CAA 2014 PARIS

21ST CENTURY ARCHAEOLOGY

Book of abstracts

Concepts, methods and tools

Table of Contents

Program

Program

Tuesday April 22th 2014

8h Registration : Welcome of the participants

9h

W11 Introduction to network analysis for archaeologists *(Michelet S 101)*
W08 Exploring network structural properties with the GeoGraphLab GIS solution *(EHESS S Info)*
W01 Hands-on structured light scanning workshop with discussion *(EHESS Amphi)*
W07 Manage stratigraphic data with Le Stratifiant *(Michelet S info)*
W03 Hands-On Archaeological Conceptual Modelling 2 ARIADNE meeting *(Michelet S 106)*
W10 Hands-on Workshop- Using Free and Open Source GIS tools :
QGIS and GRASS for Archaeology and Cultural *(Panthéon S Info2)*
ARIADNE meeting *(Michelet salle Doucet)*
ECAI meeting *(Michelet S 106)*

10h35 Coffee break *(15 mn)*

10h50

W11 Introduction to network analysis for archaeologists *(Michelet S 101)*
W08 Exploring network structural properties with the GeoGraphLab GIS solution *(EHESS S Info)*
W01 Hands-on structured light scanning workshop with discussion *(EHESS Amphi)*
W07 Manage stratigraphic data with Le Stratifiant *(Michelet S info)*
W03 Hands-On Archaeological Conceptual Modelling 2 ARIADNE meeting *(Michelet S 106)*
W10 Hands-on Workshop- Using Free and Open Source GIS tools: QGIS and
GRASS for Archaeology and Cultural Resource Applications ECAI meeting *(Panthéon S Info2)*
W05 Online Resources for Archaeological Research *(Panthéon S info1)*
ARIADNE meeting *(Michelet salle Doucet)*
ECAI meeting *(Michelet S 319)*

13h Lunch

14h

W10 Hands-on Workshop- Using Free and Open Source GIS tools: QGIS and
GRASS for Archaeology and Cultural Resource Applications *(Panthéon S Info2)*
W12 One hour, one model: Agent-based Modelling on-the-fly *(EHESS S Info)*
W02 Digital Documentation of Cultural Heritage Structures and Objects with
Terrestrial Close Range and Medium Range Laserscanning *(EHESS Amphi)*
W09 Data analysis for human and social sciences : a multidisciplinary interface *(Michelet S info)*
W04 Vocabularies as Linked Data - Workshop ARIADNE meeting ECAI meeting *(Michelet S 101)*
ARIADNE meeting *(Michelet salle Doucet)*
ECAI meeting *(Michelet S 319)*

16h05 **Coffee break** *(15 mn)*

16h20

W10 Hands-on Workshop- Using Free and Open Source GIS tools: QGIS and GRASS for Archaeology and Cultural Resource Applications *(Panthéon S Info2)*

W12 One hour, one model: Agent-based Modelling on-the-fly *(EHESS S Info)*

W02 Digital Documentation of Cultural Heritage Structures and Objects with Terrestrial Close Range and Medium Range Laserscanning *(EHESS Amphi)*

W09 Data analysis for human and social sciences : a multidisciplinary interface *(Michelet S info)*

W06 Belling the Cat: Making CIDOC Conceptual Reference Model (CRM) data available as Linked Open Data (LOD): A practical hands-on workshop of a complete solution using freeware *(Panthéon S info1)*

ARIADNE meeting *(Michelet salle Doucet)*

ECAI meeting *(Michelet S 319)*

18h **Archaeology and informatic meeting**

Wednesday April 23th 2014

8h **Registration**

Opening Speech *(Amphithéatre Richelieu - Sorbonne)*
Computers and mathematics in Archaeology, Anatomy of an unavoidable success ! *(F. Djindjian)*
Jean-Claude Gardin and the evolution of archaeological computing *(P. Moscati)*
Agent-Based Modeling and Archaeology: Past, Present and Future *(James E. Doran)*
3D Simulations as Tools of Discovery: New Light on the Relationship of the Ara Pacis and Montecitorio Obelisk in Augustan Rome *(B. Frischer)*

10h **Coffee break** *(25 mn)*

10h30

S03 Archaeology in the Woods: New Technologies, New Perspectives *(Panthéon Amphi 2A)*
S26 Digital archaeology *(Panthéon Amphi 2B)*
S27 New trends in virtual reconstructions of cultural heritage *(Panthéon S06)*
S21 Data mining in archaeology and historical sciences : new trends and developments *(Panthéon S02)*
S09 Strategy, Practice & Trends in Online Archaeology *(Panthéon S01)*
S16 GIS, a new trowel for archaeologists? The challenges of using GIS in preventive archaeology *(Pantheon S15)*
S23 Modelling approaches to investigate population dynamics and settlement patterns over the long term *(Panthéon S11)*

13h **Lunch**

13h **Steering committee** *(Pantheon S17)*

14h

S03 Archaeology in the Woods: New Technologies, New Perspectives *(Panthéon Amphi 2A)*
S26 Digital archaeology *(Panthéon Amphi 2B)*
S27 New trends in virtual reconstructions of cultural heritage *(Panthéon S06)*
S21 Data mining in archaeology and historical sciences : new trends and developments *(Panthéon S02)*
S09 Strategy, Practice & Trends in Online Archaeology *(Panthéon S01)*
S16 GIS, a new trowel for archaeologists? The challenges of using GIS in preventive archaeology *(Panthéon S15)*
S23 Modelling approaches to investigate population dynamics and settlement patterns over the long term *(Panthéon S11)*
R2 Linked Data Approaches to Numismatic Catalogues *(Panthéon S16)*

16h **Coffee break** *(15 mn)*

16h20

- S03 Archaeology in the Woods: New Technologies, New Perspectives *(Panthéon Amphi 2A)*
- S26 Digital archaeology *(Panthéon Amphi 2B)*
- R3 Virtual Archaeology - the first 25 years *(Panthéon S06)*
- S21 Data mining in archaeology and historical sciences : new trends and developments *(Panthéon S02)*
- S09 Strategy, Practice & Trends in Online Archaeology *(Panthéon S01)*
- S16 GIS, a new trowel for archaeologists? The challenges of using GIS in preventive archaeology *(Panthéon S15)*
- R05 CAA Publication issues *(Panthéon S11)*
- R02 Linked Data Approaches to Numismatic Catalogues *(Panthéon S06)*

18h **CAA Annual General Meeting**

19h30 **Cocktail**

Thursday April 24th 2014

8h Registration

8h30

- S29 Virtual Reconstruction in Archaeology *(Panthéon Amphi 2A)*
- S19 GIS methodologies, applications and regional Case studies *(Panthéon Amphi 2B)*
- S07 Ontologies and standards for improving interoperability of archaeological data : from models towards practical experiences in various contexts *(Panthéon S06)*
- S25 Agents, Networks, Equations and Complexity : the potential and challenges of complex systems simulation *(Panthéon S02)*
- S10 Archaeology at large: embracing massive audiences for online applications *(Panthéon S01)*
- S28 Digitization, visualisation and interpretation of ancient sculpture *(Panthéon S11)*
- S04 Integrated and multidisciplinary approaches for digital documentation and research in Archaeology *(Panthéon S15)*

10h30 Coffee break *(15 mn)*

10h50

- S29 Virtual Reconstruction in Archaeology *(Panthéon Amphi 2A)*
- S19 GIS methodologies, applications and regional Case studies *(Panthéon Amphi 2B)*
- S07 Ontologies and standards for improving interoperability of archaeological data : from models towards practical experiences in various contexts *(Panthéon S06)*
- S25 Agents, Networks, Equations and Complexity: the potential and challenges of complex systems simulation *(Panthéon S02)*
- S10 Archaeology at large: embracing massive audiences for online applications *(Panthéon S01)*
- S28 Digitization, visualisation and interpretation of ancient sculpture *(Panthéon S11)*
- S04 Integrated and multidisciplinary approaches for digital documentation and research in Archaeology *(Panthéon S15)*

13h Lunch

14h

- S29 Virtual Reconstruction in Archaeology *(Panthéon Amphi 2A)*
- S19 GIS methodologies, applications and regional Case studies *(Panthéon Amphi 2B)*
- S07 Ontologies and standards for improving interoperability of archaeological data : from models towards practical experiences in various contexts *(Panthéon S06)*
- S25 Agents, Networks, Equations and Complexity: the potential and challenges of complex systems simulation *(Panthéon S02)*
- S12 Community Archaeology and Technology *(Panthéon S01)*

14h

S22 Reading between the lines: Computing applications for the analysis of archaeological and historical texts *(Panthéon S11)*

S04 Integrated and multidisciplinary approaches for digital documentation and research in Archaeology *(Panthéon S15)*

16h **Coffee break** *(15 mn)*

16h20

S29 Virtual Reconstruction in Archaeology *(Panthéon Amphi 2A)*

S19 GIS methodologies, applications and regional Case studies *(Panthéon Amphi 2B)*

S07 Ontologies and standards for improving interoperability of archaeological data : from models towards practical experiences in various contexts *(Panthéon S06)*

S25 Agents, Networks, Equations and Complexity: the potential and challenges of complex systems simulation *(Panthéon S02)*

S12 Community Archaeology and Technology *(Panthéon S01)*

S22 Reading between the lines: Computing applications for the analysis of archaeological and historical texts *(Panthéon S11)*

S04 Integrated and multidisciplinary approaches for digital documentation and research in Archaeology *(Panthéon S15)*

20h **Dinner cruise on the Seine River**

Friday April 25th 2014

8h Registration

8h30

- S01 Towards a History of Archaeological Computing *(Panthéon Amphi 2A)*
- S02 Archaeological prospection, geophysics and remote sensing *(Panthéon Amphi 2B)*
- S20 (Re)building past networks: archaeological science, GIS and network analysis *(Panthéon S06)*
- S17 From stats to storylines : computational approaches to archaeological spatial data and its interpretation *(Panthéon S02)*
- S14 Practising Digital Cartography in Archaeology: What is at Stake ? *(Panthéon S01)*
- S18 How to deal with time in order to understand the dynamics of societies ? *(Panthéon S11)*
- S06 Modelling the Archaeological Process *(Panthéon S15)*

10h30 Coffee break *(15 mn)*

10h50

- S01 Towards a History of Archaeological Computing *(Panthéon Amphi 2A)*
- S02 Archaeological prospection, geophysics and remote sensing *(Panthéon Amphi 2B)*
- S20 (Re)building past networks: archaeological science, GIS and network analysis *(Panthéon S06)*
- S17 From stats to storylines : computational approaches to archaeological spatial data and its interpretation *(Panthéon S02)*
- S14 Practising Digital Cartography in Archaeology: What is at Stake ? *(Panthéon S01)*
- S06 Modelling the Archaeological Process *(Panthéon S15)*
- S13 Databases on cultural heritage and their geographic visualization *(Panthéon S11)*

13h Lunch

14h

- S01 Towards a History of Archaeological Computing *(Panthéon Amphi 2A)*
- S02 Archaeological prospection, geophysics and remote sensing *(Panthéon Amphi 2B)*
- R1 What do you want from Digital Archaeology ? *(Panthéon S02)*
- S08 The third and fourth dimension in archaeological data modelling *(Panthéon S01)*
- S13 Databases on cultural heritage and their geographic visualization *(Panthéon S11)*
- S24 Modelling approaches to study early humans in space and time *(Panthéon S15)*
- Horizon2020-Reflective 7 parallel Meeting *(Pantheon S16)*

16h Coffee break *(15 mn)*

17h Conclusion

PROGRAM

NOTES

Introductory and Keynote Conferences

(Wenesday 23th 8h30 - 10h05 Sorbonne Amphi Richelieu)

Computers and mathematics in Archaeology, Anatomy of an unavoidable success!

François Djindjian

Université de Paris 1 Panthéon Sorbonne & UMR 7041 Arscan

Since about fifty years ago, the use of computer science and mathematics in Archaeology develops and today becomes an indispensable tool in all business process of the archaeologist: documentation, planning and data recording in the archaeological surveys and excavations, laboratory studies, landscape analysis, reconstruction of systems of societies, archiving, disseminating in the scientific and general public word. New technologies have revolutionized Archaeology: archaeological information systems, data retrieval systems, G.I.S., 3D systems, Internet, multidimensional data analysis, mathematical modeling and multi-agent systems. But the most ambitious contribution lies in the field of the formalization of a general theoretical framework of archaeology, whose independence from any paradigm and ideology can raise the Archaeology at the level of the most important disciplines of the world of Science.

Jean-Claude Gardin and the evolution of archaeological computing

Moscati, Paola

CNR - Istituto di Studi sul Mediterraneo Antico (ISMA)

At the opening of the CAA2014 Paris Conference, a tribute to Jean-Claude Gardin is more than appropriate. A scholar of international renown, with an eclectic academic background, in the early 1950s Gardin pioneeringly approached the use of innovative techniques to automate the processes of description and classification of archaeological materials, be they objects, iconographic themes or ancient texts. As part of his personal scientific endeavours, Gardin founded and led a number of specialised research laboratories, in which numerous research projects were launched, new methods were experimented and international events were promoted. By retracing his masterful role in the earliest stages of computer applications to archaeology, we can today explore some of the theoretical aspects underlying the subsequent evolution of archaeological computing, over and above technological progress.

Agent-Based Modeling and Archaeology: Past, Present and Future

Doran, James E

School of computer Science & Electronic Engineering,

Universitty of Essex, Wivenhoe Park

Colchester CO4 3SQ

Agent-based modelling has a 40+ year history in archaeology, although the word “agent” was not initially used. This rather long history prompts three obvious questions: what progress has been made so far, however hesitantly? What now are the major technical obstacles facing ABM in archaeology? And where should we be going with this line of research?

In this talk I shall briefly discuss these questions touching upon:

(i) past waves of published studies and the questionable benefit of current software tools for ABM,

(ii) the need for social models of the type deployed in archaeology to include more genuinely cognitive agents and the difficulty of meeting this need,

(iii) the possible distinctions that can be drawn between individual, social and compound agents and whether the notion of a compound agent undermines the

distinction between the psychological and social sciences

(iv) the idea of a hierarchy of models of varying degrees of abstraction and the important notion of an emergence oriented model, and finally,

(v) the development of archaeological modelling to support whole society modelling, for example to study the possible trajectories to statehood given agents with particular cognitive characteristics, and to support agent-based global modelling targeting human species catastrophe avoidance -- a modelling application that merits and is currently receiving substantial attention.

3D Simulations as Tools of Discovery

Bernard Frischer

School of Informatics 919 East 10th Street Room 200

Bloomington, IN USA 47408

This talk will exemplify how 3D simulations can serve not only as illustrations of expert knowledge but also as tools that experts can use to generate new insights and discoveries. The focus of the talk will be the «Digital Meridian of Augustus Project.» From 13 to 9 BC, Augustus, Rome’s first emperor, developed the hitherto unoccupied northern Campus Martius in Rome by constructing three monuments whose relationship has long intrigued Roman archaeologists and topographers: the Montecitorio Obelisk (one of the first two obelisks to be brought to Rome from Egypt), the nearby monumental Meridian, and the Ara Pacis (Altar of Peace). In the past, scholars have speculated that the Obelisk (which postdates the Ara Pacis by several years) was sited so as to cast its shadow onto the western facade of the Ara Pacis on Augustus’ birthday (September 23). We created a 3D simulation of the northern Campus Martius using Unity enhanced with a plug-in that uses azimuthal solar data from NASA’s Horizons System database to create lighting solutions minute-by-minute for the entire period from January 1, 9 BC to December 31, 40 AD. The simulation shows that on September 23, the shadow does not hit the vertical axis of the western facade of the altar, but it does do so on a series of other dates. The simulation also supports virtual fieldwork, making it easy to move around the northern Campus Martius, change the time of day, date, and year to take observations of the obelisk's shadow and the sun itself. We call this methodology «simpiricism,» or empiricism supported by computer simulations. The fieldwork has allowed us to develop a new theory explaining the relationship of the Obelisk and Ara Pacis: it is not the obelisk's shadow that is important, but the sun's disk seen centered over the obelisk in the late afternoon of the annual festival to the Roman sun god, Apollo, who happens to have been Augustus' favored divinity.

Session 01

Towards a History of Archaeological Computing

(Friday 25th 8h30-17h Pantheon Amphi 2A)

Chairs : Paola Moscati[1], François Djindjian[2]
1 : Istituto di Studi sul Mediterraneo Antico (ISMA) - Italy
2 : Université Paris 1 Panthéon Sorbonne & UMR 7041 Arscan - France

The session will focus on the reconstruction of the main progressive steps of a boundary discipline, archaeological computing, which set its roots in the 1950s, in order to shed light on the theoretical implications arising from the meeting between computer science and the humanities and the role played by information technologies for the development of archaeology.

The main topics of the session will contribute to achieve a scientific definition of "archaeological computing" as an autonomous discipline, with its chronological evolution and its own methods and procedures.

Particular emphasis will be given to the role played by computer techniques not just as a tool supporting the investigation, but rather as a methodology affecting the entire cycle of archaeological research, in order to enucleate and debate the following main evolutionary steps:

- The first attempts to automate archaeological data processing
- The pioneering work by Jean-Claude Gardin in France
- The rising movement of the New Archaeology
- The introduction of databases
- The breakthrough of PCs
- The impact of the Internet
- The development of Geographical Information Systems
- The introduction of Virtual Reality techniques
- Towards a "global archaeology"
- Integration, multimedia and Open Science

During the session, the international project on the "Virtual Museum of Archaeological Computing" will be officially presented to the public.

The Development of Data Sharing and Open Data in Archaeology

Richards Julian[1]

1 : Archaeology Data Service (ADS)

University of York The King's Manor Exhibition Square York YO11 7EO

http://archaeologydataservice.ac.uk/

In the past year Open Data has become a hot topic for discussion across all disciplines. In June 2013 the EU Parliament ratified new rules which require all state-funded cultural heritage organisations to make their data freely available, and the G8 Open Data Charter was unveiled at the G8 Summit in Northern Ireland, recognising «a new era in which people can use open data to generate insights, ideas, and services to create a better world for all». Open Data in Archaeology has a long tradition as it has long been a professional ethic that project archives should be publicly accessible to allow future generations of scholars to test excavators' interpretations, and to develop their own. There has also been a growing trend, reflected in the introduction of the CAA Recycle Prize, that has suggested that since archaeological fieldwork is an expensive and unrepeatable act, it is better to use existing data where it exists, rather than destroy more of the primary resource. With the advent of the Internet, students have also been encouraged to make use of existing data sets rather than spend 3 years of their doctoral studies on data collection.

However, early attempts at online data sharing in Archaeology had a mixed history. In 1986 Sebastian Rahtz and Kris Lockyear proposed an Archaeological Information Exchange for data and/or software but in 1988 concluded that there was little use of the service by archaeologists. In the United States Harrison Eiteljorg III established the Archaeological Data Archive Project in 1994 but was forced to close ADAP in 2002 due to lack of sustainable funding. One of the more successful ventures in data archiving and data sharing has been the Archaeology Data Service (ADS), established in the UK with 2 members of staff in 1997, and still going strong today with a current staffing of 17. This has recently been joined by Digital Antiquity, based at Arizona State University, and there are new ventures in a number of European countries, such as IANUS in Germany.

This paper will discuss the history of data preservation and access in archaeology, based on the experience of the ADS, and draw lessons on what worked, and what didn't work, and why, as well as providing some possible pointers for future directions.

Towards a History of Archaeological Computing: An Introduction

Moscati Paola

CNR - Istituto di Studi sul Mediterraneo Antico (ISMA)

CNR - Area della Ricerca di Roma 1, Via Salaria km. 29,300 c.p. 10 - 00015 Monterotondo Stazione (RM)

http://www.isma.cnr.it/

The international research project on the history of archaeological computing, conducted in cooperation with the Accademia Nazionale dei Lincei and the Italian National Research Council, was designed to investigate some methodological aspects which are associated with the introduction and subsequent development of computer-based techniques in archaeological research.

Through the presentation of the «Virtual Museum of Archaeological Computing», this paper will illustrate the contribution of some of the pioneers, most notably Jean-Claude Gardin, to the introduction of new research methods, the establishment of ad hoc research centres, the organisation of international events, and the dissemination of information tools. By outlining the stories of scholars involved in this innovative movement, both in the field of prehistory and classical archaeology, we will retrace the main theoretical lessons of the first few decades after the birth of archaeological computing.

In this period, the convergence of the so-called «two cultures» led to an enhanced specialisation of scientific inquiry in the Humanities in general and in archaeology in particular, so that an indispensable teamwork was promoted. Therefore, the history of archaeological computing emerges as part of a more complex methodological renewal process. It opened up new directions for research that were the result of the integration or synthesis of tools and objectives inherited from different disciplines but capable of creating new ones.

Jean-Claude Gardin, a free archaeologist !

Djindjian François

Université Paris 1 Panthéon Sorbonne & UMR 7041 Arscan

The scientific attitude and the archaeological work of Jean-Claude Gardin is analysed through the filter of its relations with the scientific world in general (semiotics, linguistics and computing in Humanities) and archaeological in particular (DAFA, CNRS). The originality of his academic approach was reflected in its permanent modernity always ahead in the Humanities (documentation, vocabularies, database, etc.), its independence of the paradigms of the time (the inductive approach of «logicism» in opposition with the hypothetico-deductive approach of the “New Archaeology”), the research for a generic formalization of the archaeological construct (“a theoretical archaeology”), his appetite for the latest technological advances (expert systems) and its refusal to any hermeneutic in archaeological reasoning.

Jean-Claude Gardin and research strategies in archaeology

Gallay Alain

Université de Genève

Laboratoire d’archéologie préhistorique et anthropologie Institut F.-A. Forel ? sciences de la Terre et de l’environnement

18 route des Acacias CH-1211 GENEVE 4 http://www.unige.ch/

* : Corresponding author

During the academic year 1977-1978, Jean-Claude Gardin held a lecture at the University of Geneva on « research strategies in archaeology ». By contrast to the preceding lecture on « theoretical archaeology » in which originated his book « A theoretical archaeology », this second course did not lead to any specific publication.

Jean-Claude Gardin provided the following definition of what is a research strategy: « The analysis of the (in)experiences of the archaeologists considering the modalities of archaeological practice attaining determined objectives thought to be key issues taking into account the means at disposal ».

Our communication pursues two objectives:

1. Providing an overview of the major issues developed at that occasion based on the notes taken during this lecture, notes I have widely used for my teaching. To this regard, the investigations conducted into Bactria by Gardin are only one example.

The main thesis of the lecture can be summarized by two proposals:

- Research strategies still play a very minor role in archaeological work; it may be instructive, therefore, to reflect on reasoned choices made more or less consciously at each stage of our constructs.

- This reflection should in no way be considered as an unconditional defense of rational choices made with regard to the objectives, the subjects, and the methods of archaeological research, in that the practice of archaeology without greater strategy may, under certain conditions, also be acceptable.

Four cases are examined:

- the choice of the locations, sites or monuments investigated and their justification.

- the practices of registering and archival storage

- sampling methods, whether mathematical or not,

-the emphasis on « cumbersome » methods with regard to an increasing number of research programs.

2. Measuring the impact that this lecture had on our own practice of archaeology through our excavations. When investigating the necropolis of Petit-Chasseur in Valais we referred to the teaching of Leroi-Gourhan with regard to the « exhaustiveness » required for archaeological observations. The rescue excavations conducted between 1973 and 1980 into the very difficult site of Rances in the canton of Vaud, gave us the occasion to challenge this dogma by following the teaching of Gardin given the unavoidable restrictions of the questions to raise and the search for responses that were strategically and tactically consistent, a reconversion we completed at the occasion of the excavations conducted in Senegal 1980-81 into the megalithic site of Santhiou Kohel and later during our ethnoarchaeological research in the Niger bend. This communication will be a plea for the project to publish one day the notes taken in Gardin's lecture on research strategies in our possession.

J.-C. Gardin on archaeological data, representation and knowledge: a historical epistemology

Dallas Costis[1,2]

1 : Faculty of Information, University of Toronto (iSchool, UofT)
140, St George street Toronto ON M5S 3G6
http://current.ischool.utoronto.ca

2 : Digital Curation Unit, IMIS/Athena Research Centre (DCU-ARC)
Artemidos 6 & Epidavrou GR-151 25 Maroussi
http://www.dcu.gr

Jean-Claude Gardin has been a seminal figure for archaeological computing, but one whose work transcends the boundaries of archaeological work, linking out to fields as diverse as documentation, classification theory, semiotics, material culture studies, archaeological typology, argumentation theory, and the philosophy of the social sciences and the humanities. As the intellectual concerns and working methods of archaeological computing were mainstreamed into standard archaeological research practice, and as particular strands of it morphed into cultural heritage informatics and digital humanities, some of Gardin's key ideas, research initiatives and contributions remain pertinent, and in fact, if not explicitly recognized, shape our contemporary understanding and approaches regarding the constitution of archaeological data and reasoning, as well as the practices, tools and representation of archaeological knowledge. From his generation, Gardin is perhaps the closest that the 20th century has produced to a figurehead not of archaeological computing, but of a computational archaeology.

This paper approaches the important contribution of J.-C. Gardin, and his logicist theoretical and methodological program, in the context of a broader perspective that situates it within the intellectual impact and promises of major currents of contemporaneous social science with which Gardin was an notable interlocutor, notably systems and information theory, automation, information retrieval, structural linguistics, New Archaeology, structuralism and semiotics. On this basis, it attempts to identify, and assess, the important contributions that Gardin has made, on the one hand to the methodology and practice of archaeological description, typology and classification, and on the other hand to the epistemology and theory of archaeological ? and by extension, social ? knowledge and its semiotic apparatus. His methods for the description of archaeological material, his work on classification «codes» for diverse classes of cultural objects (from pottery to religious monuments), his careful appraisal of the tenets of Anglo-American New Archaeology, his method of formal analysis of archaeological argumentation, the differentiation he introduced between archaeological «compilations» and «explanations», his work on archaeological expert systems and of models in archaeology, his quest for a «third way

» of scholarly communication beyond the model and the narrative genre, prefigure and in many ways condition pressing contemporary issues, discoveries and debates.

Gardin was a pioneer in developing the theoretical principles for the constitution of archaeological databases, expert systems and knowledge bases. His foundational work on the constitution and formal representation of archaeological epistemic objects bears directly on challenges faced in contemporary application domains as diverse as cultural heritage information integration, digital scholarly infrastructures, electronic publishing in the humanities and social sciences, and cultural heritage ontologies. By viewing his work in the context of a historical epistemology of late 20th century and contemporary archaeology, this paper purports to throw light in an aspect of the history of archaeological computing which, despite its fundamental significance, remains hitherto understated, and thus to draw useful conclusions for current research challenges in archaeology and beyond.

Form, function and descriptive analysis in archaeology.

Semeraro Grazia

University of Salento (Lecce, Italie) (Unisalento) Dipartimento Beni Culturali Via D. Birago 64 73100 Lecce www.unisalento.it

The history of Archaeological Computing is strictly linked with the progress in the field of descriptive analysis of archaeological materials. Central to the arguments developed in the paper is an examination of the relationships between advance in archaeological methods and theory and development of descriptive language used in computer applications. Starting from the lesson of J.-Cl. Gardin the paper will investigate the main steps relating to the problems of data formalisation in archaeology. Focusing on contextual approach to the interpretation of archaeological data, attention will paid to the role of computer application in representing and exploring the complexity of social behaviour hidden in stratigraphic datasets. The management systems for excavation data are seen as strategic instruments for realising the potential of the means of analysis and interpretation of contexts. In this regard, the problem of which standards to adopt in the definition of finds, in particular portable items, becomes central. The theoretical framework required in order to achieve this aim is discussed. A survey of various experiences realized by scholars in Europe represents the starting point for an assessment of present ? day trends. Moreover, the paper discusses the most suitable criteria for the creation of dictionaries (structures for cataloguing) aimed at evidencing the functional aspects of portable finds, as an instrument for the best interpretation of contexts. References to recent developments in multidisciplinary, archaeometric, research aimed to detect the functions of ancient artefacts open new scenarios: a new challenge for descriptive analyses in archaeology.

Computing and scientific redefinitions: Georges Laplace's and Jean-Claude Gardin's archaeology programs

Mounier-Kuhn Pierre[1,2], Plutniak Sébastien[3*]

1 : CNRS & Université Paris-Sorbonne
CNRS : UMR8596

2 : Centre Alexandre Koyré - Centre de Recherche en Histoire des Sciences et des Techniques (CAK-CRHST)
École des Hautes Études en Sciences Sociales [EHESS]Cité des Sciences et de l'IndustrieCNRS : UMR8560Ecole des Hautes Etudes en
Sciences Sociales (EHESS)
27 rue Damesme 75013 Paris http://www.koyre.cnrs.fr

3 : Centre d'étude des rationalités et des savoirs ? équipe du LISST (CERS-LISST)
École des Hautes Études en Sciences Sociales [EHESS]
5 Allée Antonio Machado 31058 TOULOUSE CEDEX 9 http://w3.lisst.univ-tlse2.fr/lisst_cers2.htm

* : Corresponding author

The research programs developed through the second part of the 20th century by Georges Laplace and Jean-Claude Gardin both offered in-depth redefinitions of the criteria of scientificity and of the reasoning process in archaeology. Their criticism was grounded in their concern to make these processes explicit through the use of new formalized methods. George Laplace's «typologie analytique et structurale» was based on arithmetical formalization, while Jean-Claude Gardin's « archéologie logiciste» relied on logical and semantic formalizations, rooted in his former work on automatic documentation. However, even though they shared a common concern for formalization, these programs underwent very different social and institutional developments. This paper aims at comparing their stories, with a focus on the role played in their evolution by the use of data processing instruments.

Paying attention to instruments has become a classical perspective in science studies, especially in ethnographical investigations of scientific practices [Strasser 2002]. Here we shall consider instruments at a macroscopic level, in order to examine three issues:

1) The relationships between these archaeology programs and the broader computerization of science in France, with an attention paid to the geographic location of computer resources.

2) The appearance of certain patterns of scientific collaboration, related to the use of instruments.

3) The direct and indirect impacts of archeological research on computer science. Our communication will rely on the analysis of archives and on interviews with individuals involved in these archaeological programs and in the development of computer science in France. Based on two cases which are considered to be pioneering by historians of archaeology [Djindjian 2012], we will display the relationship between archaeology and information machines, in a period when computing became progressively a scientific discipline [Mounier-Kuhn 2010].

Beyond the particular case of the permeability between archaeological and logico-mathematical fields (particularly applied mathematics), we deal with the broader issue of the evolution of the regime of knowledge production throughout the 20th century. Historians and sociologists of science have proposed numerous frameworks to interpret this evolution, mostly with regard to experimental science and «Big Science». For instance, M. Gibbons [1994] proposed.

Interviewing Hodson and Doran: A personal history of computing archaeology

Ceccarelli Letizia

Division of Archaeology, University of Cambridge Downing Street, Cambridge CB2 3DZ http://www.arch.cam.ac.uk/

As part of the international project on the «Virtual Museum of Archaeological Computing», directed by Paola Moscati, two of the pioneers in the application of computers in archaeology in Britain were interviewed in 2013, Roy Hodson and Jim Doran. Thanks to this unique opportunity, it has been possible to outline a history of the development of the archeological thought towards the systematic use of computerized methods in archaeology.

This paper will present a personal history of the main steps that led to the publication in 1975 of «Mathematics and Computers in Archaeology» written by Hodson and Doran, a milestone for the discipline.

Of particular interest is how the development of this innovative approach was part of a wider change that made scientists and archaeologists from across Europe come together and exchange experiences in conferences in the 1960s and early 1970s. The meetings in Rome in 1966 and Marseille in 1969, and the Mamaia Conference in 1970 are considered the most important scientific events which led to the consolidation of the quantitative movement in archaeology. The paper will focus on the technical and theoretical developments in the late 60s and 70s that took their roots in the British New Archaeology and the Cambridge school but moved the discipline further towards a new approach of computing archeology.

