually United in Real Time: Museum Collections and Archaeological Context Explored. Granada, IEEE.
**WENDRICH, W.Z. / SIMPSON, B. / ELGEWELY, E. ( 2014):** Karanis in 3D: recording, monitoring, re-contextualizing, and the representation of knowledge and conjecture. Near Eastern Archaeology Journal, September.77(no. 3: Cyber-Archaeology).

# Digital 3D reconstructed models – Structuring project workflows using semantic technologies to develop recommendations

**Mieke PFARR-HARFST | Stefanie WEFERS | Frank BOOCHS | Ashish KARMACHARYA**
(TU Darmstadt, Darmstadt, Germany)

**Keywords:** 3D data, research sources, data processing, ontology

**Abstract:**
Digital 3D reconstructed models of Cultural Heritage (CH) assets have to be understood as a combination of research sources, the contemporary historical and cultural context (Zeitgeist), the project background and the work process. All available information is collected, consolidated, filtered and assembled into a coherent picture. In the case of digital 3D reconstructed models, the result is a digital data set that can be processed for different application fields. This paper gives a structured view on digital 3D reconstructed models within the CH domain. They are understood as a result of a complex creative process and as a synthesis of a CH research project, its CH context, the available research source material, and the modeling process itself. This paper seeks to differentiate the various research sources being the basis for digital 3D reconstructed models and defines work phases of such projects allowing a quality assessment. Semantic technologies are used to consolidate the structured view. Relevant components are represented through classes and inter-dependencies in an ontology model (so-called COSCHKR ontology model). Furthermore, the inter-dependencies are bound by rules. Through a guided user interface, these rules are inferred in order to retrieve information based on individual user input supporting the planning of projects creating digital 3D reconstructed models.

**Relevance conference | Relevance session:**
An interdisciplinary approach is presented using semantic technologies to support CH projects creating digital 3D reconstructed models.
**Innovation:**
A guide is developed giving access to semantically structured expert's knowledge involved in the creation of 3D reconstructed models.
**References:**
MÜNSTER, S. / KUROCZYNSKI, P. / PFARR-HARFST M. / LENGYEL, D. (2015): Future Research Challenges for a Computer-Based Interpretative 3D Reconstruction of Cultural Heritage – A German Community's View. Proceedings CIPA Symp. 2015, Taipei, 207-213
WIEMANN, A.-K. / WEFERS S. / KARMACHARYA, A. / BOOCHS, F. (2014): Characterisation of Spatial Techniques for Optimised Use in Cultural Heritage Documentation. Proceedings Euromed 2014, 374–386.


# Virtual Research Environment for digital 3D reconstructions – Standards, thresholds and prospects

**Piotr KUROCZYŃSKI**
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**Keywords:** Digital hypothetical 3D reconstruction, semantic data modelling, virtual research environment, e-research technologies, 3D visualisation, documentation of the cultural heritage

**Abstract:**
Since the 1990s the application of the digital 3D reconstruction and computer-based visualisation of cultural heritage increased. The virtual reconstruction and 3D visualisation revealed a new "glittering" research space for object-oriented disciplines such as archaeology, art history and architecture. Nevertheless the academics concerned with the uprising technology recognised early the lack of documentation standards in the 3D projects leading to the loss of information, findings and the fusion of knowledge behind the digital 3D representation. In the last decade guidelines on the scholarly approved computer-based visualisation and thoughts on 3D documentation (e.g. metadata) where introduced. The recent academic commitment to the design and application of so called Virtual Research Environments (VRE) for 3D research projects is promising. The investigation of the experiences with the VRE under construction and the establishment of the sustainable digital research infrastructure has still to be forced.
Based on the methodological fundamentals of the digital 3D reconstruction the potentials and

challenges in the light of emerging Semantic Web and Web3D technologies will be introduced. The presentation subscribes a scientific methodology and a collaborative web-based research environment followed by crucial features for this kind of projects. As the groundwork a human- and machine-readable "language of objects" and the implementation of this semantic patterns for spatial research purposes on destroyed and/or never realised tangible cultural heritage (art&architecture) will be discussed. Using examples from the practice the presentation explains the requirements of the Semantic Web (Linked Data), the role of controlled vocabularies, the architecture of the VRE and the impact of a customised integration of interactive 3D models within the WebGL technology. The presentation intends to showcase the state-of-the-art on the way to a digital research infrastructure. The focus lies on the introduction of scholarly approved and sustainable digital 3D reconstruction, complaint with recognised documentation standards and following the Linked Data requirements.

**Relevance conference | Relevance session:**
Analytical presentation of issues to be considered on the way to virtual research environments and digital research infrastructures for digital 3D reconstructions.
**Innovation:**
Structured overview of the complex issue combining the methodology, data process, data model, file formats and features. Subsequent analyse of the thresholds and potentials based on practical experience.


## From Reconstruction to Analysis: Re-use and re-purposing of 3D scan datasets

**András PATAY-HORVÁTH**
(Institute for Ancient History ELTE / Archaeological Institute MTA, Budapest, Hungary)

**Keywords:** sculpture, master-hand attribution, 3D analysis

**Abstract:**
The paper describes two related research projects concerning the sculptural decoration of a well-known classical Greek monument, the temple of Zeus at Olympia. Both projects are based on the same data set, i.e. the 3D scans obtained from the original pieces of marble sculpture, but they are used for two completely different purposes. In the first section, a summary is given on the results concerning the virtual 3D reconstruction of the east pediment, the second part describes another research question, the identity of the so-called Olympia master and a new analytical method, which makes use of the possibilities offered by the digital datasets and may open up new perspectives for the traditional art historical analysis. Beside the re-using and re-purposing of the raw data, the 3D models are not the final output of the project, but they are used to enhance our knowledge in a new way, which would be hardly feasible with traditional methods.

**Relevance conference | Relevance session:**
A set of 3D data, collected to create a reconstruction is used for a different archaeological/art historical purpose.
**Innovation:**
3D data are combined with an old traditional art historical method in order to elaborate a new analytical tool for sculptural works of art.
**References:**
**PATAY-HORVÁTH, A. (2011):** Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia. Budapest: ELTE / MTA, 2011.
**PATAY-HORVÁTH, A. (2015):** Master-Hand Attributions of Classical Greek Sculptors by 3D-Analysis at Olympia. Some Preliminary Remarks, in: S. Campana et al. (eds), CAA 2015 KEEP THE REVOLUTION GOING. Oxford: Archaeopress, 2016, 329-336.

# High precision 3D scanning assisting in the service of historical and art historical research

**Beatrix SZABO**
(Mensor 3D Kft., Budapest, Hungary)

**Keywords:** 3D scanning, modeling, virtual reconstruction, cultural heritage

**Abstract:**
One of the most debated burial sites of medieval Hungary is the grave of Queen Gertrude of Meran with its decorated burial monument at the Cistercian Abbey of Pilis. The queen was assassinated and this event is one the most debated historical events of the Hungarian history, with a large number of local and foreign contemporary documents. Archaeological excavations has revealed the fragments of her burial monument with high artistic qualities (human figures, architectural elements, inscription, decorated patterns, etc). During the last three decades, art historical research has discussed the foreign artistic influences of the monument and has proposed a number of different reconstructions based on the traditional documentation (drawings and photos) of the excavated fragments. A full size sculpted model has also been created on the basis of one of these hypothetical reconstructions.

The main goal of this paper is to present the results of a new research project for the creation of the first virtual reconstruction of the burial monument. The fragments of the monument and its previously sculpted physical model were captured by terrestrial laser scanner and optical 3D scanner, and consequently point clouds and meshes were created. Using the high-resolution data in a CAD environment, a 3D virtual reconstruction model was built showing a possible form of the burial monument. In order to offer the new virtual reconstruction for different research approaches (art historical studies, archaeological interpretations, comparative studies with other monuments, etc.) a new method was required to handle the huge amount of digital data. A database was built from the meshes of the fragments enabling to manage them easily. High precision 3D models of the fragments allowed for capturing their precise geometry, and it offers the opportunity to develop metrical studies on the fragments, which can be the basis of alternative reconstruction attempts. By using these 3D technologies the fragments, the reconstructions and the conclusions derived from them are available for everyone, without professional hardware. With this method, scholars can use spectacular 3D visualisations in their research and many of the artefacts' properties can be examined as well. The results are also available for a wider audience, as it has been demonstrated in an exhibition to commemorate the 800th anniversary of the death of Queen Gertrude. Thus, the paper describes the new possibilities provided by the 3D technology over conventional methods for scientific research and introduces a method where archaeological, historical and art historical examinations were integrated with the use of state of the art technologies.

**Relevance conference | Relevance session:**
Digital heritage documentation and preservation.

**Innovation:**
High precision 3D scanning in the service of art historical research.

**References:**
**TAKÁCS Imre (1994):** Gertrudis királyné síremléke. In: Pannonia Regia. Művészet a Dunántúlon 1000-1541. Szerk.: Mikó Árpád-Takács Imre. Budapest, 1994, 248-270.
**FEHÉR András (2013):** 3D szkennerek alkalmazása a régészetben Megjelent: Magyar Régészet Online

Magazin, 2013 nyár, http://www.magyarregeszet.hu/wp-content/uploads/2013/07/Feher_13Ny1.pdf

## Maxentius 3D Project

**Lucia MARSICANO | Saverio Giulio MALATESTA | Francesco LELLA | Eleonora MASSACCIO**
(Archeo&Arte 3D Lab – DigiLab, Sapienza University of Rome, Montelibretti, Italy)

**Keywords:** 3D Reconstruction, archaeology, cultural Heritage

**Abstract:**
Maxentius 3D Project starts from a workshop conducted by Archeo&Arte 3D Lab DigiLab Sapienza University of Rome.
Aim of the project is to propose a full 3D model of the Circus of Maxentius in Rome encompassing all the aspects of the environment, as well as the architectural system.
The first step of the work was the study of archaeological data, afterward the archaeological team carried on a survey to integrate the published data with new information useful to create a metrically correct reconstruction. Every single element was modeled using a scientific reference.
To model both the landscape and the architectural structures it was used Blender, an open source software.
Starting from altimetry data it is possible to reconstruct the morphology; after having imported the contour lines in Blender it was necessary to convert the curves into mesh and then, using the add-on Delaunay triangulation and Voronoi Diagram it was possible to generate 3D model.
The following step was the elaboration of the architectural 3D model including the hydraulic system and the decorative program.
Finally the team went ahead with the texturing of the models through the use of the Node Editor in Cycles Render.
The result is a metrically and scientifically correct 3D model of the Circus of Maxentius useful to study the monument from a new point of view. Integrating archaeological data and 3D graphic is possible to verify the hypothesis on the reconstruction of the monument. Indeed to propose a full 3D model an in-depth study is needed to understand the relation among the architectonical elements and the environment.

## Destroyed places and ancient wars. Digital tools for the Montecastrese fortress in Camaiore, Lucca

**Giorgio VERDIANI | Martina CARRARA | Stefano LAMI**
(Dipartimento di Architettura, Florence University, Florence, Italy)

**Keywords:** Montecastrese; 3D reconstruction; Medieval archaeology; Digital survey; 3D printing

**Abstract:**
In the XX century, after being forgotten for centuries, a series of archaeological excavations have brought to light the settlement, named "Montecastrese", a system of Medieval fortifications organized on the top of a hill near the town of Camaiore, on the Tirreno sea, placed at the borders of the Lucca Province. The archaeologists brought back to light the traces of the fortress and of the village, exploring the monumental ruins of the northern tower, still in place and tumbled down in two main large parts. In the first half of the XIII century, the castle of Montecastrese was conquered and destroyed by the army of Lucca. At the time of its major development the small fortress was organized around two main towers, with walls and various houses. A quite extended village was placed on the southern side of the hill. In 2015 a new survey campaign brought contemporary technologies between these ruins. The municipality of Camaiore commissioned a complete digital survey to the Dipartimento di Architettura in Florence. The general survey plan has seen the use of

aerial photogrammetric survey, 3D laser scanner survey and terrestrial photogrammetry. The large amount and the high quality of data allowed the definition of a perfect base to start studying and investigate the site to operate a digital reconstruction. The use of 3D modeling of all the lost parts, from the houses to the defense walls, to the system of towers was one of the focal point in this work, using the modeling process from the survey and supporting the reconstruction hypothesis with previous archaeological data, while matching the missing parts with similar architectures and the needs of the medieval defense/attack technics. For the northern tower a specific operation based on the use of 3D printed models was brought on to bring to an end the debate about the sequence of the fall of the tower, quite important to the digital reconstruction of this building, the direct manipulation of a scaled model turned out to be a fundamental step for the completion of this part of the research.

**Relevance for the conference:**
We bring a complete data processing, from digital survey to digital reconstruction, to the integration with the state of knowledge about the site and create a "final" version of the whole settlement for research and dissemination purposes.

**Relevance for the session:**
A case study were the authors themselves have followed all the operations, from the survey, to the data processing to a very specific use of 3D printing to allow reconstruction hypothesis.

**Innovation:**
Specific use of 3D printing for understanding and reconstruction, a selection of results are aimed to public presentation in the local museum rooms (using graphic and 3D physical models).

**References:**

**GATTIGLIA, G. / ANICHINI, F. (2009):** La Versilia nel Medioevo. Ricerche archeologiche in un'area buia della Toscana settentrionale, Atti del V Congresso Nazionale di Archeologia Medievale Foggia-Manfredonia 30.09-03.10 2009, Firenze 2009

**GATTIGLIA, G. / TARANTINO, G. (2013):**…loco ubi dicitur castello. Montecastrese e l'incastellamento in Versilia, in Archeologia Medievale XL

# Digital Method for Verifying Archaeological Hypotheses. Medieval Gord under Pultusk Castle

**Sławomir KOWAL | Krzysztof KOSZEWSKI | Jan SŁYK | Stefan WRONA**
(Warsaw University of Technology, Faculty of Architecture, Warsaw, Poland)

**Keywords:** cultural heritage, parametric design, virtual reconstruction, 3D printing

**Abstract:**
The interdisciplinary cooperation between architects and archaeologists undertake research issues on use of parametric methods to formulate variants of hypotheses based on archaeological relics. Main theses were related to reflection on the uniqueness of the message, content translation and clear conclusions formulation.
In the 70s (of XX) archaeologists conducted excavations under the castle courtyard in Pultusk town in Poland. The outcome was the wooden huts' relics of a medieval settlement. Analysis let the scientists form the thesis, that whole foundation represents the severity of the proto-city. In 90s an attempt was made to verify all thesis by virtual models using surface and solid modeling. It soon turned out that effects limit only to spectacular photorealistic renderings.
This paper describes the effects of cooperation between architect and archaeologists started in 2012 on the reconstruction of the medieval proto-urban site based on parametric methods supported by 3D printing. Archeological relics and interpretations delivered input data for the process of parametric reconstruction. Over 140 huts were built with use of Grasshopper for Rhino. Over 50 parameters were defined to control the form on the base of real medieval findings, rules of ancient structural methods and urban tissue characteristics. The program was able to perform reconstruction

of each hut in tens minutes. Implementation of the method directly impacted forming hypothesis. It particulary aided the process of recognition original proto-town form in the area were it was not defined by relics. Equally important step was done by implementation of modular models using 3D printing technology. They not only reflect the similarities in form, but also allow dynamic simulations. Urban model, called Rapid Reconstruction Modular Model (scale 1: 100, 120×100 cm) was developed as a set of terrain segments responding to archeological matrix of excavations. Swapping segments allow changing visual result of reconstruction and reacting on the new findings and new interpretations.