Virtual archaeology in a material world: new technologies enabling novel perspectives

Reilly Paul[1], Beale Gareth[1*]

1 : ARCG, Department of Archaeology (Southampton) (Archaeological Computing Research Group) Faculty of Humanities University of Southampton Avenue Campus Highfield Southampton SO17 1BF http://www.southampton.ac.uk/archaeology/research/groups/archaeological_computing_research_group.page

* : Corresponding author

In the 1980's archaeologists embraced the rapidly expanding field of computer modelling and visualisation as a vehicle for data exploration. Against this backdrop ?Virtual archaeology' was conceived. The term was originally intended to describe a multi-dimensional approach to the modelling of the physical structures and processes of field archaeology. It described the way in which technology could be harnessed in order to achieve new ways of documenting, interpreting and annotating primary archaeological materials and processes.

Despite their initial promise, these technologies have failed to have the impact upon archaeological fieldwork which might have been expected. Even with the prevalence of digital devices on all archaeological excavations the documentation, interpretation and subsequent narration of archaeological processes have retained their analogue character. While the archaeological record is now primarily digital, its sections, plans, drawings and photographs are facsimiles of the analogue technologies which preceded them. This retention of analogue conventions is increasingly out of step with the general prevalence of digital technologies and especially 21st century advances towards 'programmable matter' which could bring the world of virtual archaeology into closer alignment with the material one.

Archaeology and Computer Applications: the automatic cataloguing of Italian archaeological heritage

Caravale Alessandra

CNR, Istituto di Studi sul Mediterraneo Antico (ISMA) Via Salaria km 29,300 - 00015 Monterotondo Stazione, Roma http://www.isma.cnr.it/

The cataloguing of an archaeological item means to study and know it appropriately, by determining its rightful place in space and time for the purpose of its proper conservation and enhancement.

Among the first computer applications to archaeology, in many European countries, including Italy, the automatic cataloguing of national heritage gained ground. This paper presents a brief description of the principal institutions which were in charge of this task, with particular reference to the 1970s and specific emphasis on archaeological heritage. In fact, the 1970s and 1980s can be considered two remarkable decades, in which centralised national projects followed the first isolated experiments, and tools, such as lexicons and thesauri, as well as techniques for indexing and information retrieval were created.

Particular attention is dedicated to the Italian experience, with some reference to the general situation in England and in France during the same period, through the research work conducted by the Royal Commission on the Historical Monuments of England (RCHME), founded in 1908, and by the Inventaire général des monuments et richesses artistiques de la France.

As for Italy, the study focuses especially on the activity conducted by the Scuola Normale Superiore in Pisa and the Istituto Centrale per il Catalogo e la Documentazione (ICCD), established in 1975 and directed until 1990 by the art historian Oreste Ferrari. His work was very important in the development of procedures and standards for national cataloguing on a large scale. He also played a decisive strategic role in the passage from hand written paper cards to the automation of the Italian national catalogue of cultural heritage.

The exciting journey to make the online resources LIMC- France

Anne-Violaine Szabados

UMR 7041, LIMC (LIMC)

* : Corresponding author

The exciting journey to make the digital corpus of archaeological objects LIMC-France started in the early 80s with the creation of a database dedicated to iconography and to ancient documents bearing a mythological representation and its accompanying controlled vocabulary. These two achievements - aiming at giving the public access to information produced by the French team of the LIMC - have been continuously adjusted to technical progress and improved in order to make them much more focused and relevant to the needs and practices of research and cultural heritage communities. Both projects have evolved and have become on the one hand an online resource linked with other digital resources (collections of objects, ancient texts, archaeological resources) and the specialized multilingual thesaurus TheA on the other.

Some possible steps of the project or topics to be addressed: the impact of the initial choices, the insertion of digital image and of geographical data, data enrichment, web dissemination, digital repository and re-use, sustainability, mapping with standards and integration in the semantic Web and the Linked data.

Art History of the Ancient Near East and Mathematical Models. An Overview

Camiz Sergio, Di Ludovico Alessandro
Dipartimento di Matematica “Guido Castelnuovo” [Roma I]
Piazzale Aldo Moro 5, 00185 Roma
http://www.mat.uniroma1.it

The use of mathematical models in the art history of the pre-classic Near East is still comparatively little popular. Cultural as well as technical and logical problems are the main hurdles to a large or systematic use of quantitative models in the interpretation of ancient Western Asiatic figurative languages. In the history of research, such kind of approaches have been especially focussed on glyptic productions, but they mainly lack continuity and diffusion in use. Nor is the use of specific models widely spread through scholars originating from different academic institutions. This means that a comparation and a deep analysis of how productive some models could be can still not be attempted.

The authors of this contribution want to review the different uses of quantitative models in Near Eastern art history and offer a summing up and an overview of the underlying approaches and methods. Through this discussion they intend to explore both the frailties and the strong points of the different methodologies that have been used by scholars in the past and offer a perspective on the possible strategies that could be proposed in the future. The hope is that in a near future a large scale debate on the relationships between art history and quantitative models could develop. What needs to be taken into account is, on one hand, the increasingly easier and cheaper access to some new technologies which can seemingly serve as a bridge between quantitative measurings and qualitative observations. On the other hand, what really constantly plays a pivotal role is the critical perspective of each scholar. Each time the scholar chooses a specific model, he (or she) triggers a political and methodological research strategy, that is also a specific political and methodological view on the object under investigation, as well as on the way ancient artistic production and producers should been observed. The deep examination of the models and approaches that have appeared up to now in the scientific literature is, in the belief of the authors of this contribution, a first step toward the outline of possible future research courses that could become part of a wide debate on the topic of art history and mathematical models.

From the Archaeological Map of Italy to the National Geographical Archaeological Information System. The Sardinian “pole” of the national network

Azzena Giovanni, Busonera Roberto, Nurra Federic, Petruzzi Enrico
Dipartimento di Architettura, Design e Urbanistica - Università degli Studi di Sassari (DADU)
http://www.architettura.uniss.it
* : Corresponding author

The Office for the Archaeological Map of Italy was established by Royal Decree in 1889. The precious documents collected in those years, remained unpublished due to the failure of the initiative, demonstrated a solid methodological imprint. As an ideal continuation of the Archaeological Map of Italy, G. Lugli in 1926 published the first volume of the “Forma Italiae”, whose direction passed, since 1965, to F. Castagnoli. Subsequently, under the direction of P. Sommella and with the advent of information technology and satellite observing systems (GPS), it began a “new era” of archaeological mapping, adjusting the “Forma Italiae” to the latest technological developments and making up the first Territorial Information System of archaeological matter in Italy.

Inheriting the methodology of the Archaeological Map of Italy and the experiences within the Forma Italiae, and starting from the latest technological and computerized innovations, we present, in this context, the creation of the Sardinian “pole” of the national computer network dedicated to the collective construction of the web GIS of the archaeological Italian heritage. Should be pointed out that this is not the proposal for the creation of another archaeological information system, but a project for the creation of a tool for basic data sharing and the identification of the archaeological heritage property, addressed to institutions and professionals but also dedicated to the general public for the enjoyment of Goods. The project aims to be a reference, permanent and continuously updated, for the interchange of information on the archaeological heritage property, at different levels of detail and on a national and international scale.

An hermeneutic retrospective on GIS/AIS systems for public italian archaeology: searching backward for roots and looking onwards for new methodological road-maps through losen occasions, good practices, institutions digital progress and fitting achievements

Serlorenzi Mirella, De Tommasi Andrea,*, Varavallo Andrea, Jovine Ilaria, Leoni Giorgia

MiBACT - Soprintendenza Speciale per i Beni Archeologici di Roma (MiBACT - SSBAR)

Piazza dei Cinquecento 67

http://archeoroma.beniculturali.it/

* : Corresponding author

The state of the art of GIS/AIS systems for public italian archaeology calls attention of the institutional, academic and professional community to a deeper and conscious understanding ofthe cultural values assumed in the course of time by advanced informative systems, especially in terms of methodological evolution epistemological refinement and technological enhancement of archaeological research.

The need of rediscovering the roots from which the long GIS/AIS road has winded through losen occasions, good practices, institutions digital progress and fitting achievements, is related above all to the rich opportunities given by reconsidering ideas, methods, ontologies and technologies underlaying both in fallen and still alive projects, especially in those promoted by italian Ministero per i Beni e le Attività Culturali (MiBACT).

Therefore, a retrospective can be attempted in order to travel again through historical backgrounds, different cultural policy lines, scientific and technological references, logical and procedural architectures, tangible achievements and their effects on the evolution of archaeological research both at the respective application time and at the present. In such itinerary it will be tried a mapping among paradigma, logical/phisical/semantical objects, technical tools, systems, digital infrastructures, etc., to implement an initial base for an ontological description of the ?historical GIS/AIS landscape’.

It can be attempted to implement a metaphorical «GIS project of GIS projects» through which to query ideally and concretely the knowledge layers related to ideas, methods, ontologies, technologies, Persons, etc., of this sub-domain of computing archaeology.

The primary aim of this proposal is to trace the origins of GIS/AIS applications in public Italian archaeology with a philological approach by which to map the relationships between the epistemological ? methodological evolution of archaeological research and the specific technological scenarios, dealing with various case-studies quite as «textus» to point out the really interesting knowledge elements.

The mapping activities will be executed with a critical a close examination of main case-studies such as projects promoted by MiBAC and other institutions in the middle 80’s on the wave of s. c. «giacimenti culturali» (cultural deposits) legislation order, passing through the 90’s GIS/AIS outbreak, up to the actual diffusion of the public informative systems of last generation.

The work will give an analytical re-reading of failures and successes, methods sharing and diversifications, natural aggregations and specialization processes among institutions, to highlight the foundamental entities for drawing an initial ontological description of the GIS/AIS sub-domain, to better compare the cultural values underlaying to each case-study and to achieve a first analysis framework for steering new developments and applications.

The present proposal arises in the contest of SITAR Project, the first ?archaeological cadastre’ of the metropolitan territory of Rome, promoted by MiBACT ? SSBAR since 2007.

The attention payed to continuous innovations in GIS/AIS sub-domain, also thanks to the participation of SITAR workgroup in some italian and european archaeological networking experiences (e.g. GIS/IDT, Open Data and Preventive Archaeology specific workgroups promoted by MiBACT; ongoing EU ARIADNE Project; the cooperations with Universities and Research Institution as CNR, ENEA, GARR) could represent a privileged start point for the retrospective approach proposed.

Session 02

Archaeological prospection, geophysics and remote sensing

(Friday 25th 8h30-17h Pantheon Amphi 2B)

Chair : Lena Kuehne [1, 2] , Jörg Fassbinder [1, 3],
1 : Bavarian State Dept. for Monument and Site Preservation, Archaeological Prospection (BLfD) Germany
2 : Institute of Classical Archaeology (LMU Munich) Germany
3 : Dept. Earth and Environmental Sciences, Section Geophysics (LMU Munich) - Germany

Physical prospection methods have a great potential for the discovery but also for detailed non-destructive mapping and interpretation of buried archaeological sites world-wide. The application of remote sensing and non-invasive geophysical measurement methods has on many occasions been proven to have resulted in considerable new archaeological knowledge about the layout, organisation and extent of archaeological sites ranging from the oldest era of mankind to present day. This includes items like Palaeolithic fire places but even miscellaneous structures in urban sites, rural settlements, grave yards or defensive fortifications.
Recent progress in the development and application of new instruments and interpretation techniques enables the generation of detailed maps of archaeological structures hidden beneath the surface with unprecedented quality. Combinations of airborne and terrestrial laser scanning, hyper-spectral scanning and aerial photography with high-definition ground penetrating radar measurements, large scale magnetic surveys or resistivity measurements permit the detection and investigation of individual sites and their surrounding archaeological landscapes.
Integrative GIS based archaeological interpretation of the prospection data can be used for the generation of maps and, in some cases, even for the creation of digital models of ancient buildings and constructions, forming the basis for the understanding of sites and its archaeological analysis.
The purpose of the session is the communication and presentation of latest methodological and technological developments and concepts in the field of archaeological prospecting and geophysics.

Villae rusticae in NW-Noricum - filling gaps in the current state of research with remote sensing and geophysical prospection

Kuehne Lena [1,2*], Roland Linck [3*], Fassbinder Jörg [1,4*]
1 : Bavarian State Dept. for Monument and Site Preservation, Archaeological Prospection (BLfD)
Hofgraben 4 - 80539 Munich
2 : Institute of Classical Archaeology (LMU Munich) Katharina-von-Bora-Straße 10 - 80333 München http://www.klass-archaeologie.uni-muenchen.de/index.html
3 : Ludwigs-Maximilians-University, Munich, Institute of Classics
4 : Dept. Earth and Environmental Sciences, Section Geophysics (LMU Munich)
Theresienstraße 41 - 80333 München
http://www.geophysik.uni-muenchen.de/
* : Corresponding author

In research areas like the Bavarian part of Noricum, we have to handle knowledge gaps, as most of the investigations were made in the 19th or beginning of the 20th century and often even the precise location of Roman sites like villae rusticae nowadays is hard to determine. Compared to other landscapes, this area is fruitless and rarely used for agriculture and hence the possibilities of aerial archaeology are very limited. To overcome the problem, we analyzed, processed and interpreted also Airborne Laser Scanning (LIDAR) data and tried to compile the data with the old reports of the Bavarian State Department's archive . In a second step the processed LIDAR data were combined with high-resolution, but nevertheless large-scale geophysical prospecting results, namely magnetic, radar and resistivity prospecting.
In all cases the integrated prospection results in an outstanding increase of information. Several case studies show that large-scale geophysical prospection and LIDAR enable the discovery and mapping of new sites and to put them in the context of landscape archaeology.
The kingdom Noricum was in close economic and cultural contact with the Roman Empire long before it became a Roman Province. This seems to be the reason, why the Roman villae rusticae in this area have their particular tradition of architecture. The aim of the project is to document a huge number of villae rusticae as comprehensive as possible. Therefore archaeological records are selected, where already excavations took place or a high number of surface findings approve detailed information about the site. In these areas integrated geophysical prospecting is conducted. At the current state of research 51 Roman villae rusticae are known in the Bavarian part of Noricum. 22 are fully accessible, twelve are partly overbuilt, nine totally covered and eight are located in forests. Thus half of the sites are accessible for geophysical prospection. During the last 25 years eight sites have already been prospected by geophysical methods through the Bavarian State Department for Monuments and Sites, 10 where prospected in 2012/13 in the framework of this project.
The interpretation of our geophysical data together with the archaeological records reveals an architectural structure, which is different from the homogeneous villa-types in Rhaetia. It indicates a differentiated arrangement and layout of rooms and houses much more relating to each other. Also complexes with two main buildings seem to be typical for North-Western Noricum. They can be arranged differently, but the larger building always seems to be more oblong, while the smaller one mostly is quadratic. Often there is a coexistence of different house types in one villa rustica complex. Maybe this is also a result of the much earlier influence of Rome in Noricum. This however has to be proved by a chronology of the known villae rusticae in Noricum.

RADAR Satellite Data Analysis for the Delineation of Prehistoric Land Surface Features

Queneherve Geraldine [1*], Bachofer Felix [1], Prieto Flores [1], Hochschild Volker [1], Märker Michael [,2]
1 : Institute of Geography, University of Tübingen, Germany
2 : Heidelberg Academy of Sciences and Humanities
* : Corresponding author

The EARS (East African Rift System) is seen as a migration corridor linking Southern Africa and possible ways «out of Africa» for early humans. The surroundings of Lake Manyara (954 m a.s.l.) are focus of several paleo-archeological investigations, as it is located close to Olduvai Gorge where paleo-anthropological findings can be traced back to homo habilis. In the catchment of Lake Manyara, especially close to the village of Makuyuni, two hominin-bearing sites (0.63 and 0.78 Ma), lots of vertebrate fossils and handaxes from different periods were found.

In this work, we concentrated on the Lake Manyara basin located in the eastern branch of the EARS. The Manyara basin is a half graben system, with a 200-600 m high escarpment on the western side and a westwards dipping monocline. Lacustrine strata known as the Manyara Beds in the west of Lake Manyara and approximately 100 m above today's lake surface define a maximum extent proven by sediments so far, even if some authors assume an even higher lake level and a hydrological connection with Lake Natron and Magadi basins. The Manyara Beds can be subdivided into a lacustrine grayish lower member (mudstones, siltstones, diatomites, marls and tuff) which was sedimented between 1.03 and 0.633 Ma and a fluvial and terrestrial up to 13 m thick reddish brown upper member (siltstones, mudstones, conglomerates and breccias) sedimented between 0.633 until 0.44 (0.27) Ma. The transition between both members is in most sections marked by a distinct tephra layer. The sections are best exposed close to the town of Makuyuni, where the sediments are partly overlain by a thin layer of Holocene soils and caliche and where big gully systems bite into the savanna landscape. The region is affected by minor en echelon step faults (NNE and E). There have been also found stromatolites in the northwest of today's lake extent useful to provide information about the paleoclimatic fluctuations in the East African rift system. They dated three generations of Late Pleistocene and Holocene stromatolites 20 m above today's lake level. Yet, the exact location of these shorelines is not known and the presence of shorelines at different elevations was not mentioned.

With the help of RADAR-Remote Sensing analysis a broad range of paleo-shorelines could be detected. ALOS PALSAR (HH/HV) and TerraSAR-X StripMap (HH) scenes where processed. While the paleo-shorelines are hardly noticeable in optical remote sensing images, they are highlighted by their intense backscatter due to their shape, alignment and texture. A Canny Edge detector was applied using a Python-script to extract the linear features and terraces. Such linear features have been detected up to 20 km east of today's shoreline. Samples were taken in the field from stromatolites which were found on these paleo-shorelines; they indicate the paleo- water level. The derived information of former paleolake shorelines help in a deeper understanding of the former paleo landscape and landscape connectivities as an index of possible human pathways.

GIS based dynamic interpretation of GPR data volumes

Poscetti Valeria [1], Neubauer Wolfgang [,2]

1 : IC-Archpro Vienna Institute for Archaeological Science, University of Vienna, Austria. (VIAS)

2 : Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology

Ground penetrating radar (GPR) is widely used in archaeological prospection, allowing non-destructive high resolution 3D investigation of archaeological sites. The GPR data is frequently visualized as 2D time- or depth-slices extracted from a 3D data volume and also in form of isosurfaces. For the archaeological interpretation of the GPR data volumes Geographical Information Systems (GIS) provide powerful toolboxes.

The paper presents an innovative GIS based approach for the archaeological interpretation of GPR data. This approach is based on the dynamic visualization and analysis of the data in GIS environment, combined with the creation of 3D digital models showing the virtual reconstruction of the located buried remains. The display of distinct depth slices in form of animated raster images as introduced by one of the authors in 1998 has become a standard and is increasingly applied to support GPR data interpretation. This dynamic way of visualisation allows for a better perception of the anomalies produced by the buried structures, and simplifies the detection of the main changes in the stratification. Nevertheless the animations are generally created outside the GIS environment, while the interpretation in GIS is often still conducted statically (turning the layers on and off, corresponding to the respective depth levels). In the present application the animated visualization of series of depth slices is created directly within the GIS project by using animation tools (layer animations as well as time animations) allowing for a more efficient data interpretation.

The interactive graphical interpretation is conducted by using vector features (typically polygons) and by describing the archaeological structures by means of descriptive attributes documenting typology and relative chronology of the buried remains based on stratigraphic relations. The temporal data are used in order to display features dynamically in the fourth dimension according to different phases.
The 3D interpretation is performed by extruding features in the ArcScene environment. Replacing them with textured 3D models offers a more «realistic» visualization of the buried structures. A more comprehensive 3D interpretation of the GPR data is also performed by integrating isosurface representations in addition to the sequence of depth slices in the 3D display environment. The animation of the interpretative 3D visualisations within ArcScene represents an attractive method for the further analysis and presentation of the data investigating the «invisible cultural heritage » by means of a «virtual dig».
The application developed within ESRI ArcGIS is exemplified by the 3D archaeological interpretation of GPR data recently collected by the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology in cooperation with its partners at the test site of the Roman Town Carnuntum (Austria).

Heritage and Geophysics: Integrating Geophysical Methods with Community Archaeology at Flat Rock Cemetery.

Vaughan Andrew [1*], Graham Lain [1*], Glover Jeffrey [1*], Bigman D. [1*]
1 : Department of Anthropology, Georgia State University (GSU)
P.O. Box 3998 Atlanta, GA 30302
gsu.edu
* : Corresponding author

The Flat Rock Cemetery is located south of Atlanta, Georgia in the Southern Dekalb County. The site represents one of the oldest continuously occupied African-American communities in Georgia. Efforts to identify, map and record individuals in the cemetery have been ongoing since 2008, when the Flat Rock Archaeology Project was proposed by the director of the Flat Rock Archive, Johnny Waits to the members of the Greater Atlanta Archaeological Society (GAAS). Surface mapping conducted by Glover et al. revealed several voids in the cemetery layout that warranted further investigation with the use of geophysical equipment. The use of a magnetometer in the investigation of archaeological sites, and especially cemeteries has a track record of effectively identifying anomalous targets for further investigation.
Georgia State University graduate students Lain Graham and Andrew Vaughan cleared the project area of debris and laid out two large grids, 30m N x 12m E and 40m N x 36m E to encompass the unmarked areas. Magnetometer survey at Flat Rock Cemetery utilized a Geometrics G-858 Cesium Magnetometer with a single sensor. The survey was conducted in .5 meter transects running North/South in a snake line (ie. Transect 1 is run North, Transect 2 South). This direction was chosen in order to maximize the potential for anomalies related to graves (roughly 1m x 2m) to show up on 2 or more transects, as the graves are primarily oriented East/West. The sensor was set for continuous collection at an interval of .1 seconds, or 10 readings per second. The survey was then broken out into a North grid and South grid to ease collection over the rough terrain. The Flat Rock Community Cemetery site is located on a hillside in forest cover, with large trees and smaller ground covering plants. This makes for a challenging environment to utilize any geophysical survey methods, however with careful and deliberate planning we were able to overcome these issues and provide useful information to the stakeholders.
The goals of this survey were to confirm or corroborate previous efforts to map the cemetery initiated by Johnny Waits and conducted by Dr. Jeffrey Glover as well as to identify previously unidentified features for further examination. This project marks an expansion of the previous GIS based investigation and documentation of the Flat Rock Cemetery incorporating geophysical survey methods into the GIS for the cemetery. The addition of geophysical data to the archival and surface survey of the cemetery has and will continue to aid in the investigations of the cemetery by both professional and student archaeologists as well as interested and invested community members and stakeholders.

Reconstructing a medieval environment in 3D through multi-receiver EMI data.

De Smedt Philippe [1], De Reu Jeroen ,[2], De Clercq Wim ,[2], Herremans Davy ,[2], Van Meirvenne Marc [1]
1 : Department of Soil Management, Ghent University (ORBit, Ghent University)
2 : Department of Archaeology, Ghent University

Although electromagnetic induction (EMI) instruments have been available for the past decades, to date, their use in archaeogeophysical prospection remains limited. Nevertheless, the potential of EMI sensors to record both electrical and magnetic subsurface variations is a major asset in integral archaeological landscape studies as both natural and archaeological subsurface variations can be targeted simultaneously. In non-saline environments the measured apparent electrical conductivity (ECa) is mostly related to soil texture ,whereas the apparent magnetic susceptibility (MSa) is often heavily influenced by anthropogenic soil disturbances. The latest generations of multi-receiver EMI sensors further allow recording the ECa and MSa of multiple soil volumes simultaneously, enabling three-dimensional (3D) analyses of the natural and anthropogenic soil variability.
Using a multi-receiver EMI instrument, we revealed a previously unknown buried medieval landscape, located near the boundary of a 25 km2 wetland area in the north of Flanders (Belgium). The ECa data indicated a heterogeneous pedological environment, along with traces of multiple ditch systems. In addition, a number of brick structures were detected with the MSa data. Based on these data, two excavation trenches were laid out across the most characteristic anomalies. Targeting a quantitative combination of the excavation data and the multi-receiver EMI dataset, each step of the excavations was documented through computer-vision based 3D recording, mapping archaeological features, excavated soil surface and soil profiles. In a second stage, these data were combined with the multi-layered EMI dataset to compose a detailed model of the buried medieval environment. While from one excavation trench, stratigraphical information was used to calibrate this topographical model, geometrically correct profile information was used from the other trench to test the validity of the model. In a final step, the multi-layered MSa data were combined into the model to visualize the current subsurface expression of the medieval landscape. In addition, the MSa data allowed estimating the preservation potential of the detected building structures.
The integration of the 3D-recorded excavation data within the geophysical dataset to compose an accurate model of the medieval topography, shows how the combination of these 3D data volumes allows for an unprecedented geoarchaeological landscape analysis. Furthermore, this case study shows how through guided, small scale excavations the interpretation potential of geophysical survey data can be increased dramatically. The added information from the combined mapping of electrical and magnetic soil variations and the potential of multi-receiver EMI survey, along with the quantitative integration of excavation data, forms the core of this paper.

How the data jigsaw can help in reconstructing the settlement history of Gebelein archaeological site complex

Ejsmond Wojciech [1*], Baka Cezary ,[2], Chyla Julia ,[3], Ordutowski Jakub ,[2], Wieczorek Dawid ,[4], Witkowski Piotr [1], Wnuk Marek ,[5], Stachowska Aleksandra ,[5], Madej Michal ,[5]
1 : Institute of Archaeology, University of Warsaw, Poland (IA, UW) Krakowskie Przedmie?cie 26/28, 00-927 Warsaw http://www.archeo.uw.edu.pl/szablon.php?id=101
2 : Polish Centre of Mediterranean Archaeology of the University of Warsaw (PCMA) www.iksio.pan.pl/index.php?option=com_content&view=article&id=286&Itemid=106&lang=en
3 : UniGIS, UJ
4 : Institute of Mediterranean and Oriental Cultures, Polish Academy of Sciences (IKOS, PAN) www.iksio.pan.pl/index.php?option=com_content&view=article&id=286&Itemid=106&lang=en
5 : Department of Geology (Faculty of Geology), University of Warsaw http://www.geo.uw.edu.pl/
* : Corresponding author

Gebelein archaeological site complex is located in Upper Egypt, c. 28km south-west from Luxor. It played an important role in Egyptian history. In the Predynastic Period there was probably a

capital of a local proto-state. In the following periods a local necropolis housed burials of members of local elite. It was also a place of settlement of merchants and mercenaries from Nubia. The site complex contains cemeteries, settlements, a temple and a fort. All periods of Egyptian history are represented there in various forms of landmarks. Many well-known Egyptian antiquities from the early history of the Pharaonic state come from Gebelein. Although, archaeological research began there early (in 1891) and the place was researched by numerous scholars, it is still poorly known and there is a lot of unpublished material, which requires attention due to threats caused by expansion of the modern agriculture and settlements. Since spring 2013, thanks to help of Ministry of State for Antiquities, the authors are conducting an interdisciplinary field reconnaissance, which, as we hope, will result with an extensive documentation of the area. The survey started with gathering available data, such as: archival maps from last 200 years and archival as well as contemporary satellite images. Analysis of the material gave the information about landscape changes, agriculture development and highlighted some interesting features. A field prospection with use of mobile GIS was executed to verify features visible in satellite images and to document the newly gathered field data. GIS also integrated results of a variety of survey methods, among others: a geophysical prospection as well as geological and graffiti surveys. The graffiti have been discovered in 2013, and documented in 2014 with use of Reflectance Transformation Imaging. Those data, stored in GIS and used in analysis, allow to reconstruct historical as well as paleotopography and influence of the ancient Egyptians and the Nile on a local landscape. The results of the study indicate places suitable for locating settlements. Thanks to the applied survey methods it was also possible to find in field some sites today invisible on the surface, but marked on the old maps, as well as still visible sites thanks to the analysis of satellite images.
The project of documentation of the site complex is focused on gathering different types of data from several kinds of sources. The authors would like to show how the discussed jigsaw helps to reconstruct the progress of previous researches and to understand the complexity and history of Gebelein archaeological site complex.

The application of X-Band SAR interferometry in archaeology ? first results from test sites in Turkey

Rosenbauer Ralph Christian [1*], Erasmi Stefan [,2], Rutishauser Susanne [1], Buchbach Ralf [,2]
1 : Institute of Archaeological Sciences of the University Bern
Länggass-Strasse 10 3012 Bern
www.iaw.unibe.ch
2 : Institute of Geography, Göttingen University
Goldschmidtstr. 5 37077 Göttingen, Germany
* : Corresponding author

For the comprehensive understanding of the interaction between environment and settlement activity, archaeological scholars are in need of meaningful data on landscape development. Spaceborne remote sensing offers huge potential for the reconnaissance of disappeared landscape elements, such as palaeochannels, and even for discovering traces of buried settlements.
Since 2012, the Institute of Archaeological Sciences of the University Bern (Switzerland) in cooperation with the Institute of Geography at the University Göttingen (Germany) has investigated the potential of X-Band SAR for archaeology. A particular focus is placed on the combination of large-scale remote sensing (using optical and SAR satellite imagery) and exemplary investigations of prominent sites by archaeological surveys and excavations. This multi-method approach allows a comprehensive view of individual cities within their historic environment as well as the reconstruction of the inter-site relationships in whole settlement clusters. Two case studies from Turkey will be presented in the talk:
Körtik Tepe was a very important Neolithic settlement right at the junction of the Tigris River and the Batman Cay. The use of X-Band interferometry allowed the mapping of extended river terraces and enabled the reconstruction of the topographical condition of the pre-pottery Neolithic site. The strategically important and even fertile Cilician Plain is characterized by a steady change of river courses preserved in a huge amount of palaeochannels detectable by remote sensing. Profound knowledge of this historic condition at different epochs is the key to understanding

boundaries between different city-states and the network of traffic routes joining them. A special methodical focus of the paper is placed on the discussion of the first results gathered from the processing of high-resolution TanDEM-X SpotLight CoSSC data. For the case study in Cilicia, we acquired two TanDEM-X products: First, a TanDEM-X StripMap (alternating bistatic) was captured, followed by a High-Resolution Spotlight acquisition for a subset of the area covering only the ancient site of Magarsos near the Mediterranean cost. Processing of the alternating bistatic scenes was carried out using standard SAR Software (ENVI/SarScape). In order to use the full information potential of the combined StripMap and SpotLight data takes, we developed a workflow for the successive optimization of the DEM quality using all available input data. The final product was a DEM with an absolute height error of less than 1.5 m at 2 m pixel spacing.

Geophysical data integration at Portus

Richley Elizabeth
University of Southampton (Southampton, UK)

The site of Portus, Italy provides a unique opportunity to investigate the integration and visualisation of geophysical datasets for archaeological purposes. The Portus Project has been in existence for 16 years and during this time a large repository of data has been accumulated of which the geophysical data is a sizeable element, but which also includes topographical data, excavation, environmental sampling (coring, dendrochronology and flotation), 3d laser scanning and much more. Geophysics began at Portus in 1997 with c.178 ha of magnetometry data being collected and a small area of resistivity data having been collected up until 2004 (c.f. Keay et al 2005). Since then further work has been undertaken employing newer techniques (with respect to their use in archaeology) including ground penetrating radar and electrical resistance tomography.

Fusing multiple geophysical data sets offers considerable potential for the improved archaeological understanding of the subsurface. Each individual technique measures and records a different characteristic of the subsurface. For instance, a magnetic survey might reveal only part of a buried building, whereas applying resistance survey as well could reveal the lay out of the structure as well as interior components. Patterns that appear as a result of data integrations/ fusion may indicate anomalies that are much less visible or not visible at all in any single dataset and that, as a result, may have been overlooked. Integrated information in this manner from several surveys may provide increased knowledge of the subsurface, which was previously unavailable.

Integrating the data from Portus provides a good opportunity to investigate relationships between the techniques and sensors for particular geologies and materials. With the current excavation data and the environmental sampling, an in-depth knowledge is available of what is types of materials are present beneath the surface. This project, therefore, will make use of not only the geophysical data but also geo-archaeological data in the form of cores and soil samples from the excavation and Lidar survey to advance existing data interpretation and integration methods. Several methods have been employed for integration but can overall largely be grouped between graphical methods and quantitative methods. Building on previous work such as that by Kvamme (2006) and Piro (2000), this project looks to evaluate and critique methods of data integration that have been used for geophysics data with the aim to further develop a working method of data integration to better categorise subsurface phenomena with the Portus dataset as a case study. The varied and disparate nature of the data available at Portus presents a unique opportunity to investigate the integration and visualisation of geophysics datasets for archaeological purposes.

Ever decreasing circles? Multi-method prospection and survey at The Hill of Ward, Co. Meath, Ireland

Davis Stephen [1], Richley Elizabeth [,2*], Carey Chris [,3*]
1 : University College Dublin (UCD)
2 : University of Southampton (Southampton, UK)
3 : University of Brighton
Mithras House, Lewes Road - Brighton BN2 4AT
http://www.brighton.ac.uk/
* : Corresponding author

The Hill of Ward, Co. Meath, Ireland is home to the spectacular quadrivallate ?ringfort' of Tlachtga (?earth-spear'), a 150m diameter enclosure with late Iron Age affinities. Tlacthga is reputed to be one of the four foundation sites of the medieval kingdom of Mide. However, while the other three (Uisneach, Tara and Teltown) comprise complex, multi-period archaeological landscapes, until recently Tlachtga appeared to be an isolated site.

In 2010, ALS survey incorporating multiple visualisation techniques identified a number of previously unidentified archaeological features, including up to three deserted medieval settlements, a late Neolithic hengiform enclosure, several smaller ditched enclosures and a pair of curvilinear embankments, potentially indicating that the entire hilltop was formerly enclosed and suggesting hillfort-like affinities.

Geophysical survey was employed to further explore a number of these areas including Tlachtga itself, the outer embankments, the hengiform enclosure and one of the deserted settlements. While all areas produced exceptional results, this presentation will focus on Tlachtga itself. Magnetic gradiometry defined at least three phases of enclosure: the current monument, a small, 30m southern enclosure which partially overlaps this and an earlier, much larger enclosure which underlies the present phase. This earlier monument, which is also multivallate in nature is the largest of its kind in Ireland and is potentially of early date for a monument of this type. Earth resistance and GPR survey have helped to better define the central area of the current monument, demonstrating that the central area is surrounded by a segmented wall or kerb. A circular platform, potentially an inauguration mound located within this central region appears to overlie a number of large, buried radar-dense anomalies. Local geology has also helped to better define phasing at the site: differential interruption of geological striations within the southern enclosure suggests that this pre-dates the current monument rather than overcuts it. These results are comparable with elements of geophysical survey at the ?Royal' site of Tara, Co. Meath and will be discussed in the broader context of Irish Royal sites and the advent of closely-spaced multivallation in Ireland.

Landscape Tomography: Creating a work flow for 3D visualization of palaeoenvironmental information contained in large scale, high resolution GPR data sets

Schneidhofer Petra [1], Zotti Georg [,2*], Nau Erich [,2*], Hinterleitner Alois [,2], Trinks Immo [,2], Neubauer Wolfgang [,2]
1 : Initiative College for Archaeological Prospection, University of Vienna (IC-ArchPro)
Franz-Klein-Gasse 1 1190 Wien
http://ic-archpro.univie.ac.at/research/dissertation-topics/petra-schneidhofer/
2 : Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology (LBI ArchPro)
Hohe Warte 38 1190 Wien
http://archpro.lbg.ac.at/team/archaeological-interpretation-spatial-analysis-and-virtual-archaeology/georg-zotti
* : Corresponding author

The motorization of ground penetrating radar systems based on grid-free positioning systems using Realtime Kinematic GPS enables the efficient large-scale application of multi-antenna arrays, covering up to five hectares per day while simultaneously reaching a sampling resolution of less than 10 cm cross-line spacing. The resulting novel three-dimensional high-resolution data sets provide new ways for the non-invasive investigation of archaeological landscapes. However, a considerable part of the geophysical data sets can be devoid of archaeological structures. Yet, these «empty» areas can carry significant information about the palaeo-environmental dynamics of the study area. Palaeo-environmental features should be considered of equal importance for

the comprehensive understanding of archaeological landscapes. Currently, most geophysical prospection surveys disregard this potential and often only focus entirely on the apparent archaeological features and information.
One of the reasons for this deficit is based on the complexity of palaeo-environmental information and the specific requirements for its extraction, visualization and implementation into the interpretation process. Many palaeo-environmental features display a continuous, four- dimensional character, such as finely laminated beach deposits accumulated over time or laterally migrating palaeo-channel systems. Specifically these properties demand a three-dimensional visualization as fundamental basis for any further analysis and subsequent interpretation.
The study presented is investigating the specific requirements for extraction and analysis of palaeo-environmental information contained in large-scale, high-resolution GPR data sets with particular regard to technical aspects of three-dimensional data visualization. For this purpose, two large-scale, high-resolution GPR data sets have been chosen from Viking Age sites in Vestfold, Norway, displaying different types of palaeo-environmental features such as beach deposits, coastal ridges, bedrock outcrops and extensive palaeo-channel systems. Data sets were acquired using a 16 channel 400 MHz MALÅ Imaging Radar Array system with 8 cm cross-line spacing, as well as a six channel 500 MHz Sensors & Software PulseEkko Pro SPIDAR system with 25 cm cross-line spacing resulting in very densely sampled data and high imaging resolution. Several 3D visualization and GIS software packages were tested with particular attention paid to their performance in handling large data sets, visualization modes and possibilities, data interoperability and eventually data integration with traditional archaeological interpretation results. Test results were incorporated into a work-flow for extraction, visualization and analysis of high-resolution GPR data sets for palaeo-environmental information. The experience gained with the newly developed workflow and archaeological prospection approach is presented.

Detection of ruins in satellite images using histogram of oriented gradients and support vector machine.

Robin Amandine[1], Falconer Daniel, Sadr Karim[2]
1 : University of the Witwatersrand, School of Computer Science
Wits 2050, Private bag 3
http://www.cs.wits.ac.za
2 : University of the Witwatersrand (WITS)
Private Bag 3 2050 WITS Johannesburg, South Africa
http://web.wits.ac.za/

Pre-colonial stone-walled structures have been the focus of archaeological remote sensing studies in South Africa since the 1960's using conventional air photos. New technologies and satellite imagery provide ample reasons to revisit these ruins. A desirable goal is to formulate an algorithm for automatic detection of these ruins on satellite imagery.
Using high resolution images, the detection of ruins can be particularly challenging as stone-walled ruins tend to be occluded by other features such as trees, or hard to distinguish from the trees which form also circular shapes on the ground.
In this paper, we show that histograms of oriented gradients (HOG) are excellent descriptors to extract ruins features. Initially introduced for human detection in [N.Dalal, B. Triggs 2005] , one key advantage of the HOG is that they capture edge structures (via the gradient) which characterize local features very well. The approach we propose is based on the computation of HOG over a sliding window throughout the image to characterize ruins, followed by the use of a support vector machine classifier for the detection. The support vector machine requires a training phase in order to learn what kind of features to detect as ruins, and then expand the rule to the whole image.
Our first experiments focused on the detection of ruins in the Suikerbosrand Nature Reserve (South Africa) using Google Earth images, where a ground truth is available. The method proved to be successful in cases where even the human eye would hardly distinguish between walls and trees. In addition, it appeared that the number of false detections is kept minimal, unlike classical features detection methods which tend to over detect features in the image.
Future work encompasses an extended analysis of the performances as well as an analysis of the spatial distribution of the ruins for classification purposes.

Automated detection of archaeological ruins in high- resolution remotely sensed images of the Silvretta Alps

Lambers Karsten[1*], Zingman Igor[2]
1 : University of Bamberg
2 : University of Konstanz
* : Corresponding author

Automated detection of archaeological sites and objects in aerial and satellite images is a challenging task, but also a promising approach to assist archaeological prospection. While the quantity and quality of remotely sensed images is rapidly increasing, methods for their efficient and reliable analysis are still not widely available in archaeology.
Over the last three years we have used image data and archaeological data of the Silvretta Archaeological Project to develop algorithms that are able to detect a specific category of archaeological ruins in high-resolution aerial and satellite images. Our study area is located in the high mountains on the Swiss-Austrian border, at an altitude of 1500 to 2500 masl. This alpine zone has been used for seasonal pasture since at least the Bronze Age. Our target objects are decayed buildings associated with alpine pasture economy such as livestock enclosures and huts. These buildings, while all in ruins, are usually visible on the surface.
In this paper we present a new method of automated detection of such ruins in remotely sensed images of 0.5m resolution, which is still under development but has already yielded good results. In order to be useful, our approach requires a high true-to-false detection ratio and has to be computationally fast and easy to use. We base our approach on geometric cues of our target objects, which can be described as linear features meeting at approximately right angles. Since the target objects are located in open grassland, we first filter out wooded and urban areas based on their high texture contrast. We then extract linear features using morphological operators. In order to identify groups of linear features that meet the geometric definition of our target objects, we define convexity and angle constraints that are used to assign a rectangularity measure to each group. This measure effectively expresses the likelihood that the group at hand corresponds to a target object. The result is a likelihood map that can be used to guide and assist archaeological fieldwork. This approach works quite well with incomplete instances of livestock enclosures, even in cases where one side is completely missing. Additional work is required to adapt it to ruined huts with interior walls, which is a different category of target object. Furthermore, we plan to test our approach on data sets from other mountainous study areas with similar archaeological features to further improve its robustness. The long-term goal of our research is to provide a method of rapid, efficient and reliable screening of large image data sets for a predefined category of target objects prior to fieldwork.

New sights of cities from ancient Near East: the contribution of geophysical approach

Benech Christophe
ARCHEORIENT - Environnements et sociétés de l’Orient ancien (Archéorient)
CNRS : UMR5133Université Lumière - Lyon II
Maison de l’Orient et de la Méditerranée Jean-Pouilloux 7 rue Raulin 69365 LYON Cedex 07 http://www.archeorient.mom.fr/

The growing use of geophysical methods for around twenty years brought new sights on the spatial organization of archaeological sites. The results have been particularly spectacular in the case of the study of city planning which were known before by more or less extended excavations from which was extrapolated the rest of the plan. Despite the massive interest of such a new source of information, the use of the geophysical maps is most of the time still limited to the identification of the main characteristics of the city planning. The opportunity to have at our disposal the entire plan -or at least a significant part- opens interesting and innovative approaches taking in account the variability of the quality of the geophysical data.
The geophysical map brings interesting results to consider all aspects around the creation of a city planning, from its theoretical concept to its evolution through the occupation of the archaeological site. The identification of the streets network offers an innovative approach on the conditions of traffic inside the city, connections between different quarters and the position and access

facilities of administrative, religious, cultural and commercial buildings. From a methodological point of view, different spatial analysing tools usually used for the study of modern cities are usable with geophysical data.
This paper will present different cases of city planning of ancient Near East from the Early Bronze Age until the Byzantine period. Different models of urban planning will presented and for each one we will consider its evolution from the theoretical concept to its adaptation to the historical and environmental context. The transition from medieval cities to modern is well known thanks to the preservation of buildings and streets networks but the study of urban dynamics of more ancient cities is more marginal due to the lack of documentation. The information brought by geophysical investigation provides a more detailed approach which integrates more accurately the most ancient towns in the field of urban studies.

Utilizing Magnetic Prospection and GIS to Examine Settlement Organization in Neolithic Southeastern Europe

Niekamp Alexis,*, Sarris Apostolos
Institute of Mediterranean Studies, Foundation for Research and Technology - Hellas (FORTH-IMS)
* : Corresponding author

On the Great Hungarian Plain and surrounding region, archaeological research on the Late Neolithic period has focused mainly on the excavation of tell settlements, while many adjacent flat-lying settlements are unrecognized or examined very little. The large horizontal extent of the flat settlements imposes unique difficulties not incurred while excavating tells; time and cost constraints often limit the amount of features that can be uncovered and other methods, such as surface collection and soil coring, offer limited information about the site's overall layout and organization.
With the increasing use of geophysics in archaeological projects, more and more areas surrounding tells have been surveyed with the hope that geophysical approaches and spatial analysis can contribute to our understanding of the major settlement reorganization that took place during the Late Neolithic to Early Copper Age transition. Of particular interest is the shift in settlement tendency from increasing settlement nucleation in the Late Neolithic period to the abandonment of tell-centered villages and the founding of smaller, more dispersed, autonomous villages by farmers in the Early Copper Age.
In this study, attributes of settlements' organization, based on magnetic survey data and excavations, were examined and the degree of variation among six Late Neolithic and Early Copper Age settlements from Southeastern Europe was compared. To accomplish this, maps of the mainly flat-lying settlements generated through magnetic prospection and plans of excavations were digitized and analyzed with ArcGIS, and intra-site settlement data such as house orientation, size, and distribution were generated. These analyses indicated a large amount of deviation within and between most sites in the sample, and this is congruent with expectations for autonomous villages with little social differentiation or ranking. Through this study, questions related to the exploitation of the landscape and the cognitive attributes of the environment are addressed, providing a number of suggestions about the land use patterns and the trajectory of occupation that may reflect a corresponding social variation.

Assessment of a Multi-frequency Slingram EMI for archaeological prospection

Simon Francois-Xavier, Thiesson Julien, Sarris Apostolos
Laboratory of Geophysical-Satellite Remote Sensing and Archaeo-environment (GeoSat ReSeArch)
Melissinou & Nikiforou Foka 130, P.O. Box. 119 Rethymno 74100, Crete
http://www.ims.forth.gr/

For the past forty years, electromagnetic methods were employed for archaeological prospection. Latest studies show the great interest of this kind of survey, with the common use of multi-coils spacing EMI. These recent studies in the area of archaeology or field management take advantages of different characteristics of EM instruments, like simultaneous measurement of electrical con-

ductivity and magnetic susceptibility. Its implementation doesn't need any contact between the soil and the instrument allowing a fast data collection. Actually, magnetic susceptibility has a complex form, where the quadrature out of phase part corresponds to the magnetic viscosity. Several studies, try to measure this viscosity by different ways. The first one is the measurement of the frequency-dependent susceptibility, related to magnetic viscosity like the MS2B (Bartington ltd) does (Dearing et al. 1996). Another one is the measurement of the magnetic viscosity by TDEM instrument like the VC100 (Thiesson et al. 2007). We try here to assess the capability of a commercially available device to retrieve the magnetic viscosity by using multi- frequency measurements.
We used for our study, the GEM-2 from Geophex, a Slingram EMI with a 1.66 m coil-spacing in Vertical dipole mode. It could change to Horizontal dipole mode by a rotation of 90 degrees around the instrument axis. This device, like others (e.g. EMP-400 from GSSI), works at various frequencies (from 300 Hz to 90 kHz). We have studied in which proportion the signal at these frequencies could be changed when the contrast of electrical conductivity, magnetic susceptibility and magnetic viscosity varies.
As a first step we make some 1D and 3D modeling in order to study the depth of investigation of the instrument. According to the model and solution described by A. Tabbagh (Tabbagh 1986) we simulate a thin layer with different properties to study the behavior of signal in-phase and in-quadrature part. We consider both configurations available for this instrument. According to the theoretical consideration about restriction of Low Induction Number for this kind of geometries, coil-spacing, and target dimension, we noticed that depth of investigation doesn't change with the frequency. These obvious results indicate that for each frequency we measure apparent properties for the same volume.
As a second step we try to understand the differences between the measurements at each frequency. For the two lowest frequencies we observed a strong noise which affects the quality and stability of the measurements, so we only use the three highest frequencies. Then we try to separate the part of the quadrature out of phase signal linked to magnetic viscosity (independent of the frequency used) and the one linked to electrical conductivity (frequency dependent). In this way we can propose a new transformation to express electrical conductivity and magnetic viscosity.
This new approach of processing measurements would be applied on various archaeological sites in Greece and compared with some other methods and geophysical properties. This study takes part of the Politeia-Kripis project.

Searching for Iron Age Ireland: the impact of Archaeolandscapes Europe

Corns Anthony, Devlin Gary, Shaw Robert
The Discovery Programme (DP)
63 Merrion Square Dublin
www.discoveryprogramme.ie
* : Corresponding author

This paper discusses the impact that the EU funded Archaeolandscapes Europe (ArcLand) project has had in furthering the research being undertaken by The Discovery Programme to identify sites related to the Iron Age in Ireland. This elusive and relatively under-researched period in Ireland's past is the subject of a multi-disciplinary three year research project to which remote sensing technologies are a central and fundamental resource. Arcland (www.archaeolandscapes.eu) is a five year project funded within Culture 2007-2013 receiving a total of ?2.5 million which has over seventy partners. Among its many objectives is the aim to promote the understanding and use of remote sensing and to this end it has provided a wealth of knowledge and experience to our research into Iron Age in Ireland.
The project has adopted some conventional approaches, such as accessing online geospatial data resources, lidar derived terrain models, and orthoimagery to determine sites of potential interest for extensive geophysical survey. However it has also looked to more sophisticated uses of remote sensing. Complex visualisation algorithms are being applied to detailed terrain models derived from high resolution lidar data that have been flown specifically for archaeology. These models are revealing hidden details of the micro-topography identifying previously unrecognised features

in the landscape, and enhancing the detail and understanding of known sites. New exciting processing algorithms are also being used to re-visit photogrammetric data of wide landscape areas with terrain models of a quality close to those from lidar being achieved. The potential implications of this are enormous given the relative cost of lidar and photogrammetric data capture.
The next phase of our Iron Age research will be further enhanced through the Arcland partnership, with the potential of collaborations and workshops bringing advanced geophysical prospection equipment and UAV's to Ireland. The conclusion of the paper will focus not only on the remote sensing achievements of the project, but also the benefits derived from the partnership with a multi-partner pan-European project.

Low-cost and efficient UAV-based 3D documentation in Tamtoc (Mexico)

Block-Berlitz Marco [1], Ducke Benjamin [,2*], Martinez Mora Estela [,3], Kroefges Peter [,4], Rojas Raúl [,5]

1 : University of Applied Sciences Dresden (HTW Dresden)
Dresden
http://www.htw-dresden.de/
2 : Independent researcher and software developer (IR/SD)
Berlin
http://www.gvsigce.org
3 : Instituto Nacional de Antropologia e Historia (INAH)
Mexico City
http://www.inah.gob.mx/
4 : Universidad Autonoma de San Luis Potosi (UASLP)
San Luis Potosi
http://www.uaslp.mx/
5 : Freie University Berlin
http://www.fu-berlin.de/
* : Corresponding author

High-resolution aerial imagery is a fundamental prerequisite for the documentation and digital preservation of archaeological sites and built heritage. Structure from Motion (SfM) is a popular method for extracting 3D structure from series of overlapping images. The two complement each other ideally in the form of ultralight Unmanned Aerial Vehicles (UAVs) carrying high-resolution video cameras.
This paper discusses the use of low-cost, consumer grade UAVs and cameras for archaeological documentation. To illustrate principles and practice, we present a case study from the ancient Huastec site of Tamtoc in the Mexican federal state of San Luis Potosi. Tamtoc is a massive Mesoamerican site that features the impressive, now partly restored, remains of pyramids, temples, elite residences and other monumental architecture, as well as large stone reliefs. Managing the site is a challenge, due to tropical climate and limited accessibility (which was further reduced by the extreme weather events of 2013). Our case study is thus a good example of what versatile, lightweight and robust technology can achieve even under adverse working conditions.
The video material produced by UAV-borne cameras constitutes ideal input for the SfM-based reconstruction of buildings, sites or terrain. Unfortunately, the flexibility and affordability of this approach comes at the price of extreme computational demands and inhomogeneous 3D point cloud output. Rigid image acquisition strategies and intensive post-processing are required to obtain both densely sampled 3D point clouds and high-quality meshed surfaces. However, advances in GPU-based parallel processing allow for the rapid production of preview models for quality assurance, while increasingly efficienct, automated workflows allow for on-demand, off-site data processing at full detail level.
The work presented in this paper is part of “Archaeocopter” (www.archaeocopter.de), a joint research project by the University of Applied Sciences Dresden and the Free University of Berlin. It is committed to the design and development of UAVs for airborne image data acquisition in archaeology and related fields. In order to optimise the hardware and software for real-world applications, the project’s research and development work is continuously supported and guided by international partners, such as the state heritage management authorities of the German federal state of Saxony, the German Archaeological Institute (DAI) and the Mexican National Institute of Anthropology (INAH).

Using electrostatic and electrical prospection seeking the limits of the Roman forum of Bayeux (Calvados France)

Atanasova Anna [1*], Thiesson Julien [1*], Schütz Grégory ,[2*]
1 : Structure et fonctionnement des systèmes hydriques continentaux (SISYPHE)
École Pratique des Hautes Études [EPHE]CNRS : UMR7619Université Pierre et Marie Curie [UPMC] - Paris VIMINES ParisTech - École nationale supérieure des mines de ParisUniversité Pierre et Marie Curie (UPMC) - Paris VI
4 Pl. Jussieu 75252 Paris cedex 05 http://www.sisyphe.upmc.fr/
2 : Conseil Général du Calvados (CG14)
conseil général du Calvados
Service Archéologie 36, rue Fred Scamaroni - 14000 CAEN
http://www.calvados.fr/cms/accueil-calvados/actions-departement/bien-vivre-dans-le-calvados/culture-et-patrimoine/Archeologie/le-service-archeologie
* : Corresponding author

In 2010, archaeological excavation at the 10 rue Franche bring to light the remains of what looked like the roman forum of the Baïocasses, former inhabitant of the city. Unfortunately, the area investigated do not show any limits. A geophysical survey was then undertaken to gather some knowledge about the surroundings of the excavation. The survey was made in two steps the first one in 2011 and the second one in 2013.
The first survey was held on the 8 and 14 rue Franche. At the time, only classical electrical prospection device was available. The survey was limited to place with grass where a good galvanic contact could be achieved. However, some alignments in the resistivity contrasts are in good agreement with the directions known formerly by archaeologist. Especially, a potential north corner of the forum place has been discovered and a first extent of the forum place was proposed (figure 1).
The second survey was undertaken to complete the maps around the 10 rue Franche and to better constrain the shape of the forum place. Provided with a new electrostatic device (flageul et al; 2013) we have prospected all the areas including the streets itselves (Franche and des Ursulines) and all the part of the gardens where classical electrical prospecting with electrodes could not be achieve.
The results of both surveys have been gathered and it appears that:
- The prospection along both street are quite noisy, this is mainly caused by the modern pipes and sewers. Nonetheless, the area of each survey could be divided in three parts, two resistive ones surrounding a conductive one. These limits appear to be coherent with the first extent proposed. Furthermore, these new results drive us to say that the forum place do not go far after crossing the street.
- However, the survey located at the 12 rue Franche exhibit high value of resistivity. The location of this resistive feature is not according with the hypothesis of the forum appearing as an area with lower resistivity values.
According to these results, two hypotheses now compete. The first one, considering that the resistive feature at the 12 rue Franche is from the roman period and then that the Forum place did not extend under the 12 and stop at the limit of the 10. The second possibility is that the resistive feature is included in the forum extent. And then, the extent could run to the 14 rue franche like in the 2011 proposal.
This study shows that electrostatic prospecting could bring useful archaeological information and that it could be use intensively in urban context where achieving good galvanic contact could be difficult. On our site, it permits to give some new information to better constrain the extent of the Roman forum and to guide future archaeological investigation.

Remote Sensing Approach to Map and Interpret Amerindian-Colonial Landscapes

Sonnemann Till
Faculty of Archaeology - Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/

As part of the ERC-Synergy grant NEXUS 1492 research at Leiden University, this postdoctoral project is developing a methodological approach to investigate Caribbean cultural landscapes using non-invasive techniques at different scales. By collaborating with local and international institutions, the ultimate goal is to identify and map pre- and early post-colonial indigenous settlement patterns and other anthropogenic changes to the landscape. Together with heritage specialists, the results aim to determine cultural heritage prospective, potential threats, boundaries, and means of protection. The questions will answer which work flow of applied non- destructive techniques provides accurate, valuable data for the understanding of Caribbean archaeological landscapes?

The first step targets the regional scale. A variety of remote sensing data sets, from visual to SAR satellite data covering the northern Dominican Republic and several islands in the Lesser Antilles, as well as the Venezuelan coastal regions, are compiled and analysed. Since there are few cultural sites with structures in the Caribbean, their detection by remote and close range sensing may be dependent on secondary evidence such as changes in soil moisture and vegetation. TanDEM-X DSM and NASA satellite information provide sufficient resolution for topographic & view shed information at regional scale. The SAR component, in combination with multispectral image analysis provide land cover information and define water courses to identify potential settlement areas. The determined potential factors of settlement patterns prior and post arrival of the Europeans help to establish predictive models, to provide clues for field research. On site archaeological and geodetic surveys in the northern Dominican Republic in February 2013 support and contest this analysis. In the long run, these results will be complemented by other data input by the NEXUS team. LiDAR data, archaeological excavations and prospection surveys, historic maps, geographical and geological factors, and ethno historic narratives will ultimately be united in a GIS environment.

The research is part of the ERC-Synergy NEXUS 1492 project hosted at Leiden University, directed by Prof. dr. Corinne L. Hofman, and funded by the European Research Council / ERC grant agreement n° 319209.

Integration of geophysics in a preventive archaeological project: The CSNE project

Hulin Guillaume
Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
16 rue du Général Leclerc 80400 Croix-Moligneaux http://www.inrap.fr

Preventive archaeology before large-scale development projects in France is often linked to new working methodologies. The CSNE - Canal Seine-Nord Europe - project carried out by Inrap - Institut National de Recherches Archéologiques Préventives - since 2008 is the biggest preventive archaeology project ever made in Europe. The project consists in a 106 km long channel to link the fluvial system of the Seine River to the northern Europe channel system in order to increase the fluvial transportation. The whole area represents a surface of 2500 ha.

One of the particularities of this project has been to integrate geophysics during excavation and not during evaluation which is, currently, the most common use. Evaluation of the archaeological potential has been done by trial trenching on 10% of the area. This method, used in France since 90's, remains the best way to efficiently assess the archaeological impact.

In this project, scientific benefits of geophysics are particularly high because this tool has been used in a well-reasoned way only when archaeological issues have been well-defined. This approach is totally different from the current tendency which consists in extensive surveys on large areas but generally with relatively weak results compared to the cost.

Thus, geophysics, with integration into the global GIS of the project, has been used to answer to three different issues. The first one concerned the survey around excavations in order to precisely determine extent of the human occupation when the archaeological and pedological conditions are favourable. In this case, information brought by geophysics (magnetic or electric survey) offers a global view of the archaeological site in association with a good characterization of remains. Without this archaeological characterisation (datation, preservation, function), a geophysical map has only a very limited scientific interest.

The second approach is more oriented to the integration of the archaeological site within its geomorphological context. That, generally, requires extending the survey on a wide surface due to the large-scale of entities which are looked for. In particular, this has been used with very high efficiency by electromagnetic survey on the Oise Valley for the determination of the

palaeolandscape linked to Mesolithic occupations.
Finally, the third approach is more original since the aim has been to bring some information about the excavated area directly after topsoil removal. By measurement of magnetic properties (total magnetic field, magnetic susceptibility or viscosity), it is possible to highlight some anthropogenic phenomena which are often very difficult to observe even totally invisible (magnetic ghosts concept). This approach has been used on several excavations and information for archaeologists has been particularly important.
Works done on the CSNE project point out the variety of issues that can be solved by geophysics which is clearly not limited to remains detection. These approaches, which are the fruit of interdisciplinarity and integration of a geophysicist into an archaeological team working on preventive archaeology, open up interesting perspectives to refine archaeological assumptions.

Archeological research of the Odra's Gate I

Kovacik Peter*, Janák Vratislav, Papáková Kateřina*, Hořínková Andrea*, Knápek Ale?, Rataj Petr,*,Boček Jan
Silesian University of Opava
* : Corresponding author

Multidisciplinary research of the Odra's Gate being under way since 2009 is in accordance with priorities and scientific aiming of the Institute of Archeology of Silesian University of Opava ? oriented on the «Silesian archeology» and «Archeological research of the peripheral areas». Within the scope of several different projects the research team strives for the historical landscape image reconstruction of the Czech Silesia, the contact region of the prehistoric cultures, protohistoric ethnics as well as historical states where one of the most important communication routes of Central Europe ? the Amber Road, was going through.
The research (prospection, geophysics, remote sensing) is going on the level of interaction of the natural landscape and culture as well as the level of the time and space landscape relation, settlement and communication network and at the same time on the level of relations centre ? periphery with the goal to discover dynamic changes of the landscape its natural relations from the prehistoric times till the early modern times and make the virtual reconstruction of the settlement network development based on the identification of the settlement compounds and its components (GIS).
In the course of the first 5 years, in the are of the Odra's left bank, there was managed to identify chain organized micro region of the secondary Neolithic settlements of the Linear Pottery Culture (LPC) based on the distribution of the silicites of the Kraków ? Cz?nstochova Jurassic (SKCJ) from the end of the 6,000 BC (Bravantice, Studénka, Butovice, Hladké ?ivotice, Kujavy, Pustejov). Discovered facts indicate interesting phenomenon that in this landscape which had been before and then after unsettled or settled just scarcely, episodically existed settlements situated on the route of the supply of SKCJ far away from the known settlement regions of the LPC and working as a distribution centre of this strategic material in Moravia and Silesia.
It seems then that several of hundreds of years after ending of the episodic existence of the left bank micro region of the LPC and running region wild was here, partly in the same area, formed in the end of the 5,000 BC a micro region of the Lengyel Culture settlements. We do not know what its own cause of existence was yet. Anyway this is in harmony with the increasing trend of interest for the area of the Odra's Gate and in general the peripheral areas in the time of ending of Lengyel Culture development in the Odra's area, which is also the time of arrival of Eneolit in Central Europe.
In the following prehistoric periods was the situation of the Odra's Gate area changed within the meaning of the partial spinal route relocation of this north-south prehistoric arterial road to the right bank of the Odra river, where just the continuing research can answer, whether it is the real archeological reflection of the past, or it is just a torso discovery given by the state of the research.

Integrating Remote Sensing Techniques: Results from Quintana Roo's North Coast.

Vaughan Andrew, Glover Jeffrey*, Rissolo Dominique,*
Department of Anthropology, Georgia State University (GSU)
P.O. Box 3998 Atlanta, GA 30302
gsu.edu
* : Corresponding author

The use of remotely sensed data in archaeological investigations has a long history. Beginning with the use of airborne observation through to the present day use of sub-meter resolution multispectral satellite imagery, the value of a top down perspective for locating archaeological sites for investigation has long been recognized. As technological innovation increases, the application of technological tools to the investigation of archaeological resources is directly correlated to their utility for answering, or helping to answer, research questions. Satellite and airborne remote sensing platforms provide avenues to investigate questions of archaeological significance, specifically, they can be used in settlement pattern and landscape surveys at various scales, depending on the resolution of the data.

Satellite based multispectral imagery has been utilized in other regions within the Maya area to successfully identify anomalous targets for ground truth reconnaissance. Garrison et al. identified anomalous reflectivity, hypothesized to be from distressed vegetation growing on ancient structures, which was followed up by ground truth survey, identifying sites and mapping structures through direct observation on the ground. The use of LiDAR for archaeological investigations is becoming ever more prevalent. Airborne LiDAR allows for the rapid surveillance of large swaths of territory, creating a detailed elevation map revealing terrain (and architecture) underlying vegetation.

This paper examines the utility of remotely sensed data for identifying anomalies to be ground truthed as potentially undiscovered sites in the Northern Yucatan. We utilize freely available LiDAR point cloud data (as well as extrapolated digital elevation models) from INEGI as well as multispectral satellite imagery from a variety of imaging platforms to identify and cross verify anomalous targets in GIS. These points are then used to navigate to the anomaly locations on the ground where more conventional archaeology takes place: sketch mapping any structures located and examining the area for surface artifacts. We report on the processing methodologies for anomaly identification as well as on the results of a brief ground truth field campaign.