In conclusion: Parametric techniques and 3D printing technology have become a platform for almost simultaneous dialogue between scientists from different disciplines. In addition, results are dissemination of knowledge and also bring the arguments in favor for archaeological excavations the remaining 60% of the proto-city. This time in order to verify how the hypotheses are confirmed in the artifacts still hidden under the castle courtyard in Pultusk.

**Relevance conference:**
The paper describes innovative method which facilitates interdisciplinary cooperation between archeologists and architects, helps to archive and present visual data, and supports constructing hypothes

**Relevance session:**
The paper concerns the process which ties various digital and physical techniques to facilitate cooperation and understanding within expert team and beyond.


## How much of a historic town can be mapped by a terrestrial laser scanner within a working day?

**Nikolaus STUDNICKA | Christoph FÜRST | Martin PFENNIGBAUER**
(RIEGL Laser Measurement Systems GmbH, Vienna, Austria)

**Keywords:** terrestrial laser scanning, high speed mapping, historic urban area

**Abstract:**
We are all aware that in some respect it's undoubted that cultured heritage must be conserved. As an example, downtown Vienna is one of the most famous cultural sites in central Europe and most complex structures which are not easily captured with 3D mapping. One possibility to survey such an environment is new sensor equipment as a 3D laser scanner from tripod which is available and capable doing this with tremendous speed.

So we performed a test with the new RIEGL VZ-400i terrestrial laser scanner. In the night from 2nd to 3rd of June 2016 for eight working hours, one single operator has used the scanner through the city centre of Vienna. He managed to take 514 high resolution laser scans approximately every 10 meters covering various historical monuments along this path like "Stephansdom", "Peterskirche" and the "Hofburg" to name a few. Using the data acquired in the course of this project the authors want to show the potential of state-of-the-art terrestrial scanning to preserve very detailed 3D-information of various sites within very limited amounts of time. This paper describes the complete workflow from the one touch operation in the field up to the automatic registration process of the laser scans which were collected within this urban area.

**Relevance conference | Relevance session:**
This case study should show the auditorium how to select a terrestrial laser scanner in order to scan and register scan data of large historic urban sites as efficient and well-proven as possible.

**Innovation:**
The shown „high speed collection and automatic registration workflow" for static terrestrial outdoor scans of urban areas will be published for the first time.

# Photogrammetry in Underwater and Aerial Archaeology

Chairs: Marco BLOCK-BERLITZ | Roman SCHOLZ, Germany | Luka BEKIC, Croatia

## Digitisation of the architectural heritage of Slovakia combining of lidar data and photogrammetry

**Ladislav DEDÍK | Jana MINAROVIECH**
(STUDIO 727, Bratislava, Slovakia)

**Keywords:** Architectural heritage, digitisation, Slovakia, 3D models

**Abstract:**
During the years 2013-2016 a great number of buildings (medieval castles, churches and other monuments) in Slovakia were digitized. STUDIO 727 was the main provider of these digitalization works.
The subject of our investigation were the most significant Slovakian historical objects. Within the digitalization project we have created 3D models of the most important Slovakian monuments, as e.g. Bojnice castle, gothic church in Spišský Štvrtok or Devin castle, where are located also artefacts from Roman period, La Tène era and middle ages.
The aim of the project was to identify current technological possibilities of creation virtual presentations of real spaces. During creation of 3D models we used combination of Photogrammetry and 3D space scanning by laser scanner LIDAR (Leica brand). Final modification of laser outputs was made by Cyclone software. Post processing was done by Capture Reality, Autodesk Maya and MeshLab softwares. 2D documentation was made by AutoCAD.
The purpose of documentation is to capture the appearance of historical buildings and historical building technologies, to keep culture heritage for next generation. There have been documented some monuments, which have been falling apart progressively. Created documentation contributes to culture heritage publicity and offers a documentation for the future renovation of these particular monuments. The Entry of this project was the process of creating 3D virtual models and 2D documentation.
Contribution was created thanks to EU project, within the Operational program Informatization of society. Project was supported by The Ministry of Culture of Slovak Republic and Government Office of Slovak Republic.

**Relevance conference | Relevance session:**
The relevance of the paper is to show an example of using new software for the digitisation of cultural heritage.
**Innovation:**
The innovation of this paper is combining lidar data and photogrammetry in one software.

## Systematic SfM and MVS-based documentation and interpretation: The underwater excavation of the Mondsee culture settlement Seewalchen/Attersee, Upper Austria

**Henrik POHL | Ronny WESSLING**
(Kuratorium Pfahlbauten, Attersee a. Attersee, Austria)

**Keywords:** structure from motion, underwater archaeology, lake villages

**Abstract:**
150 years after the discovery of Austria's first lake dwellings, today's modern scientific methods allow us to obtain new and extraordinary insights into these unique archaeological sources under

water. In order to equate the Upper Austrian National Exhibition of 2020 with latest scientific standards, new interdisciplinary research projects are being developed and realized with great support by the Upper Austrian National Museum,the curatorship palafittes as well as the province of Upper Austria.

The main objective hereby is to portray the phenomenon lake dwelling from a modern perspective. Investigation into archaeological findings at the public bathing beach of Seewalchen-Attersee in 2015 commenced the pilot project Zeitensprung. During these first underwater excavations in Austria after more than 30 years, new technologies such as Structure from Motion (SfM) and Multi View Stereo (MVS) have been implemented to gain a systematic 3D documentation. Hence, first field reports documenting the use of these methods supporting a more laminar excavation documentation will be presented.

Surface models can be represented as two-dimensional images, e.g. true orthophotos and elevation coded images, which provide an ideal basis for mapping and drawing. Overall, five site plans and a cross section drawing were derived from the models. Conventionally, such time consuming work is carried out directly at the site. However, the application of SfM and MVS defers most of the graphic work into the post excavation process and therefore saves valuable time during fieldwork. 3D models can be animated in time. By moving through realistically texturized 3D models, sorted according to their stratigraphic position, a four-dimensional virtual reality can be constructed. With this technique a digital copy of the recorded features, arranged in time and space, is still accessible after their destruction and permits a virtual desktop based re-excavation of the site.

**Relevance conference | Relevance session:**
It´s exactly about the conference theme: cultural heritage and new technologies.
**Innovation:**
During these first underwater excavations in Austria after more than 30 years, new technologies such as SfM and Multi View Stereo (MVS) have been implemented to gain a systematic 3D documentaion.


# Retrospective Photogrammetry in Greek Archaeology

**Colin WALLACE**
(University of Waterloo, Waterloo, Canada)

**Keywords:** photogrammetry, 3D modelling, archival photographs, archaeology

**Abstract:**
In the past decade the use of photogrammetry to produce 3D modelling of archaeological sites has seen rapid growth and acceptance due to a significant reduction in cost and labour. While this bodes well for having accurate modelling available in the future, past excavations could benefit from similar treatment. Fortunately archaeological research has a long history of requiring comprehensive photographic documentation and in many cases the photographs have significant overlap, enabling their use in photogrammetry to produce 3D models. Some, at the time, were taken with the intention of using photogrammetry to create topographic maps. Now, with the use of these maps we can reverse the procedure to georeference the photographs in order to create properly scaled phototextured models.

This paper addresses the advantages as well as the obstacles in practicing retrospective photogrammetry based on archival photos and examines how the results can be put to use. Not all photo archives are suitable for photogrammetry as they were not photographed with the intention of overlap and other photogrammetric qualities. By selectively choosing photographs with common points and manipulating exposures, cropping and other properties to enhance commonality, 3D models of past structures and excavations can allow us to revisit them, measure them and view them from angles that were never photographed and may not even exist any longer.

Some sites are still available for modern comparison and surveying allowing us to quantitatively compare conditions at the time of excavation with the current state of those sites. Given the right treatment, retrospective modelling will have impacts in preservation, restoration and monitoring of

deterioration of archaeological sites. Examples from the Athenian Agora and Ancient Corinth will be used to demonstrate these possibilities.

**Relevance conference | Relevance session:**
This paper demonstrates how current technologies can be combined with past documentation to produce results that demonstrate the ongoing worth and purpose of archives
**Innovation:**
The innovation is the re-use of archival data in order to produce 3D models.

# Multi-source photogrammetry as instrumental tool in integrated archaeological prospection

**Łukasz MISZK[1] | Wojciech OSTROWSKI[2]**
([1]Jagiellonian University in Krakow | [2]University of Technology, Warsaw, Poland)

**Keywords:** Photogrammetry, Nea Paphos, Cyprus, Classical Archaeology

**Abstract:**
In our paper we would like to present role of the photogrammetry and remote sensing for projecting and conducting of the archaeological research. Experiences from the Paphos Agora Project will be used as an exemplification. During aforementioned project economic infrastructure is a main point of the researchers, however conducted research take into consideration whole area on Paphos Archaeological Park (which cover half of area on ancient Paphos City). Before final process of the excavation the full process of the remote sensing studies is being conducted. Expedition has gathered all possible data from the old (archival aerial images) and modern satellite (WorldView-3) sources, which were compared with complemented by the high-resolution 3D data from the UAV prospection. Using archival aerial images is extremly important for rapidly developing urba areas. In Paphos case it facilitated understanding changes in surrounding landscape. Selected areas crucial for the main areas of the project, have been selected. The next step was the investigate selected area with the geophysics and geomorphological research. At the end archaeological excavations were conducted. Photogrammetry were used as a main tool for the documentation and research process facilitate making decision on archaeological site. We are going to present our experiences in implementing photogrammetry and remote sensing during every step of the research process.

**Relevance conference | Relevance session:**
Combination of the wide range of methods for archaeological workflow will be presented.
**Innovation:**
Innovation of the presented worklow is based on the complexity of the designed worklow for single archaeological site.
**References:**

**CAMPANA, S. et al. (2012):** 3D Recording and Total Archaeology: From Landscapes to Historical Buildings, International Journal of Heritage in the Digital Era volume 1 number 3 2012
**AGAPIOU, A. et al. (2015):** Impact of urban sprawl to cultural heritage monuments: The case study of Paphos area in Cyprus. Journal of Cultural Heritage, 16(5), 671–680.

# Pairing fossil oyster shells

**Ana DJURICIC | Peter DORNINGER | Sascha RASZTOVITS | Clemens NOTHEGGER | Mathias HARZHAUSER | Oleg MANDIC | Philipp GLIRA | Norbert PFEIFER**
(Department of Geodesy and Geoinformation, Vienna University of Technology, Vienna, Austria)

**Keywords:** pair matching, fossil shells, center line, automation

**Abstract:**

The protected fossil oyster reef in Stetten, Austria is the world's largest excavated fossil oyster reef, formed by large sea shells. About 50.000 up to 60-cm-long shells cover a 459 m$^2$ large area. The reef consists primarily of Crassostrea gryphoides shells. In this study, our motivation is to reconstruct the original shell positions with automatic 3D object matching and by finding similar or identical objects in a database with determined shell size. Four initial criteria were defined for the object matching: i) iterative neighbourhood search near the examined shell, ii) specified shell convexity: down, up, iii) specified shell side: left, right and iv) shell length with 20% tolerance. For all shells matching the criteria, their centrelines were analysed in the next step. In analysis, the centreline and its neighbouring points are profiled. The profiling produces spatial features, such as sphericity, planarity, scattering and change of curvature. The features describe if the lateral surface of a shell is flat, concave, or convex. All analysed shells are compared to see if they match together by studying left-sided shells with the right ones. The analysis assumes that shell features should be invariant within a potential pair. Finally, the potential matching candidates are brought close together and pairing is completed using an iterative closest point (ICP) algorithm with a constraint that the matching surface cannot intersect between left and right valve.

The proposed method gives a possibility to match and link spatially separated complex objects together if their surface properties have enough feature correspondences along their centreline profiles. The matching over distance supports in making spatial interpretations and objects visualizations in several disciplines, including geology, palaeontology, and biology.

**Relevance conference | Relevance session:**
The matching over distance supports in making spatial interpretations and objects visualizations in several disciplines, including geology, palaeontology, and biology.

**References:**
**HARZHAUSER, M. et al. (2015):** Disentangling the history of complex multi–phased shell beds based on the analysis of 3D point cloud data. Palaeogeography, Palaeoclimatology, Palaeoecology 437, 165–180.

**DJURICIC, A. et al. (2016):** 3D central line extraction of fossil oyster shells. The ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Science.

# Drone on the water: multipurpose unmanned surface vehicles (mUSV) for photogrammetric surveying of submerged archaeology

**Ronny WESSLING | Michael KONRAD**
(Crazy Eye – geoinformatics and digital archaeology, Vienna, Austria)

**Keywords:** underwater, pile dwellings, unmanned surface vehicle, photogrammetry

**Abstract:**

As unmanned aerial vehicles are becoming a standard tool for archaeological aerial survey it is a logical extension to apply autonomous vehicles to underwater prospections. In this study a self-made low cost multipurpose unmanned surface vehicle (mUSV) is presented. It allows to follow a predefined path on the water surface using satellite based navigation and is therefore ideally suited for systematic surveying of submerged areas of archaeological interest. Due to the very low draught of about 0.1 m it becomes possible to survey very shallow water too. Sailing routes are automatically calculated by advanced open source software considering the desired overlap and resolution of the generated data. The mUSV is designed to carry acoustic (multi-beam sonar,side scan sonar, sub-bottom profiler, boomer, pinger), geophysical (ground penetrating radar) and photogrammetric (camera) sensors. First tests were carried out equipped with an underwater camera attached to a vertical adjustment slide to adapt to the depth of water. By recording highly overlapping images of the sea ground geo-referenced orthophotos and bathymetric data is created which can be used for the detection, mapping and monitoring of submerged archaeology. The talk will evaluate the derived

data taken from pile dwelling sites at Lake Attersee, Upper Austria in terms of cost, quality and further optimization possibilities.

**Relevance conference | Relevance session:**
In this study low cost hardware and open source software are combined to a sophiticated device for underwater prospection
**Innovation:**
The potential of unmanned surface vehicles for underwater archaeology has not been explored yet. This paper analyses its application for
photogrammetric surveying in shallow environments.
**References:**
**HENDERSON, J. et al. (2013):** Mapping Submerged Archaeological Sites using Stereo-Vision Photogrammetry. International Journal of Nautical Archaeology, 42, 243–256.
**DRAP, P. et al. (2015):** The ROV 3D Project: Deep-Sea Underwater Survey Using Photogrammetry: Applications for Underwater Archaeology. Journal on Computing and Cultural Heritage 8(4): 21

## Close-up, Macro and Micro photogrammetry and image perspective: a comparative studio on different lenses at work with small and medium size objects

**Giorgio VERDIANI | Paolo FORMAGLINI | Filippo GIANSANTI | Stéphane GIRAUDEAU**
(Dipartimento di Architettura, Florence University, Florence, Italy)

**Keywords:** Photogrammetry; Close-up; 3d modeling; Digital photography; lenses;

**Abstract:**
The digital photogrammetry has renewed the approach to measurement for archaeologists, architects and many researcher, student, professionist, involved in Cultural Heritage subjects. The quick approach and the possibility to use almost any digital cameras has created a sort of "nice 3d models for approach that have definitely enhanced the way to use the cameras to capture architecture, objects and finds. Thus most of the troubles coming from the more and more advanced software for photogrammetry processing came from purely photographic mistakes or poor knowledge about photographic tools.
As well stated in previous studies, there are various way to take pictures more efficiently and gain more quality in the final results, but in the paper proposed here the focus will be on perspective and its influence in the result coming from medium and small size objects and finds. The study will present the results from the use of very different lenses and a short dissertation about perspective, depth of fields and their influence in producing well working pictures for the photogrammetric use. The main structure of the study will concentrate on three lenses used on the same professional DSLR camera body: the AF Micro-NIKKOR 60 mm f/2.8D with 1:1 reproduction ratio (RT), the Venus Laowa Micro 15mm f/4 with 1:1 RT and a Nikkor 18mm F3.5 MF used with extension tubes to reach a 1:1 RT. The subject of the test shooting will be a set of significant finds from the Archaeological Museum in Florence. The full processing and procedure of matching the data will be presented to bring an useful contribution and reference for other scholars.

**Relevance conference | Relevance session:**
An operative study for an operative audience
**Innovation:**
We hope to bring a useful contribution on the operative level in the choice of the correct tools
**References:**
**GUIDI, G. / GONIZZI, S. / MICOLI, L.L. (2014):** Image pre-processing for optimizing automated photogrammetry performances, in SPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume II-5

**MANGANELLI DEL FÀ, R. / RIMINESI, C. / TIANO, P.(2015):** Monitoring of the surface pattern of artistic and architectural artefacts by means of ultra close range photogrammetry, in European Journal of Science and Theology, April 2015, Vol.11, No.2, 179-187

# Archaeonautic: Low-cost and efficient 3D Videogrammetry meets Palafittes at Mondsee/Austria

**Marco BLOCK-BERLITZ | Cyril DWORSKY | Carmen LÖW | Benjamin GEHMLICH | Dennis WITTCHEN | Niklaas GÖRSCH | Benjamin DUCKE**
(HTW Dresden, Dresden, Germany)

**Keywords:** 3d reconstruction, videogrammetry, uuv

**Abstract:**
The videogrammetric approach (the use of videostreams instead of single images) was successful introduced to UAV-based aerial 3d reconstruction in the project Archaeocopter. The results of several campaigns have shown that videogrammetry is a fully viable approach to reconstructing single objects as well as complete archaeological areas. The amount of recorded data, the ability to record while moving and the low cost make it a universal tool for documenting archaeological sites. Since 2015, our 3d reconstruction scope has been extended to underwater archaeology. The project Archaeonautic (HTW Dresden and Freie Universität Berlin) was initiated in cooperation with the German Archaeological Institute (DAI).
We present our miniature UUV (Unmanned Underwater Vehicle) Eckbert II, equipped with GoPro cameras, additional lights and a flexible taring system, based on OpenROV. We discuss our customized enhancements to work across a broad range of underwater situations, not only in fresh- and saltwater. The complete hardware system (three GoPro Hero 4 BEs included) is about 3000 USD. In April 2016, Eckbert II was successful deployed to document a shipwreck in Veruda/Croatia at an average depth of six metres. This campaign was conducted in cooperation with the DAI and the International Centre for Underwater Archaeology in Zadar (ICUA). Also in April 2016, subsequent to the saltwater campaign, the same system eas deployed to document the palafittes (Pfahlbauten) in Mondsee/Austria at an average depth of about two metres. The main difference and the most critical point here was to ensure that the UUV never touches the sea bottom or the salient lake dwellings. We present best practice routines, such as solutions for cable management, supporting the UUV when strong currents are prevalent, and documentation/record keeping.

**Relevance conference | Relevance session:**
The presented system allows to document cultural heritage underwater in a cost-effective way.
**Innovation:**
Underwater videogrammetry poses very specific technical challenges, such as colour correction, that our research addresses in a ground-breakingly simple and cost-efficient manner.
**References:**
www.archaeonautic.de

# Image fusion as an enhancement technique of DEM visualization in archaeology

**Benjamin ŠTULAR | Edisa LOZIĆ**
(ZRC SAZU, Institute of Archaeology, Ljubljana, Slovenia)

**Keywords:** DEM, visualization, image fusion

**Abstract:**
Using photogrammetry in aerial archaeology or SfM methods in documenting archaeological excavations the two major outputs are either a ("real") 3D model or a (2.5D) DEM/DSM. The latter – used in landscape-size projects and due to its compatibility with the existing 3D-GIS software often in documenting archaeological sites – is the focus of this presentation.

The successful use of the DEM/DSM in supporting processes of interpretation and decision-making during fieldwork depends firstly on the quality of the model, a subject of many specialized papers. Unfortunately, the importance of visualization is often overlooked. Visualization of DEM's has been a focus of lively research in the archaeological applications of lidar data in archaeology, though. In this presentation advancement in the field of DEM visualization through the image fusion will be presented.

Early research in focused on finding the best visualization technique for archaeological interpretation of DEM's. Good practice recommends the use of multiple visualizations and nowadays, we argue, the focus is shifting towards combining the benefits of different visualization techniques. There are many benefits to this approach, e.g. combining the details of openess visualization with SLRM (accentuated large features; see attached image), Sky Model (accentuated geomorphology) or multi-scale topographic position analysis (accentuated geomorphological context).

To achieve this a simple application of panchromatic sharpening is not adequate due to the spectral distortions. On the other hand, in cartography these effects are often applied in image post processing. This is executed in graphic design environment and it is not suitable for inclusion in the scientific workflow since it is difficult to document with settings being case dependent, more art than science so to speak.

As a solution, we are presenting the workflow and a case study of enhancement of DEM visualization through the image fusion based on WhiteboxGAT open source software.

**Relevance conference | Relevance session:**
The presented workflow is focused on being a well documented scientific method for extracting information (i.e. archaeological interpretation) from digital born data (i.e. DEM).
**Innovation:**
we are presenting the workflow of enhancement of DEM visualization through the image fusion based on WhiteboxGAT open source software; to our knowledge this is the first such attempt.
**References:**

ŠTULAR, Benjamin / KOKALJ, Žiga / OŠTIR, Krištof / NUNINGER, Laure (2012): Visualization of lidar-derived relief models for detection of archaeological features. Journal of Archaeological Science 39(11), 3354-3360.
DURAN, Joan / BUADES, Antoni / COLL, Bartomeu / SBERT, Catalina (2014): Implementation of Nonlocal Pansharpening Image Fusion. Image Processing On Line 4, 1-15.

# JEnhancer: Automatic Enhancement Toolkit for Underwater Images

**Damian HETTMANCZYK | Marco BLOCK-BERLITZ | Benjamin GEHMLICH**
(HTW Dresden, Dresden, Germany)

**Keywords:** UUV, 3D videogrammetry, image enhancement, automatic color transformation

**Abstract:**

Images taken under water are often of a monochromatic appearance, due to the physical interaction (absorption and reflection) between particles and light sources. Enhanced images with improved saturation, for which the monochromatic character has been corrected, are more suitable for generating 3D models and for identifying structures and materials by human experts.

In this paper we present an automatic method to identify the mean water color from a set of images. This mean color represents an average gray and is used to describe a new axis in CIELab color space. An extended color variance and a histogram equalization are simultaneously applied to the image. The main advantage of this method is the fully automatic enhancement process. An UUV can operate without providing a color reference scheme. The software presented is written in Java and was integrated into the module JEnhancer.

Beside color correction, defocusing and noise reduction are also useful for improving underwater images. JEnhancer was successfully tested in several documentation campaigns to enhance images with different mean colors like blue, green and red, and was integrated into the videogrammetric software pipeline Archaeo3D to produce 3D models from videos. We will showcase its application in diverse real-world case studies from Veruda/Croatia (blue colored salt water), the Surin Islands/Thailand (blue colored salt water), Zwischenahner Meer/Germany (red colored freshwater), Kamenz/Germany (green colored freshwater) and Mondsee/Austria (beige colored freshwater). JEnhancer is freely available for non-commercial purposes from our project page [www.archaeonautic.de](www.archaeonautic.de).

**Relevance conference | Relevance session:**

New free methods and low-cost solutions to document underwater archaeology sites are necessary to open up this research area for more archaeological institutes and people.

**Innovation:**

Fully automatic solution for color correction of underwater images and videos, to be used as the first processing step in an underwater videogrammetry pipeline.


# Geo-referencing from Photo-based Documentation in Freshwater and Marine Archaeology

**Roman SCHOLZ | Luka BEKIĆ | Marco BLOCK-BERLITZ**
(HTW Dresden, Dresden, Germany)

**Keywords:**

**Abstract:**

This preliminary report follows the structure from motion (SFM) method which has become increasingly popular in the cultural heritage world in recent years. That process (based solely on image data) allows for a relatively easy production of 3D models which can create very accurate drawings and video animations. Initial field tests have shown that this method can also be utilized underwater. In the future, the use of SFM will greatly ameliorate research in the underwater sector because it allows for the accurate reproduction of complex three-dimensional models. Moreover, SFM offers the first satisfactory solution for the examination of sites at greater depths (which necessarily curtail research divers' working hours). The quality of this data shows that SFM can be employed underwater with great accuracy. Via the better recording of in situ archaeological material, it is now possible to document even the most complex archaeological situations. The first field tests which took place during diving campaigns in the Mediterranean and the Baltic seas utilized various different recording methods. Divers took photos with a full format camera as well as with a

submersible robot with multiple GOPROs. To enable the creation of an accurate scale as well as to facilitate the geo-referencing required in the later creation of the model, a measurement framework or, more accurately, a multi-functional bridge was installed at the site in the Mediterranean. The results of this research as well as the team's experiences in its utilization 'on the ground' are the subject of this article. Additionally, this text addresses the optimal extraction of data during research dives and the equipment which was used to this end. As these factors are crucial to the quality of the models which are later produced, this aspect should be emphasized in future research.

## Templars in Iceland-an Illusion?

**Hansjörg THALER**
(free archaeologist, Brixen, Italy)

**Keywords:** Iceland, Templar knights, prospections, drones

**Abstract:**
One of the most interesting mysteries around the Knights Templar is their famous archive, which was kept in different places during the last decades of the existence of their order. The last notice about it appears in 1307 when the last Grand Master De Molnay refused to bring it to France and when he was arrested.
In the same year, Dante, who was supposedly a Templar himself, started to write his "Divine Comedy". It is believed that his famous work might contain hidden clues to the location of the archive. After a decade of intensive study, the Italian engineer and Dante-expert G. Gianazza was able to extrapolate the coordinates for the hiding place of the supposed Templar Archives in a specific area in Iceland. A decade ago in the same area a scattered short sword (Dage), typical for the Templars, and from the early 14th century was found. The presence of Templars on Iceland seems to be confirmed by sources from the Icelandic parliament Althing, which report the constant presence of a larger group of continental knights around the turn of the century.
In order to investigate the supposed presence of the last Templars on Iceland this area was surveyed with geo-radar in collaboration with Sirri Seren and the ZAMG Vienna as well as acquired digitally by Marco Block-Berlitz, HTW Dresden with UAV, creating a 3D model of the territory. Furthermore, an archaeological excavation was conducted with the focus on the walking horizon of the early 14th century, which was possible to determine by cross-dating the stratigraphic sequence with the many already dated volcanic eruptions. Marco Block-Berlitz supports also the excavating monitoring with systematic flights of UAV under extreme weather conditions with wind speed up to 50 km/h.
The use of cutting-edge survey and acquisition technology on a landscape scale, the processing of large data sets and the archaeological results achieved will be discussed and presented in this paper.

**Relevance conference | Relevance session:**
Drones and Geo-Radar in collaboration with Marco Block-Berlitz and ZAMG Sirri Seren, also excavation
**Innovation:**
New thematic, interdisiplinary project
**References:**
Marco BLOCK-BERLITZ, HTW Dresden, Germany
Sirri SEREN, ZAMG Vienna, Austria

# The Employment of Mobile Applications for Survey, Documentation and Information

Chair: Claudiu SILVESTRU, Austria

## Integration of a Geographic Information System with Augmented Reality Technologies to build a divulgation mobile application

**Eduardo BAVIERA LLÓPEZ | Jorge MARTÍNEZ PIQUERAS | Jorge LLOPIS VERDÚ | José Luis DENIA RÍOS | Carlos BONAFÉ CERVERA**
(Instituto Universitario de Restauración del Patrimonio Arquitectónico – Polytechnic University of Valencia, Valencia, Spain)

**Keywords:** GIS, Augmented Reality, Mobile Application, Fontilles

**Abstract:**
The San Francisco de Borja Sanatorium is strategically located at La Vall de Laguart (Alicante, Spain). It is founded in the early twentieth century to collect, isolate and treat leprosy. The architectural ensemble consists of more than 30 pavilions that were built during the century.
Archival work has been one of the most important parts of the research. Graphic and historic documents have been gathered and classified by date and building, which facilitates the study of each pavilion's evolution.
The best way to manage such a big amount of information is through a GIS (Geographical Information System). Thus, every piece of information (historical pictures and data, plans…) will be georeferenced and stored in a SQL database (PostgreSQL).
The mobile app that we are developing will provide historical information of every building in Fontilles. The system will show not only related information to the building that the user is nearby but also the specific point of view of every picture. Therefore, using augmented reality tracking methods, it will be possible for the user to compare the present with the past.
This paper is developing part of the results of a research project in progress (El Sanatorio de San Francisco de Borja de Fontilles. Modelo de análisis para la recuperación integral de complejos sanitarios de valor patrimonial HAR2013- 42060-R) funded by the Ministry of Economy and Competitiveness of Spain.