Geoelectric resistivity assessment of cavities around Neolithic sites in the Southern Gargano Area, Apulia, Italy

Maerker Michael [1,2], Rellini Ivano
1 : Heidelberg Academy of Sciences and Humanities (HAW)
c/o Geographisches Institut der Eberhard Karls Universität Tübingen Rümelinstr 19-21, D-72070 Tübingen
www.roceeh.net
2 : Department of Earth Sciences University of Florence (DST)
Dipartimento Scienze della Terra Università degli Studi di Firenze Via G.La Pira 4 Firenze 50121, Italy
www.dst.unifi.it

The topography in the north-western parts of Manfredonia, Apulia, Italy are constituted prevalently by limestone and calcarenites. Manfredonia is placed along the southern coast of the Gargano promontory, with several cave sites on a first terrace level of probably marine origin. This terrace has steeper slopes towards the northern parts close to the uplifted Gargano mountains and it is almost flat southwards towards the Mediterranean sea. The wide presence of limestone and the climatic conditions, at least in the past, favored karst processes in the whole Gargano promontory. Limestone has a low primary porosity but an high secondary porosity represented by fractures where acid water slips and dissolve the rock. The removal of rock in solution develop an underground drainage system formed by channels and caves. In the area many examples of interlayer cave, formed between two layer of limestone in consequence of the limestone dissolution and the following collapses of the vault caused by seismic events can be obsered. Caves are important sediment traps both for sediment formed inside and for sediments transported from outside into the caves. The stratigraphic reconstruction of the cave's deposits combined with the study of the archeological and biological contents (remains of plants or animals) provides an excellent record of the climatic changes happened in the cave and offers information about landscape evolution. Since the area is characterized by important archeological sites (Occhiopinto Cave) we investigated the area north of Manfredonia in order to get an idea of cavities and their spatial distribution in the ground.

In this study we made in total 8 transects with three arrays each. The arrays utilized are Dipol- Dipol; Wenner and Schlumberger. Schlumberger array is said to be superior in distinguishing lateral from vertical variations in resistivity in respect to Wenner. Whereas Dipol-Dipol array is especially useful for measuring lateral resistivity changes. The utilized electrode spacing for the surface transects was 2m. Thus, we made a compromise between a broad screening of the area and a sufficient vertical resolution. In order to validate the analysis we compared all different arrays measurements. Generally the major spatial pattern were reproduced for all transects confirming a high reliability of the methodology. However, Dipol-Dipol arrays seem to show generally a higher spatial detail then the other two arrays. Carbonatic rocks and Dolomites have resistivity values ranging roughly from ca. 1.000-10.000 Ohm m. Voids, cavities or air filled poors show very high resistivities from 1.500 Ohm m onwards. Larger cavities show values from around 10.000 Ohm m onwards. In this study we utilized a threshold value for larger cavities of

15.000 Ohm m. Whereas, smaller voids in dolomite rocks might appear already at resistivity values of less than 10.000 Ohm m. With the given value ranges and the respective electric resistivity arrays we were able to identify the location and depth of the major cavities in a 1km² test plot area of in the North of Manfredonia. Thus, the reconstruction of the spatial distribution of cavities was possible.

Session 03

Archaeology in the Woods: New Technologies, New Perspectives sensing

(Wenesday 23th 10h30 - 18h Pantheon Amphi 2A)

Chairs : Rachel Opitz, Kasper Hanus, Clement Laplaige, Benjamin Stular,
Center for Advanced Spatial Technologies, University of Arkansas (CAST) - Website

In this session, we hope to bring together papers on a range of technologies, prospection methods, and analyses applied in the contemporary study of forested environments. We define forests broadly, encompassing everything from the temperate deciduous woodland, to the mediterranean scrublands, to the tropical rainforest, from organized and intensively exploited plantations to regenerated and unmanag ed mixed woodland, to 'ancient' forests which have been exploited continuously or episodically over an extended period. The technologies and methods of interest include ALS (airborne laser scanning / LiDAR), which has been rapidly changing the large scale picture of archaeology preserved under woodland for the past decade, geophysical survey in woodlands, where important advances are being made in the detailed description of little studied types of sites, new applications of geochemistry and geochemically-oriented spectral surveys e.g. XRF/XRD which could complement both geophysical and ALS surveys, and the ever growing importance of digital databases and ontologies which make trans-regional comparisons and research increasingly feasible.

In this session we are taking inspiration from the work of researchers like A. Groves and O. Rackham, and asking ourselves how the big archaeological picture about woodlands and forests is changing as the result of the deployment of all these new technologies, which are producing enormous amounts of new evidence about past landscapes preserved under woodland canopy. We would like to address both our understanding of the past state(s) of these now-forested areas, our knowledge of activities and experiences of landscape specific to woodlands, and the implications of past activities in forest and the remains of these activities for the landscapes which exist today.

The implications of the technological and methodological leap which has been taking place for the past decade for the study of forests as an theme/concept/aspect of the landscape/aspect of past societies and economies are not always immediately evident. It is easy enough to say that the advent of these new technologies is changing our understanding of the archaeology of forests, but the nature of this change, the new ideas and understandings, are still in gestation. The creation of a bridge between archaeologists working directly with new technologies, the enormous data generated by these technologies, and the 'data wrangling' tools and methods needed to extract information from these data, and archaeologists and researchers in related disciplines studying forests and woodlands from various other perspectives requires that all concerned consider the broader implications of their work. This session aims to draw out expressions of the broader aims, implications, and new perspectives and understandings from the archaeologists working directly with the new technologies and the big datasets they often generate which, we argue, should be leading us to reconsider many aspects of past and present woodlands. The emphasis will be on the chaine operatoire between the technologies, the methodologies, and the archaeological knowledge they create.

Exploitation and temporary occupation of late medieval Mediterranean woodlands (Provence, South-eastern France): archaeologist faces the ephemeral

Burri Sylvain
Laboratoire d'Archéologie Médiévale et Moderne en Méditerranée (LA3M)
Aix-Marseille Université - AMUCNRS : UMR7298
5 Rue du château de l'Horloge - BP 647 13094 AIX EN PROVENCE CEDEX 2 http://la3m.cnrs.fr/pages/accueil.php

Woodlands, and more broadly the incultum that is to say all the non-regularly cultivated lands, are an essential economical and social component of medieval countryside. Far from being marginal, the incultum was the scene of large and various activities related to the use of plant, animal and mineral resources. While historians have studied, with more or less attention, the management and exploitation of woodlands, archeologists seem to be more interested in the archeology in the wood or in paleoenvironmental studies, than in the archeology of woodland, as a cultural production. It can be partly explained by the poor visibility of archaeological remains under plant cover which orientated the research towards open lands, like high altitude pastures. The current development of remote sensing in archaeology, mainly the Lidar, fills partly this disadvantage. The second factor is that most of these activities and woodsmen lives, or have not left material remains, or when they did, the traces are very few and fleetingness.

Historical and archaeological sources give a partial but complementary vision of past reality. So, it's necessary to develop a historical and archaeological integrated approach to study woodlands as an ecological, economical and sociological entity. Written documentation provide information on the broad spectrum of the activities linked to plant exploitation, like timber cut, firewood, charcoal burning, leaves and barks harvest for tannery, cork harvest, resins and wood tar, honey harvest... Texts draw a first spatial analysis of these activities and guide archaeological survey. They also enquire archeologists on possible traces and on their conservation through time. Indeed, such activities have left none or few remains because they deal with perishable materials and because they are often seasonal activities. The excavation of the archaeological site La Roche Redonne (Le Castellet, Var) and the study of written documentation (mainly legal, fiscal and notarial sources) bring of the shadows this unknown craft in its technical, economical and social dimension from the XIIIth century to the XVIIIth century. Because of spatial, temporal and technical constraints, some activities give birth to temporary dwelling. Their study faces a problem of identification, characterization and dating. These structures are often the result of a succession of temporary occupation and are characterized by palimpsest soils and architecture. Differential recording between archaeology, history and iconography enquire on the real importance of wooded temporary dwellings which escape the more often to archeology. Ethnoarchaeological approach on woodland crafts in south Italy and Morocco (mainly charcoal burning and wood tar making) improves our knowledge of these activities and of the «woodsmen » lifestyles. It also leads to a discussion on the preservation and the identification of their archaeological remains through the study of depositional and post-depositional processes. A multi-disciplinary approach (mainly chemical analysis and bioarchaeology) on current site is contributing to the development of new methodologies and analysis protocols to apply then on archaeological sites.

Aerial and Terrestrial LiDAR for Human Settlement System Analysis in a Tropical Forested Landscape in Polynesia

Clark Jeffrey, Day Stephanie, Quintus Seth, Schwert Donald, Denton Anne
North Dakota State University (NDSU)

Airborne light detection and ranging (Lidar) and terrestrial laser scanning (TLS) are providing high resolution spatial and imaging data that are advancing archaeological research, but thus far those efforts have been limited in their geographic application. The use of these techniques by archaeologists working in the vast region of the world known as Oceania has been limited to a few attempts in New Zealand and Hawai'i. In this paper we present preliminary results from the application of Lidar and TLS on the island of Ofu, in the Samoan Archipelago of western Polynesia. The study is part of a long-term investigation of prehistoric settlement and subsistence patterns that developed in Samoa over the 2,700 years since initial colonization of the archipelago. Previous settlement system studies in Oceania have been based on ground surveys that were hampered by dense tropical vegetation and rugged terrain that made access to survey areas, especially in the islands' interiors, difficult at best. Aerial photography has been of minimal value due to the difficulty of identifying low elevation surface features of anthropogenic origin beneath the high forest. Consequently, only a small fraction of the interior regions of Oceanic islands have been subject to any form of archaeological investigation. Our team of archaeologists, geologists, and computer scientists present early results of the integration of prior pedestrian survey data with Lidar and GIS-based interpretations, in conjunction with TLS data of selected sites, to investigate settlement feature distribution and agricultural production on Ofu Island. The settlement features of interest are house terraces, large pits, water-control ditches, farming plots, and low mounds (used for pigeon catching as status competition). These types of anthropogenic features can be difficult to discern both on the ground and from remote images (photographic, Lidar, and satellite). We are also employing, therefore, techniques in machine learning and data mining to develop and test automated feature extraction algorithms for use on aerial Lidar and satellite data. The combination of these data and their analyses are making an important contribution to our understanding of the development of social complexity in Samoa and elsewhere in the central Pacific.

Turning stone heaps into pastoral landscapes ? Combining airborne and ground-based sensing methods to document and contextualize vernacular stone buildings in the Slovenian karst region

štuhec Seta [1*], Mlekuž Dimitrij [1*], Verhoeven Geert [,2*]
1 : Department of Archaeology, Faculty of Arts, University of Ljubljana
Aškerčeva 2 SI-1000 Ljubljana
2 : LBI for Archaeological Prospection & Virtual Archaeology (LBI ArchPro)
Franz-Klein-Gasse 1 A-1190 Vienna
http://archpro.lbg.ac.at
* : Corresponding author

Vernacular buildings, rooted in local traditions, are up-standing remains related to past activities of common people. The Slovenian karst region is characterized by such constructions of different types and functions (e.g. residence, shelter, storage place), built in the long-held building technique of dry stone. Today, many of these buildings are often difficult to access because they are located in the forest. To this end, a multi-scalar approach that joins airborne laser scanning (ALS) with meticulous ground-based three-dimensional (3D) acquisition techniques was set up to both inventory and (better) understand these specific archaeological constructions, with an emphasis on the shelters built by shepherds (in this region known as hi?ka or kjuta).
First this paper will provide a comparison of various terrestrial techniques (such as image-based modeling and terrestrial laser scanning (TLS)) that were applied to document the 3D geometry of these vernacular constructions. Besides the specific characteristics (such as accuracy) of each dataset, the various documentation methods will also be analyzed with respect to their practical application in dense forests. Afterwards, the first results of this detailed ground-based documentation will be provided. More specifically, this terrestrial phase should allow to draw conclusions on the average dimensions of these buildings and the amount of building material and effort needed for their construction. Third, ALS datasets will be used to position and contextualize the terrestrial data.
Both methods (airborne and ground-based) contribute to the inventory, interpretation and understanding of these structures in their own specific but complementary manner. ALS works as a broad brush approach and therefore enables one to contextualize the structures by fitting them into the landscape, while terrestrial datasets facilitate a detailed examination of the individual structures. Using the detailed 3D datasets provided by terrestrial acquisition techniques, it is

also hoped to develop a specific ALS filtering and object recognition strategy that allows to semi-automatically detect such buildings that remained hitherto unknown.

LiDAR data for the study of past and present landscapes: some results and perspectives around Besançon (Franche- Comté, France).

Fruchart Catherine
Université de Franche-Comté - MSHE CN Ledoux USR 3124 (UFC - MSHE CN Ledoux USR 3124)
Université de Franche-Comté
http://mshe.univ-fcomte.fr/

Nearly half of the Franche-Comté region (north eastern France) is under woodland cover. Archaeologically, most of these forested areas are poorly documented. Besançon, now the regional capital of the Franche-Comté, has been an urban centre since the Iron Age. It was a provincial capital during the Roman Period (Vesontio) and it remained important through the Medieval and Modern Periods. The city itself is fairly well studied, thanks to extensive excavations and a long history of academic research. In contrast, almost nothing is known about the archaeology of the surrounding area, a heavily wooded landscape dominated by the Forêt de Chailluz to the north-east of Besançon's urban centre. The Forêt de Chailluz is a very old wood which belonged to Besançon from the Medieval Period and has broadly maintained its present day extents for over six centuries.
A LiDAR survey (ALS) was commissioned in 2009 to support the study of the wider landscape around Besançon, to better understand the long term interaction between the urban centre and the surrounding area. Research has aimed to identify archaeological and key natural features, and through the contextualized study of these elements to investigate the management and experience of past landscapes, using microtopographic data as a continuous descriptive framework, linking physical form, orientation and place on the feature, site and landscape scales, focusing attention on the process of landscape formation and development.
This presentation will provide an overview of the results obtained through four years of research, mostly dedicated to the Forêt de Chailluz area. It will show how LiDAR data has significantly increased basic archaeological documentation, providing a better understanding of past land use around Besançon. Focusing on a few examples, it will discuss the methodology applied for feature detection and recording. It will explain how complementary fieldwalking surveys, carried out in parallel with LiDAR data analysis, helped in interpreting and dating the features. Further, it will present the importance of the collection and integration of archival maps and documents (dating from 14th to 19th c.), to build a picture of the study area's comparatively recent history with the chronological depth necessary to contextualize the results for earlier periods.
This presentation will also focus on the use of spatial analyses to synthesize the results of the survey. Issues of taphonomy, conservation of remains, and visibility / detectability of features will be discussed, and approaches for data interpretation through spatial analysis will be introduced. Finally, a few «snapshots» of the Forêt de Chailluz landscape over time will be proposed, and future possible research questions evoked.

Clearing the wood - evaluation of different software packages for ALS filtering

Klimczyk-Lugmayr Agata [1], Fera Martin [2], Doneus Michael [1,3], Briese Christian [1,4], Pfeifer Norbert [4]
1 : LBI for Archaeological Prospection & Virtual Archaeology (LBI ArchPro)
Hohe Warte 38, 1190 Wien
2 : Vienna Institute for Archaeological Science, University of Vienna
Franz-Klein-Gasse 1, 1190 Wien
3 : Department of Prehistoric and Historical Archaeology, University of Vienna
Franz-Kleingasse 1, 1190 Wien
4 : Department of Geodesy and Geoinformation, Vienna University of Technology
Gusshausstrasse 27-29, 1040 Wien

During the last decade high quality digital terrain models (DTM) and digital surface models (DSM) became very important information sources for archaeological interpretation. This is due to the fact that the terrain structures represented in the models give not only knowledge about the contemporary world but include also features remaining in the topography of past landscape. Airborne laser scanning (ALS) proved to be very useful for generating dense and accurate DTMs and DSMs. The data collected by the ALS systems represent the whole landscape in a very detailed manner: vegetation, terrain, buildings etc. In order to obtain the information essential for the archaeologists the point cloud must be filtered. The aim of the filtering is to separate all man-made objects and vegetation from the terrain i.e. a classification of the point cloud into terrain and off-terrain points. This process is usually done automatically using various filtering algorithms implemented in numerous software packages. However, its outcome is highly critical for further processing and interpretation of the data for the intended purpose and thus deserves a more detailed examination.

Currently many ALS data processing software packages, which are able to perform the automatic ground-points extraction, can be found on the market. The goal of the presented research is to evaluate the available software packages by testing: the filtering procedures used by the software, the accuracy of the results and the difficulties that occurred during the work. The outcome is a library of filtering parameters that gave good results for chosen type of point cloud and terrain. The experimental comparison is based on three reference point clouds, which have been filtered in a manual way. They are located in Leitha Hills (Lower Austria), a region in the focus of integrated archaeological research since many years with a broad temporal and typological variety of remnant archaeological structures. The data used in the project was collected over this area using a Riegl Airborne Laser Scanner LMS-Q560 on the 8th of April 2006.

The information gathered during the research will be published in a dynamic way by creating a web-page. The web-page should facilitate the access to various filtering methods, software packages and parameters. It would be used as an exchange platform in order to share the experience in ALS filtering. The outcome is dedicated not only to ALS beginners but to the whole ALS community.

(Semi-) Automated extraction from airborne laser scanning (ALS) data for road & path detection in forested areas.

Vletter Willem [1], Briese Christian ,[2]

1 : IC-Archpro, Vienna Institute for Archaeological Science, University of Vienna
Franz-Kleingasse 1, 1190 Vienna
http://ic-archpro.univie.ac.at

2 : Department of Geodesy and Geoinformation, Vienna University of Technology
Gusshausstrasse 27-29/E120.7, 1040 Vienna
http://www.ipf.tuwien.ac.at/

Until recently, the application of prospection techniques in heavily vegetated or forested areas has been very problematic. This has had a negative impact on research of roads and paths, especially as they tend to be better preserved in these kind of areas. Over the last decade, Airborne Laser Scanning (ALS) has changed the situation. With this remote sensing technique it is possible to visualise on a large scale the microtopography of landscapes. Moreover, it can also be applied in heavily vegetated or forested areas. Therefore, it is now possible to conduct research on road networks on a large scale in these areas. Nevertheless, compared to ALS data filtering, only few articles have been dedicated to the use of ALS data for road and pathway detection (Mallet et al., 2010; ?tular, 2011; ?tular, 2011) and work still has to be done for automatic extraction of linear features (Mallet et al. 2010, Doneus & Briese 2004). However, good suggestions (Hough transform, geostatistical kriging, automatic breakline extraction, openness) have been made to further the development of automated road and path network extraction for archaeological purposes (Mallet et al., 2010; Humme et al., 2010; Briese, 2004; Doneus, 2013). In this paper we will present different workflows for the extraction from ALS data for road and path detection in forested areas based on the concepts of break lines and openness.

The visualisation concept openness was first introduced by Ryuzo Yokoyama, MIchlo ShIrasawa, and Richard Pike in 2002. Both the positive and negative openness are an angular measure denoting the aperture angle of a cone centred at a grid point and constrained by the neighbouring elevations within a specified radial distance (Pregesbauer, 2013). This technique is considered as ideal tool for mapping and outlining of archaeological features. Firstly, because it has some advantages over several other visualisation techniques, as it does not produce directional bias and horizontal displacement. Secondly, openness provides a clear distinction between relief features and the surrounding topography and it highlights both the highest and lowest parts of features (Doneus, 2013).

In the break line approach a grouping of the point cloud into two groups takes place. Each group includes the points on either side of the break line, and subsequently reconstructs the surface on each side independently. This leads to two surface descriptions, which are valid for one side only. So, in a more technical sense, the definition of break line is: the intersection of two smooth surfaces, each surface interpolating the points on either side. The high degree of accuracy and completeness makes this approach to be preferred over the raster, grid and tin based approaches (Briese, 2004).

The products of both openness and the break line technique are followed up by further elaboration steps in a GIS environment to finalize to extraction workflow. The obtained results based on openness and break lines demonstrate that this line of research is worthwhile for road and path detection in forested areas and invites to further investigation.

Deep in the forest by LIDAR. Geodetic-topographical survey of the High Medieval and Early Modern outland in the forested upland in Western Bohemia

Brejcha Roman*
Institute of Archaeology of the Academy of Sciences of the Czech Republic, Prague
* : Corresponding author

This paper reports about one part of the Czech pilot project called ? The potential of archaeological landscape survey in the Czech Republic using 3D airborne laser scanning (LIDAR)» which was undertaken at the Department of Archaeology of the University of West Bohemia in Pilsen during the years 2010 ? 2011. One of the areas covered in the project was the polygon «B?ezina», situated in the southwest part of Rade? highlands in Western Bohemia. This area is characterized by the relatively higher altitude, uninterrupted forest cover, continuously sparse population and low level of archaeological knowledge. In opposite of the poor archaeological record are the rich presence of raw materials, such as iron ores and vitriol slates, and the frequent written sources dealing with the use of these natural resources in the surrounding settlements during the past. The aim of the author's research was to evaluate the true archaeological potential in this forested and not so well accessible terrain in the ways of geodetic-topographical survey with the use of airborne laser scanning. In this polygon of 13 km2 there were 11 382 360 points recorded in the density of 4 points/m2 in March 2010. A DTM was created using the data filtered and visualized by various methods (shading, slope, sky view factor, local relief) in an open source software GIS Grass. In combination with the Surfer programme, more than 550 potential archaeological features of anthropogenic origin were identified, classified and recorded as preserved in the relief. For selected features a detailed 3D model was then made. A large part of these was subsequently located using GPS, verified and photographically documented during surface survey. Part of the «ground-truthing» was also the recording of morphological characteristics, the number of features and their spatial context, preliminary interpretation and other relevant information. On the basis of this interpretation the documented features were divided into the following categories: exploitation areas (iron mines, stone quarries), production areas (charcoal hearth platforms, glassworks), fortifications (hill forts, small fortified sites) and others (deserted communication network, ridges and furrows and recent features made by forest workers). Few samples of charcoal were also taken for an anthracological analysis which has shown the rate of representation of particular wood species in selected charcoal hearth platforms. The data obtained were uploaded into GIS, where various spatial analyses were applied. This complex GIS record, including relevant archaeological and geographical information, represents an ideal basis for effective management of the archaeological heritage preserved in the woodlands of this region, which was a specific resource area for raw materials and goods in the Middle Ages and Early Modern Era. According the Scandinavian concept of outland it could represents the Central European type of «utmark».

Challenges and perspectives of woodland archaeology across Europe

Lambers Karsten [1], Kenzler Hauke
University of Bamberg

Woodlands cover important parts of the European landmass, from little more than 10% in the western and southern parts of the continent to more than 70% in some northern and eastern regions. For a long time, forested areas have been literally uncharted territory on the archaeological map, since common methods of archaeological survey, such as aerial archaeology and geophysical prospection, do not work well in forests. This is a problem for both archaeology and cultural heritage management, as important portions of these woodlands are secondary forests that cover formerly open areas used for farming, settlement, or other forms of resource use. Other parts of forests have been intensively used over centuries for charcoal burning and wood pasture. Thus, many forests contain important archaeological remains that are often well preserved but little known and protected.

Exciting technological and methodological developments, mostly in the field of remote sensing, have recently opened up new avenues for archaeological research in woodlands, and this is the main topic of this session. Of equal importance for the success of archaeological research in woodlands is the regulatory framework and, more generally, the public perception of this kind of research. The fact that forests often hold well-preserved but understudied and underprotected archaeological remains is generally little known, not just among the wider public, but also among other stakeholders and decision makers involved in forest management. Most importantly, forestry today may cause serious damage to archaeological sites through the use of heavy machinery. Forests are also often used for leisure activities, and understood and managed in terms of biodiversity and environmental protection. While the economical, recreational, and ecological dimensions of forests are widely known and well supported by existing legal frameworks, this is not necessarily the case for their archaeological dimension. To develop and implement strategies for the documentation and preservation of archaeological sites and landscapes in woodlands is often a challenging task, as activities and requirements pertaining to such goals tend to conflict with other, more widely accepted goals. While this is a prevailing situation across Europe, there is currently little effort to develop common strategies to deal with this problem, as the management of woodland resources, and of the archaeological heritage in woodlands, is organised very differently from country to country, and often from region to region. Therefore, archaeologists and cultural heritage managers across Europe need to engage with other stakeholders in quite different ways in order to raise awareness of the importance of the archaeological heritage contained in woodlands, and to develop and implement strategies for its protection.

This paper discusses different legal and administrative frameworks that regulate archaeology in woodlands across Europe. Our goal is to show that while individual solutions are required for different countries and regions of Europe, it is worthwhile to discuss common problems and chances on a European level in order to identify best practice and suggest guidelines that can be applied under different conditions. The new technologies available for woodland archaeology provide an excellent starting point to do so.

The Story in the Canopy. Archeological interpretation of DTM and satellite imagining for afforested areas

Hanus Kasper Jan
Department of Archaeology, the University of Sydney (USyd) Quadrangle Building A14 University of Sydney NSW 2006 http://sydney.edu.au/arts/archaeology/

An aim of my presentation is not an attempt to answer a specific research question, but rather to provoke a discussion about what we can learn about pre-historic and historic societies by elaborating a digital terrain model obtained by the airborne laser scanning or satellite images for the afforested areas.

The greatest advantage of the LiDAR system is a possibility of penetrating through canopies to obtain extremely accurate maps presenting topography. Past societies modified the relief by erecting dykes, digging through canals or building roads and remains of those constructions are clearly visible in the data obtained by LiDAR, which accounts for its usefulness while conducting archeological prospection on the afforested areas. That is why one of the first steps is separation of the ground points from non-ground points. However, I would like to consider which archeological data can be obtained from the digital terrain model, including also such landscape elements as trees.

Archeology of tropical areas is my specialization and that is why I have asked myself a question what a role trees and forests played in the cultural landscape of the societies dwelling in the area of interest for me. Even today, driving through a Khmer's village , one can see that trees of economic importance, such as a sugar palm ? a source of sweet juice, hard building timber, or in the historical times, leaves, which were used as a writing material, concentrate around homesteads. A lot of pre-historic and historic societies did not only use forest resources, but they also began to transform the forest to increase its yield. That type of economy, which is in the shadow of agriculture and farming, is called forest gardening. Like in the agriculture the useful tree species were selected, and then grown. Remains of the landscape modified by the selective forest economy are visible in a lot of parts of the Old and New World.

I would like to present on an example of my own experience from work on Mekong Plain, and also by a review of the results of other research projects, performed, among others, on Mayan Plains on the border of Mexico, Guatemala and Belize, or in the southern-American Amazonia, how use of airborne and satellite remote sensing methods influence our knowledge about a relation of a men with a forest, and also how we can read the history written in the canopies.

Gold rush in the woods ? studies on medieval gold mining in Silesia, Poland

Legut-Pintal Maria[1*], Pintal Lukasz[2]
1 : Institute of History of Architecture, Art and Technology; Wroc?aw University of Technology
Faculty of Architecture, Wroc?aw University of Technology, ul. Boles?awa Prusa 53/55 , 50-377 Wroc?aw
2 : Institute of Informatics; Wroc?aw University of Technology
* : Corresponding author

Big-scale gold mining was provably developed in Silesia from the beginning of 13th to 15th c. Gold, mostly alluvial origins, was included in a gravels (placer deposits). Gold-bearing layer was located from one to a few meters below the ground level. The most common technique of exploitation was to dig a shaft or an opencast, extract gold-bearing layer and wash the gold nuggets. This technique caused vast transformations of the landscape. Remains of manning, such as shafts, ore washers and piles of mined material are preserved only in forested areas and are hardly difficult to record.

The usage of ALS (airborne laser scanning) is redefining the research on mining in the forested areas. It enables recognition of a ground surface even under the vegetation. Digital terrain model made from ALS data is also highly useful in identification and documentation of large surface mining sites, impossible to record using traditional methods. The high cost of ALS method refrains its usage in archaeology, but owing to governmental projects as «ISOK», those data become more available.

In this project we emphasize the leap in research over last years by comparing current state of art with data received from ALS. The data revealed the overwhelming scale of the terrain transformation related to mining works. Post processing of DTM allowed making accurate plans of sites and extracting information impossible to obtain by field works. Applying original image processing, segmentation and stochastic algorithms on DTMs for automatic evaluation of scale and density of mining works in the area results in obtaining both qualitative and quantitative information.

The conducted research brought us closer to determinate the actual surface and scale of mining activities in Silesia in Middle Ages. We discovered that our mining sites are one of the biggest and best preserved in Europe. Furthermore, we try to draw attention to the problem of gold mining heritage protection in the woods.

Saint Gengoux de Tallenay: From an intra-site survey to a broader understanding of a woodland landscape

Opitz Rachel [1*], Laplaige Clement,*, Bossuet Gilles, Girarclos Olivier, Fruchart Catherine, Daval Daniel, Nuninger Laure ,[2]
1 : Center for Advanced Spatial Technologies, University of Arkansas (CAST)
304 JBHT, University of Arkansas, Fayetteville, AR 72701
cast.uark.edu
2 : Laboratoire Chrono-environnement / MSHE C.N. Ledoux / GdR MoDys (LCE)
CNRS : UMR6249Université de Franche-ComtéMSHE C.N. Ledoux UMR 3124GdR MoDys
UFR SLHS 30, rue Megevand 25030 BESANCON Cedex http://chrono-environnement.univ-fcomte.fr/
* : Corresponding author

In this session, we are asking ourselves how the big archaeological picture about woodlands and forests is changing as the result of the deployment of a suite of new or repurposed non-destructive survey methods and technologies, which are producing enormous amounts of new evidence about past landscapes preserved under woodland canopy. The importance of non-destructive and relatively rapid survey for the understanding of micro-regional patterns is well established. Equally, more intensive non-destructive survey has been demonstrated to be an effective means of studying both larger urban and smaller rural or production sites, usually accomplished by combining fieldwalking and geophysical surveys.
As elsewhere in the landscape, the non-destructive study of archaeological remains in a forested landscape calls for a multi-faceted approach, fusing data from several sensors. This combination of methods best suited for the study of sites in woodlands will necessarily be different from that used in green field sites or on those under cultivation. Prospection for objects will rely heavily on metal detection, with significant implications for the types of materials found and the biases of the finds evidence in terms both of chronology and activities. The manner in which geophysical surveys are conducted must be adapted to a situation in which straight lines and continuous profiles often cannot be collected. ALS replaces aerial photography, again with implications for the types of features which are likely to be detected, and the chronologies and activities represented. The introduction of botanical evidence and geochemical and soil condition information adds a dimension not usually found in open field surveys. The botanical data in particular provides a window onto the impact of past activities in forests for the landscapes which exist today.
We present the detailed implications of a suite of techniques we deem well suited for woodland intra-site surveys using the example of Saint Gengoux de Tallenay, a medieval church surrounded by a complex of enclosures, and linked to a suite of production activities in the nearby landscape. This case study, in focusing on a single complex, is intended to illustrate the depth of knowledge which can be created through extended study of individual sites within larger projects, like the broader survey of the Forêt de Chailluz. The detailed study of this complex, combining geophysical, metal detection and ALS surveys with geochemical and botanical analyses, allows us to reflect on the longer term impact of the establishment and occupation of a relatively limited area on the broader structure of production and travel activities in the surrounding woodland, from the time of the site's occupation through the present day.

Historic Forest Change: New approaches to Land Use Land Cover Analysis

Stancioff Charlotte Eloise [1], Robert Gilmore Pontius Jr ,[2], Scott Madry ,[3], Jones Elizabeth ,[3]
1 : Leiden University
2 : Clark University
3 : University of North Carolina

In the field of archaeology, geographic information systems has proven a significant addition to available tools of analysis. As GIS methods only advance, there have been growing use of historic and ancient maps within land use land cover change analysis. Using historic maps as significant data in environment and urban planning has provided key details of land practices and planning of the past. (Baily, 2007; Eremiasova and Skokanova, 2009; Gasperi, 2007; Grosso, 2009) While there has been growing research into the use and accuracy of historic maps, there has been little research into the use of modern land cover analysis techniques applied to these historic maps.