**Relevance conference | Relevance session:**
The San Francisco de Borja Sanatorium has always been considered as one of the most important leprosariums in Europe.
**Innovation:**
We are combining GIS with Augmented Reality
**References:**
**MARÍN TOLOSA, E. R. / HIDALGO DELGADO, F. (2014):** Sanatorio de san francisco de borja, fontilles. secuenciación arquitectónica. análisis y evolución de sus estructuras y técnicas constructivas. In M. V. Vivancos, M. T. Doménech, M. Sánchez Pons, & J. Osca Pons (Eds.), Emerge2014. Jornadas de Investigación Emergente en Conservación y Restauración de Patrimonio (535–544). Valencia: Editorial Un

## From multimedia 2D to interactive immersive 360° Virtual Reality Apps

**Gerhard SINDELAR**
(beyondarts GmbH, Klosterneuburg, Austria)

**Keywords:** 360° Virtual Reality, Mobile Apps, Multimedia, Panoramic View

**Abstract:**
Experiencing touristic highlights, cultural and archaeological treasures at home is currently very limited. The experience is normally reduced to 2-dimensional images and audio.
Although 360° panoramic views of highlights are available, related high quality content and interactive tours are not.
Immersive VR-Applications provide new visual possibilities and experiences, however, they are still at the beginning, often they have several shortcomings related to the user experience, quality and stability, often they are „tech-demos". Products that are market-ready are rare.
Previewing the cultural highlights at home can of course not replace the real visit. On the location itself the adequate solution as guiding tools are the beyondarts 2D app/guides.
Our apps/guides, including multilingual audio files alongside text, images and features like geo-positioning, already provide high quality content in the touristic sector. A good combination of the selection of the 10 highlights, detailed information and storytelling lead to an exciting experience of 1 to 2 hours.
The existing app is now simply extended, a 360° panoramic view is implemented. The existing content can be used, only the panoramic images have to be created.
The user sees the highlights of the beyondarts app in a 360° panoramic view in 3D and thus as an immersive experience. The detail buttons are integrated in the 360° view, so that the user can simply navigate by sight within the app. Designed for Google cardboard, Samsung GearVR and mobile virtual reality headsets for all platforms: iOS, Android and as a web-application for windows hardware and touch screens.
VR develops to a "life-style" product in an emerging market – estimated 37 millions of mobile virtual reality headsets will be on the market 2020.
beyondarts develops content and the technical application for this market. In our presentation we will show how our 2D and our 360°VR app/guides work, what features they offer. We will explain their wide range of uses and show the new possibilties for marketing and distribution.

**Relevance conference | Relevance session:**
New technologies can help to understand cultural heritage and gain new target groups.
**Innovation:**
We present one of the rare market-ready 3D App-Guiding solutions.
**References:**
The 3D Application is brand new, we have already created 2D solutions e.g. for Burghauptmannschaft Österreich (Guide Hofburg Vienna), Klosterneuburg Monastery (Guide Kl. Monatsery) and the cities of Baden (Guide Baden near Vienna) and Gmunden (Guide Seeschloss Ort).

# ROUND TABLES

# Long-term preservation and access: Where is an archive for my data?

Organisers: Edeltraud ASPÖCK | Guntram GESER, Austria

## Small Solutions for Small Institutions – Steps Towards Archiving and Preservation of Digital Data

**Reiner GÖLDNER**

(Archaeological Heritage Office Saxony, Dresden, Germany)

**Keywords:** long term preservation, archiving, archaeological data

**Abstract:**
Archiving (in English better: preservation) means to permanently preserve content and functionality of digital data and provide access to it. OAIS defines six complex functions to be performed, e.g. data management and preservation planning. So, archiving is the most intensive and most expensive way to store data. But aren't there any alternatives?
Based on intensive discussions in a in a working group of the Association of State Archaeologists in Germany (Verband der Landesarchaeologen in Deutschland – VLA) and on first lessons learned while operating a digital archive the presentation will address some small steps leading towards a proper archiving without using large budgets.
The first step is to hold somebody responsible for Preservation of digital data. This person has to acquire competencies in the fields of archiving, information technologies and cultural resource management (may be archaeology). He/she would benefit from some clear archiving objectives and requirements.
Next steps may be to think about the security of the existing data, to index the existing data with metadata and to reduce the amount of data formats to a small set of well suited archiving formats. Going such steps will help to reduce the risk of losing important digital information.
Going these steps will also bridge the gap until proper preservation tools are available at a reasonable price.

**Relevance conference | Relevance session:**
The presentation matches the conference theme in the field of archaeological data that has to be preserved sometimes without large budgets.
**Innovation:**
Up to now digital preservation is a story for the rich. Almost all success stories tell us of large systems. So it is very interesting to create some bottom up ideas.
**References:**
**GÖLDNER et al.:** Ratgeber zur Archivierung digitaler Daten (http://www.landesarchaeologen.de/fileadmin/Dokumente/Dokumente_Kommissionen/Dokumente_Archaeologie-Informationssysteme/Dokumente_AIS_Archivierung/Ratgeber_Archivierung_V1.0.pdf)
**BIBBY, D. / GÖLDNER, R.:** Authenticity and Functionality at Digital Archaeological Data (http://www.chnt.at/chnt-18-proceedings)

### IANUS on the road – building a national research data center in Germany

**Felix SCHÄFER | Maurice HEINRICH**
(IANUS c/o Deutsches Archäologisches Institut, Berlin, Germany)

**Abstract:**
The research data centre IANUS is currently on its way to being a national data repository for archaeology and ancient studies in Germany. Up to now it is still a project with a second 3-year funding but we strive to become a permanent infrastructure with reliable services. From this perspective we can contribute to the round table discussion with insights about the current situation of IANUS, about its strategies and about its experiences so far. We can offer some answers to the questions described: what are our stakeholders, how is IANUS organized, how is the disciplinary community in Germany involved, what governing bodies exist and are planned, what is the financial concept, who could be institutional partners to ensure a long-term funding, what legal issues are to be addressed, how important is public relations work? The answers we can give are very much still work-in-progress but might be helpful for other projects and actors. We can also add our observation on the current developments in Germany where many institutional or regional data centres evolve, some disciplinary digital infrastructures already exist and many initiatives in-between these positions are coming (and going). Moreover, we can bring in and discuss two results from our first project phase: a stakeholder analysis about data handling in archaeology and ancient studies in Germany and a small evaluation of 20 different data collections from various authors which highlights the heterogeneity in data organization and diversity of data formats in archaeological projects.

**Relevance conference | Relevance round table:**
The preservation and re-use of archaeological research data is the main service of IANUS as a national repository in Germany for archaeology and ancient studies.
**Innovation:**
IANUS is one of the first discipline specific archival infrastructures being built up in Germany in the field of the humanities.
**References:**
http://www.ianus-fdz.de
**HEINRICH, M. / SCHÄFER, F. (2014):** IANUS. Archivierung von digitalen Forschungsdaten in den Altertumswissenschaften, in: J. Filthaut (Hrsg.), Von der Übernahme zur Benutzung. Aktuelle Entwicklungen in der digitalen Archivierung, 18. Tagung des Arbeitskreises Archivierung von Unterlagen aus digitalen Systemen am 11.–12. März 2014 in Weimar (Weimar 2014), 11–20.


# The integration between archaeology and history based on ICT

Organisers: Ingeborg GAISBAUER, Austria | Irmela HERZOG, Germany


### The Missing Link. Modelling urbanization dynamics in the Lowlands AD200-1200

**Jaap Evert ABRAHAMSE | Rowin VAN LANEN | Menne KOSIAN**
(Cultural Heritage Agency of the Netherland, Amersfoort, The Netherlands)

**Abstract:**
As a result of the Atlas of the Dutch Urban Landscape research project, the Cultural Heritage Agency of the Netherlands (published 2016) has created an overview of European urbanization from the Roman period up to the present in a series of digital GIS-based maps. These maps represent a combination of archaeological, spatial, landscape, demographic and historical data. On these maps we can clearly see the shifting of economic centres under the influence of changing infrastructures, the rise and fall of nations and empires, industrialization, and many other factors.
The maps represent the periods around AD 200, 1000, 1300, 1500, 1700, 1800, 1900 and 2000. These time slices represent a subsequence of periods in urban history. In this chronological sequence there is a single striking gap between AD200 and 1000. In between these two periods, we have seen the ascent and disappearance of a special category of towns: the emporia of early medieval Europe.
In this paper we would like to propose a methodological framework for a comparative, synthesizing approach of urban development from the Roman era to the High Middle Ages, with the Netherlands as a case study. Will it be possible to outline and explain the fundamental shifts from the urban-oriented Roman empire, to the dynamism of the early medieval emporia, to eventually the pattern of towns that emerged in the Middle Ages and which continued into the early-modern period? What data are available and how can we integrate them into a comprehensive model?

**Relevance conference | Relevance Round Table:**
This paper deals with the integration of digital and analogue data into a comprehensive model, aiming at creating an overview of urban development in the period AD200-1200.
**Innovation:**
An overview like this has not been made before.
**References:**

**RUTTE, Reinout / ABRAHAMSE, Jaap Evert (eds.) (2016):** Atlas of the Dutch urban landscape. A millennium of spatial development, Bussum (Thoth Publishers) 2016.
**VAN LANEN, R.J. et al. (in review):** 'Route persistence. Modelling and quantifying historical route-network stability during the last two millennia: a case study from the Netherlands', Archaeological and Anthropological Sciences (in review).

# Historical maps and ALS visualisations

**Ralf HESSE**
(State Office for Cultural Heritage, Esslingen am Neckar, Germany)

**Keywords:** historical map, ALS, lidar

**Abstract:**
Historical maps are very valuable sources of information for understanding the past and for locating possible archaeological sites. However, due to various inaccuracies of such maps, many features shown on them can be difficult to locate. For example, many 18th century maps are based on a mix of survey methods (e.g. triangulation of important landmarks and less important places filled in based on walking distances or estimation) with very different error margins (from tens of metres to several kilometres). Standard methods for georeferencing therefore often result in maps which are severely distorted or in which only the well-surveyed points (usually those considered important at the time) are shown in the correct location. Features like roads, stream channels or artificial ponds (including commonly associated features such as bridges, gallows or mills) which are often depicted on historical maps can be very important from an archaeological point of view. However, their exact location may have been unimportant (or unknown) to the creator of the map. Interpretation of ALS (airborne lidar) visualisations can in many cases provide the necessary information to locate such features shown on historical maps. On the other hand, historical maps can support the interpretation of ALS visualisations. In many cases (and in particular for maps predating the 19th century), time and effort for a combined interpretation of historical maps and ALS visualisations are high.

**Relevance conference | Relevance round table:**
This paper relates to the theme of the conference by looking at both historical and new data (maps and ALS) in the context of the interconnections between settlements.

# Reconstructing Pre-Industrial Long Distance Roads in the Bergisches Land, Germany, Based on Historical and Archaeological Data

**Irmela HERZOG**
(The Rhineland Commission for Archaeological Monuments and Sites, Bonn, Germany)

**Keywords:** Historical maps, Lidar data, least-cost analysis

**Abstract:**
The aim of this contribution is on the one hand to map pre-industrial long distance roads in the study area covering part of the Bergisches Land, Germany, as exactly as possible and on the other hand to assess the accuracy of least-cost approaches that are increasingly applied by archaeologists for prehistoric road reconstruction. The earliest maps covering the study area east of Cologne date back to 1575, 1607, and 1715. These maps are distorted so that rectification is difficult. But it is possible to assess the local accuracy of these maps and to transfer the approximate routes to a GIS. Afterwards road sections coinciding on several historical maps are identified. This historical data is supplemented by the ancient trade route descriptions published by Nicke (2001) who walked in the region and recorded remains of the old roads discussed mainly in local literature. Based on these route reconstructions with limited accuracy, Lidar data is checked to identify remains of these routes. This enables us to map some route sections at high accuracy. The most probable routes resulting from this analysis are compared to the outcomes of least-cost approaches like least-cost-paths and accessibility maps. In regions where the least-cost results coincide with several of the high accuracy road sections, these approaches can also be used to predict missing links. For areas of less convincing least-cost results, the limitations of the methodology are analysed.

**Relevance conference | Relevance round table:**
The contribution presents a combined analysis of historical and archaeological data applying several GIS approaches.
**Innovation:**
A methodology combining historical and archaeological data is presented allowing to map pre-industrial long distance roads as exactly as possible.
**References:**
**HERZOG, I. (2013):** Calculating accessibility. In: Earl/Sly/Chrysanthi/Murrieta-Flores/Papadopoulos/Romanowska/Wheatley (eds.): Archaeology in the Digital Era, Volume II. Proceedings of the 40th Annual CAA Conference, 720-734.
**NICKE, H. (2001):** Vergessene Wege. Das historische Fernwegenetz zwischen Rhein, Weser, Hellweg und Westerwald, seine Schutzanlagen und Knotenpunkte. Nümbrecht.

# A new historical basemap for archaeological research for medieval Netherlands

**Menne KOSIAN | Rowin VAN LANEN**
(Cultural Heritage Agency of the Netherlands, Amersfoort, The Netherlands)

**Keywords:** landscape, GIS, history, archaeology, public awareness

**Abstract:**
Historical and archaeological research and education is often hampered by lack of imaginative maps of the contemporary landscape. Most scientific maps are mainly technical studies into geology and

geomorphology, which, by default, are both very precise as well as very specialist-oriented. For non-specialists and the general public these maps are often not suitable.

The Cultural Heritage Agency of the Netherlands tries to offer both adequate scientific information as well as information for a wider audience through our several CH portals. For one of these portals a new map is developed that reconstructs the cultural and physical landscape of the Netherlands in 1575, the formation of the modern Dutch state after the uprising against the Spanish reign.

This reconstruction is aimed at a user group of both scientists and interested public. In order to achieve this goal the map is constructed uasing an almost inverse method for landscape mapping. Starting point were the city plans by Jacob van Deventer (second half of the 16th century). These were georeferenced and digitized by using the modern street GIS systems.

Next, the city plans were linked to each other using modern research into regional and long-distance route networks in the Netherlands. These routes were based on landscape features as well as historical maps. This way both the methodology of the route networks research could be verified as well as the georeferencing method of the Van Deventer maps.

This new, corrected, 'skeleton' of medieval Dutch topography was confronted with recent research into the palaeogeography of the Netherlands. From a very detailed level, the general picture of the Netherlands in 1575 could be drawn, and refined where necessary. This produced a map that not only has a strong scientific base, but also gives the opportunity to be read and understood by the general public, zooming in on their home town.

With this new map the Cultural Heritage Agency tries to reach not only scientists, but also create awareness of the heritage and history in the surrounding landscape with both the general public as well as local administrators.

**Relevance conference**
New technology used to create public, political and scientific awareness of history in own surroundings
**Relevance round table:**
New technologies in heritage dissemination


# Target Groups, Users, Followers, Fans – The Nature and Potential of Social Data in Archaeology

Organiser: Carmen LÖW, Austria


## Experimental archeology in social media – the example of Archeomuse

**Elisabeth MONAMY**
(Archeomuse, Vienna, Austria)

**Keywords:** database, statistics, social medias, experimental archaeology

**Abstract:**
Archeomuse started 2015 to promote experimental archaeology in Austria and mainly in Vienna through antique cooking workshops. The use of social media has been of a great importance endorsing the information that these courses exist. After one year it is very interesting to have a look at the audience of the postings. Who is the audience, who are the followers and the users? Does it match with Archeomuses expectation or offline target group? Is it another audience than the one targeted by posters, flyers, newsletters? What are the postings about? Does the audience vary depending on the data presented: articles about new scientific research or new evidences from excavations or advertising an upcoming event, antique cooking workshop or conference? Apart from the audience, how and when do users react? Do they "like" a posting or a picture, or do they react

and write something? In these few minutes during the round table it will be exciting to present statistics about how many or which postings are seen and / or read by the audience and how many people really book an antique cooking workshop or attend any kind of events offered by Archeomuse. Finally, these statistics will show if the social media are reaching potential clients or just awaken interest for (experimental) archaeology.

**Relevance conference | Relevance session:**
How experimental archaeology pleases in social media and how potential interest is awakened.
**Innovation:**
A survey of the offer of experimental archeology workshops in a non-scientific field for a wide audience in social media in Austria.
**References:**
https://www.facebook.com/archeomuse/?ref=aymt_homepage_panel
exampel of an article about an ancient beer recipe and the reaction on facebook
https://www.instagram.com/archeomuse/
pictures from events hosted by Archeomuse and the number of followers

# The use of weblogs to impart scientific results at the example of the Hallstatt research

**Fiona POPPENWIMMER | Hans RESCHREITER**
(Natural History Museum Vienna, Vienna, Austria)

**Keywords:** Hallstatt, Weblog, Social Media

**Abstract:**
In 2013 the archaeological research of Hallstatt, pursued by the Natural History Museum of Vienna found an own weblog. Since then, the weblog developed to be the main tool for public relations of the Hallstatt research.
Over the years we became aware of more and more important data, which can help us to understand our target groups and to observe their behaviour in reading. Since the very beginning it was a main goal of the Hallstatt weblog, to reach the people of the Salzkammergut region as well as the cooperation partners and professional colleagues. Groups, whose interests are not always easy to unite. The medium weblog is – especially in the field of humanities – still often very underestimated. Its content and language is mostly in the middle of scientific articles in print media and short-dated news on Facebook, so the definition of its target group and the adaption of content, language and public relation to this target group is essential. This is possible with the data we get from the used Blogger Tool.
One of the benefits of a weblog is the personal connection between authors and readers, which mainly is reached with a personal writing style. In contrast to classic print media, you can watch the feedback of your readers very directly.
Significant is also the interaction of Weblogs and social media. The main part of the hits are linked with Facebook, which is why it was the focus in promoting the weblog. Attention should be payed to the fact, that the promotion took place just on private accounts (like the ones of the editor and the authors). With an own account for the Hallstatt research the success would probably increase.
The experience of the last years gave us a good foundation for further development in the fields of online communication and social media data.
How can we increase the hits of our weblogs? How can we connect different science weblogs more and support each other? How can we improve the reputation of weblogs in science and reach more influencers? These and further questions I would like to discuss in the round table and exchange experiences, ideas and new concepts.

# POSTER – AWARD | APP – AWARD

## POSTER – Session

Organiser: Peter DORNINGER, Austria

## CULTURAL HERITAGE

### The three medieval fighters from Cölln/Berlin

Jessica ROTHE[1] | Claudia Maria MELISCH[2] | Natasha POWERS
([1]Charité Berlin, Germany | [2]Humboldt-University, Berlin, Germany)

Keywords: Forensic Genetics, Medieval cemetery, excavation

Abstract:
The department of Forensic Genetics at Charité Berlin investigated a triple burial that was found during recent excavations at St. Peters square in Berlin and dates back to the 12 th century and therefore to the beginning of the settlement Cologne/Cölln, Berlins medieval sister city. This triple grave was particular striking because of the unusual orientation of the skeletons and the high number of sharp force injuries that the buried individuals had to suffer prior to their death. Analysis from different disciplines, as well as the here in detail demonstrated DNA-analysis revealed the social function and of three individuals were that of mercenary soldiers, a part of the medieval societies which so far has been relatively poorly studied. Germany's capital Berlin originated from the medieval twin cities Berlin and Cologne and was founded during the last quarter of the 12th century. In the center of the early Cölln stood the Saint Peter's Church with its graveyard, which is believed to serve as the burial site for the first settlers of Cölln. Relatively few is known about the first settlers of Cölln – Who where this first settlers? – Where they came from? – What were their life conditions and their social constructions? Modern genetic research can help to find out much more about the early deceased.

### The Mausoleum of Giuseppe Tonietti on the Elba Island: From a masterpiece of Adolofo Coppedè to a compromising state of decay

Angela MANCUSO | Andrea PASQUALI | Giorgio VERDIANI
(University of Florence – Dipartimento di Architettura, Florence, Italy)

Keywords: digital survey, mausoleum, liberty architecture, Coppedè, Tuscany

Abstract:
The study shows the results of the digital and photographic surveys operated on an architectural work of great importance: it is the Mausoleum for Tonietti family, by Adolfo Coppedè, built on the Elba Island in Tuscany-Italy at the beginning of the 20th century.
The current alarming conditions of the building invite to make some reflections on the unpleasant but common fate of many architectures of the Liberty and Eclectic period in Italy. With the evolution of rationalism of the architectural form and thus the gradual purifying of decorative plastic organisms from architectural objects, architectural research, and with it the observation and conservation of cultural heritage, has focused increasingly on new rational style, omitting so many examples in floral

style equally deserving of attention.

The alarming state of preservation of Tonietti Mausoleum, combined with the total absence of projects by local authorities, set the conditions for the dissolution of the work and the consequent loss of the cultural and territorial connotation that it creates.

The processing of the surveys and the gathering of documentation wants to create the basis for the comparison of work conditions in its original state and the current form, fixing the actual conditions of decay.

There is the hope that this work can create a conservative practical input that restores the integrity of the cultural property designed by the youngest of Coppedè brothers, giving to it its real and necessary value in the study of the history of architecture and the development of the evolutionary dialogue necessarily connected to the same historical evolution.

## The lapidary of Palazzo Ancarano, headquarter of the Archaeological Superintendence of Emilia Romagna

Veronica VILLA[1] | Tatiana PIGNATALE[2] | Ilenia TRAMENTOZZI[2]
([1]Accademia di Belle Arti di Bologna, MIUR AFAM | [2]Dipartimento di Architettura DIDA, Università degli Studi di Firenze, Italy)

**Keywords:** Lapidary, Palazzo Ancarano, Heritage protection

**Abstract:**

In Italy, in the academic field, there are many cases of collaboration between the University and the various institutions protecting Cultural Heritage. It is made possible because of the large section of archaeological heritage requiring restoration interventions and thanks to the need from students to put their skills into practice. This is the case of the partnership between the Archaeological Superintendence of Emilia Romagna and the Fine Arts Academy of Bologna (Italy) established in 2012. This collaboration has permitted to open an important restoration site to recover the lapidary located in the courtyard of the historical Palazzo Ancarano. The restoration project was developed over a period of three years, plus an additional year to reorganize the exhibition path. To each student was assigned the maintenance of an archaeological find with the purpose of producing a thorough and complete documentation on the intervention made, necessary to leave a proof of the methods and materials used. A targeted work on every archaeological find present in the court, having an aim to arrange them around the perimeter of it in chronological order based on historical era. At the conclusion of the restoration and reorganization of the area, it is now necessary to add value in particular to the stele collection: pre-Roman, Roman and Medieval. This objective will be reached by opening the courtyard of the Palazzo Ancarano to the public, to bring again its original function, that is, a museum. To reach this purpose, we propose to use appropriate digital technologies associated with the archaeological items on display to improve the understanding of the collection by a wide variety of visitors, we intend to provide an instrument presenting information of various levels of detail and thoroughness enabling each visitor to deepen their knowledge according to their own interest.

# The teaching of restoration in the Archaeological University Courses: the innovation of the practical ceramic conservation laboratory inside the Graduate School in Archaeology – UNIFI

**Giulia DIONISIO | Daniela PUZIO**
(University of Florence, Florence, Italy)

**Keywords:** restoration, ceramic, university, practical laboratory

**Abstract:**
In theoretical Archaeological University courses it is often impossible to act directly on artifacts owing to the lack of products and working spaces and the poor availability of suitable materials. However, the archaeologist's work is mainly carried out in the field and in most cases requires direct conservative procedures on archaeological ceramics to allow their study and documentation. As such, the lack of practical restoration laboratories within the university curricula represents a serious gap in the training of future professional archaeologists. In 2016 a practical laboratory of ceramic conservation was established for the first time inside the Graduate School of Archaeology of the University of Florence. The goal was to give students the opportunity to put into practice the theoretical conservation lessons learned in the classroom. Trainees were put to work directly both on the archaeological and modern ceramic materials, so as to learn which materials to use and how to make all relevant operations to the cultural heritage conservation (cleaning, sticking and integration of missing parts). All the operations carried out during the course followed the same procedures currently required on archaeological ceramics by the Superintendency for Archaeological Heritage of Tuscany. All the steps taken in the laboratory are similar to those implemented on a Mycenaean stirrup jar reported in the poster as an example.

# The Ruspoli Chapel at the Porte Sante cemetery in Florence. Material and diagnostic survey for conservation

**Anna Livia CIUFFREDA | Alonso Elena JUAREZ | Petronilla PATTI | Sara SOLDAINI**
(University of Florence, Florence, Italy)

**Keywords:** Ruspoli chappel, Porte Sante cemetery, historical building, material survey, diagnostic survey

**Abstract:**
Porte Sante is one of the monumental cemetery in Florence, located within the fortified bastion of the Basilica di San Miniato al Monte.
In the 1840s the town council decided to find a large area near Florence, to use as a cemetery. It was chosen the Fortress of San Miniato for the solemnity of the place.
The first project was entrusted to Niccolò Matas in 1844 and in the 1860s the architect Mariano Falcini designed a new project using the area of the sixteenth-century fortress that stretched around the church.
The Porte Sante cemetery surprised visitors with its comingling of styles: it was important to appear, to show the dignity of their own social class. This eclectic mix reveals interesting monuments for the style, for materials and construction methods.
One of this examples is the Ruspoli chapel, designed in 1891 by Giovanni Paciarelli, architect sensitive to modernism and designer of Paggi Palace in Florence.
The chapel, commissioned by Valsè-Pontellini family, stands out in the landscape for the precious texture of exotic carvings and inlays of polychrome marble, mosaics and historiated glass. Today it is in bad state of conservation.
The recovery of the chapel must provide for a careful restoration project whose foundation is the comprehensive knowledge of good, which can be achieved through the survey operations, the

historical analysis and diagnostic investigations.

The use of a photogrammetry software allowed us to obtain a virtual 3D model, which forms the basis for subsequent analyzes and evaluations on the state of conservation of the building.

Such study will be applied to other artifacts in the cemetery, by implementing current and future studies on the whole complex of the Porte Sante.

## The Bogliaco Bartolani Chapel in the Cemetery of Porte Sante, Florence. Survey and analysis for the restoration

**Angela MANCUSO | Olimpia Barbieri GENTILI CALCAGNINI | Gabriella GORETTI | Milena ROCCABRUNA**
(University of Florence – Dipartimento di Architettura, Florence, Italy)

**Keywords:** burial architecture, Italian Eclecticism, metrical survey, decay, analysis

**Abstract:**
The Cemetery of the Porte Sante in Florence is located on San Miniato al Monte, one of the highest hills of the city. The cemetery was built in 1854 and it has always been characterized by a monumental nature. Since the end of 1800 the excavated burials were enriched with decorations, and other areas were dedicated to the creation of chapels and mausoleum made by the most famous architects of the time. Today the cemetery is not well preserved: many tombs are abandoned and there is a general need of restoration.

During the Diagnostics Laboratory of the Specialization School of the University of Florence, many studies on the major chapels of the cemetery have been carried out.

In this paper is presented the survey and the analysis on the state of decay of the Bogliaco Bartolani Chapel, projected in 1913 by Architect Enrico Dante Fantappiè, an Italian master of Eclecticism. This chapel is a very interesting example of the style, in which stands out the juxtaposition and contrast of different materials and crafts. The studies on the chapel follows a line that go from an initial photographic and metric survey, to a bibliographic and archive research work and finally to an examination of the decay phenomena on the exterior façades.

The final phase will be a comparison between this tomb and another example of chapel by Fantappiè, located in the same cemetery: similar construction design leads to similar state of decay. Moreover the workflow presented could be an interesting example of how studies can be carried out with reduced expenses in case of a very low budget. In the cemetery public and private properties (often dispersed) are converging: pushing the boundaries of proprieties is crucial to carry out a policy of recovery of one of the monumental hills of Florence

## Non –destructive analysis in the diagnostic process on the cultural heritage buildings

**Francesco CUCCURU | G.CASULA | S. FAIS | P. LIGAS | M. G. BIANCHI**
(Dipartimento di Ingegneria Civile, Ambientale e Architettura – University of Cagliari, Italy)

**Keywords:** non-destructive analysis, terrestrial laser scanner, ultrasonic techniques, petrographic analysis

**Abstract:**
This paper describes the results of a survey aimed to use a non-destructive methodology based on the integrated application of 3D terrestrial laser scanning (TLS), acoustic techniques and petrographycal analysis in evaluating the quality of cultural heritage structures.