Similar to the use of GIS in satellite imagery, using historic maps allows for research into the visualization and quantification of changes seen in landscapes through time.
In this study, the land cover change of a study site in the Uxeau Commune of Burgundy France is explored through a time series created from historic maps, aerial photos, and recent topographic maps. Covering 163 years, this time series is constructed to measure the land change of forest to non-forest by using GIS methods of georeferencing, digitizing, as well as statistical analysis, as a platform to analyze the land use/land cover change found in the region from 1840-2003.
In order to analyze the changing land pattern, all land cover data must be comparable. Preprocessing must be followed before analysis of land cover can be completed. This in turn raises questions of methodology, as processes must be found to best extract the data of a historic map. As such, this study investigates how to convert historic attributes and features to modern counterparts. Additionally, this research builds on the existing field of study of georeferencing, digitalization and eventual extraction of historic maps in order to extract forested regions for further analyze. Following these steps, attention is turned to how best analyze the changing landscape patterns. Intensity analysis, developed by S.Z. Aldwaik and Robert Pontius, is used to understand the interval change between forest loss, gain and persistence annually throughout the study site. After this comparison on the interval level, an examination of the stability of change throughout the 163 period of time is made using Stability Analysis, developed by Dan Runfola.
Unlike other similar research, the integration of historic and modern data to create the observed pattern of land cover change could serve as a model for subsequent studies on extended temporal land studies. As it questions the validity of historic map use in current day studies, it also provides relevant steps and possible analysis to understand the processes of change. With an extended time series available provided by historic maps, we are able to assess the drives behind land cover change in the historic context of anthropogenic and natural processes.

Combination of Lidar techniques and recent advances on the stone structures ? protohistoric and Gallo-Roman ? of the Châtillonnais forests (Côte-d'Or).

Goguey Dominique*, Cordier Alexandra*
Archeologie, Terre, Histoire, Sociétés (ARTeHIS)
MIN CULTUREUniversité de BourgogneCNRS : UMR6298
6, Bd. Gabriel 21000 Dijon www.artehis-cnrs.fr
* : Corresponding author

GPS surveys have produced a decisive breakthrough in forest archeology, thanks to a change of scale in knowledge of sites whose interest lies not in a particular individual site, but in their association and their distribution. Since 1997, in the framework of P.C.R. Vix and its environment, campaigns of coordinated surveys have been conducted on the limestone plateau (Y. Pautrat) and on ledges overlooking the rivers (D. Goguey). One part of these structures, classified according to a typology[1], is better known, especially 77 habitats in perishable materials have been identified through a multi-factor protocol, spread throughout La Tène and Gallo- Roman period. The Lidar 2012 of the National Park, processed by the MSH University of Burgundy, includes those areas already studied and we propose here to start from these achievements and issues to highlight some examples of the contributions of Lidar and associated techniques in the field of habitats and associated fragmented parcels. The "Envix" database, which already has all the GPS data, is now being fed with additional structures introduced by the Lidar coverage of 383 km².
Identifying habitats on the Lidar image tends towards greater completeness (concerning those with visibility grades 1 and 2) and makes it possible to understand the occupation of the land. Beyond the cues identifiable only on the ground (dressed stone), one index to distinguish less visible habitats in surrounding plots (60 of 77) is the significant variation in walled volumes (taller and wider), which the observation of 2D and 3D images makes it possible to observe. In these irregular and non-closed habitats, Lidar techniques also make it possible to better distinguish the different typological profiles corresponding to the occupied terraces.
La Tène and Gallo-Roman habitats should be supplemented by thirty habitats from the High Middle Ages, very poor in material, which take the form of a square mound whose top part is flat,

with profiles revealed by theodolite being replaced by the Lidar profile, distinguishing both mounds and tumulus graves excavated as throughout Bussaut-Bellenod.
The plots in which the habitats are included, after reviewing the Lidar image which covers the plots, make up three or four different models associated with historical trends, and it is now possible to know the proportion of each of these as well as empty areas.
The extension of typologically ancient forest plots in land that is currently cultivated sheds new light on the question of the sustainability of the plot: we thus compare a few examples, using the study of structures on the ground, Lidar coverage (under forest cover and on cultivated land), aerial photographs and the Napoleonic ;amd survey

[1] GOGUEY et alii 2010 : Goguey (D.), Pautrat (Y.), Guillaumet (J.-P), Thévenot (J.-P.), Popovitch (L.) et alii, Dix ans d'archéologie forestière dans le Châtillonnais (Côte d'Or) ; enclos, habitats, parcellaires, Revue Archéologique de l'Est, éd. CNRS. T.59, 2010 p.99-209.

Archaeological mapping of large forested areas, using semi-automatic detection and visual interpretation of high-resolution lidar data

Trier øivind [1*], Pilø Lars ,[2]
1 : Norwegian Computing Center (NR) P.O. Box 114 Blindern, NO-0314 Oslo http://www.nr.no/
2 : Oppland County Administration (OFK)
Section for Cultural Heritage Management, P. O. Box 988, NO-2626 Lillehammer
http://oppland.org/Oppland-English/Responsibilities/Cultural-heritage/
* : Corresponding author

This paper presents results from the on-going mapping of cultural heritage in Oppland County, Norway, based on airborne lidar scanning of forested land.
We have recently published a new method for the semi-automatic detection of archaeological pits in airborne lidar data with at least five emitted pulses per square meter. A computer-based image analysis system is used in combination with manual inspection of visualizations of the ground surface, derived from the lidar data, and targeted field survey. In this manner, large forested areas in Oppland County, Norway have been mapped for ancient moose hunting systems and iron extraction sites. Today, these are manifested as pits in the ground. The iron production sites were used 1400?700 years ago, and consist of charcoal burning pits, often located in groups of three or more around a central oven. The hunting systems were used 2000?500 years ago, and consisted of concealed pitfall traps and wooden fences, located on moose trekking routes. The fences are gone, but the pits remain.
Oppland County, Norway, has several on-going and planned road construction projects, and some areas are being zoned for building of mountain cottages. Also, many areas have commercial timber production. To reduce conflicts between cultural heritage protection and modern land use development, Oppland County Council is conducting a much more accurate and complete mapping of cultural heritage than has been done previously.
As of 2013, the new lidar-based mapping has covered 4700 km2 of forested land. At Gravfjellet in Øystre Slidre municipality, a 70 km2 area has been zoned for mountain cottages. A total of 1650 archaeological features, mostly charcoal pits belonging to iron extraction sites, have been mapped and ground-proofed. This enables the municipality to plan the location of individual cottages, local roads, etc., in order to minimize the destruction of cultural heritage. In Gausdal municipality, prognosis mapping (as yet without ground-proofing) of 290 km2 revealed about 1800 cultural heritage objects. These figures illustrate the density of cultural heritage in some areas in Oppland County, and the need for detailed archaeological mapping.
In conclusion, airborne lidar data is now being used extensively in the mapping of cultural heritage in forested areas in Oppland County, Norway. The results of combining semi-automatic detection and visual inspection are good. Fieldwork may be done in a much more targeted and limited way than traditionally. Provided that the quality of the lidar data is sufficiently high, that is, the digital elevation model derived from the lidar ground returns contains sufficient detail; prognosis mapping of archaeological pits may be done without fieldwork. Much larger areas may be mapped than before the introduction of airborne lidar scanning, at the same time providing a much more accurate and complete mapping of cultural heritage.

Magnetic properties prospection of a Late Iron age settlement in the forest of Châtillon sur Seine (Burgundy , France)

Atanasova Anna [1*], Thiesson Julien [1*], Giosa Alain ,[2*]
1 : Structure et fonctionnement des systèmes hydriques continentaux (SISYPHE)
École Pratique des Hautes Études [EPHE]CNRS : UMR7619Université Pierre et Marie Curie [UPMC] - Paris VIMINES ParisTech - École nationale supérieure des mines de ParisUniversité Pierre et Marie Curie (UPMC) - Paris VI
4 Pl. Jussieu 75252 Paris cedex 05 http://www.sisyphe.upmc.fr/
2 : Archéologies et Sciences de l'Antiquité (ArScAn)
Université Paris I - Panthéon-SorbonneCNRS : UMR7041Université Paris X - Paris Ouest Nanterre La Défense Maison René Ginouvès Boîte 3 21, allée de l'université 92023 NANTERRE CEDEX http://web.mae.u-paris10.fr/recherche/arscan.htm
* : Corresponding author

The site investigated was occupied from the 1st to the IInd century AC. The remains of the settlements are now only stone walls delimiting area which could be related to agricultural activities like cropping, farming or living areas. A pedological and geochemical study is undergoing on the site and the magnetic properties prospection was undertaken to assess the spatial variability at the intra plot scale and compare it to the pedological and archaeological results.
The properties investigated are the magnetic susceptibility which is sensitive to magnetic material content (clay and iron oxides) and the magnetic viscosity which is sensitive only to some kind of magnetic material (iron oxides with at the limit between superparamagnetic and single domain). These properties were measured in two prospections.
The first one aimed to evaluate the spatial variability in the plots identified and was undertaken with 10 by 10 m2 square mesh. The results are shown on figure 1.
The magnetic susceptibility map show interesting variations. First, all the value above 120e-5 SI have been identified as coal producing furnaces identified as 19th century features. Considering these points as outliers, we plot a new map which exhibits clearly the limits of the plots where it has been reported thanks to an airborne LIDAR survey. The pattern associated with the limit is exhibit low values at the lower topographic part of the limit and the high values at its upper part. This could be link to the accumulation of fine earth.
The magnetic viscosity map does not show exactly the same variations. Particularly, there is an important part of the area which appears with high values. The Eastern limit of the area is quite clear and seems to extend the limit which is at the north. The second prospection was undertaken over a cleaned area identified as a former settlement.
We used a mesh of 2 by 2 m2. Both properties show clearly two areas (figure 2), giving evidence of the changes in the type of settlements.
The magnetic properties are used widely to characterize the human impact on the environment. On this site, they seem to be linked with particular human activities and as their spatial sampling is less sparse than the pedological one, it could be used as an ancillary data to assess the spatial variability of the soils.

Ditched earthwork sites in southwestern Amazonia

Trindade Thiago, Neves Eduardo
Museu de Arqueologia e Etnografia, Universidade de São Paulo (MAE/USP) Av. Professor Almeida Prado, 1466 Cidade Universitária - São Paulo, SP 05508?070 http://www.mae.usp.br/

Broadly known as «geoglifos» in Portuguese and as «zanjas circundantes» in Spanish, the archaeological sites discussed here are composed of earthworks ditches and associated mounds which range from 1.5 to 4 meters deep and 8 to 15 meters of width. Those archaeological earthworks occurs in linear or closed formats with circular, quadrangular/rectangular or ellipsoidal shapes, which can appear in isolation, conjunction or superimposition with other shapes. They range from 50 to 2,000 meters in their longest dimension and are distributed in the southwestern corner of the Amazon basin. Known since the 1910s due to the work of Swedish researcher and explorer E. Nordenskiöld, these sites only recently have received greater attention from scholars and the general public, due predominantly to the recent discovery of new sites in Brazil because of the unfortunate, fast and intense process of deforestation.
These earthworks were built across a large and environmentally and ecologically diverse area

with at least three types of settings: a) interfluvial regions of humid tropical forests, b) partially flooded riparian areas and c) seasonally flooded savannahs of central Bolivia. Distinct hypotheses have been proposed, over the years, to explain the function of these structures: use/habitation areas restricted to local elites, traps for wild animals, water canals of diverse uses, or ceremonial areas with transcendental significance. Although determinations of the functions and uses of the geoglyphs have not yet been established, they are a sign of intense landscape modifications in ancient Amazonia which began by the first millennium AD.

This study presents a general summary of the known sites in southwestern Amazonia and some considerations of the built format, geographical and ecological settings of new sites discovered in the Guaporé/Iténez basin, near the current border between Brazil and Bolivia. The basic information, including location, shape and extension for the already known sites, was taken from a selected bibliography while new sites were located with the help of a diverse range of satellite imagery ? freely distributed by Google Earth 5 (Google Inc.) software ? and were ground truthed during fieldwork in February 2013. Other geographical information (elevation above sea level, area within the polygons formed by the ditches, distance to water, distance between sites etc.) was acquired primarily from the Brazilian Institute of Geography and Statistics (IBGE) and United States Geological Service (USGS) and manipulated in the software ArcGIS 9.3 (ESRI Corp.). The results are presented as maps of distribution of these sites but also as a minimal statistical examination of the structures, which were separated by ecological groups (a?c, as cited above) and by the main shape of the ditches.

Pécs-Jakabhegy: an Iron Age hillfort in the wood ? a case study from Hungary

Gati Csilla, Bertók Gábor
Janus Pannonius Museum (JPM)
7621 Pécs, Káptalan utca 5.
http://www.jpm.hu/

The Iron Age hillfort Jakab-hegy near Pécs (S-Hungary) has been known for a century now. The first archaeological investigations took place in the 1950s, when some of the nearby lying tumuli were excavated. During the 1980's planned excavations were undertaken by the local Janus Pannonius Museum. This campaign produced evidence about the age of the tumuli and also partly of the ramparts. However, because of the dense woods and undergrowth the exact size of the tumulus cemetery could only have been estimated.

In 2011 we reinitiated the archaeological research of the hillfort and its surroundings within the framework of the ArchaeoLandscapes Europe project. We have fieldwalked selected areas within the ramparts using metal detectors uncovering a formerly unknown chronological horizon in the history.

Also supported by ArcLand, a LiDAR survey was undertaken in 2012. The results have shown a very detailed plan of the barrow cemetery and the complete structure of the earthwork: new elements of the ramparts could be recognized that indicate a multi-period building time for the fortification. In the inside of the hillfort small terraces were observed.

In the medieval times a monastery was built on the plateau. Some of the walls are still clearly to be seen on the surface. The ALS has shown some hidden details of the monastery structure lying under the vegetation.

In the future the next step would be to clarify the building periods of the fortifications by trial-trenching, however the dense vegetation will certainly cause serious difficulties for any further investigations.

Karst protohistoric landscape (north eastern Italy) revealed by air-borne LiDAR remote sensing

Bernardini Federico [1*], Sgambati Alessandro [,2], Vinci Giacomo [,3], Potleca Michele [,4], Micheli Roberto [,5], Montagnari Kokelj Manuela [,6], Tuniz Claudio [1]

1 : The ?Abdus Salam? International Centre for Theoretical Physics, Multidisciplinary Laboratory (ICTP)
2 : Agricolture and Forests Inspectorate of Trieste and Gorizia
3 : University of Udine, Departement of History and Protection of Cultural Heritage
4 : Civil Protection of Friuli Venezia Giulia
5 : Soprintendenza per i Beni Archeologici del Friuli Venezia Giulia
6 : University of Trieste, Department of Humanities
* : Corresponding author

The karstic plateau at the northernmost shore of the Adriatic Sea is rich in protohistoric hill forts protected by dry-stone walls, locally called castellieri, built from the Early Bronze Age to the Late Iron Age. Many of these archaeological sites were already identified in the second half of the 19th century when large parts of the area were almost without vegetation coverage for the effect of sheep breeding and exploitation of wood resources. Only a few open-air sites have been discovered in the last century due to the lack of systematic archaeological surveys as well as to reforestation. Airborne LiDAR (light detection and ranging) data, originally acquired for environmental monitoring over the Friuli Venezia Giulia region (north eastern Italy), have been recently analysed for archaeological prospection of the Trieste and Gorizia Karst areas by means of the free open source software SAGA GIS. The LiDAR derived images have allowed identifying several unknown fortified structures, ranging from very small watching spots to very large settlements within a complex archaeological landscape that includes funerary barrows, possibly agricultural terraces and other structures. The collected data are remarkably changing our knowledge about the Bronze and Iron Age landscape of the investigated region. Nonetheless, accurate chronological data obtained through specifically planned archaeological excavations would be absolutely necessary to understand the complex palimpsest uncovered by LiDAR derived images and related archaeological surveys. A wide range of spatial analyses has been carried out in order to preliminarily explore the use of the fortified structures, often characterized by different dimensions and positions, and to evaluate their possible relationship. The use of multi-scalar techniques, such as Ripley's K function, GIS-led cumulative and directional visibility and cost-surfaces carried out in a probabilistic framework based on Monte Carlo simulation, has allowed to identify clusters of structures often visible from a distance and overlooking important connection routes. The emerging picture strongly suggests a high degree of strategic and perhaps political control over specific areas by the communities who lived the Karst in the Late Prehistory.

LiDAR technology for Archaeological Surveys and Predictive Modelling: A case from the Venezuelan Rain Forest

Herrera Malatesta Eduardo [1], Arvelo Lilliam [,2]

1 : NEXUS1492 - Faculty of Archaeology, Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/
2 : Centro de Antropología, Instituto Venezolano de Investigaciones Científicas (IVIC) http://www.ivic.gob.ve/

This paper is an outcome of the project «Memoria Histórica y Paisaje Cultural de las comunidades de la cuenca del río Cuira, área del embalse Tuy IV», a cooperation between Hidrocapital and the Instituto Venezolano de Investigaciones Científicas, and coordinated by Dr. Lilliam Arvelo and Dr. Horensia Caballero. The objective of this project was to rescue and reconstruct the historical memory and cultural landscape of the communities that will be affected and relocated by the construction of the Tuy IV dam in northern Venezuela. As part of this research, a LiDAR dataset was collected by the engineering team and provided to the archaeological team to aid in surveying this topographically complex area with dense rain forest vegetation and steep slopes. This project has reaffirmed that LiDAR is an excellent method for reconstructing topographic surfaces under canopies, even in areas where vegetation is dense.

This paper discusses two main aspects related to the LiDAR dataset. First, it presents the analytical process used for analysing the LiDAR data within the objectives of the archaeological rescue project. This consisted of the visual identification of cultural evidence on a «hillshade» map and

the confirmation of these visual evidences as cultural features in the field. The outcome of this can be resumed in three practical results executed in different chronological stages: first, a survey map was created in which the cultural features were pointed out to aid in decision making in the field; after the validation of this evidences in the field, a predictive model was produced which use the cultural features detected on the hillshade map; and finally survey maps were drafted based on the predictive models. Secondly, the results of the LiDAR and fieldwork study will be discussed in terms of the accuracy of surveys and predictive modelling power. The discussion will emphasize the socioeconomic and political contexts of using LiDAR in combination with large, regional surveys. Synergy and efficiency of field surveys and predictive models are especially important for the viability of archaeological (rescue) projects in Venezuela. The implications and opportunities of using such new but expensive technologies for the archaeology of countries that do not have highly developed research methods and techniques are discussed.

Prehistoric flint mines under the woodlands. Identification and analysis.

Budziszewski Janusz, Jakubczak Micha?*, Leloch Micha?, Radziszewska Katarzyna
Institute of Archaeology Cardinal Stefan Wyszy?ski University in Warsaw (IA UKSW)
Wóycickiego St. 1/3 01-938 Warsaw
http://www.archeologia.uksw.edu.pl/
* : Corresponding author

The majority of flint mines in Poland are dated to the Neolithic/ Early Bronze Age and are located in the forested areas. Due to that in many cases the prehistoric mining landscape was preserved which manifest itself by the traces of human activity left on the reliefs of the sites' surface. One of the most well know mine in the region «Krzemionki Opatowskie» are more than 70 hectares, with shafts remains clearly visible during surface prospection . However, the location of forested areas creates many challenges in conducting a precise survey prospection.
In 2011 the Institute of Archaeology Cardinal Stefan Wyszy?ski University in Warsaw lunched project «Research of prehistoric flint mines with an aplication of LiDAR» aimed at identification of prehistoric flint mines. Most of investigated mining fields are located in diverse geological conditions and were used to extract four different kinds of siliceous raw material. High resolution model of the ground exposed morphological features either visible and invisible from the surface of the ground. These traces show precise geology of mining fields and places of prehistoric flint extraction.
The obtained data give us opportunity to verified ranges of already known sites and localization of unknown flint exploitation points. The LiDAR allowed us to distinguish different types of humanly altered reliefs and assign them to certain types of flint exploitation methods. No without significance are research about impact of forestry and agriculture on destruction of mining relief. We verified the usefulness of the different ways to visualize LiDAR data in research of prehistoric flint mining. All this became the basis for accurate survey with use of GPS hand-held receivers, which allowed us for further analysis of the spatial distribution of artifacts in GIS programs. The results of our study reveal new details about the methods of prehistoric flint extraction during prehistory in analyzed area.

How government project can help archaeology? So-called ISOK project and its use in polish archaeology of woodlands.

Szubski Micha? [1], Jakubczak Micha? [,2]

1 : Institute of Archaeology Cardinal Stefan Wyszy?ski University in Warsaw (IA UKSW)
Wóycickiego 1/3, 01-938 Warsaw
http://archeologia.uksw.edu.pl/
2 : Institute of Archaeology Cardinal Stefan Wyszy?ski University in Warsaw (IA UKSW)
Wóycickiego 1/3, 01-938 Waraw
http://archeologia.uksw.edu.pl/

ISOK is polish acronym for project named “Computing System of National Guards against extraordinary threats”. Project is led by the National Water Management as the leader of the con-

sortium, in collaboration with the Institute of Meteorology and Water Management, the Head Office of Geodesy and Cartography, Government Security Center and the Institute of Communications. Main goal of this project is acquisition of elevation data based on airborne laser scanning technology for the river basins. Completed the first stage of the project provided data from total target area of about 255 thousand km2. It will be continue next year and cover most of the country. Basic scanning accuracy of LiDAR data for ISOK start from 4 points up to 12 points per meter so it may be useful for archaeology.
In Poland woodlands are almost 30% of the country. These are very poorly known areas from archaeology approach. Traditionally preferred method for detecting archaeological sites in Poland is fieldwalking survey. Nowadays we have recognized ca. 435 000 sites from survey program called AZP (Polish Archaeological Record). From all of them only 1000 are located in forests.
ISOK gives us opportunity to investigate a lot of this unknown sites. Luckily one of the duties of this project is to provide obtained data for public use. It is important especially for archaeologist. Everyone can purchase this information for relatively little money or obtain it for free as a research data. In the paper we want to introduce how this, unique in Europe, project can provide necessary data. We want to show its possibilities and limitations because unfortunately nothing is free from some disadvantages. We would like to demonstrate samples of different types of archaeological features from our research, like remains of hill forts or barrows, located deep in the woods and show how they display in different lie of the land.

Session 04

Integrated and multidisciplinary approaches for digital documentation and research in Archaeology

(Thursday 24th 8h30-19h Pantheon S15)

Chairs : Carlo Bianchini, Alfonso Ippolito,
Dipartimento di Storia, Disegno e Restauro dell'Architettura - "Sapienza" Università di Roma (DSDRA)

Since the early 1990s, researchers started to apply the potential of digital numeric models to the representation of "real" phenomena also in apparently far disciplines like Archaeology. Nowadays this approach has become common practice also in archaeological research: nevertheless the possibility of exploiting increasingly large amounts of data often imply more complex procedure for investigation and categorization of phenomena. The whole process it's clearly connected to the quality of the conceptual and real models adopted to gather, organise and process this information thanks to detailed and accurate 3D numeric models that are becoming widely available after the diffusion of several "new technologies" for automatic 3D acquisition, digitalization and real time browsing.
These new technologies are substantially changing the approach to the workflow:

- 1) Creating interactive and dynamic graphical models for the analysis and investigation of the documentation produced on-time with the excavation;
- 2) New possibilities for data sharing, with the creation of GIS and AIS platforms and visual databases, including digital models;
- 3) Development of detailed analysis of the artefacts and the archaeological architectures for the interpretation of sites, carried out with interactive models (2d and 3d) which can be easily web-shared.

The session will focus on different approaches, techniques and methodologies based on the non-contact 3D acquisition of data and their following elaboration into 2D-3D digital models at a large and small scale, from archaeological sites to small objects.
Contributions to this session will discuss the use of integrated and multidisciplinary approaches in archaeological research, highlight their benefits during both the acquisition and the interpretation of data from the fieldwork, and examine the potential problems associated/not associated with their application. The session aims at outlining theoretical foundations, as a starting point for further debate about the changing approach to Cultural Heritage.

Reflectance Transformation Imaging (RTI) 3.0: Beyond Interactive relighting

Schroer Carla [1*]
1 : Cultural Heritage Imaging, Simon Frasier University
http://culturalheritageimaging.org
* : Corresponding author

Since the original form of RTI, Polynomial Texture Mapping (PTM) was introduced in 2001 the technique has largely been used as an interpretive tool, allowing an imaging subject's relighting from any direction and associated mathematical enhancements which enhance discovery of surface feature details.
New tools and approaches are enabling the same image sets captured to generate traditional RTIs to be used for generating measurable 3D geometry. The highly accurate geometry made possible by this new research also enables monitoring physical changes in subjects over time. New tools from a team at Princeton University collaborating with Cultural Heritage Imaging (CHI) provide enhanced sub-pixel alignment of the images in RTI data sets, prior to RTI generation. Such an alignment increases the accuracy of normal calculations, necessary for relighting calculations, regardless of the RTI building algorithm chosen. CHI and a team at Simon Frasier University (SFU) will demonstrate new ways of using RTI data. The new RTI algorithm produces RTIs where changes in lighting direction produce colors, self-shadowing, and specular highlights that match photographic ground truth. The proof of this claim is demonstrated by removing one of the photos from the RTI data set and synthetically generating a new photo from the same light position. After examining many different subjects in this way, the data convincingly demonstrates that the synthetically built photos exactly match the attributes of the removed photo. The new algorithm can generate empirically accurate shadows and highlights associated with any incoming light direction. The SFU research algorithm uses a radial basis function to separate shadows and highlights and weight them according to their intensity. The algorithm also creates a third set of pixels, which have neither shadows nor highlights. The normal field is calculated per pixel using the pixel samples from this third set. In previous forms of RTI, including Polynomial Texture Maps (PTM) and Hemispherical Harmonics (HSH), the calculation of normal directions can be significantly skewed by the presence of shadowed and highlighted pixel samples. Normal direction calculations using pixel samples without shadows and highlights produce highly accurate normal fields. These normal fields accurately represent the topology of the imaging subject's surface. These normal fields can also be integrated to create 3-D geometry representing the subject's surface. When this geometry is measured, it will yield accurate results. Subsequent RTI data sets, captured from the imaging subject will enable the identification and tracking of 3D shape changes over times. These tools have the potential to dramatically improve the quantification of change of humanity's legacy.

Using bad 2.5D data in archeology; use-cases of PCSAPS (a GRASS GIS script) on aerial LIDAR and other archaeological data...

Le Jeune Yann*
Paleosystem Paleosystem http://www.paleosystem.fr/ylj_pro/
* : Corresponding author

The important development of 3D imaging in archeology involves both large and small scale objects, from landscapes to simple artifacts. However, 3D imaging could some times be downgraded to 2.5D and this would yield very similar proceedings to DEM treatments currently used by GIS softwares. This is usually quite efficient to quicken calculation. Applications would range from archaeological sites detection by aerial LIDAR data, photogrammetric modeling of an epigraphic artifact or lasergrammetry of a wall.
In this contribution we present Point Cloud Simple Archaeological Process Script (PCSAPS), a shell script that can automatically process large amount of point clouds in 2.5D dataset, for ar-

chaeological applications.
PCSAPS is produced under GPL license and uses only open source software (bash, GRASS GIS, ffmpeg,...). We will offer a live demo of the script, display results obtained on data including aerial LIDAR, photogrammetry and lasergrammetry, and discuss its limitations.
PCSAPS provides common 2.5D documents, like slopes, shadings and also measurement of quality like density or coverage that are useful for archaeologists to assess the quality of their data and therefore make a better use of them. We have also developed a mean difference multi-scalar process that can extract relative reliefs and reveal archaeological shapes at different sizes, even on heavily noised datasets.
Production of data in GIS format (Geotiffs), PDF maps and animated shadings (AVI) are automated. PCSAPS produces a set of general documentation directly usable by archaeologists even without GIS or 3D software knowledge. We hope that kind of simple tool will ease the integration of 3D data in archaeological studies.

Seamless fieldwork integration of database, tablet apps and repositories through shared data structures

Johnson Ian
University of Sydney Faculty of Arts and Social Sciences (USyd FASS)
Camperdown NSW 2006
sydney.edu.au/arts

All too often, field data collection devices operate as standalone units generating a file of data which must be integrated into the project database. The process may be more, or less, automated but there is generally plenty of room for error and a requirement for some level of technical skill, particularly as the ubiquity of low cost mobile devices encourages projects move to individual data collectors for every team member. The design of the data collection protocols is also likely to be a separate exercise from the design of the core database. I argue that this paradigm is outdated and we should be aiming to operate with external data collectors which act like field extensions of our core project databases.
Working with the FAIMS project (Federated Archaeological Information Management System, http://fedarch.org), we have built a seamless methodology where multiple tablets, together with their sensors (GPS, camera, calipers, total station) simply appear as part of a site and/or survey database set up with Heurist (HeuristScholar.org). The FAIMS app and synchronisation server provide the field data collection interface and synchronisation of data across multiple tablets. Heurist generates the configuration files required by the FAIMS system to initialise the field data collection forms and reintegrates data from the FAIMS system with negligible effort from the user, providing an analysis and presentation interface as well as repository output.
In this paper I will outline the workflow from database design to the field and back and illustrate this system in use. I will also discuss the design principles of Heurist's mechanisms for publishing data structures and selectively importing published structure to build new projects. These functions have been used to allow publishing of, and access to, pre-configured archaeological modules, shortcutting the setup of new projects. The FAIMS team are using these methods to provide access to pre-configured modules for different data collection needs, including locally mandated data requirements. By supporting sharing of data structures in this way, while providing tools for easy modification and customisation, FAIMS and Heurist aim to encourage data interoperability without constraining the user to a fixed structure.

Documentation and research in Archaeology as a multidisciplinary and integrated process

Bianchini Carlo [1], Ippolito Alfonso [1*], Borgogni Francesco [1*]
1 : Dipartimento di Storia, Disegno e Restauro dell'Architettura - "Sapienza" Università di Roma (DSDRA)
Piazza Borghese, 9 00123 ROMA
http://www.dsdra.it/drupaluni/
* : Corresponding author

Graphics and photographs have always played a fundamental role in the documentation of archaeological contexts, and most times support later interpretation of old-dated fieldwork. As the conducting of archaeological fieldwork itself, documentation may be affected by subjective interpretation, and leave little space to further elaboration. During the last decades, the adoption of a digital approach has much helped to speed up the fieldwork and to provide enough information for multitasking platforms, through the simultaneous management of all kind of information deriving both from the topographical environment and the following elaboration of data.

Since the early 1990s, researchers started to apply the potential of digital numeric models to the representation of «real» phenomena also in apparently far disciplines like Archaeology. Nowadays this approach has become common practice also in archaeological research: nevertheless the possibility of exploiting increasingly large amounts of data often imply more complex procedure for investigation and categorization of phenomena. The whole process it's clearly connected to the quality of the conceptual and real models adopted to gather, organise and process this information thanks to detailed and accurate 3D numeric models that are becoming widely available after the diffusion of several «new technologies» for automatic 3D capturing, digitalization and real time browsing. The digital catching of information from the fieldwork is of course a critical step in the whole process and should be performed taking into account both the need of collecting the most possible information in the shortest time and the lack of economic resources. Taking into consideration numerous survey campaigns carried out for years, this paper seeks to present a «modus operandi» that seems to be indispensable for standardizing and regulating procedures of data collecting, elaborating and representing applied by our research team from the Department of History, Drawing and Restoration of Architecture (Sapienza - University of Rome), the aim being to make the final result «scientific», i.e. as much objective and correct as possible. Together with a general methodological framing, we shall describe a number of research projects spanning from large sites (Jerash - Jordan), single buildings/ architectural structures (The Temple of Divus Claudio, Rome) and small objects (Tombs and artifacts in Crustumerium ? Rome).

Concluding ILAC ? An Interdisciplinary Approach towards Image-Based Classification of Ancient Coins

Kavelar Albert [1*], Zambanini Sebastian [1*], Anwar Hafeez [1], Kampel Martin [1*], Vondrovec Klaus ,[2], Siegl Kathrin ,[2]

1 : Vienna University of Technology (TU WIEN)
http://www.tuwien.ac.at/tuwien_home/EN/
2 : Kunsthistorisches Museum Wien (KHM)
http://www.khm.at/en/
* : Corresponding author

Automated image-based classification of ancient coins is still subject to ongoing research in computer vision and has reached the point where the incorporation of domain-specific numismatic knowledge can be used to improve the results. To overcome this limitation, the ILAC (Image-based Classification of Ancient Coins) project bridges the gap between numismatics and computer science and combines the knowledge of both disciplines to research an automated image-based coin classification system from which numismatists benefit likewise when it comes to the classification of large amounts of coins, as encountered in, e.g., coin hoards. Since digitization of coins by means of photography is already common practice among museums for archiving and scientific purposes and to provide online access to their collections, no additional effort is required for the development of image-based coin classification techniques. Thus, such a method is easy to implement and likely to be accepted and used by numismatists.