The application of a methodology useful to evaluate the quality of stone building materials and locate altered or damaged zones both in shallow and inner parts of the investigated architectural elements is presented in this study based on the integrated application of three independent

techniques, two non destructive such as the terrestrial laser scanning and the ultrasonic techniques in the 24kHz – 54kHz ultrasonic range, and a third to analyze the petrographical characteristics of the stone materials, mainly the texture, with optical and scanning electronic microscopy (SEM). A very interesting case study is presented on a carbonate stone door of great architectural and historical interest, well suited to a high definition survey. This architectural element is inside the "Palazzo di Città" museum in the historical center of the Town of Cagliari, Sardinia (Italy). The integrated application of TLS and in situ and laboratory ultrasonic techniques, enhanced by the knowledge of the petrographic characteristics of the rocks, improves the diagnostic process and affords reliable information on the state of conservation of the stones used to build it. The integrated use of the above non destructive techniques provides useful data in assessing and monitoring the status of the investigated monumental structure and in planning its restoration.

## The Tower of Torrenostra in Torreblanca – Spain: studies and documentation for a landscape virtual reconstruction

**Fabrizia GIANNOTTI | Andrea PASQUALI | Andrea LEONARDI**
(University of Florence – Dipartimento di Architettura, Florence, Italy)

**Keywords:** Coastal Tower, 3D reconstruction, Cultural Heritage, Landscape, Musealization

**Abstract:**
The Tower of Torrenostra, built between the XVIth and XVIIthcenturies, is located in the city of Torreblanca – Spain, and is one of the still-exiting towers of the Valencian Coast, projected by Ing. G. B. Antonelli.
During the survey campaign of the TOVIVA research project "Torres de vigía y defensa del litoral valenciano. Generación de metadatos y modelos 3D para su interpretación y efectiva puesta en valor", many of these towers have been digitally surveyed using 3D laser scanner, terrestrial and aerial photogrammetry. The survey campaign took place in April 2015 and after the data gathering, a phase of elaboration has succeeded to produce the classical architectural drawings of plans, elevations and sections. A part of this documentation has been collected on the poster "When an isolated building becomes a guideline for the urban pattern. The case of "Torrenostra" in Torreblanca, Castellón, Spain", by T. G. Piqueras S. Giraudeau and A. Leonardi in 2015.
This poster present an evolution of the work on this tower, aimed to a reconstruction of the original landscape around it: if today the tower is presented surrounded by other buildings in the two lateral sides, the situation was very different in the past, when the tower was totally isolated on the coast. The re-discovery of the original landscape of the city could be an interesting topic to explain in a Museum of the Territory of Torreblanca, that could take place inside the tower and that could explain to the tourist, how was the territory in the past and how it has been evolved, involving the structure of the tower itself, changing its shape and value. The 3D reconstruction, both digital and tangible is also a good way to involve children and adults at the same time, adding a special value to an historical building.

## Survey documentation about some refectory in Cappadocia

**Carmela CRESCENZI | Elena VANNACCI**
(UniFI-DIDA, Florence, Italy)

**Keywords:** Rupestrian settlement, Cappadocia, Göreme, landscape survey, digital survey, 3D scanner, photogrammetry, virtual tour

**Abstract:**
The poster features the study of three refectory present in the historical region of Cappadocia: the Basilica building identified as the refectory nell'Allaçh monastery in Ortahisar, the refectory of one of the complexes in Kılıçlar valley in Göreme (33a) the elaborate refectory of complex Geyikli kilise in Soğanlı.
The study and the identification of the characteristic elements that distinguish the dinrefectory inrupestrian architecture was supported by innovative technologies for the survey that allowed a greater understanding of the volumes and underground connections.
The comparison of the three buildings in the rock, it was assessed all refectory, and other yet undocumented exhaustively (at the same level), highlights the characteristics and differences that define "the refectory "denoting in some cases a possible different use of some buildings regarded as such, which the refectory of -Allach.
The processed data contribute to the knowledge and promotion of a heritage rich in connotations. They are disappearing and concurs with the canonical representation of three-dimensional classification of their components for easier reading and classification of any other similar environments.
The work was carried out within the European project Chrima-CINP (2010-2012) coordinated by UniFI-DIDA, and PRIN 2010-2011 and in conjunction with "the mission" Rock painting in Cappadocia.
For a project of knowledge,conservation and enhancement "directed by Disbec-Unitus, latter 's supported by the General Directorate of Monuments and Museums of the Turkish Republic and the Archaeological Museum of Nevşehir, the Research Unit of the DIDA has had interest as the "Representation for knowledge, preservation and improvement of the Mediterranean rupestrian habitat. "
The aim of these projects specific to the UR – DIDA is the documentation of the rupestrian Cultural Heritage, fragile heritage and in the process of dissolution.
The site's documentation has been produced with different digital techniques; especially the architectural survey was Carried out using 3D laser scanner, several Photogrammetric restitution techniques, and in some cases, with 360 panoramic virtual tours.

# Using a Development Plan from 1930s to evaluate Urban Archaeological Potential in Tarsus

**Züleyha Sara BELGE**
(Mersin University, Faculty of Architecture, Department of City and Regional Planning, Mersin, Turkey)

**Keywords:** Tarsus, Hermann Jansen Plan, QuantumGIS, Urban Archaeological Traces

**Abstract:**
"The Scientific and Technological Research Council of Turkey (TUBITAK-Project No: 113K132) supported the research project in Tarsus, which has been settled since Neolithic ages in the course of Cydnus River in Cilicia (Turkey), to develop a method to handle urban archaeological heritage within planning process of multi-layered historic city centres. Therefore, primary and secondary datasets are used to evaluate urban archaeological potential in Tarsus historic city centre. One of them is Tarsus Development Plan was prepared by Hermann Jansen, Walther Banghert and Walter Moest in 1935. Digital copies of Tarsus Master Plan (1935) were obtained in high resolutions that indicating urban pattern and conserved archaeological traces in 1930s from the archive of the Museum of Architecture of the Technische Universität Berlin (http://architekturmuseum.ub.tu-berlin.de). By the way, a mound in Tarsus historic city centre, even not known by local archaeology museum, was

discored by research group. An area in the east side of ancient bed of Cydnus River, was marked as Hüyk (synonym of "the mound" in Turkish) in Tarsus Development Plan. However, the research team observed that mound wholly destroyed, but cadastral differences with that area and near surroundings indicates a potential. The poster aims to present the process and evaluate a rectified Plan (1935) and recent pattern to undertand urban archaeolgoical potential.

## Experimental Restoration and Replica Studies Using 3D Technology

**Ugur GENC**
(Ministry of Culture and Tourism – FOCUH (Friends of Cultural Heritage), Istanbul, Turkey)

**Keywords:** Restoration, tomography, museology, 3D technology, historical artifacts

**Abstract:**
Cesme is a settlement and a harbor situated on the promontory of a peninsula that projects out over the Aegean Sea, in Western Anatolia. In Turkish Naval History, Cesme also grieves in rememberance of "The Sea Battle of Cesme", which had an important impact on Turkish maritime history when the Ottoman Armada was destroyed by re ships sent by the Russians in 1770. In this war, the burning main mast of the Turkish vessel fell onto the ship The admiral ship called "Yevstafiy" and in a few minutes Yevstaiy blew off. Diving studies was started in 1996 and a sword was removed from the Yevstafiy wreck. This sword hasn't been touched in 20 years and in 2015 moved to the laboratory for conservation. In this study, Computed Tomography was used for the 3d model and to see the corruption of the sword in the scabbard. We used 3D scanner and 3D printer technology in for this restoration Project.
Sword image could not be obtained with a flat panel. In this study, around the metal or composite an artefact is sufficient to scan a given object and to create a two- dimensional projection. CBCT was helpful to enabled visualization of fracture areas. CBCT is a very high spatial resolution, relatively low radiation dose and excellent 3D-reconstuction possibilities. Tomography technique for studying internal damage in sword. In the analysis, the presence of absence of the sword in the scabbard as a whole, dividing it into pieces able to retain the form. The sharp edge of the sword quinine down section, in the body of the plate, in the case of the steel of the sword was examined. Density values of the tissues that gives with the help of different materials by comparing the values of the sheath cases have been revealed. It according to the structure of the iron is a spongy, density is nearly wood close by. The under the brass in view of iron corrosion more than other areas. This effect of iron corrosion by galvanic decays faster with the result that, at the same time Iron brass that may provide for cathodic protection. Also, by using this information we was reproduced some part of sword with 3d Printer. Copy Sword and Scabbard was exhibited when conservation, restoration and replica studies finished.

## Archaeological Excavation and Documentation of Kafirkala Fortress

**Tomoyuki USAMI | Alisher BEGMATOV | Takao UNO | Amridin BERDIMURADOV | Gennadiy BOGOMOLOV**
(The Graduate University for Advanced Studies, Kyoto, Japan)

**Keywords:** Kafirkala, archaeological documentation, GIS

**Abstract:**
Kafirkala is a tall square fortress surrounded by three towers respectively from North and South and its suburb. The fortress is located approximately 12 kilometers south of modern Samarkand city and it consists of three main parts: Citadel, Shakhristan and Rabad. Archaeological excavations have been sporadically carried out on the site since as early as 1936. The Italian-Uzbek expedition actively excavated during 2001-2008 years and found nearly 500 pieces of sealings with various human and

animal figures, and some Sogdian and Bactrian inscriptions depicted on them, as well as numerous coins and other artifacts. Most of the artifacts were found from the ash layer of the citadel that was the remains of the fire which supposedly occurred during the Arab conquest of the area. The Japanese-Uzbek expedition has been continuing the excavations on the citadel since 2013. This expedition is also following the success of the previous one finding over 200 pieces of sealings and numerous coins of the Sogdian kings.

However, we have not been able to exactly judge the function of the fortress. There are two main ideas about its function. One is that the fortress served as a detached castle for the kings of Samarkand which can be supported by Ibn Hawkal, a tenth century geographer and chronicler who mentioned that there was a castle in the South of Samarkand. The other idea is the fortress functioned as a temple. Terracotta goddesses found from the site and the main hall for holding ceremonies may suggest that it was for some ritual purposes. This year's excavation is expected to shed some light on such an issue. In this presentation, we will show the results of our excavations and documentation conducted by employing 3D measuring techniques, and attempt to discuss the formation processes of Kafirkala.

NEW TECHNOLOGIES

# How to use the new LIDAR information

**Willem BEEX**
(BEEX, Amsterdam, The Netherlands)

**Keywords:** LIDAR, DEM, New Archaeological Finds

**Abstract:**
How to really use LIDAR point clouds
LIDAR is not a really new technology. But with Light Detection And Ranging of Laser Imaging Detection And Ranging in our time, we now are also able to get an accurate model of the actual surface completely stripped from the buildings and vegetation. And even more interesting for Cultural Heritage and Archaeology, most of the data is already freely available for research.
This is certainly the case for the Netherlands, with our "Actueel Hoogtemodel Nederland 2", or "AHN2". The density of the measured points is at least 50 centimetres, which guarantees that any remains of a structure larger than one by one metre will be detected. And many unknown structures have been discovered since.
This excellent result however, made many a person within the world of Cultural Heritage and Archaeology completely oblivious for obvious mistakes regarding the just interpretation of the available data.
This Poster is intended to show what is allowed, and what is not. It is also based on a former paper for Workshop 7 by the author, the old name of CHNT.

# Prospection based on airborne laser scanning as a method of cultural heritage

**Julia KLAMMER**
(Department of Prehistoric and Historical Archaeology, Vienna, Austria)

**Keywords:** geographical information system, airborne laser scanning, digital terrain model, prospection

**Abstract:**
The poster showcases the project "LiDAR-based prospection in the Vienna woods", which was funded by the Federal Monuments Authority Austria and supported by the municipality of Vienna (MA49). It was launched in order to find new archaeological sites within Vienna's wooded regions, to

survey and analyse known historic monuments and, finally, to confirm selected sites through field walking. First, the recorded point cloud was processed in order to generate a high resolution digital terrain model. This was the main initial data, from which several visualisations were derived, for example hillshades, local relief models and opennesse models. After the calculation of the visualisations, they were systematically gone through, often in combined views, in order to arrive at the entire spectrum of all possible archaeological features expressed by height values. Thus, they were the main basis for the interpretation of the relief and thus also for the archaeological structures. This prospection work resulted in a total of 2,841 mapped historical structures, which could be related to human activities within the research area. In addition, 186 places were interpreted and registered as archaeological sites. This huge amount of structures underlines the value of this technique in gathering archaeological information and therefore the use of this method for cultural heritage purposes. In fact, there is nothing new about the principles involved, even though some of the processes and visualisations have been developed only recently. Instead, it is a recognised and promising technique, with demonstrable value for archaeological and cultural heritage objectives.

# Exploring Archaeology from a First Person Perspective using a Go-Pro

**Erika LOVELAND | George AUSTIN**
(Western Michigan University, Kalamazoo, USA)

**Keywords:** Historical Archaeology, Public Archaeology, Go-Pro

**Abstract:**
The public seldom understands the complexity of archaeology and the many activities that archaeologists conduct in the course of site investigations. Our research aims to provide a first person perspective into how archaeologists, community members, and online viewers experience the site of Fort St. Joseph, an eighteenth-century mission, garrison, and trading post in present-day Niles, Michigan. Throughout the 2016 field season, we filmed hours of point-of-view footage using two Go-Pro cameras to show the ways in which we work and involve the community. The raw footage captured excavations at the site and the Project's public outreach programs from the perspective of the field school students and summer campers of all ages. We compiled a brief and fast paced three minute video and shared it on YouTube and social media websites to promote and educate viewers on public archaeology and the site by grabbing their attention in new and exciting ways. As the primary goals of the Fort St. Joseph Archaeological Project are to examine the site in ways that ensure the community's education and involvement, our research works to expand these goals by testing the Go-Pro film's ability to attract younger audiences. To gain insight on the public's reaction a short survey was attached asking about the effectiveness of the video in demonstrating archaeological processes, placing the viewers' in the archaeologists' shoes, and attracting the future involvement of our viewers in the Project or archaeology in general. This research is significant because it uses the Go-Pro technology to observe the site and public outreach programs through the eyes of the Project participates in addition to sharing this view with the public in hopes of providing a brief, but meaningful experience to its viewers.

# Virtual Rome: a digital model of the ancient city

**Matthew NICHOLLS**
(University of Reading, UK)

**Keywords:** Rome virtual reconstruction model

**Abstract:**
I am a Roman historian at the University of Reading, UK. I have created a detailed digital model of the entire city of ancient Rome as it appeared c. AD315. The poster will naturally be illustrated by scenes

taken from the model.

The text will discuss the research and modelling processes behind this project, which involved several years of research, site visits, and the use of several different types of source data including the first complete 3D reconstruction of all placed fragments of the marble Forma Urbis.