The ILAC project comprises five major aspects: (1) Image acquisition, (2) image processing, (3) coin Classification, (4) performance and (5) the creation of an archive database. In the digitization process, over 4.000 Roman Republican coins were digitized using a DSLR camera. Lighting plays a crucial role and must be performed in a way that minimizes specular highlights that pose additional problems for the later on image-based recognition. Image processing deals with the automated removal of rulers and other background clutter. Coin classification is the part that actually deals with the image-based recognition of the coin type depicted in an image. Incorporating domain-specific knowledge such as a lexicon of possible coin legend words which can be used to recognize the legend depicted leads to an increased recognition rate. Moreover, manual recognition practices of numismatists ? such as coarse-to-fine classification based on specific, discrimi-

native coin characteristics ? can be mimicked and have been proven successful for automated classification. Obviously, performance ? regarding both, classification rate and required computation time ? needs to be considered. Finally, besides basic research in the field of computer vision, a large-scale database of annotated images of ancient Roman Republican coins was created. Parts of this database will be made accessible for other researchers and thus creates a benefit for the scientific community.
This paper summarizes the work done in the ILAC project and explains the different image-based methods developed for the automated classification of ancient Roman Republican coins. Moreover, the benefits for both, the numismatic and the computer vision community are highlighted and the gain of the presented interdisciplinary approach is emphasized by the experimental results achieved on a numismatic database.

Survey, Documentation and Analysis of the Archeological Architecture: the House of the Knights of Rhodes in the Forum of Augustus

Tacchi Gaia Lisa [1], Bianchini Carlo [,2*]

1 : Dipartimento di Storia, Disegno e Restauro dell'Architettura - "Sapienza" Università di Roma (DSDRA)
2 : Dipartimento di Storia, Disegno e Restauro dell'Architettura - "Sapienza" Università di Roma (DSDRA)
Piazza Borghese, 9 00123 ROMA
http://www.dsdra.it/drupaluni/
* : Corresponding author

The study and interpretation of the so-called Archeological Architecture is generally quite a difficult task: such elements or complexes nowadays show in fact very stratified and heavily restored configurations resulting from centuries of interventions.
Survey represents one of the major instruments for deeply investigating the intimate nature of such artifacts thanks to its ability to enlighten both the studied object and its context, their mutual relationships and the sequence of transformations.
Survey has to be intended though as an «open» process aiming at improving the general Level of Knowledge of the studied object; a process in which three main phases can be recognized: Data Acquisition, Data Selection and Interpretation, Communication. Phase one includes all information-gathering activities coming mainly from measurements and, under certain conditions, it leads to datasets «tending» to be objective. Conversely, during the Selection and Interpretation phase this database is «intelligently» reviewed for a critical selection and interpretation leading thus to «subjective» results. Finally, during the Communication phase results are codified in order to make them widely available for the scientific community.
The whole process always starts from getting acquainted with the artifact by direct inspection and by an historical investigation of archive sources (documents, drawings, pictures, etc.) able in outlining the timing and evolution of changes. All this information would in fact crucially guide the following operations of data capturing (surveying).
From this standpoint the House of the Knights of Rhodes in the Forum of Augustus is quite emblematic: no recent and systematic documentation is in fact available; present building is the result of many historical phases that have over time added or subtracted elements to the original roman building; the complex is actually a tangle of architectural and archaeological elements and for this reason it can be assumed as a «showcase»; finally the researches on the House, as relevant part of the Forum of Augustus, have received a new significant impulse by some recent excavations campaigns.
The research on the House of the Knights of Rhodes we are presenting has been then focusing on all these issues, aiming at demonstrating both the inner «coherence» of the Survey process and the potentials of the Integrated Survey procedures where many surveying techniques (3D scan, photomodeling, ortophotography, topography, GPS, direct survey) are used at the same time in order to optimize time, resources, models and results.
Models (2D, 3D) have been positively used to investigate this very fragmented portion of the Roman Forum (the building itself, the context of which it is part, the overall alignment of ancient structures, the consistency of buildings as well as the functions they used to host) not neglecting their role as means for communication of results and dissemination.

The Recursive-Relational Archaeological Database (ReArch) and Sherd Image Viewer and Analysis (ShIVA): A Post-Structural Model for Inter-disciplinary Archaeological Research and Collaboration

Greene Alan [1*], Hartley Charles ,[2*], Doumani Paula ,[3*], Forero David ,[4*]

1 : Department of Anthropology, Stanford University

2 : University of Chicago Department of Anthropology
Edward H. Levi Hall 5801 South Ellis Avenue Chicago, Illinois 60637
http://www.uchicago.edu/

3 : Washington University Saint Louis
Mailbox: Campus Box 1114 One Brookings Drive St. Louis, MO 63130-4899
http://wustl.edu/

4 : Computation Institute, University of Chicago

* : Corresponding author

Since 2005, the Making of the Ancient Eurasia (MAE) Project has been collecting two- dimensional (2D) digital radiographs and three-dimensional (3D) X-ray computed tomograms as part of a technique development and analysis project focused on archaeological pottery from prehistoric settings in the Caucasus, Central Asia, and China's Central Plain. Our management and analysis of these voluminous and diverse 2D and 3D datasets has necessitated the development of both a database management system (DBMS) and analytical software that provide seamless links between archaeological and archaeometric data points. While many existing computing platforms offer both data management and image analysis capabilities, these tools fail to provide a setting where geographically and paradigmatically disparate research projects can easily compare their data and debate their findings, which is an essential element of archaeological inquiry. In this paper, we present the development of the Recursive-Relational Archaeological Database (ReArch) and Sherd Image Viewer and Analysis (ShIVA), a platform specifically oriented toward the collaborative, inter-disciplinary, and post-structural management of complex archaeological data, including 2D and 3D imagery of several types, as well as the excavation measurements, satellite imagery, micrographs, and geochemical data that contextualize their analysis. ReArch and ShIVA permit an integrated and iterative analytical process, allowing collaborators to share information, contest each others claims, and use various results and data points from other projects to inform their materials analysis and archaeological interpretation.

While recent years have witnessed the proliferation of multiple DBMS platforms for the management and analysis of archaeological or archaeometric data, most have struggled to articulate excavation, survey, and GIS datasets with the secondary and tertiary materials analyses, like MAE's radiographic and tomographic data, that emerge as archaeologists move from the field to laboratory. In order to implement a data management and analysis schema that acknowledges these technical impediments without relinquishing the benefits of traditional table- based data storage, our recursive-relational model preserves the practical configuration that tables provide, while relaxing the strict, attribute-based model that so characterized modern databases. Central to ReArch is the recognition that object attributes and relations between various objects in the archaeological or laboratory record constitute objects themselves and thus require descriptive and/or relational characterization. This model therefore has an inherently recursive and extensible structure that can incorporate heterogeneous observations and analyses into a common framework in order to evaluate their commensurability. In this manner, ReArch provides a simple platform for analyzing and formally expressing the chains of qualifications and associations that fundamentally characterize excavation contexts, pottery, and the secondary 2D and 3D data formats derived from those materials.

Our paper outlines the conceptual apparatuses, development process, and implementation of ReArch and ShIVAas a stable, portable, and scalable system of open source software components, including PostgreSQL, the Django web framework, GRASS open source GIS, R statistical software, and Python scripting language. It discusses the application of this system to the integration, analysis, and publication of strongly heterogeneous data from several contexts across the Eurasian landmass, from the South Caucasus, to Central Asia, and China's Central Plain.

From survey to the representation of the model. A documentation of typological and chronological sequences of archaeological artefacts : traditional and innovative approach

Ippolito Alfonso, Senatore Luca J,*, Belelli Marchesini Barbara,*, Ceroli Gabriella,*
Dipartimento di Storia, Disegno e Restauro dell'Architettura - "Sapienza" Università di Roma (DSDRA)
Piazza Borghese, 9 00123 ROMA
http://www.dsdra.it/drupaluni/
* : Corresponding author

The integration of the traditional approach with the continuous technological advancement/ improvement and in particular the great digital revolution offer new research tools that can be easily applied to science. In the field of survey and representation the introduction of new information technologies has quickly revolutionized the way we understand and address the matter. Even though the fundamentals of the existing disciplines haven't changed, they have been interacting with new tools and applications for a long time now.
Not only in the discipline of architectural survey but also in the archaeological survey technological advancements lead to the development of three different fields of research: the first deals with data collection; the second restricted one aims at the development of new low cost solutions; the third one concerns the traditional methods and their integration with the former two.
We believe that it's not appropriate to focus our attention on a specific technique but to the integrate all different techniques, tools and methodologies, in order to achieve the best interpretation of the analyzed subject.
For this reason drafting a procedure based on the interaction between direct and indirect low cost methodologies for the elaboration of 2d and 3d models would be a topic of great interest.
This study aims to suggest a modus operandi for the standardization and regulation of data collection, processing and recovery procedures applied by the research group, in order to make the final scientific results more objective and correct.
All of these considerations make it clear that the problem must be addressed as a whole, through the design, testing and concrete application of innovative management tools, suitable to deal case by case with the complex issues we have outlined. Such tools, however, cannot yield their full potential without a substantial change in perspective: archaeology cannot and must not be regarded as an isolated approach, but as part of a larger «cultural cluster».
Obviously, this implies that a broader management and the implication of different skills is necessary: archaeologists, architects, restoration specialists, administrators.
The paper discusses different experiences in the digital-catching of information and aims at discussing advantaged and disadvantages of non-contact documentation in respect of the « traditional» approach.
The aim is to discuss the advantages of digital catching during the phase of documentation and restoration of the artifacts. For this last case-study we experimented the geometrical virtual reconstruction of hand-made irregular artifacts (anforette di tipo laziale). The aim of research is to evaluate if it's possible to «virtualize» their shape and profile of a hand-made irregular artefact and whether the digital approach is too extreme/stiff for such an application.
This is the starting point for the case-study of the huge dolium found in Pyrgi helps to highlight the benefits of (preliminary) virtual reconstructions for the needs of publication, in respect of expensive restoration of huge objects.
As regards digital-catching of information, the paper focuses the use of image-matching and compares the results which have been obtained, both in terms of precision and in terms of economic benefits.

Acoustical approaches to Ightham Mote: towards a lived experience.

Cooper Catriona [1,2*], Murillo Gomez Diego [2,3*]
1 : Archaeological Computing Research Group (ACRG)
http://acrg.soton.ac.uk/
2 : University of Southampton (Southampton, UK)
3 : Institute of Sound and Vibration (ISVR)
http://www.isvr.soton.ac.uk/
* : Corresponding author

Multisensory experience is a relatively neglected topic in archaeology. The ephemeral nature of the senses beyond the visual makes it hard to study and quantify. Using acoustical survey and analysis techniques it is discussed how sound can be engaged with beyond a phenomenological approach to inform our understanding of medieval spaces. This paper assesses the auralization of the Great Hall of Ightham Mote based on geometrical acoustics methods using the commercial package Catt-Acoustics. For this, the Room Impulse Response was measured in order to estimate the absorption coefficients of the materials. From this data two models were simulated: the building as it stands today and how it would have stood in the 14th century
The results suggest that is possible to obtain good agreement between the measured and the simulated data in terms of reverberation time, early decay time and clarity. However, the subjective test revealed that the subjects were able to identify the measurement from the simulation. The last may be attributed to the lack of the Geometrical Acoustics methods to calculate correctly the low frequencies. This can be solved by implementing other technics as Finite Element Methods for this range of frequencies.
Our aim is to discuss whether this methodology is affective and whether we can use this technique towards the study of sound in the past. To achieve this we present results which have been analysed both numerically and subjectively, by archaeologists and acousticians. We will discuss the technological constraints, theoretical issues and the success of the project.
This paper explores a multidisciplinary approach, involving participants from the Institute of Sound and Vibration and the Archaeological Computing Research Group at University of Southampton.

ArkeoGIS, merging geographical and archaeological datas online

Bernard Loup [1], Ertlen Damien, Schwartz Dominique
1 : Université de Strabourg (UMR 7044)
université de Strasbourg
MISHA
5 allée du Gal Rouvillois
CS 50008
67083 Strasbourg cedex http://umr7044.u-strasbg.fr

After a few years of existence, ArkeoGIS is now fully operational in his version 3. This webGIS adds over 20 databases in French and German, with over 10 000 archaeological sites and environmental features. Inventorial databases, searchers databases, students and laboratories cooperate in the Rhine valley, implementing each other datas, and having access to cross- boundary information and literature in two languages. Users and contributors, once logged, have the possibility to build quick queries with a handy interface, questioning several informations on four depth levels. For this paper, the focus will be on the benefit happening while showing archaeological sites and finds on an interactive map where the user can add geographical inventories, existing analysis and how this helps us finding new questionings.
Cross data mining helps both archaeologists and geographers to obtain relative datings of sites, with a direct access to literature and/or the producer of the data. Furthermore, the questionings related to erosion and taphonomy are easier to apprehend and will certainly help us to a better modelisation of the past.

Enhanced 3D-GIS: Documenting Insula V 1 in Pompeii

Landeschi Giacomo [1*], Dell'unto Nicolo' [1], Ferdani Daniele [,2], Lindgren Stefan [,3], Leander Anne-Marie [,4]
1 : Department of Archaeology, University of Lund
Box 201, SE-221 00 Lund
http://www.ark.lu.se/en/
2 : Istituto per le Tecnologie Applicate ai Beni Culturali, CNR Rome (CNR ITABC)
Area della Ricerca Roma 1 - Montelibretti Via Salaria Km. 29,300 - C.P. 10 00016 Monterotondo St. (ROMA)
3 : Humanities Lab, University of Lund
Box 201, 22100, Lund
4 : Department of Archaeology, University of Lund
Box 201, SE-221 00 Lund
* : Corresponding author

This project was recently carried out as a part of The Swedish Pompeii Project, which was started in 2000 as a research and fieldwork activity initiated by the Swedish Institute in Rome. The aim was to record and analyze an entire Pompeian city block, Insula V 1. Since autumn 2011 a new branch of advanced digital archaeology, involving 3D reconstructions and documentation methods, was added to the project agenda. The insula was completely digitized using laser scanner technology and the raw data were employed to develop different research activities in the area of digital visualization and analysis. In this context, a newly developed research line was setup with the purpose of implementing the above mentioned dataset into a 3D-GIS platform (ESRI ArcGIS 10 suite). The system was designed with the goal of (i) increasing the connection among the different typologies of data recorded in the last 10 years, (ii) retrieving a larger number of information, and (iii) analyzing data from a fully functioning geodatabase made up of 3D models. First step of the work consisted of the GIS integration of the 3D models (previously acquired with laser scanner technology) of the south house of Caecilius Iucundus, which was used as a case study to make a general assessment of the project feasibility. Each 3D model was transformed into a multipatch feature, and it was associated to an attribute table along with its related information. In this way it was possible to link each feature to the documentation provided by the Swedish Pompeii Project website (http://www.pompejiprojektet.se/). Furthermore, the editing extension available allowed digitizing 3D features straight into GIS, providing with the opportunity to setup even very basic modelling functions. This project allowed us to use all the potential provided by a GIS platform to explore in a GIS the complexity of an ancient building geometry along with its architectural details and peculiarities. Furthermore, a virtual reconstruction of the Caecilius Iucundus house was super imposed alongside the acquired site and used to make comparisons between bottom up and top down representations. The development of this aspect will allow using GIS analytic tools for investigating aspects connected to the cognitive process in an ancient building, with the possibility of generating new hypotheses about the spatial organization of the Roman house based on the notion of visibility of specific elements.

A project for the digital documentation of the Archaeological site of Masada

Bertocci Stefano [1], Parrinello Sandro, Fantini Filippo, Vital Rebeka, Bua Sara, Picchio Francesca, Porzilli Sara
Dipartimento di Architettura (DIDA)
www.unifi.it

The project is part of the international research in the field of 3D digital documentation and mapping of a sites of great cultural and historical relevance: the Masada fortress in Israel. A team of international researchers belonging to the department of Interior Building and Environment design of Shenkar College of Design and Engineering, The Department of Architecture of the University of Florence and the department of Architecture of Civil Engineering of the University of Pavia are carrying out a laser scanner survey, integrated with SFM applications, of the Herod's Palace in the frame of an ongoing research collaboration.

The program for the documentation of the archaeological site of Masada includes a series of survey campaigns organized in three years. Each mission planned has the aim to achieve a better understanding of the site characterized by a great morphological complexity and a series of different pavilions with different functions. The first campaign is focused on the northern part of the huge plateau of Masada where a series of spectacular terraces were made during the first century b.C. on artificial and natural platforms. The data integration of traditional direct survey methods and instrumental techniques (Leica C-10) permitted a full morphological description of the analyzed part of the site by means of point cloud models and 3D digital models. Those kinds of representations are going to be used as a scientific platform for different activities ranging from conservation and restoration practices to dissemination by means of computer graphics applications and last but not least the management of this important UNESCO Site (belonging to the World Heritage List since 2000).

Models for presenting archaeological collections – The Mount Vernon Midden Project

Freeman Mark [1], Breen Eleanor [,2*]
1 : Department of Anthropology [University of Tennessee]
250 South Stadium Hall, Knoxville, TN 37996-0720
http://web.utk.edu/~anthrop/
2 : George Washington's Mount Vernon (MV)
http://www.mountvernon.org/
* : Corresponding author

The ethics statements for the Society for American Archaeology and the Society for Historical Archaeology both stress the communication of archaeological research with SHA being more specific in asking members to «strive to engage citizens in the research process.» With most archaeological data now digital, the following questions arise: at what level of granularity should archaeological data be shared, and who are the audiences for primary archaeology data? The Mount Vernon Midden Project website showcases archaeological collections from Mount Vernon, George Washington's Virginia plantation. The midden website presents over 700 selected objects, each with catalog information, images and «public text.» Additionally the objects are tagged, and linked to thematic articles (gender, consumerism etc.) and object types (shot, beads, tea etc.). The archaeological collections are also integrated with several primary documentary sources ? a local account book, and Washington's orders and invoices. Both in design and content the site is intended to serve as a new model for access to archaeological collections, reaching audiences beyond archaeologists, while maintaining a scholarly focus. This paper examines how this website attempts to integrate multiple primary sources through ontological tools and how it promotes the use of archaeological data for multiple publics.

Archaeology in the third and fourth dimensions: A case study of 3D data collection and analysis from Prince Rupert, BC, Canada

Parker Alyssa, Eldridge Morley [*]
Millennia Research Limited
510 Alpha Street Victoria, BC V8Z 1B2
www.millennia-research.com
* : Corresponding author

During a large excavation project on the Northwest Coast of America in Prince Rupert, BC, Canada, a very large (over 140,000 data points) data set of 3-dimensional data points was collected. Data collection used a Total Station for 3D provenience of all materials, supplemented with tablet computers for attribute data collection, and linking the attribute and spatial data with barcodes. This 3D dataset was augmented by photography of features for conversion to 3D models using SFM (structure from motion) software, as well as 3D scanned models of artifacts. These models have been georeferenced and visualized with the surrounding point cloud data, which is symbolized by a variety of different collected attributes. This visualization has allowed detection of patterns that were not apparent in the field, and which may have gone unnoticed if standard excavation and recording methods had been used. The 3D point cloud and 3D models allow an unprecedented view of the archaeology of this region, ranging from the micro (individual artifact) to macro (multiple «sites») scale. The ability to select from a range of types of archaeological data that can be viewed simultaneously is also unprecedented. This paper will discuss the methods used to collect, store, and analyse this data, with a focus on different methods of 3D visualization and data sharing using web-based applications.

Large scale to close-range photogrammetry in preventive archaeology: the example of the Jacob-Bellecombette millstones quarries

Arles Adrien [1*], Heckes Jürgen [,2], Painsonneau Simon [1]
1 : Arkemine
Researche & Preventive archaeology
http://arkemine.fr/
2 : Deutsches Bergbau-Museum (DBM)
http://www.bergbaumuseum.de
* : Corresponding author

During preventive archaeology excavations, the time on the field is a parameter quite critical to manage. All information has to be recorded in a quite short period. Besides considering the pursuit of the construction that previously set the excavation off destroys the archaeological remains, there is no possibility to come back later if something has been missed out when it is more easily possible in research archaeology. Thereby, archaeologists working on preventive excavations are quite inclined to develop and use new methodologies to survey more information in a short amount of time.

In this paper, we will present different photogrammetric protocols to define a global survey methodology used during a preventive excavation of a medieval and modern millstones quarry. The excavation site is located in Jacob-Bellecombette (France) on the Alps buttress. Before the construction of a residential district, a 14000 m² area has been excavated during a five weeks period. The whole surface of the archaeological site has been mechanically and manually excavated to reveal the exploited stone beds. Finally, 30 individual quarries overall spread on the studied area have been found. The quarries can be very small (one or two millstones extracted) or quite big (up to 80 millstones exploited) depending on the period of their exploitation but also the quality of the stone. Considering the extension of the site to study and the diversity in the size of the structures to be surveyed, we choose set up a multi-scale photogrammetric protocol as a global survey technique.

The large scale approach had to be extensive enough to produce a digital elevation model (DEM) and an orthophotography of the site. Then we can confront different disciplines (geology and topography) to understand the origins of the quarries installations. Two different photography solutions have been tested: the first using an hexacopter and the second, pole photography. In the paper, we will discuss pro and the cons of each solution.

During our mean scale approach, each quarry has been surveyed by the standard photogrammetric process. Considering that quarries actually are 3D structures, it is clearly relevant to study 3D reconstructions. From the produced virtual models, we have extracted proper surveys and cross sections to reveal the different extraction techniques used by the ancient stone workers.

Finally, we have set up a close-range photogrammetric approach to study some tool marks observable in some quarries. The high resolution of the 3D reconstructions reveals the microtopography of the quarries walls. We used rendering algorithms to illuminate the surface artificially and create preconditions to extract tool marks automatically. Once fully exposed the tools marks can be completely surveyed. From this kind of data, archeologist can discuss about the processes and the timeline of the extraction.

Eventually, all georeferenced, the 3D data can be gathered in the same system and displayed to extract different kind of information according to the scale of the structure considered.

Augmented palaeontological sites: an interactive application for smart phones and tablets of the Sacco river valley in Italy

Empler Tommaso [1*], Fratarcangeli Marco [,2*], Quici Fabio [1*], Murru Giovanni [,2*]

1 : Department of History, Representation and Restoration in Architecture (DSDRA)
Piazza Borghese 9, 00186 Rome
http://www.dsdra.it/drupaluni/

2 : Department of Computer, Control, and Management Engineering
Via Ariosto 25, 00185 Rome
http://www.dis.uniroma1.it/

* : Corresponding author

The proposed research experiences the use of new technologies to promote information and scientific study of prehistoric sites, which are connected to the evolution of man in his environment. Through the development and use of smart tools (smartphones and tablets) the research focuses the attention to a scientific heritage of global interest, such as that represented by the Sacco river valley (close to Anagni, in the southern part of Lazio territory - Italy), where 2 million years ago were present numerous lakes around which lived plants and animals now extinct.

The fruition of sites and paleonthological evidences is achieved through the use of new technologies, developed and applied to the knowledge of cultural heritage, working on the possibilities of virtual exploration and visualization of sites and remains allowed by an APP designed for

smartphones and tablets.
The APP guides the visitor through some prehistoric sites, and, for each of them, allows to display a general information fact sheet, which containes a descriptive/scientific text and a collection of relevant iconography. The fact sheet is supported by additional functional resources to obtain an integrated knowledge of the area and its presence :
- site's visualization in augmented reality (AR +), with geolocated icons, related to paleontological remains discovered during the excavations, and with the possibility of more specific views and information sheets for each of them;
- a 360° panoramic view of the current state of the site today and its morphology referred to two million years ago, with the possibility of passing from one to another in real time, by means of a «time bar» control function;
- an index/abacus of the animals found in the site in recent excavations.
For each animal evidence found on the sites, there is a specific «animal fact sheet», designed with reference to its cataloguing with the ability to view and manage a 3D model reconstruction of the animal itself (such 3D can also be extended to the discovered plant fossils), integrated with a text description and a gallery of reconstructive drawings developed by paleontologists.

The Digital Documentation of Ireland's most iconic early Christian sites: in partnership with the 3D-ICONS project

Corns Anthony, Devlin Gary*, Shaw Robert
The Discovery Programme (DP)
63 Merrion Square Dublin
www.discoveryprogramme.ie
* : Corresponding author

As a partner in the EU funded 3D-ICONS project the Discovery Programme has been surveying a wide range of the most iconic cultural heritage sites in Ireland. This pan-European project with sixteen partners from nine countries aims to establish a complete pipeline for the production of 3D replicas of archaeological monuments and historic buildings, and to publish the content to Europeana for public access.
This paper will focus on the digital documentation of some of Ireland's foremost early Christian sites selected for study as part of this pilot project. These include; Skellig Michael, a site included on UNESCO's World Heritage List; the monastic city of Glendalough; the monastery at Clonmacnoise and the boat-shaped oratory at Gallarus. These sites presented a range of different challenges for the survey team, the aim in each case being to gather high resolution scientific quality data. A range of survey techniques have been applied including airborne laser scanning (ALS), terrestrial laser scanning (TLS), object scanning and structure from motion photography. It is this multi-level approach to monument documentation which achieves a complete and definitive record.

Integrated RTI approaches for the study of painted surfaces

Kotoula Eleni, Earl Graeme
University of Southampton, Archaeological Computing Research Group (ACRG)
Southampton SO17 1BF
http://acrg.soton.ac.uk/

The present paper serves to show the potential of integrated Reflectance Transformation Imaging (RTI) approaches, namely the microscopic, multispectral, trans illumination and trans irradiation RTI, with a particular emphasis in the study of painted surfaces. Classical-Hellenistic painted ceramic vases as well as egg-tempera paintings on wood and oil paintings on canvas were captured using the proposed integrated RTI methodologies.
Previous work has already proved that RTI (Mudge et al. 2005) and Polynomial Texture Mapping (PTM) (Malzbender et al. 2001), significantly contribute to analysis, conservation and representation of painted artefacts (Padfield et al. 2005, Baade et al. 2012, Klausmeyer 2005, Castriota & Serotta 2011, Artal-Isbrand et al. 2011, Beale et al. 2013, Bridgman & Earl 2012, Earl et al. 2010).
Integrated RTI approaches introduce an advanced perception of three dimensionality. Transmitted

imaging (Cucci et al. 2012), multispectral imaging (Fischer & Kakoulli 2006) and optical microscopy fail in the visualization of this crucial feature for the appreciation of artefacts. Moreover, results indicate that the advanced visualizations obtained broaden our understanding about artefacts, assisting condition reporting, investigation, documentation and artefacts studies. In particular, microscopic RTI catalogues the surface topography at a microscopic scale and shed light on minor details of West Slope ceramic fragments, infrared RTI gave an insight into the red-figure vase painting technique and the hidden features of painted panel paintings and transmitted RTI enabled an advanced visualization of paint application and assisted condition reporting.
The promising results of the present case study demonstrate that integrated RTI approaches can potentially revolutionise visual analysis from scientific, conservation and historical perspectives. Moreover, the practical implementation of microscopic, multispectral and transmitted RTI data capture and the future directions for research so as to reach more safe conclusions regarding their application and to understand their limitations and full potential is discussed.
The paper will discuss the challenges of taking such high resolution (and high volume) data sets and decimating them to fufill the 3D-ICONS dissemination objective. It will look at the output options from used simple 3D pdf to the more visually pleasing 3D models generated in gaming software such as Unity. It will consider how data fusion of ALS and TLS data has been achieved and the value of modelling architectural structures in their wider landscape surrounding.
Access to scientific data is proving invaluable in furthering the understanding of the monuments and assessing and quantifying threats which may exist. Each structure within these archaeological complexes has been recorded to a resolution which allows for stone by stone interrogation. The paper will conclude by considering how this enables us to extract information about structures which would be otherwise impossible to determine by conventional archaeological recording techniques.

An open source solution for topographic surveys and GIS

Bibby David [1*], Ducke Benjamin [,2]
1 : Digital Archaeology, State Heritage Management; Baden-Württemberg/Germany (SHMBW/Germany)
www.denkmalpflege-bw.de
2 : Independent researcher and software developer (IR/SD)
Berlin
http://www.gvsigce.org
* : Corresponding author

Survey2gis (www.survey-tools.org) is a simple yet versatile, stand-alone software capable of producing GIS vector features from line-based text data produced with total stations or other topographic surveying devices. Input consists of one or more simple text files with one point measurement per line. Output consists of one or more 2D or 3D shapefiles containing points, lines and polygons in separate files, as well as associated attribute data in DBase format. Complex geometries, such as lines and polygons (incl. multiple parts and holes), are automatically assembled from simple point measurements by evaluating user-provided tags. The processing can be adapted to individual workflows and input data structures via a freely configurable parser. The software is user friendly, features verbose logging and has been optimised to support efficient field recording workflows. As opposed to many CAD-based solutions, it will produce topologically clean GIS data (incl. snapped polygon boundaries) in standard GIS formats, immediately suitable for subsequent data analysis. The software is completely free and distributed under an open source license. It runs under Windows, Mac OS X and Linux operating systems, using either the command line or a graphical user interface. A plug-in for direct use from within the open source desktop GIS gvSIG CE (http://gvsigce) exists as well.
The development of survey2gis has so far been sponsored by the state heritage management authorities of Baden-Württemberg/Germany.

Variable level of detail models from structure from motion: examples from Ravenna's urban archaeological architectures

Cipriani Luca,*, Fantini Filippo
Università di Bologna-Dipartimento di Architettura (UNIBO) Viale del Risorgimento 2, 40136 Bologna http://www.da.unibo.it/it/dipartimento/
* : Corresponding author

The historical centre of Ravenna has been UNESCO site since 1996 because of its outstanding universal value concerning mosaic art contained inside monuments, and also because those monuments in particular baptisteries and churches provide crucial evidences related to the evolution from Roman typologies into Late Antiquity buildings.
In the frame of an integrated and multidisciplinary research, a series of surveys were carried out in order to document some relevant examples of urban architectural archaeologies by means of interactive 3D digital models. Those multipurpose models are produced through an integrated pipeline aimed at producing «light» and reliable 3D representations for web sharing, documentation, architectural/archaeological investigation.
The methodology adopted starts with topographic survey of the monuments, followed by a photographic campaign with the focus of creating image based models from structure from motion. The large amounts of data obtained have been processed through a set of programs ranging from mesh processing to entertainment applications for the achievement of optimized assets.
Colour processing is a fundamental part of the workflow on the pictures used for the texturing of models since the representation quality of mosaic decoration, residual frescos, etc. is aimed to a scientific use. The integrated approach applied to the case study of Arian Baptistery has also the purpose to propose to the scientific community the possibility to use displaced subdivision surfaces (Catmull Clark subdivision scheme with displacement maps), characterized by a variable level of detail as an opportunity for solving the problem of how to manage large amounts of data from passive sensors.
The possibility to work on low-polygonal meshes instead of high definition scans (with abundant

occlusions difficult to integrate and complete) is one of the goal of this methodology even if it is based on different modelling tools and techniques which nowadays make complex and articulated the pipeline.
In any case the possibility to have at disposal “light” models with user’s defined level of detail and reliable colours for texturing, has the merit to merge together scientific and diffusion purposes inside only one model capable to be used in different representation tools (from real-time game engines to common rendering applications).

Counting sheep without falling asleep: using GIS to calculate the minimum number of skeletal elements (MNE) and other archaeozoological measures at Schöningen 13II-4 ?,Spear Horizon?.

Garcia-Moreno Alejandro, Hutson Jarod, Villaluenga Aritza, Turner Elaine, Gaudzinski- Windheuser Sabine
MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution (MONREPOS)
Schloss Monrepos 56567 Neuwied
http://web.rgzm.de/23.html?&L=1

In the last decades, the application of GIS and computing to Archaeology led to great developments within the discipline on a variety of issues, such as Spatial and Landscape Archaeology, Heritage Management, predictive modelling and Virtual Archaeology. Today, GIS capacities allow for a wider range of applications to Archaeology. The combination of database management and image or shape (vector) entities representation makes GIS a useful tool for archaeological collections documentation and management on a much finer scale. In this paper, we present a GIS-based methodology for calculating the minimum number of skeletal elements (MNE) and other archaeozoological measures, such as cut mark distribution and density. As a case study, we present a preliminary application to the Middle Pleistocene site of Schöningen 13II-4, the so-called «Spear Horizon.»
The archaeological site of Schöningen 13II-4, located in Lower Saxony, Germany, is considered one of the most significant Palaeolithic sites from Central Europe thanks to the discovery of a series of well-preserved wooden spears in association with a large assemblage of Middle Pleistocene fauna. While the exceptional preservation of faunal remains allows for extensive, high-resolution archaeozoological analyses, the thousands of identifiable skeletal elements impose difficulties for quantification, procedures that are often laborious.
Our methodology, based on the previous work of Marean and colleagues (Marean et al. 2001; Abe et al. 2002), uses of a series of digital templates, each one representing a specific bone. Every identifiable bone or bone fragment is drawn into a template, and once all fragments corresponding to the same bone and species have been drawn, they are added to a GIS and converted in a raster layer, where different features (e.g., bone fragment, cut mark, striation, etc.) are given a concrete value. Combining these layers by summing cells values allows for the calculation of archaeozoological abundances. This methodology yields a direct and more accurate calculation of MNE and provides a foundation for assessing other critical archaeozoological measures, such as cut mark distribution and density. The analysis and interpretation of these measures is essential for understanding Palaeolithic subsistence strategies and hominin behaviour.

A prototype software to navigate and measure a spherical panorama.

Valenti Graziano Mario, Romor Jessica*
Department of History, drawing and restoration of architecture (DSDRA) Università degli Studi di Roma “La Sapienza” Piazza Borghese 9 00186 Roma http://www.dsdra.it/
* : Corresponding author

Research shows the development of an experimental prototype software, designed for the representation and measurement of spherical panorama models, made with Ultra High Resolution Image.
The software has been developed directly by researchers to have reliable information on the changes that the image undergoes both UHR stages of organization in pyramid structure, and in

the subsequent stage of projection which is required by three-dimensional representation of the landscape.
The direct knowledge of the software procedures used made it possible to keep under control the gap between the metric measurements taken on the spherical panorama and those verified ? in situ' with other relevant instruments.
The navigation software of the panorama was also equipped with some special drawing functions, which had been considered necessary for studying the prospects walls.
In particular, there are two ways to build lines in three dimensional space: the first is to draw lines capturing point on the panorama projection sphere and then project them onto a plane defined at will; the second - only possible in stereoscopic vision - allowing instead to build lines drawing directly in three-dimensional space that is properly oriented.

Session 06

Modelling the Archaeological Process

(Friday 25th 8h30-13h Pantheon S15)

Chairs : Cesar Gonzalez-Perez 1, Patricia Martín-Rodilla,
Institute of Heritage Sciences, Spanish National Research Council (Incipit, CSIC)

Most of the efforts that are made in the realm of information technologies and archaeology are directly related to data, or information. However, information technologies have been also successful in organising and improving processes as well as data. Recent debates in the field
of archaeology suggest that the formal treatment of process, often neglected, is becoming more and more present in the research arena. European initiatives such as DARIAH and ARIADNE, as well as numerous academic works in recent CAA conferences and other venues, recommend that we start paying serious attention to the systematic study of how people do things in archaeology.
This session aims to address this by, precisely, analyzing how people do things in archaeology, i.e. by studying the processes, products, actors and related aspects of archaeological practice from an abstract viewpoint.
Major research areas that are welcome in the session include (but are not limited to) the following:

- What are the key "products" of archaeological work? What models, documents, ideas, artefacts, etc. are used, changed or generated, and how?
- What is the relationship between the "primary" material evidences and the "secondary" information records that are derived from them? How are the latter constructed from the former?
- Who are the key actors in the process of archaeological practice? What individuals,
- roles and groups act upon the material evidence and the information, and how?
- What kinds of processes, tasks and techniques are employed in archaeology?
- Who uses them and why?
- What kinds of tools are used in archaeology, and how do they mediate in the
- interaction between actors and things?
- What kind of workflow takes place within an archaeological project? What tasks occur before what others, and why? What products are used by whom? Who participates and who does not? What tools are used?
- Do we use methodologies in a prescriptive manner, in order to guide the work? Or do we use them descriptively, to report on what was done?
- What kinds of reasoning processes take place that use archaeological information as input and/or output?
- Do we improve our archaeological practices over time? How do we measure this "progress"?
- How do we build consensus decisions on top of archaeological evidence?

Please bear in mind that the session is intended to focus on the theoretical and analytical study of archaeological practice, rather than on the detailed account of specific case studies.
The session will be of interest to people who:Design documents, models and other de-

liverables or products of the archaeological work are highly specialized in the use of a particular archaeological tool or technique. Need to assess the impact of tool or technique adoption on the overall results of their work. Make decisions about methodological choices, either small- or large-scale.
Are responsible for archaeological or inter-disciplinary teams who will need to work together in complex projects sharing a common methodology. Are interested in the mechanisms by which meaning is constructed in archaeology, either individually or collectively.

From understanding scholarly practice to defining an ontology of digital methods: the case for archaeology

Dallas Costis [1,2], Constantopoulos Panos [,2]
1 : Faculty of Information, University of Toronto (iSchool, UofT)
140, St George street Toronto ON M5S 3G6
http://current.ischool.utoronto.ca
2 : Digital Curation Unit, IMIS/Athena Research Centre (DCU-ARC)
Artemidos 6 & Epidavrou GR-151 25 Maroussi
http://www.dcu.gr

This paper presents the methodological and theoretical framework as well as early results of the work conducted in the Digital Curation Unit, IMIS-Athena Research Centre towards developing an evidence-based account of scholarly information practices in the field of archaeology, and, on this basis, defining a middle and lower ontology of digital research methods used in archaeological work in the domains of academic scholarship, archaeological resource management, and public communication of knowledge on the material past. The work draws from important prior developments in the field of cultural heritage informatics and digital humanities, including work on a humanities digital methods taxonomy by AHDS, OUCS and DARIAH-DE, the Scholarly Research Activity Model developed by DCU in the context of the EHRI project, the CIDOC CRM cultural heritage ontology. In particular, it links to and reflects on the work of the DARIAH-EU working group on "Understanding and expanding scholarly practice" (VCC2, Task 2), and its collaboration with the NeDiMAH «Digital methods ontology » WG, as well of the recently formed «Archaeological digital methods and research practices » SIG of ARIADNE.

The scope of our research on formalizing archaeological process encompasses both non-digital archaeological information practice, and work that depends on the appraisal, creation, curation and use of digital archaeological data, resources and tools. It seeks to include a broad spectrum of approaches, including quantitative and qualitative analysis, idiographic and nomothetic approaches, and phenomenological, contextual and positivist work. It also seeks to cover methods of information seeking, use and modification of digital resources used in archaeological research practice, and research methods proper from the initiation of a research field, idea or conjecture, to publication and review by the scholarly community. In addition, it also seeks to model practices related to academic teaching, and to supporting the public understanding of archaeological knowledge.

To achieve the goals of this project, we adopted an evidence-based, inductive ontology engineering approach, based on combining the outcomes of prior classifications on archaeological research methods with elicitation of knowledge from experts. Ontology definition and development consists of successive steps, ranging from appraisal of general ontologies and domain models relevant to scholarly work, study of the information seeking, behaviour and use literature, primary research based on original questionnaire, case studies and focus groups, as well as of identifications, descriptions and relations between concepts included in existing digital research methods taxonomies; conceptualization and formalization of abstract entities, and of their properties and relations, in the form of a middle ontology layer; development of a lower ontology layer, by re-expressing systematically the archaeological methods, research problems, types of information objects, and concepts found in earlier work and by integrating the outcomeof empirical research. The intended outcome of the work presented here is to provide archaeologists with a useful set of web services allowing semantic access to research methods useful for archaeological research broadly defined, as well as to the research contexts, kinds of archaeological evidence, digital tools, and actual projects in which these methods find use.

Authenticity and Functionality at Digital Archaeological Data

Goeldner Reiner [1], Bibby David ,[2]
1 : Archaeological Heritage Office Saxony / Landesamt fuer Archaeologie Sachsen (LfA Sachsen)
Zur Wetterwarte 7, 01109 Dresden
http://www.lfa.sachsen.de
2 : Digital Archaeology, State Heritage Management; Baden-Württemberg/Germany (SHMBW/Germany)
www.denkmalpflege-bw.de

There is no way around it. Archaeological information has to be archived in digital format. Excavation reports, context descriptions, photo documentation, 3D scans of excavation areas and finds and many more key products of archaeological process are created digitally with increased regularity. The data is stored increasingly less often as analogue copy on paper or film in filing cabinets, boxes and sleeves - indeed, for some data it is impossible, difficult or even makes no sense to create analogue copies. Digital data provide many more possibilities and more functionality then analogue data. But how far can we trust digital data? Are they "true"? Are they still authentic after years and years in the archive?
There are some problematic aspects using the classical concept of "authenticity" in the digital domain:

- A digital object can be cloned - so which one is the authentic original?
- Do changed system environments and changed presentation software cause loss of authenticity?
- What about data migration to newer versions of data formats caused by very short life cycles of digital systems?
- Digital documents can be very complex, not only supporting viewing and reading. What about the preservation of functional features?

Clearly, an unspecified absolute authenticity cannot be achieved in archiving digital data. But what can be achieved? The poster discusses some thoughts and concepts on digital authenticity and illustrates some aspects, that may help to preserve digital authenticity over years. The aim of this poster is to attract attention to this as yet neglected theme.

Modelling the building of a funerary space over time: issues and limitations The example of Passy-type cemeteries (France, 5th mill. BC)

Pillot Lucile [1*], Saligny Laure ,[2*]
1 : Archeologie, Terre, Histoire, Sociétés (ARTeHIS)
MIN CULTUREUniversité de BourgogneCNRS : UMR6298
6, Bd. Gabriel 21000 Dijon www.artehis-cnrs.fr
2 : Maison des Sciences de l'Homme de Dijon (MSHD)
Université de BourgogneCNRS : USR3511
Université de Bourgogne - Esplanade Erasme - BP 26611 - 21066 Dijon Cedex
* : Corresponding author

This paper aims to criticize a modelling approach made on archaeological data. We want to show the contribution of this technique for understanding the construction of funeral spaces, but also its limitations. We studied one of the first monumental events in Western Europe (Passy-type necropolises ? Paris Basin France, 4500 BC). The stratigraphic study and the architectural restitution of monuments bring out the hypothesis of a well-codified building project. Indeed, it is likely that a same architectural module has been repeated several times over time, explaining that some of these monuments have an impressive length (> 300 meters). This analysis shows that building module of ~ 25 m can be repeatedly built in space. These modules are added to the first stage of building (a mound limited by a ditch). This building-module has been likely a sustainable concept over time. The space seems built and structured according to this architectural concept.
This phenomenon was modelled in order to understand how the funerary space was perceived, structured and occupied. The result of this study is to lead to a breakdown of each monument in several distinct phases of elongation. We must characterize the different monumental phases by a lot of descriptors. For example, we describe some building methods which are identified due to stratigraphic and planimetric analysis of monuments. Moreover, variability of dimensions and orientations of each phase is also described. These descriptors are then used as part of the modelling of the evolution of architectural monuments. This model uses the method of informative

modelling developed to describe the historical architectures which have widely been transformed over time. This method is based on InfoVis procedures (Information visualization). It is used as a medium of research and information visualization. It allows the production of visual representations of data, which have interest in acquiring knowledge about the internal structure of these data and their intrinsic characteristics. Each phase is decomposed into different forms that are represented by symbols, which are then assembled. The use of this method allows the comparison of different phases monumental. By modelling we can study the monumental phenomenon at two stages: The building process of monumental architectures (observation of similar patterns which reflect a building standard. observation of particular and specific patterns). The building process of cemetery space (observation of «rhythms» through the construction of monuments in space. observation of an hypothetical scenario of the building and structuration of the cemetery space through time). Our paper will focus on the conceptual modelling, as support of the understanding of the neolithic cemeteries. Nevertheless, a return on this application allows to see his operability on the archaeological process. The contribution of this technique seems very convincing at the scale of a site, and even at the entire corpus of cemeteries. But, it have limitations (i.e. when we want apply to another corpus):
The need of a homogeneous description of dataset with exhaustive descriptors Need to dissect each data Modelling effort for the establishment of scenarios where uncertainty remains.

Process and appropriation in the digitalisation of archaeological archives and archiving practices

Huvila Isto [1,2]
1 : Department of ALM, Uppsala University (UU)
Box 256, SE-751 05 Uppsala
http://www.abm.uu.se/
2 : School of Business and Economics, Åbo Akademi University (ÅAU)
Fänriksgatan 3B, 20500 Åbo
http://www.abo.fi/hhaa

In contrast to the considerable investments in creating technologies, infrastructures and standards for digitalisation, preservation and dissemination of archaeological heritage, there is still only little indepth research on the consequences, opportunities and implications of digitalisation to archaeological work, the emergence of archaeological knowledge and how it is used by diverse stakeholder groups from ordinary citizens to researchers, museum professionals, landowners and property developers. Apart from the excavating or prospecting archaeologist with a personal experience of a particular site, the principal source of information for other stakeholders is the 'archaeological archive'. There are on-going national and international (e.g. ARCHES-project and the archives workgroup of European Archaeologiae Consilium) initiatives to standardise archiving practices in archaeology and a relative long albeit somewhat slender line of theoretical and practice oriented research on the topic (e.g., Merriman and Swain, 1999; Swain, 2006; Brown, 2011; Lucas, 2010). What is lacking, but would support the practical work and to contextualise earlier theoretical openings, is a broader empirical understanding of the everyday premises of how archaeological archives are managed in practice and how archiving is and is not related to the development of archaeological information systems, databases and archaeological information management practices.
The presentation reports of a Swedish interview study that explicates and maps the work practices and perspectives of the primary stakeholders of archaeological archives. The analysis of the interview records show that there are multiple technical, legislative, conceptual and structural problems that complicate the building, management and use of archaeological archives. Privatisation of archaeological fieldwork, the diversity of involved actors, and often diverging practical and statutory requiments and responsibilities of preserving different types of materials. Further, the digitisation and growth of the amount documentation material has brought demands for effective means of capturing and preserving new forms of data, but also a need to reconsider the concepts of «archaeological archive» and »archaeological data», and their functions in archaeology and the society as a whole. The analysis shows that the different actors appropriate (as e.g., in Ramiller and Chiasson, 2008; Twidale et al., 2008) rather than share or even translate the ideas of archaeological information process, archaeological data and archives from a widely

different premises to fit their urgent priorities. The findings have several both theoretical and practical implication to the mapping of the digitalising archaeological information processes from the perspectives of different stakeholder groups, standardisation and documentation of current practices and clearer definition of responsibilities, explicit allocation of budgets for archival tasks and the explicit acknowledgement of the diversity of how archaeological information is produced, archived and used.

The recording of preventive archaeology data from test trenching by the National Institute for Preventive Archaeological Research (Inrap ? France) in the Rhône Alpes area : elements of archaeological metrology

Vachon Véronique, Segain Ellébore*, Moulin Bertrand*
Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr
* : Corresponding author

In the particular framework of preventive archaeology in France, our aim is to evaluate archaeological potentials by carrying out systematic surveys on lands concerned by development projects. The results of these evaluations will allow the archaeological state departments to consider whether an exhaustive excavation should be carried out or not.
In this context, various internal reflections led us to (i) test theoretical sampling strategies to be set up on sites and to (ii) establish an experimental operating chain or protocol for archaeological data to be recorded by Inrap teams in Rhône-Alpes area.
This approach aims to record and archive data in consistent archaeological stratigraphic context, to be adapted at a regional scale through field dataset recording, later integrated into an archaeological database (BDA) using PC-tablet, and topographic - GIS measurements.
The exploratory potential of the GIS tool and its ability to produce various analytical maps in a same space are used to assess archaeological potential of fields and helps with site analysis. This presentation exposes in detail the operational scheme and actors from the test trenching strategy to the conception of the archaeological database up to the final restitution of the spatial information, as well as the type of tools used.

Session 07

Ontologies and standards for improving interoperability of archaeological data: from models towards practical experiences in various contexts

(Thursday 24th 8h30-19h Pantheon S6)

Chairs : Anne-Violaine Szabados [1, 2], Katell Briatte [3],
Maria Emilia Masci [4], Christophe Tufféry[5, 6],
1 : Archéologies et Sciences de l'Antiquité (ArScAn)
CNRS : UMR7041, MAE-Maison René Ginouvès. NANTERRE - France
2 : Fondation internationale pour le Lexicon Iconographicum Mythologiae Classicae (LIMC)
MAE-Maison René Ginouvès. NANTERRE - France
3 : DGP – DSIP Ministère de la Culture et de la Communication
4 : Scuola Normale Superiore di Pisa (SNS)
5 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
6 : Cités, Territoires, Environnement et Sociétés (CITERES) CNRS : UMR7324
, Université François Rabelais - Tours

The documentation and data of archaeology - planned or preventive - and of cultural heritage, lead to the need for technical and semantic interoperability. The development and the use of ontologies, standards and languages devoted to archaeology intend to facilitate the integration, exchange and sustainability of cultural information. Some researchers have explored these approaches during the previous CAA (Perth 2013 sessions 4, 5 and 6). Archaeology, and its documentation and data, are multidisciplinary and heterogeneous. In order to make the best use of conceptual reference models and their implementation in standards, a balance must be found between general approaches, which allow promote interdisciplinary exchanges, and specialized ones that preserve the unique aspects of archaeological research (contextualization, uncertainty, incompleteness, evolution analysis, review of dating, different spatial scales, subjectivity methods, observation and / or interpretation, allocation, etc.). The use of ontologies and standards for treatment of cultural heritage information (CIDOC-CRM / ISO 21127; Europeana Data Model ...), spatial information (INSPIRE, ISO 19115, GML, GeoSPARQL ...) or languages and thesauri (OWL, SKOS ...) already has a proven basis but it may be insufficient. During their implementation in recording, study and management applications using archaeological data, various standards and conceptual models should ensure that archaeologists can choose the level of representation of information, from operational to continental scales. To encourage the use by cultural heritage specialists of languages and construction principles of ontologies, works specific to their domains have to be shown. This will involve presenting standards, and models, but also tools developed on recognized standards already adopted by the scientific community and cultural institutions. The use and reuse of archaeological data encoded in a standardized way, and metadata widely available also raises several points of discussion: the integrity of archaeological data, the risk of misinterpretation, the quality of recorded data, the need for labeling data, the level of specialization in data description and levels of generality imposed by interoperability, etc. The purpose of using ontologies and standards is to enable interoperability and a large but controlled diffusion of archaeological and cultural heritage data in the general context

of wide diffusion of big and open data.
The session’s goal is to provide practical use cases of ontologies and standards to address these issues. Theoretical aspects too difficult to be transposed will be avoided. Papers may focus on the more practical issues in the construction of ontologies, models and applications, from experience feedback analyzed, and available tools built on such approaches. Finally, communications will enable the various actors of archaeological research and cultural heritage to identify and evaluate, what can be used if they wish to engage in the use of standards for interoperability and wide dissemination of their data.

The Digital Archaeological Workflow: A Case Study from Sweden

Smith Marcus
Swedish National Heritage Board (RAÄ)
Box 1114 621 22 Visby
http://www.raa.se/

The Digital Archaeological Workflow (DAP) is a programme of work being carried out at the Information Development Unit at the Swedish National Heritage Board, in partnership with the major Swedish archaeological stakeholders. The programme aims to streamline the flow of archaeological data (and its associated metadata) between different actors in the Swedish archaeological process, and to ensure that this data is preserved in a sustainable and accessible manner. It aims to address a number of problems which have hampered the practice of archaeology in Sweden for some time, but which have now started to become more acute as digital technology saturates the processes involved.

There is no centralised register of archaeological fieldwork in Sweden, making it difficult not only to keep track of what is going on where, but also to know what fieldwork ? if any ? has taken place in connection to a particular site in the national sites and monuments record. Sweden also has no central digital archive for the storage of either archaeological fieldwork data or reports; as such records are now produced digitally, valuable archaeological data is thus increasingly at risk of being lost.

Furthermore, despite the fact that almost all of the data and administrative metadata surrounding archaeological work are digital-born, they are still handled according to analogue paradigms, particularly when information must be shared between different organisations. Sources of archaeological data which are currently made available digitally by various national and local bodies are not typically linked together. This leads to inefficiencies in information transfer, duplication of data and effort, and to information describing the same 'objects' being stored in different systems within different organisations.

The DAP programme intends to address these problems over the course of a five-year period, using standardised platform-agnostic data formats and protocols to streamline information transfer between organisations, by releasing a series of open taxonomies and ontologies for common Swedish archaeological terms and concepts on the semantic web in order to facilitate data interoperability, and by creating a secure digital repository both for the raw data and reports arising from fieldwork and research. We aim to make this information freely available as linked open data.

Our overall mapping of the current Swedish archaeological process is complete (although some details remain) and we are currently working on a conceptual model on which our future information architecture will be based. In parallell, we are also working to translate and release our existing (analogue) archaeological taxonomies to SKOS and release them as linked open data authorities, beginning with the Swedish monuments types thesaurus.

This paper will describe the work that we have accomplished so far and the progress we have made, as well as our plans for the rest of the programme. In particular, it will focus on our mapping of the existing archaeological processes in place in Sweden and our plans to digitise them, our ongoing translation of existing controlled vocabularies to SKOS, and our use of the semantic web as a fundamental method.

Find the balance - Modelling aspects in Archaeological Information Systems

Schwarzbach Frank [1*], Schäfer Felix F. [,2*], Schulze Alexander [,3*]
1 : Dresden University of Applied Sciences
2 : German Archaeological Institute
3 : Brandenburg University of Technology
* : Corresponding author

With the conception and the design of (archaeological) information systems, the question arises whether a presently standardised application schema (e.g. CIDOC-CRM) can be utilised, includ-

ing the associated implementation specifications. The use of such a scheme has a number of advantages: savings of analysis and modelling effort, subsequent use of the available software and a high level of semantic and syntactic interoperability. In other cases, an existing conceptual scheme cannot be used as a fall back option. Traditionally a project-specified data model will then be developed and described in a formalized manner (today mostly with UML) in an often protracted, complex process. A highly specialised but more inflexible data model also arises as a result of this analysis.
Independent of whether a standard is used for conceptual modelling, this approach requires that before the implementation of the information system, an agreement is achieved regarding the professional view on the «Universe of Discourse» and its scope. However, this pre-condition is not met if the information system needs to be flexibly used for numerous projects in different areas of application and for user groups with non-harmonised professional perspectives. This situation typically occurs if the information system is part of the service offer in an infrastructure, e.g. for geographic data or archaeological research data. Then a solution will be needed that is, on the one hand, sufficiently general, generic and thereby flexible but, on the other hand, supports the domain-specific standards with the aim of an interoperable exchange of information.
This presentation will firstly contrast properties of specialised and generic models. In doing so, conditions, areas of application, modelling principles and effects on the operation of the information system will be discussed. Subsequently, specific approaches of an archaeological research data infrastructure project (OpenInfRA) and of INSPIRE (Infrastructure for Spatial Information in the European Community) will be explained. Alongside modelling details, this presentation will expand on the effects of the generic approach on the associated database and XML-scheme as well as the application. Finally the consideration of relevant standards will be presented.

linkedARC.net: addressing the standards question in archaeological digital data management using Linked Open Data

Lynam Frank
Trinity College Dublin (TRINITY COLLEGE DUBLIN) Trinity College Dublin, College Green, Dublin 2, Ireland http://www.tcd.ie/

The employment of standards by the archaeological digital data management community is by no means the logical and uncontentious design decision that it might at first appear. Whether one chooses to side with the pro or anti standards camps says a lot about their fundamental beliefs on how archaeology should be practiced. On the pro side, standards promise to greatly ease the load of the archaeologist who seeks out broad-ranging generalities and patterns within the material record of the past. For this group, the archaeological method exists within the positivist scientific space; data is fed into processes and truths are produced at the other end. On the other side of the argument, advocates of the postmodernist archaeological method eschew the very constraint and simplicity that the pro-standards camp craves. Insight, for this second group, can only be arrived at through a process of informed contextual and specific analysis; what works for one material-set by definition cannot explain and provide structure for the material of another point in space or time. Therefore, the standard for the postprocessualist is a potentially deterministic methodological tool that is not to be trusted and one that should be avoided as much as is practically possible.
As an archaeologist, I have struggled with the implications of this methodological reality since entering the discipline. At a philosophical level, I see myself as a hermeneutic archaeologist of the Hodder-Shanks-Tilley school of thought and yet as an every-day practitioner of archaeological digital data management, I am drawn to the structure and clarity that the standard promises, and I would suspect that this internal dilemma is not unique to myself. This paper presents a summary of my digital data management investigations over the last number of years within the context of this debate. Specifically, I am interested in how the principles of Linked Open Data might be implemented to alleviate some of these tensions.
linkedARC.net is a LOD-compliant server architecture that I have designed to implement the theoretical positions generated by my research. Data is housed within a relational database core and is exposed to the digital world as a part of the greater data mesh that we know as the Semantic Web. linkedARC.net's data is semantically transparent, being structured by public ontologies. A

web app frontend consumes and contributes to the data housed within the linkedARC.net core. The test dataset for the project comes from the excavation and post-excavation records from Priniatikos Pyrgos, a highly complex multi-period site in East Crete. The challenge of designing the web app and the underlying server architecture has been manifest in the provision of a level of structure that the complexity of the data necessitates, while also allowing for the interpretive scope demanded by the researchers active on the project. As such, it is a very practical example of an implementation of cutting edge LOD technology within archaeology that has required a constant attention to the philosophical questions that surround this space.

Dykes of standards supporting polders of data: the practices used in the Netherlands for making archaeological data available and accessible

Gilissen Valentijn
Data Archiving and Networked Services (DANS) Postbus 93067 2509 AB Den Haag http://www.dans.knaw.nl/

In the Netherlands, the archiving and publication of archaeological research data has led to the establishment of EDNA, the e-Depot for Dutch Archaeology http://www.edna.nl/, accommodated at DANS (Data Archiving and Networked Services) http://dans.knaw.nl/en.
EDNA is a collaboration between DANS and the Cultural Heritage Agency (RCE). EDNA was set up as a project within the broader organisation of DANS. DANS is an institute of the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Organisation for Scientific Research (NWO). DANS serves as the archive for scientific data. Among other services, DANS maintains its on-line archiving system EASY (Electronic Archiving System, https://easy.dans.knaw.nl) which allows researchers to deposit and describe their own datasets.
The mission of DANS is to enhance permanent access to digital research data. DANS stimulates cooperation between data producers and users and does research into long- term accessibility. By participating in international projects such as CARARE and ARIADNE, DANS is continuously improving on the options for finding, accessing and re-using (archaeological) data. The existing infrastructure of the e-depot for Dutch Archaeology allows for sharing of good practices such as long-term preservation, data organisation and data dissemination for accessibility.
Agreements in order to fulfil this mission have been laid down in the KNA: the quality standard for Dutch archaeology. This is not the only standard which servers to structure and strengthen the Dutch data flow. Datasets are described in EASY using the Qualified Dublin Core metadata standard. The archiving process involves file format migration to preferred formats according to DANS policy with attention to file format aspects for long-term preservation and long-term accessibility. DANS continuously strives for international certification, by means of applying the (self-) audit and assessment of the TRAC (Trusted Repositories Audit & Certification) and by following the guidelines of the DSA (Data Seal of Approval). Additionally, DANS participates in the implementation of a Dutch national protocol of exchanging excavation data.
These standards and practices make for the foundations of a successful running service in which durable archiving and unlocking of all digital documentation of the archaeological research is ensured. By 2013, EASY provides online access to more than 20,000 datasets: 17,000 archaeological reports and 3,000 large datasets consisting of data of excavations and explorations (photos, GIS, data-tables, drawings). Both the research descriptions and all data can be downloaded via the online archiving system EASY.

Integration of Archaeological Datasets Through the Gradual Refinement of Models

Gonzalez-Perez Cesar, Martín-Rodilla Patricia
Institute of Heritage Sciences, Spanish National Research Council (Incipit, CSIC)
http://www.incipit.csic.es

The problem of integrating disparate archaeological datasets has received a great deal of attention lately. This is a relevant problem, and we do not dispute the advantages of being able to query and process information that is uniformly accessed from a wide array of distinct sources. However, we observe that most, if not all, of the approaches to integrate archaeological datasets comprise extremely ad hoc efforts that suffer from one of the following two issues, and sometimes both. The first issue that we have observed is that, in order to integrate different datasets, a new, distinct model capable of catering for all of them is created. This results in the paradox of generating yet one more unique, non-standard view on the data. The second issue that we have observed is that, when carrying out the integration, individual datasets are mapped to a reference model such as CIDOC CRM [1], bridging the large gap that exists between the specific implementation (often at the database level) and the conceptual expression, which is costly and error prone.

In this paper we propose an alternative approach to archaeological dataset integration, which introduces the notion of the gradual refinement of models. In order to integrate a collection of disparate datasets, we propose that a conceptual model of each dataset is first created; these models must be extensions of a given abstract reference model such as CHARM [2], so that they capture the peculiarities of each dataset, but at the same time they share a common conceptual framework. Then, these particular models are examined for similarities, and more abstract models are generalised from those that are the closest. This can be repeated as necessary until, eventually, a hierarchy of models is finally obtained, and a number of views on the data are generated at different levels of abstraction, each one encompassing more datasets the more abstract it is.

The paper will illustrate this approach through the integration of three real datasets: a subset of the SIA+, the 20-year old, half-million object dataset that Incipit CSIC uses as their regular archaeological database; the «Camiño Primitivo» database, a purpose-built store also by Incipit CSIC for the cataloguing of sites and associated ethnographic elements along the Way of St. James in Spain; and the «Town and Country in Roman Essex» dataset offered by the Archaeological Data Service of the University of York, a Roman settlements database from Essex in the UK. A particular model will be presented for each of the three datasets. Then an abstract particular model will be generalized from the two datasets belonging to Incipit CSIC, since it is assumed that, having been created within the same organisation, they should share a significant number of conceptual commonalities. Integrated querying and information processing will be demonstrated at the top level of abstraction, involving the three datasets, as well as at an intermediate level of abstraction, which involves only the two datasets at Incipit CSIC but provides much richer and more specific semantics.