The poster will also explain some of the results and uses to which the digital model is now being put: research goals (sightline and illumination studies), pedagogical uses (illustration for teaching materials and innovations including a university course on digital modelling, which won a UK national teaching award in 2014), and adaptation for broadcast, for viewing on mobile devices, for an online course (MOOC) on ancient Rome, and for an immersive computer game. In delivering this range of outputs the project is fulfilling various university goals including commercial 'impact' and outreach work. This rich mix of outputs takes advantage of new technological developments and reflects the advantages of a digital project, in which different sorts of material can be generated as new technologies and opportunities arise.

## The fortress of Riolo Terme, near Ravenna: digital survey and 3d printing for cultural dissemination

**Elisa SGHERRI | Giovanni ANZANI**
(Dipartimento di Architettura, Università degli studi di Firenze, Florence, Italy)

**Keywords:** Fortress, Riolo Terme, Digital survey, 3D printing, Masonry stratigraphy

**Abstract:**
In this work, initially developed as a thesis project, it has been studied the management of the different information methods derived from the 3D laser scanner survey, of the Fortress of Riolo Terme, near Ravenna, Italy. After studying the building and its history this type of survey has been chosen because of its fast acquisition of three-dimensional data with the advantage of a level of details and a resolution impossible to be reached by other methods. The geometrical survey of the whole fortress and its surroundings has been enriched by the gathering of color information: taking a specific set of photos for every station, each single scan has been associated to a panoramic image, obtaining a point clouds provided with the corresponding color values.

Given the complexity and articulation of the building part of the project was dedicated to the work program, in terms of the decimation of the data, balancing a fluid management of the vast amount of collected data, and the conservation of the appropriate resolution of the information. This brought to the creation of an automatism both for the alignment of the scans, and for the following graphic post-processing. In addition to the production of drawings as plans, elevations and sections, whose outlining has been automated by creating several procedures for Autodesk AutoCAD, a specific part of the project was aimed to the construction of an optimized model of a portion of the building to be printed out using 3D technology.

The project allowed investigating punctually an architectural complex that is an outcome of stratifications over time, from the XIV century until the contemporary age. The chosen approach and the type of products elaborated are part of a renovation project for the enjoyment and historical knowledge of the building, which was the primary aim of this work.

## Digitisation of the cultural heritage of Slovakia. Combining of lidar data and photogrammetry

**Ladislav DEDÍK | Jana MINAROVIECH**
(STUDIO 727, Bratislava, Slovakia)

**Keywords:** Cultural heritage, digitisation, Slovakia, 3D models

**Abstract:**
During the years 2013-2016 a great number of buildings (medieval castles, churches and other monuments) in Slovakia were digitized. STUDIO 727 was the main provider of these digitalization works.
The subject of our investigation were the most significant Slovakian historical objects. Within the digitalization project we have created 3D models of the most important Slovakian monuments, as e.g. Bojnice castle, gothic church in Spišský Štvrtok or Devin castle, where are located also artefacts from Roman period, La Tène era and middle ages.
The aim of the project was to identify current technological possibilities of creation virtual presentations of real spaces. During creation of 3D models we used combination of Photogrammetry and 3D space scanning by laser scanner LIDAR (Leica brand). Final modification of laser outputs was made by Cyclone software. Post processing was done by Capture Reality, Autodesk Maya and MeshLab softwares. 2D documentation was made by AutoCAD.
The purpose of documentation is to capture the appearance of historical buildings and historical building technologies, to keep culture heritage for next generation. There have been documented some monuments, which have been falling apart progressively. Created documentation contributes to culture heritage publicity and offers a documentation for the future renovation of these particular monuments. The Entry of this project was the process of creating 3D virtual models and 2D documentation.
Contribution was created thanks to EU project, within the Operational program Informatization of society. Project was supported by The Ministry of Culture of Slovak Republic and Government Office of Slovak Republic.

## 3D modeling and study of the dispersion of pottery from the late Neolithic site of Boussargues, Herault, France

Ester RIBO-DELISSEY
(University of Paul-Valery Montpellier III, Montpellier, France)

**Keywords:** 3D modeling , GIS, post-depositional, karst environments, Neolithic

**Abstract:**
The primary focus of this study is to characterize post-depositional processes affecting the artefacts, by using a Geographic Information System (GIS). More precisely, we sought to characterize the conservation and the dispersion of in-situ broken vessel as well as the racking. Both are frequent in Karst environments. The study of these racking is based on verticalization and the 3D modeling of the shards and substrate. In order to do so, we have recovered the data of house number 1 of the site of Boussargues (Hérault, France) excavated in the 1980s. The house has been excavated square meter by square meter and the shards were drawn in situ. Altitudes of the shards were also recorded. The data has been incorporated into Qgis: georeferencing of the minutes of the excavation, creation of a file of points for the shards specifying the part of the vase and the number of the vessel to which they belonged. We furthermore conducted photogrammetric survey of the substrate of the house which allowed us to get the DTM and orthophotography of the substrate. We subsequently modelled in 3D the substrate and projected the shards.
From the study of the distribution of vases, and the observations made on the 3D modeling and verticalisation of the shards of each container, we can appreciate the dispersion of shards in the substrate and the racking. We propose an primary position of the vases. Therefore, it is also possible to propose a combination of the house and model the organization of domestic spaces.
This study offers a new method of evaluation of the processes of dispersion of artefact within Neolithic settlement on calcareous substrate. The analysis of the dispersion of the artefact is usually horizontal. We propose to study it through 3D modeling which seems more suitable for the study of

the sites where the substrate is highly cracked and plays an important role in the dispersions of the artefact.

## Picking up the pieces: Assessing the role of archaeological survey data in interpreting regional social change in Bronze Age Crete

**Christine SPENCER**
(University College London, London, UK)

**Keywords:** survey datasets, Monte Carlo simulation, human-environment relationships, settlement patterns, Bronze Age

**Abstract:**
Intensive surface surveys form a unique resource for archaeologists to reconstruct cultural landscapes and examine fluctuating human-environment relationships. Although much work in recent years has mitigated issues affecting the variability of survey data and our ability to interpret cultural phenomena from survey material assemblages, Cretan archaeological surveys have never been collectively analysed to explore long-term patterns in island settlement dynamics. Most studies have been project-specific, with localised interpretations of settlement patterns limiting explanations of social change. This preliminary study addresses the lack of formal analysis on prehistoric Crete by applying spatial statistical modelling to a dataset built from multiple independent survey reports. It proposes a methodological framework where logistic regression and inhomogeneous point-process models are iteratively run on simulated samples of the dataset to evaluate both the effect of data uncertainty on the robustness of correlations between settlements and landscapes, and the shifting nature of settlement systems throughout the Bronze Age. This research considers methodologies to integrate survey data by critically re-examining what questions archaeologists ask of them, whether they are appropriate to the type of information, and how to interpret the results of analyses appropriately.
Results show similar patterns to other survey datasets, which supports interpretations of parallel developments in the Prepalatial and Protopalatial periods, and suggests wider inter-regional interactions percolated down to the community level. Equally, the ambiguous results for later periods suggests that underlying processes cannot be deduced from settlement patterns alone. Speculation when comparable data was poor was avoided, so although major transformations in the region were linked to inter-regional developments, without comparably rigorous studies of other surveys, some issues remain unresolved. This study hopes to lay the groundwork to directly confront the difficulties in integrating survey datasets, and prove the applicability of statistical methods to explain changes in settlement patterns across Bronze Age Crete.

## Clustering of multi-sided Aegean Seals

**Martina TROGNITZ**
(Universität Heidelberg, Heidelberg, Germany)

**Keywords:** unsupervised machine learning, clustering, Aegean seals

**Abstract:**
I would like to present first results of my ongoing doctoral thesis about Minoan and Mycenaean seals with more than one seal face published in the "Corpus der minoischen und mykenischen Siegel".
As for today just over a thousand multi-sided seals are known and recorded in the Arachne-database of the DAI and the University of Cologne. Due to the large number of seals, applying unsupervised machine learning techniques may be a viable way to detect whether there exist specific patterns for combinations of different motifs on the seal faces.
Considering material, provenance, number of seal faces and represented single or combined motifs,

it may be possible, by means of clustering algorithms, to discover new seal groups, which then can be analysed from an archaeological point of view. This allows to answer questions like the following: Are there only patterns for some seal groups or none at all? If patterns exist, do they allow to draw conclusions about the function of the seals? Do they bear a meaning not yet known to us? Does the place of origin play a role in the design of a seal?

The poster will give an overview of the data, point out issues while preparing the data, discuss advantages and disadvantages of the used clustering methods for this task, and display first results from the clustering process.

## Pelagios Commons: facilitating better linkages between online resources documenting the past

**Rainer SIMON | Leif ISAKSEN | Elton BARKER | Pau DE SOTO CAÑAMARES**
(AIT Austrian Institute of Technology, Vienna, Austria)

**Keywords:** Linked Data, Integration, Annotation, Search, Visualization

**Abstract:**
Pelagios is a community initiative that facilitates better linkages between online resources documenting the past, based on the places they refer to. Initially focusing on the classical worlds of Greece and Rome, Pelagios has been working with a growing network of partners from the humanities and archaeology disciplines towards connecting different types of online resources – the literature of different periods and languages, archaeological databases, maps and other images, the results of scholarly research, etc. – so that they become more easily discoverable and seamlessly navigable for users.

Through Special Interest Groups (SIGs), Pelagios actively fosters the development of best practices, as well as the development and dissemination of openly licensed digital resources and software tools. Examples include the Pelagios conventions for publishing gazetteer metadata as Linked Open Data; the openly licensed base map tiles from the Digital Atlas of the Roman Empire (DARE); or software tools such as the "Recogito" document annotation platform, which aids the process of linking digital texts and maps to the places they refer to, and "Peripleo", a prototype search interface for visualizing and navigating the growing pool of interconnected open data published collectively by the community. Pelagios recently launched the "Commons" (http://commons.pelagios.org), an online forum where practitioners from a range of institutions and fields are collaborating across a number of thematic (e.g. Archaeology, Ancient Greek, Roman, Medieval, Byzantine, Islamic, East Asian, Maritime) and technical SIGs (e.g. Gazetteers or "Linked Pasts" concerened with technical integration issues) to develop further the goals and assets of the initiative.

The poster will present the Pelagios initiative more generally; introduce our Special Interest Groups, key partners, and the community at large; and provide an overview of our digital resources and software projects including the DARE map tiles, Recogito and Peripleo.

## DokuVis – A Documentation Tool for Digital Reconstructions

**Jonas BRUSCHKE | Markus WACKER**
(University of Applied Sciences Dresden, Dresden, Germany)

**Keywords:** documentation, digital reconstruction, graph database, CIDOC CRM, web application

**Abstract:**
We propose a documentation tool for use in 3D reconstruction projects to support frequent tasks in digital reconstruction processes. Digital reconstruction is becoming ever more common in archaeology, architecture and other disciplines. Lost, but also present structures are being visualized to enhance the understanding of artifacts and point out historical and constructional relationships of the objects under consideration. Furthermore, the process of reconstruction leads to an aggregation of knowledge, becoming a substantial part of historical research.

Reconstruction projects today often lack a proper, traceable, rigorously applied — therefore valuable — documentation practice. In a completed reconstruction, sources and references of design decisions may only be available to experts involved in the project. The proposed documentation software enables scientists and engineers to impart this implicit knowledge to be usable beyond the reconstruction phase. Our tool aims mainly to facilitate documentation and development processes in such a way that the input of data becomes simple and intuitive. We provide both a collaboration platform and a research environment, complying with guidelines and metadata standards, such as the London Charter principles and the CIDOC CRM.

## Data integration in a mining landscape

**Gerald HIEBEL | Klaus HANKE**

(AB Vermessung und Geoinformation, University of Innsbruck, Wien, Austria)

**Keywords:** Mining landscape, Semantic Technologies, Geoinformation

**Abstract:**
The localisation and identification of mining structures within the mining landscape of Schwaz/Brixlegg in Tirol is of importance for many disciplines starting with Archaeologists, Geologists, Historians, Linguists, as well as Culture and Tourism agents up to emergency forces. Different information sources like historical and recent geological maps, high resolution digital elevation models, archaeological field surveys, onomastic research and historical reports only hold part of the knowledge available for the mining structures. In this poster we want to show how we used the CIDOC CRM ontology to integrate the data on a conceptual level, applied semantic technologies to create a knowledge graph that holds all the available information and finally use a Geoinformation system to display mining sites in their spatial and temporal extent together with the information relevant for specific user groups. For archaeologists interested in prehistory the knowledge graph can be queried to show all mining sites where a fire setting technique was applied to extrude material, which is often an indication for prehistoric mining activities in this specific area. Linguists and historians have information on the names of mines and mining activities that have been documented in written sources but do not know the locations of these mines. For them the localisation together with the stories of the mines and the names is a beneficial application. Emergency forces need names and exact locations of mines. For all these groups interested in specific information about the mines a subset of the created knowledge graph is of interest which could of course be generated in a tabular form and presented in a geoinformation system, but we want to highlight the benefits of a graph representation relating all the information.

## From multimedia 2D to interactive immersive 360° Virtual Reality Apps

**Gerhard SINDELAR**

(beyondarts GmbH, Klosterneuburg, Austria)

**Keywords:** 360° Virtual Reality, Mobile Apps, Multimedia, Panoramic View

**Abstract:**
*Methodology/Approach:*

Experiencing touristic highlights and cultural treasures at home is currently very limited. The experience is normally reduced to 2-dimensional images and audio. Although 360° panoramic views of highlights are available, related high quality content and interactive tours are not. Immersive VR-Applications provide new visual possibilities and experiences, however products that are market-ready are rare.

*Results:*

A high grade of immersion also means a stronger emotional connection to a city and a region and can influence the decision-making of tourists for certain destinations.

*Innovations:*

The beyondarts-2D App already provides high quality content in the field of art and culture. The existing app is extended, a 360° panoramic view is implemented. The existing content can be used, only the panoramic images have to be created. The user sees the highlights of the beyondarts app in a 360° panoramic view in 3D and thus as an immersive experience. The detail buttons are integrated in the 360° view, so that the user can navigate within the app. The result ist a combination of VR, high quality content, storytelling and interactivity that is currently not available anywhere else.


## Caching the walls of Lucca

**Francesca TOMEI | Marta LAZZARONI | Veronica SELVANETTI | Teo BASILI**
(University of Padova, Lucca, Italy)

**Keywords:** heritage caching, web-app, promotion, tourism, accessibilty

**Abstract:**
Gamification has been taking part of many field during last years, and in the near future will get inside digital tourism, according to World Travel Market Report 2013 previsions. Gaming with smartphones and tablets may offer a combination of experience, culture and creativity which tourists will look for more and more in the near future. Gaming is also giving a great hand to knowledge and promotion of cultural heritage and they are coming out many kinds of "educational games", working as geocaches.

This project aims to promote and give historical features on the Walls of Lucca (Tuscany, Italy) though a "Walls Geocache", combining the use of a web-app and the presence of a real tourist guide. The web-app works like Geocaching with a geolocated map of the walls of Lucca and people will play three levels, corresponding to the chronology of the walls (Roman, Medieval, Modern). The guide time by time will send to the web-app tasks to be solved to reach next "point of interest" and will give historical and archaeological information on it. People will play in groups and may decide to play all together or to challenge. At the end tourists will get a complete historical view on the main cultural heritage of the town, after having an involving experience where they played the main role. The innovation of this idea leads on the web-app accessible to every mobile devices with a internet connection and on the presence of a tourist guide, which will not leave alone the tourist, giving tasks, help and information. The idea is also replicable and applicable to other places, towns/cities/archaeological sites, in order to give a new way to experience and promote cultural heritage.

This project got a funding from a local ONG and will be developed in the next months.

# APP – Session

Organiser: 7reasons, Austria

## Archaeo Tour / Archaeological tour

**Dagmar BARGETZI | Andrea HAGENDORN | Guido LASSAU | Till SCHOLZ**
(Archäologische Bodenforschung Basel-Stadt, Basel, Switzerland)

**Keywords:** Journey, Archaeology, Basel, Audioguide App, Original sites

**Abstract:**
The cathedral hill is the historical "centrepiece" of Basel City (Switzerland). An extensive archive of the history of the city is concealed below ground. Important turning points in the history of Europe are highlighted, such as the Romanisation of Celtic society, the transition from Late Antiquity to the Early Middle Ages and the development of medieval episcopal cities with a variety of sacred buildings.
The Audioguide App by the Archaeology Department shows you around original sites from the Celtic, Roman and medieval history of Basel, where archaeological information points have been set up. It allows you to experience the millennia-old history of the cathedral hill in all its diversity. While visiting the sites you can learn more about the background of and insight gained from important excavations thanks to the visible archaeological monuments and the app. Digital reconstructions and numerous pictures help you immerse yourself in the subjects dealt with at the individual points on the archaeological tour.
The app contains 20 minutes of audio material. The tour takes 60 to 90 minutes.

## Solomon tower – a VR experience

**Gabor BODO**
(Mensor3D Ltd, Budapest, Hungary)

**Keywords:** laser scanning, virtual reality, heritage preservation

**Abstract:**
The technological advances in spatial data collection and 3D imaging developments are changing our perception of the real world. Surveying, data processing, modeling are key elements of these development processes to achieve the output products, Virtual – and Augmented Reality. Cutting edge multimedia software and displaying devices can offer the viewer an experience ever closer to the reality. The main concept of the application is to explore both the technological side and the implementation capabilities of this state of art technology.
The primary objective of this application is to digitally preserve Solomon tower's (Visegrad, Hungary) historical site and its artifacts in 3D with high fidelity and precision, and to provide a 3D multimedia experience for research and educational purposes. Aerial photogrammetry, terrestrial laser scanning and structured light scanning devices have been used successfully to capture real-world sites and objects. These methods provide reliable results, but considered expensive. The output of current scanners are not yet ready for direct analysis or real time interaction on generic platforms. Usually some minor data continuity issues have to be addressed, basic editing is necessary. There are robust tools to correct these deficiencies. Specialized, independent virtual working environments provide solutions from the initial steps (processing raw captures) to delivering the final results, AR – augmented reality or VR – virtual reality.
With the help of this proposed application it is intended to introduce current display and motion capture technologies and explore how to apply these devices and multimedia products in open or confined spaces. To fully experience the surroundings in 3D and in right scale, special hardware has

to be utilized. There are many ready to use and in development technologies to display virtual content. The HMD (Head Mounted Display) technology can seamlessly involve visitors in fully virtual scenarios, or augment real world sites with digital content.

# Wounded

**Josef ZÁRUBA**
(Artzoom digital media s.r.o., Olomouc, Czech Republic)

**Keywords:** 3D digital content, Art and Modernism, Cultural Heritage presentation

**Abstract:**
*Archaeological input:*
Application Artzoom viewer: Wounded presents one of the most important Czech sculptural work of the first half of the 20th century. And refers to the cultural heritage of modernism.
*Concept:*
Artzoom viewer is interactive education app that takes you into fascinating world of visual arts. You can explore fully digitized virtual scans of art objects, statues and valuable artifacts. In aplication you can interactively zoom and rotate with models for a thrilling and detailed view or you can listen the artist life story. You can look at the detailed photos of museum items or explore the history in artists photo album. Great benefit is coordinated audio storytelling with authentical statement.
*Originality:*
Applications collects all data and facts about one of the most impressive works of Czech sculptor. It describes historical events which led to its creation. Creates audio coordinated story with support in visual data such as hi-resolutin photos of collection item. A collection of photographs from the archives and last but not least 3D digital scan of the item.
*Informative content:*
The main component of the application is a 3D digital scan, a series of photos and audio stories.
*Entertainment value:*
Entertainment value refers to the new training methods using digital technology. Amusing convey information from the cultural heritage sector, so that the viewer has learned as much information in a short time. Also refers to interactive training using PC or tablet. App Wounded is multilanguage educational aplication which gives you possibility to obtain immersive knowledges from the history of visual arts.

# beyondarts Art & Culture Guides

**Gerhard SINDELAR**
(beyondarts GmbH, Klosterneuburg, Austria)

**Keywords:** 360° Virtual Reality, Mobile Apps, Multimedia, Panoramic View

**Abstract:**
beyondarts has already been succesfully developing high quality content apps as guiding tools for the field of art and culture for several years. Now we go one step further, because in 2016 new VR products come to the market, such as the Oculus Rift, Gear VR and the HTC Vive. For those new devices content is rare, in the area of art & culture content practically inexistent.
The beyondarts-App already provides high quality content in the touristic sector. Our apps contain multilingual audio withn professional story-telling, text and high resolution pictures, geo-positioning and other exciting features.
To create a 3D experience, the existing app is extended, a 360° panoramic view is implemented. The existing content can be used, only the panoramic images have to be created.
The user sees the highlights of the beyondarts app in a 360° panoramic view in 3D and thus as an immersive experience. The detail buttons are integrated in the 360° view, so that the user can

navigate by sight within the app.

The solution is platform independent and is thus available for iOS and Android. Moreover, the app will also be available as a HTML5 page, so that VR devices such as the oculus rift are also compatible devices.

The result is a combination of a VR application with high quality content which can be used by tourists from home, and the already existing app which is designed for use at the site. The target audience is thus expanded via the VR solution to tourists that are still in the planning phase for their trip or are looking for a way to re-experience their trip, perhaps together with their friends.

We present one of the rare market ready 3D solutions that combine VR, high quality content, storytelling and interactivity.

## SmartGeology4Public

**Clemens NOTHEGGER[1] | Ana DJURICIC[1] | Mathias HARZHAUSER[2]**
([1]4D-IT GmbH, Pfaffstätten, Austria | [2]Naturhistorisches Museum, Vienna, Austria)

**Keywords:** Oyster reef, augmented reality, interactive

**Abstract:**

The geo-edutainment park „Fossilienwelt Weinviertel" at Stetten in Lower Austria exposes the world's largest fossil oyster biostrome. From 2005 to 2009, approximately 20,000 up to 80-cm-long shells of Crassostrea gryphoides covering a 400 m² large area were excavated. A cooperative team of researchers from the "Naturhistorisches Museum Wien" (NHM) and the Vienna University of Technology (TU Vienna) investigates the formation of the reef which took place more than 16.5 million years ago. The foundation of their work is a high-resolution (1 mm resolution), textured 3D-model of the entire excavation area. The core idea of SmartGeology4Public is to build the link between researchers and a broad public, i.e. the visitors of the excavation site. Using the interactive app, visitors get an insight on the researchers work. The 3D-data as well as scientific results are presented on a TabletPC and can be investigated in their "real environment" using augmented reality technologies. Education, information and entertainment are the unique selling property of this application. Additionally, SmartGeology4Public enables researches to investigate scientific results embedded into the study area supporting to find new scientific relations. And finally, the content of the app is available "off-site" as well. Hence, people who do not have access to the site may visualize the content in their own environment.

## Pitoti Prometheus

**Frederick BAKER**
(McDonald Institute for Archaeological Research, Cambridge University, England, UK)

**Keywords:** 360 Gear VR Animated rock-art

**Abstract:**

Pitoti Prometheus is a 17 minute film made with 3D scanned prehistoric Rock Art figures from Valcamonica in the southern Alps. The 150,000 Pitoti (or 'little puppets' in the local Lombard dialect) range from the Copper Age to 16BC when the local Camuni tribe were conquered by the Romans. The aim of the App and VR 360 film is to tell the story of Prometheus and the Camuni through a dramatic fragment written by the poet Goethe. The film uses innovative 3D rock art scanners from the TU Graz and volumetric cameras from the Bauhaus University Weimar. The film is made for the Gear VR in 360 fully immersive 6K density. The flying birds, gladiatorial battles, dancing, hunting and ploughing scenes are highly entertaining. It is the first VR film made with original cultural heritage content and shows the potential of using academically collected material for intellectual and educational use.

## Inari AIS

**Nadja Suvi Tuulia DEBENJAK | Michael DEBENJAK | Stefan KRAUSLER**
(Inari Software, Graz, Austria)

**Keywords:** Archaeological Information System, Documentation, Analysis, Publishing

**Abstract:**
The Inari Archaeological Information System (AIS) is developed for the documentation, analysis and publication of archaeological data to reduce the time spent on paperwork and data import and export by combining all data and every step in the archaeological workflow in one software.
With the AIS all information about contexts, features, finds and more can be entered or imported directly into the system. The files and the information are then linked together, so that everything can be found easily. Our highly customizable interface gives the option to choose the displayed fields, the language and more. It also features tools like a sketchpad and an integrated QR-reader.
Field workers, site directors, conservators —so many people need the same authoritative data for smooth coordination between field an office and improved decision making all around. The Inari AIS is designed as a secure system with controlled access. Administration tools in Inari AIS include everything needed to control and manage people and content.
The Inari AIS enables the user to take advantage of all the data has to offer. With our advanced search engine and integrated GIS, you can visualize large amounts of data and convey information in a powerful way. The software makes it also possible to analyse data from more angles than before to make it easier to interpret the findings an draw the right conclusions.
The requirements for documentation are growing and take time away from the fieldwork. To reduce the time used by writing reports, it is possible to create lists or field diaries in the AIS with a click an export the documents required by the government effortlessly.

# SCIENCE SLAM

Organiser: Marleen de Kramer, Austria

## Communication of Heritage Information: Tangible Interaction Approach

**Eslam NOFAL**
(KU Leuven, Leuven, Belgium)

**Concept:**
Physical heritage objects and assets are related to a vast amount of digital information varying from simple, factual aspects to more complex qualitative and tacit qualities and values. This qualitative information is challenging to be communicated to visitors in understandable and engaging ways. Recent technological advances promise new opportunities to more tightly merge the digital with the physical world. This paper therefore investigates how tangible interaction can enable the communication of heritage information to lay visitors; the integration of digital technology 'into' physical reality, as a potential medium for more enriched and playful communication of heritage values and qualities. Through a comparative, field study in a real-world museum context (Fig. 1), we examined how the tangible characteristics of an interactive prototype museum installation influence how visitors perceive a particular story. The communicated story relates a historical journey in ancient Egypt to the physical and architectural characteristics of the entrance colonnade at the Djoser Complex in Saqqara. The findings indicate how tangible interaction is able to engage museum visitors more to accomplish additional efforts, facilitating a vivid understanding of cultural values and architectural qualities of built heritage.

# Eating habits through time

**Elisabeth MONAMY**
(Archeomuse, Vienna, Austria)

**Concept:**
The main concern of Archeomuse is to have a specific glimpse on daily life of antique civilizations: a glimpse into antique cooking pots! What did all these great but mainly forgotten civilizations eat? Thanks to finds from archaeological excavations, texts, images (drawings, mosaics, sculpture, and so on), a lot is established about kings and their families, laws, architecture and religions. Clothing is also identified to a lower extend. Food is merely seen as sacrifice or grave goods or medicine. Although we can admit what kind of animals where hunt and / or bread, what kind of plants where cultivated, we hardly know anything about eating habits. When and what was eaten? An antique cooking workshop is a time travel into antique cooking pots and a way to experience archaeology.  This different approach to archaeology and history should enable more people to learn about ancient civilizations in a comfortable and amusing way.
In this Slam I would like to make a time travel and introduce the audience to antique cooking habits!


# Structuring the Motion

**Niklaas GÖRSCH | Benjamin GEHMLICH | Marco BLOCK-BERLITZ**
(HTW Dresden, Germany)

**Concept:**
Structure from Motion (SfM) is not only mathematical structure computed from image pixels. Our idea for "Structure from Motion" is to provide **structure to start the motion** of archaeology into a brighter future. A future that will have archaeologists use cutting edge technology routinely and achieving things that were formerly only possible with expensive equipment and specialist skills.
The last three years of progress in software technology have shown that it is possible to document excavations, monuments and sites in full 3D without a need for very expensive hardware. Moreover, current consumer grade hardware allows archaeologists to do this work themselves rather than having to pay for expensive externalized services and skills.
Our science slam contribution will use creative means of visualization (of magnitudes and proportions, such as area covered over time, working hours, comparative hardware cost, etc.) to inform the audience about the true magnitude of this technological revolution. We will create an awareness, in an entertaining way, that modern software-based technologies are magnitudes less expensive and more efficient than specialized scanning hardware.


# AFFANDI sustaining a legacy

**Doris GRANDITS | Lukas STAMPFER**
(TU Wien, Vienna Austria)

**Concept:**
Seeing how many individuals are still doing their everyday business around the heritage of Affandi, one of the best known expressionistic painters of Indonesia, can make you wonder how big his legacy actually is. Materialized in a vast amount of paintings and his self-designed and partwise self-built museum / home / studio / last home it is today, 26 years after his death, the challenge to work on sustaining all that for generations to come.
Sparked by his daugther Kartikas bonds with Austria a team from the University of Technology in Vienna in cooperation with Donauuniversität Krems is working on a wholistic concept to stop the decay of the things Affandi left behind. First results of that work as well as the adventures of working

in a country like Indonesia should be presented to the audience using the tools of Affandi. Hands. And loads of color. Presenting a process that uses high-tech equipment with the most basic tools humans have in a colorful theatrical approach.