Building comprehensive management systems for cultural ? historical information

Bekiari Chryssoula [1*], Doerr Martin ,[2], Agelakis Dimitris ,[3], Karagianni Flora ,[4]

1 : Institute of Computer Science, Foundation for Research and Technology - Hellas (FORTH-ICS)
N. Plastira 100, Vassilika Voyton, GR 700-13, Heraklion, Crete

2 : Institute of Computer Science, Foundation for Research and Technology - Hellas (FORTH-ICS)
N. Plastira 100, Vassilika Voyton, GR-700 13 Heraklion, Crete, Greece
www.ics.forth.gr/isl

3 : Institute of Computer Science, Foundation for Research and Technology - Hellas (FORTH-ICS)
N. Plastira 100, Vassilika Voyton, Heraklion GR-700 13, Greece

4 : European Centre for Byzantine and Post-Byzantine Monuments (EKBMM)
Leoforos Stratou 2, 546 40, Thessaloniki, Greece
www.ekbmm.gr

* : Corresponding author

Nowadays the digital scientific documentation of archaeological sites, places and museum objects in digital form is a reality. Still a very small part of the basic information is exploited by the public. The reasons are many. One of them is based on the fact that in most digital repositories about museum objects and standing monuments, the basic scientific information stored in them is only a fraction of the Information found in old reports, catalogues, photos and grey literature. For instance, a dairy tells parts of the day to day story of an excavation. A restoration study of a historical building usually contains the archaeologist’s or architect’s interpretation of the building expressed as a story based on the restored structures. A lot of human effort is needed in order this information to be documented and stored in digital repositories. But even if such an effort is achieved, there is a lack of information systems to support in a uniform, transparent and consistent way the lifecycle of information found, produced and used by professionals, scholars and interested public, which deals with all aspects of human history and activity, including products, art objects,

science, thoughts and ideas. The «classical» cultural information systems mainly address the collection management task. They provide functions well defined by various standards (Spectrum MDA, Midas, etc..) but they don't support any particular presentation and « telling story» concept. They are normally based on RDBMS, and there are dozen commercial providers.
This paper describes the requirements for data organization and management for knowledge collection and promotion along with methods of user interaction, and presents a system design and functions that supports the whole life cycle of information and knowledge including the primary recording and scientific documentation of cultural objects and sites as well as data interlinking, presentation and the knowledge enhancement.
Practical considerations are presented about the data models and procedures which are based on CIDOC CRM and other standards proposed by semantic web for collection, interlinking, presentation and enhancement of knowledge in a transparent. Also workflows requirements for administrational and scholarly processes are discussed.
The proposed guidelines and considerations have been evaluated and verified by domain experts during the implementation of a comprehensive management system about Byzantine Culture. This information system has been implemented by FORTH and has been installed in European Centre for Byzantine and Post Byzantine monuments, in Byzantine Museum in Thessaloniki and in Athens. It supports the scientific documentation for byzantine monuments and provides digital content based in archives, diaries and publications for promoting Byzantine culture via interactive information services. The e-services it offers are designed to inform teachers, researchers, schoolchildren and interested members of the general public about monuments, personalities, historical events, achievements and aspects of daily life in Byzantium. All site content is viewable in both English and Greek.

To Boldly or Bravely Go? Experiences of using Semantic Technologies for Archaeological Resources

May Keith
English Heritage (& University of South Wales) (EH)
Fort Cumberland, Fort Cumberland Road, Portsmouth. PO4 9LD

Research on the uses of Semantic Technologies for archaeological data presentation, search and reporting has advanced considerably in recent years. This has included developing the technologies for semantically enhanced cross-searching enabled by using the CIDOC CRM ontology with archaeological extensions such as the CRM-EH developed at English Heritage. This work, in particular during the Semantic Technologies for Archaeological Resources project (STAR project http://hypermedia.research.southwales.ac.uk/kos/star/), focused on some of the most common systems for archaeological recording in the UK, each using a version of the Single Context Recording methodology introduced by the Museum of London in the early 1990s. In addition this work was able to incorporate information in the semantic cross-search from free text descriptions derived from a corpus of archaeological reports (oasis.ac.uk/) that had been mapped to the same common ontologies, using Natural Language Processing techniques.
At a conceptual level much of the archaeological data recorded using the single context recording methodology are inter-related by identifying and documenting single units of stratigraphic material as recognised and interpreted by the record maker
Underlying the work of mapping 'single context' data from different archaeological database systems to a common ontology there may be even more fundamental questions about how to share data derived using different archaeological recording methodologies.
One of the associated issues that emerged from the STAR work was the need to improve the syntactic integrity of archaeological data sets to make best use of the semantic technologies for interoperability. Practical work in developing the use of the W3C SKOS standard for incorporating controlled terminologies with the CIDOC CRM in the STELLAR project (http:// hypermedia.research.southwales.ac.uk/kos/stellar/) and subsequent SENESCHAL project (http://hypermedia.research.southwales.ac.uk/kos/SENESCHAL/), has led to the development of SKOS based versions of national heritage domain controlled vocabularies and the publishing of these as Linked Open Data via the HeritageData.org web site (http://www.heritagedata.org/ blog/).
This paper will be based upon practical experiences of modelling the single context recording

system at English Heritage and mapping it to other 'single context' based systems. It will also present recent work on identifying conceptual commonalities that may exist in different archaeological recording methodologies, whether 'single context recording' or otherwise, along with practical challenges based on experiences of trying to integrate, or simply search across, data from different archaeological recording systems. In addition it will introduce the work to date on developing Heritagedata.org and suggest opportunities for sharing and aligning further archaeological vocabularies using SKOS and Linked Open Data technologies.

Aligning the Academy with the Cultural Heritage Sector through the CIDOC CRM and Semantic Web technology.

Oldman Dominic [1*], Rahtz Sebastian ,[2*]
1 : British Museum (BM)
www.britishmuseum.org
2 : IT Services, University of Oxford
http://www.oucs.ox.ac.uk/
* : Corresponding author

CLAROS[1] is a research initiative led by the University of Oxford's e-Research Centre, and funded by a small grant from Oxford's Fell Fund, that demonstrates the aggregation of nine European datasets, largely relating to Greek and Roman antiquity, by building a semantic web implementation based on use of the CIDOC CRM ontology. The aim of CLAROS was to provide a platform for experimentation with interfaces for world art, innovative searching techniques such as shape analysis, and testing RDF databases.
The ResearchSpace[2] project is based at the British Museum, London and is funded by the Andrew W. Mellon Foundation. Its aim is to create a shared infrastructure and service that supports collaborative research. This includes the development of communication and research tools, access to digital methods, and the harmonisation of data to create a knowledge environment akin to a modern day Digital Wunderkammer, transforming individual institutional knowledge into a network of connections and meanings that extend the questions that we can ask and the research directions that are available. Much of this data is likely to be available for general reuse as Linked Open Data.
The CLAROS project established the credentials of the CIDOC CRM standard as a semantic framework that can harmonise data from many different institutions while providing a richer environment (when compared to its digital sources) in which to explore and research cultural heritage data. Together with the ResearchSpace project this initial work is set to expand to include broader and denser datasets and crucially provide greater interactivity to support sophisticated research methods. With improvements in semantic database technology, greater cooperation between the academy and the cultural heritage sector and the maturity of the CIDOC CRM ontology, a more effective realisation of the research paradigm can be established. This can align discovery, argument and belief generated by research projects with the information systems of cultural heritage institutions for the benefit of future research, improved institutional knowledge resources and a radical improvement of engagement with the public using rich contextual information. This dynamic improves the relevancy of both Hhumanities research and the cultural heritage sector as a whole.
The software already developed in the CLAROS and the ResearchSpace initiatives can be used as demonstrators of the potential of the CIDOC CRM and provide important reference points for engaging both academic research and cultural heritage communities. By showing how the boundaries of computer interpretation and data modelling are being pushed by semantic technology and intelligent ontology, a cross disciplinary dialogue can be established with a range of experts including archaeologists, anthropologists and art historians, to generate new ideas for the collaborative exploitation of this technology.
[1] http://www.clarosnet.org
[2] http://www.researchspace.org/?

Making the links to Portable Antiquities Scheme data

Pett Daniel [1,2]
1 : The British Museum (BM)
Great Russell Street, London, WC1B 3DG
http://britishmuseum.org
2 : Portable Antiquities Scheme (PAS)
The British Museum, Great Russell Street, London WC1B 3DG
http://finds.org.uk

The Portable Antiquities Scheme (PAS) database (http://finds.org.uk) now holds details for over 900,000 archaeological objects found by the general public within England and Wales. These objects are richly documented through over 200 metadata fields, which provide a glorious opportunity for the creation of linked archaeological data. This paper will discuss how the author has been inspired by various projects around the Globe in the last two years to enable data to be mapped to the CIDOC-CRM and linked to a wide array of ontologies and resources and to supply our data to high profile academic projects such as Pelagios (http://pelagios-project.blogspot.co.uk/). This paper will discuss the ontological choices made, the pros and cons of the chosen and the methods employed to enable their integration (for example the use of OpenRefine). It will then move in to discuss exemplars within the field that have proved to be an inspiration for the author. Firstly, lessons have been learnt from the Mellon funded ResearchSpace project (http://researchspace.org) with Portable Antiquities data being mapped in a similar fashion to British Museum CIDOC-CRM rdf. Secondly, the author was inspired by assembled intellectual geniuses that came together for the Linked Ancient World Data Institute in 2012 (ISAW, New York University) and 2013 (Drew University, New Jersey) to discuss linking Classical world resources together to provide a richer foundation for academic research. This paper will show how the PAS data has been linked to a wide variety of resources such as Pleiades (http://pleiades.stoa.org), the Ordnance Survey (http;//data.ordnancesurvey.co.uk), the British Museum (http://collection.britishmuseum.org), dbpedia (http://dbpedia.org) and Nomisma (http://nomisma.org). This paper will also examine the technological choices that have been made for delivering and producing this RDF dataset (for example via Apache SOLR indexes and the use of XSLT) to a wider audience, how Linked Data is consumed (through the use of SPARQL and opensource software packages such as EasyRDF) within the PAS website for enriched pages and the software used for implementing a triple store. It will attempt to demonstrate that this process was not too difficult and provide a real world example of how to emulate it for other small archaeological finds datasets.

The interoperability of the ArSol database (Soil Archives): reflections and feedbacks experiences on the use of the CIDOC-CRM ontology and the integration of thesauri

Le Goff Emeline [1*], Marlet Olivier [2*], Rodier Xavier [2*], Husi Philippe [2*]
1 : UMR 7324 CITERES (CITERES)
CNRSUniversité François Rabelais - Tours
MSH Val de Loire Université François Rabelais BP60449 37204 Tours cedex 03 http://citeres.univ-tours.fr
2 : UMR7324 CITERES (UMR7324 CITERES-LAT)
Université François Rabelais - ToursCNRS
* : Corresponding author

The ArSol system (Soil Archives) was developed by the «Archéologie et Territoires» Laboratory (CNRS - Tours University) for processing archaeological data. It can be used for all stratigraphic excavations and has the dual purpose of data management and research. Since its elaboration in 1990, access to data constituted one of the priorities. The software used for the DataBase Management System (DBMS) is 4th Dimension TM (4D). It was chosen because it enables a client/server and multi-platform application and can be accessed via the internet.
Joining the trend of exchanges of data and interoperability of applications, ArSol will become a system in compliance with computing standards, both in its technical aspects (ontology) and semantic aspects (thesaurus). In this perspective, we are a partner of the MASA consortium (Memory of the archaeologists and the archaeological sites) which aims towards a unified access to digitized corpuses, and is interested in the CIDOC-CRM (Conceptual Reference Model of the International Committee of Documentation).

In this context, the complexity of ArSol then becomes a difficulty: as it was elaborated in order to take into account the needs for stratigraphic and artifact data as well as to the whole documentation constituting excavations archives, this system was constructed as an open system; it is flexible and above all not conditioned by the integration of predefined thesauri. Wishing not to modify the conception logic of the recording structure of ArSol which is based on the manual stratigraphic recording system in use since 1969 on excavations in Tours, it was decided to develop an additional module in order to satisfy interoperability requirements.
The first step consists in the selection of the main information included in ArSol: features and artifacts. Secondly, a stage of mapping aims to establishing the correspondences between fields necessary for the use of the CIDOC-CRM standard and the available fields in our application. In 2014, the integration of the CRM in the database ArSol will thus be realized through a module allowing to export a selection of data towards a RDF version built according to the CIDOC-CRM and structuring as well the value of fields endowed with list of values. This last operation aims at insuring a compatibility with thesauri used by the community of the Social and Human Sciences - in particular PACTOLS. Joined into the ArSol-CRM module, these reference tables will constitute a footbidge to allow outer users to reach all the connected information, listed in ArSol.
To summarise, this paper will present our reflections as for the construction of the ArSol-CRM ontology, and the methods used to manage semantic equivalences within the framework of the compatibility with thesauri. This experience raises numerous questions around the perspectives and around the sustainability of the development of this kind of specific application, in particular in the field of archaeology. It is part of a valuation practice of the data while respecting their integrity and without forgetting their intrinsic purpose which is to answer research questions at the scale of a site or of a territory.

Geosemantic Tools for Archaeological Research (GSTAR)

Cripps Paul [1,2], Tudhope Douglas [1*]

1 : Hypermedia Research Unit, University of South Wales Pontypridd Wales, UK CF37 1DL http://hypermedia.research.southwales.ac.uk/

2 : Archaeogeomancy
http://www.archaeogeomancy.net/

* : Corresponding author

Much work has been undertaken over the past decade relating to the application of semantic approaches to archaeological data resources, notably by English Heritage and the University of South Wales. These two organisations, over the course of a number of projects, developed an archaeological extension to the CIDOC CRM ontology through the Ontological Modelling Project (Cripps & May, 2010), then applied this to a number of archaeological resources through the subsequent STAR project (May, Binding and Tudhope, 2011), implementing tools to facilitate integration of other resources through the STELLAR project (May, Binding, Tudhope, & Jeffrey, 2012), and now, in partnership with the Bespoke HER User Group, RCAHMS, RCAHMW and Wessex Archaeology, are implementing SKOS based vocabularies and associated tools to enable the augmentation of these semantic resources through the SENESCHAL project.
From the outset, it was observed that the spatial component of archaeological data would be a key element, archaeological data being inherently spatial in nature. To date, most current applications of spatial semantics in the heritage sector have focussed on place names and named locations for sites and monuments and object provenances. The GSTAR project aims to extend semantic approaches to archaeological data fully into the geospatial domain and is instead focussing on the detailed spatial data emerging from archaeological excavation and survey work and is investigating approaches for the creation, use, management and dissemination of such spatial data within a geosemantic framework, building on the CIDOC CRM, with particular reference to sharing and integration of disparate resources.
This paper will present work to date in the first year of the GSTAR project. This has been centred on the identification of suitable platforms and methods for the integration of semantic and geospatial data including comparisons of different approaches emerging from the Semantic Web and Geospatial research communities. Testing and prototyping has been accomplished using sample data from the Archaeology Data Service, making use of available geospatial and (geo) semantic tools, both FOSS and commercial.

Linked Open Pottery

Gruber Ethan [1], Smith Tyler Jo [,2]
1 : American Numismatic Society (ANS)
75 Varick Street, floor 11 New York, NY 10013
http://numismatics.org/
2 : University of Virginia
P.O. Box 400182, Monroe Hall, Charlottesville, VA 22904-4182
http://www.virginia.edu

Linked open data methodologies have tremendous potential in facilitating data interoperability, aggregation, and analysis. With lessons learned in the development of Nomisma.org, a collaborative project dedicated to the definition of numismatic concepts in the semantic web, the author has endeavored to apply these methodologies to the field of Greek pottery. While several thesauri have been published online, not all employ linked data, and none of them currently interact as «five star» linked data, as defined by Berners-Lee. This paper discusses the development of a discipline-specific thesaurus which serves as a bridge between the Getty vocabularies (soon to be published as linked open data), British Museum, and other thesauri, supplemented by URIs from the Pleiades Gazetteer of Ancient Places (http://pleiades.stoa.org) for production places, Virtual International Authority File (http://viaf.org) identifiers for people, and DBpedia URIs whenever applicable.
The paper will discuss the challenges in data normalization between vocabularies, the creation of an ontology in terms that pottery specialists understand, employing SKOS, OWL, Dublin Core, etc. when possible, and the development of an architecture for maintaining, editing, and publishing linked open data. This architecture is based primarily on Nomisma.org, utilizing XForms for editing linked data in web forms, allowing for sophisticated validation scenarios, SPARQL/Update, and other types of REST interactions.
Only by building a bridge between existing thesauri can large-scale aggregation of pottery data be possible. The paper will conclude with several test-case scenarios, showing quantitative and geographic visualizations made possible by the normalization discussed above: the statistical distribution of pottery shapes by vase painters or production places or the distribution of the vessels created by specific potters over time and space, rendered in the form of maps and timelines.

Uncertainty handling for ancient coinage

Tolle Karsten [1], Wigg-Wolf David [,2*]
1 : Databases and Information Systems (DBIS) Goethe University - Frankfurt am Main http://www.dbis.cs.uni-frankfurt.de/
2 : Römisch-Germanische Kommission (RGK) Deutsches Archäologisches Institut - Frankfurt am Main http://www.dainst.org/de/department/rgk
* : Corresponding author

Coinage is a rich source for the study of the ancient world, and the study of Roman Imperial coinage in particular is now well established in the print medium. The basic structure of Imperial coinage has been the focus of a type corpus known as Roman Imperial Coinage (RIC) providing a basic description of each the 40,000+ recorded varieties of the coinage. This allows the date of production of coins which are found, for example in archaeological excavations, to be dated quite exactly. If these coins are found together with other artifacts, then this context information helps to infer the dating of the latter.
However, due to corrosion and decomposition coins may be bad preserved and even experts can sometimes hardly identify the exact coin type of a given coin. In our database Antike Fundmünzen Europa (AFE), where we record finds of ancient coins within Germany, we want to preserve as much information as possible. This also includes containments of possible coin types, or marking attributes of the coin as uncertain if the exact value can not be assured. Together with other context information and reasoning techniques one then can narrow existing possibilities.
As long as data remains within the original system, we are free and flexible as to what and how we model uncertainty or imperfect data. The data in AFE per se are based on a relational model. However, we want to link AFE with other databases in Europe, and have already generated some promising results within the framework of the European Coin Find Network (ECFN). Following the idea of linked open data, this means that ontologies are needed. One of the cornerstones we

envisage is the use of Nomisma.org IDs in order to provide a common reference for the identification of entities and concepts. Uncertainty is handled only to a very limited extent in Nomisma.org, which makes sense since uncertainty is not something specific for coinage and should be modeled on an upper level.
On a very generic level there is SKOS. SKOS provides un-sharp relations and therefore also deals with uncertainty. However, SKOS was build for the mapping between different data models. It does not help us to model the uncertainty within one model.
We explored different models within the archaeological and cultural heritage context such as CIDOC-CRM and EDM, looking explicitly at how to model the uncertainty we defined in our relational model. Currently we are exploring the Uncertainty Ontology of the W3C and how it could be adopted for AFE.
Within the paper we will provide a brief overview of existing solutions for modelling uncertainty and incomplete data. However, the focus of the paper consists of our use case descriptions, how we plan to model them and our lessons learned.

Some Issues on LOD in Cultural Heritage: the Case of Historical Place Names

Signore Oreste, Fresta Giuseppe, Martinelli Massimo
CNR-ISTI
via G. Moruzzi, 1 ? 56124 Pisa
http://www.isti.cnr.it/

The context is essential to fully understand the meaning of any artifact. This implies a highly interdisciplinary approach where the scholar uses his/her knowledge to link different information items. However, the scholars' knowledge remains implicit and often unexpressed. The huge amount of information available both on the web and in the archives makes mandatory to link such dispersed information items to get new knowledge, without imposing a single rigid schema. The Semantic Web technologies and the Linked Open Data (LOD) approach promise to offer a way out.
In the presented case study the issue of historical place names has been considered. Starting from the experiences that lead to TGN, an ontological representation of the pilot study data has been drawn. However, to really conform to the LOD principles, a further refinement lead to a more complex ontology, where the role of Events has been introduced. Finally, to really share the knowledge on a world wide scale, a «reconciliation» with the CIDOC CRM ontology has been performed, enriching the reference ontology with appropriate properties and classes.
The paper shows as Semantic Web technologies support a LOD approach, and why reusing well established and shared ontologies, possibly adding some extensions, is mandatory to achieve the goal of sharing and enhancing knowledge.

Periods, Organized (PeriodO): a Linked Data gazetteer to bridge the gap between concept and usage in archaeological periodization

Rabinowitz Adam [1], Shaw Ryan ,[2], Kansa Eric ,[3] ,[4]
1 : The University of Texas at Austin (UT Austin)
Department of Classics 2210 Speedway, Stop C3400 Austin, Texas 78712-1738
www.utexas.edu
2 : The University of North Carolina at Chapel Hill (UNC)
http://unc.edu/
3 : Open Context
http://opencontext.org/
4 : The University of California at Berkeley (UC Berkeley)
http://www.berkeley.edu

As the web of data built around shared concepts of place and person continues to expand, the need for a resource to anchor shared concepts of time becomes ever more critical. While there are generally accepted standards for the expression of calendar dates, so far the period concepts used to describe archaeological data have proven resistant to integration in a Linked Data environment. A proliferation of heterogeneous, collection-specific thesauri have made the interoperability of period designations equally difficult for datasets using the CIDOC-CRM, despite the thorough specification of period entities in the ontology. The publication of various period thesauri as Linked Data, as envisioned by the SENESCHAL project and planned by the Getty Art and Architecture Thesaurus, is a productive development. There are still serious barriers, however, to using these thesauri to foster chronological interoperability. The expression of spatial and temporal coordinates in a quantitative, rather than a qualitative, form is necessary for the reconciliation of period concepts in different data sources. But existing thesauri are either too geographically specific for general use (e.g. the English Heritage thesaurus, which applies only to the UK) or too qualitative and vague to provide resolvable spatio-temporal coordinates (e.g. the Getty AAT). We argue that the barriers to the use of periods in interoperable systems stem from tensions between the way periods are conceptualized as unitary temporal entities in thesauri and the idiosyncratic, unstructured, and contextual way they are used in practice. A solution to the problem lies in the creation of a gazetteer not of agreed-upon, centralized, and abstracted period concepts, but of the individual assertions made by authoritative scholarly sources about the temporal and spatial boundaries of periods in particular contexts. This approach promotes scholarly agency in creating and using period concepts, while still providing the formalism needed for computer- aided reasoning and inference on period assertions. The Periods, Organized (PeriodO) project seeks to develop such a gazetteer. Rather than attempting to impose consensus about the nature of an underlying period concept -- the single Platonic form of the «Archaic period», for example -- PeriodO will formally model existing period assertions with spatio-temporal coordinates from authoritative sources, both online and in print. These assertions -- the multiple Platonic shadows of the «Archaic period» -- will form the core of an expanding gazetteer that will facilitate the reconciliation, visualization, and exploration of diverse uses of period expressions across linked datasets and texts.

This paper describes plans for the creation of the PeriodO gazetteer, including the formats it will employ to represent spatio-temporal coordinates and the Linked Data standards to which it will adhere. It discusses visualization strategies and the relevance of emerging tools and standards such as the Topotime specification under development by Elijah Meeks and Karl Grossner or the recent addition of spatiotemporal concepts to the CIDOC-CRM. Finally, it offers a consideration of the potential role of the PeriodO gazetteer in research, teaching, and Linked Data, as well as an assessment of the obstacles to its implementation.

A metadata schema for cultural heritage documentation data retrieval through publication- Using STARC metadata schema to handle 3D Cultural Heritage Documentation (The case of recording sites in Israel)

Kyriaki Yiakoupi [1], Hermon Sorin ,[2*]

1 : The Cyprus Institute (STARC)
http://cyi.ac.cy/starc.html
2 : The Cyprus Institute (CyI)
www.cyi.ac.cy
* : Corresponding author

This paper will present the Science and Technology in Archaeology Research Centre (STARC) metadata schema, explaining step by step the data capture technologies and procedure of a case in Israel. In addition, there will be a presentation of the publication and data interoperability of the content online, related to the STARC metadata schema. A number of European significance tangible and intangible heritage such as museum objects, buildings, archaeological sites and excavation areas are already located in virtual libraries and digital collections. What is more, the existing material is consisted of 3D surveys, reconstruction techniques, images, texts, videos and documentation of various steps.

Such a scientific content necessitated the establishment of virtual museums, digital libraries and scientific repositories. Today, the creation of digital collections is well understood by the majority of the scientific and education community. Consequently, this gave rise to the creation of different separable repositories in which each provider could manage and organise their digital content separately, trying to compromise it to its content standards.

Nonetheless, in order to be able to retrieve information from all these repositories it is important to have a well-structured and standardised metadata schema. Further to this paper there will be

a detailed examination on how an adhesive schema can act as the backbone structure for management, preservation and the archival of the digital assets.
The topic of this research is related to knowledge management and communication through new ways of reasoning with information technologies and metadata. Long term preservation and access to 3D digital content required the outmost of our concern to the development of standardize metadata and ontologies. Thus, an appropriate and careful structured classification of entities can ensure this.
Finally, the paper will discuss the features and dynamics of the STARC schema through a case of recording sites in Israel, as well as explain how this standardization of entities can give a full record of the digital acquisition tasks.

An Ontology for 3D Visualization in Cultural Heritage

Vitale Valeria
King's College London, Department of Digital Humanities

The use of 3D computer graphics and modelling techniques in the study of the ancient world has been mainly limited to the display of traditional research. Often, their value has been assessed merely on aesthetic quality.
Behind every scholarly 3D visualisation is a thorough study of excavation records, iconographic documentation, literary sources, artistic canons. However, this research is not always detectable in the final outcome, and 3D visualisations do not seem able to meet the standards of scientific method (reproducibility) and academic publishing (references and peer-review).
The London Charter presents methodological guidelines for recording data, but it does not offer a formal framework in which to place this information. Each modeller is left to simply follow their own style. Time and resource constrains not only affect the accuracy and availability of the documentation, but also make it very unlikely that a researcher, or even a team, develop more than one visualisation of the same cultural heritage place/object, perpetrating the naive idea that only one visualisation is possible or correct. The growing compatibility between 3D content and web browsers allows the application of RDF technology to 3D visualisations for cultural heritage to try overcoming these issues. Dividing a 3D model into smaller elements, assigning a Unique Resource Identifier (URI) to each of them and applying a dedicated ontology would make possible to connect the 3D elements with each other and with external resources. More specifically, an ontology for 3D visualisation in cultural heritage could, in the first place, define and describe the components of the 3D model and their relationships. This would help rebuilding data and metadata if the visual component was not readable anymore, enhancing accessibility, sustainability and longevity of the information. Through a dedicated ontology, a researcher could also assess the degree of speculation involved in the creation of each 3D element and its relationship with sources and referents, thus presenting 3D visualisation as a scientific hypothesis and not an «exact reconstruction». Moreover, the use of a specific ontology would: constrain and standardise the documentation, making it synthetic instead of verbose speed up the recording process thus reducing time/cost and making the documentation more likely to be retained in a project, allow 3D visualisations to join and enrich the growing network of linked digital resources to study the past, making 3D visualisations human- and machine-searchable, connecting them with the literary and historical sources that mention the visualised artefact or building,   allow and encourage comparison of different visualisations and interpretations of cultural heritage, as the same resource (historical, archaeological, literary etc...) will be connected to all the related visualisations that share the same vocabulary,   allow citations, re-use and peer- review of 3D visualisations, as every 3D element (and its author) will be always identifiable and linkable through the URI, contribute to transform 3D visualisation from a univocal display of traditional research to a collaborative virtual environment that can be shared and implemented by different scholars.

New Reflectance Transformation Imaging (RTI) tools for context metadata generation

Schroer Carla [1], Mudge Mark [1*]
1 : Cultural Heritage Imaging (CHI)
2325 3rd Street, Suite 323 San Francisco, CA 94017
http://culturalheritageimaging.org
* : Corresponding author

This talk will explore the necessity for transparent evaluation of digital tools and methods used for the scientific documentary imaging of «real world» subjects. The goal is to produce a digital stand-in (digital surrogate) that can be used for subsequent scientific or scholarly examinations. The presentation will show how a «digital lab notebook» enables this transparency using the example of the methodology and software for Reflectance Transformation Imaging (RTI).
A «digital lab notebook» associated with a digital representation provides transparency, enabling people to assess its reliability and have confidence they can rely on it for their own research purposes. For RTI, methodology developed at Cultural Heritage Imaging includes a workflow and software tools that keeps track of the information about the capture and processing of the images through to the final digital representation. Our team is developing new methodology and tools by adding management of the process history data using the CIDOC CRMdig ontology and producing a digital lab notebook consisting of Research Description Framework (RDF) files. These files enable the discovery of the relationships among data and lead to the development of knowledge This presentation will discuss a new direction for RTI practice including the tools under construction. New capture and validation tools for RTI image data will demonstrate this new approach. The full pipeline of tools for the creation and processing of RTI data contains several parts, and users have many options. The talk will show what is built, what is planned, and what remains, in order to have a complete pipeline that includes managed process history data (context metadata) that meets the CRMdig and Linked Open Data requirements.
The talk will place this work in the context of key factors that determine whether an imaging technology can practically build a digital lab notebook and the implications for the scientific and transparency needs of the cultural heritage community.

Linking potter, pots and places: a LOD approach to samian ware

Thiery Florian [1*]
1 : University of Applied Sciences Mainz
www.fh-mainz.de
* : Corresponding author

The Roman imperial period is known for the introduction of a red glossy pottery, the so called samian ware. It is crucial for archaeologists to date Roman sites in the Northern provinces. The research in samian ware pottery advanced in recent years. The spatial distribution and chronological pattern as well as the identification of kilnsites of individual potters are key research questions. Most recent studies are based on a dataset collected by several scholars in the past decades [1]. It comprises detailed and reviewed data of potters, pots and related places. The character of the data makes it reasonable to approach it utilizing the concept of the Linked Open Data (LOD) in order to increase its potential for research.
The goal of the study presented in this poster is to migrate a subset of these data into an appropriate structure and to make it accessible through URIs. Furthermore the place resources should be linked to existing LOD projects. Finally the query of the links between potters, pots and places was to render possible through a web based interface.
The interoperability and possibility for data sharing is achieved by implementing suitable XML schemes (e.g. GML, MIDAS). Findspots and kilnsites are mapped to Pleiades places to benefit from the Pelagios project [2]. Typically Pleiades places are designed to support geographical annotation of textual sources or archaeological objects. A major challenge of the study was to link the ?samian places' to Pleiades places, because each follow their own spatial concept. Another aspect was the chronological information entailed in the dataset. Simulations of changes

in the relative chronology of the material revealed the potential of the linked data approach by providing immediate access to all implications on related datasets.
The results yield that research on samian ware can benefit from implementing the concept of LOD. Enhanced perspectives arise when extending the linked data to other resources like dies and coins. When the data is published it could contribute to the international crosslinking of archaeological information. Moreover, the data is ready for semantically modelling the relations in an ontology to foster the disclosure of knowledge hidden in the data.
The poster presents the results of a M.Sc. Thesis delivered at the University of Applied Sciences Mainz.
[1] Mees, A. (2011): Die Verbreitung von Terra Sigillata aus den Manufakturen von Arezzo, Pisa, Lyon, und La Graufesenque: Die Transformation der italischen Sigillata-Herstellung in Gallien 1. Auflage, Verlag des Römisch-Germanischen Zentralmuseums, 2011.
[2] http://pelagios-project.blogspot.de

A Living Archive for Çatalhöyük

Grossner Karl [1*], Hodder Ian [,2], Meeks Elijah [,3], Engel Claudia [,3]
1 : Stanford University
Stanford 560 Escondido Mall, Stanford, CA 94305. (650) 463-6137
http://digitalhumanities.stanford.edu/
2 : Stanford University
archaeology.stanford.edu
3 : Stanford University
* : Corresponding author

Çatalhöyük is the site of a long-running archaeological project excavating and analyzing Neolithic period settlement ruins in central Turkey. Its large international team of researchers has been led since 1993 by Stanford's Ian Hodder. In June 2012, Çatalhöyük was designated a World Heritage Site by UNESCO, in recognition of its global importance.
When ongoing excavation activity ceases in a few years, the Çatalhöyük project will need to archive its large volume of digital products in one or more repositories for permanent storage and public access. Throughout Hodder's tenure, Çatalhöyük data has been made available publicly under a Creative Commons license. Efforts are now under way to make data better organized and more easily accessible, such that it may be reinterpreted by future scholars and joined with data from other projects for comparative studies.
This paper reports on progress to date towards realization of an envisioned «living archive,» in a pilot project at Stanford directed by Hodder. A living archive in this sense is one having its core contents «frozen» upon completion of excavation activities, but made highly accessible for future analysis and interpretation, and annotation by its publication as Linked Open Data (LOD), presented in a sophisticated interface allowing complex queries and faceted browsing on spatial, temporal and thematic dimensions. In this way, both core and interpretive data layers of the Çatalhöyük project would live on for future studies and perhaps the interpretive exhibits of digital museums.
The tabular data of Çatalhöyük has been developed over a 22-year period with a single-context recording methodology, and stored centrally in a relational database system. Excavation and analysis are undertaken by researchers in 23 specialisms, whose data is stored in a dozen sets of team-specific tables. Team data all refer to object finds and samples from excavation units, a term corresponding fairly closely with the more commonly used contexts. Units are meaningfully grouped in spaces (within and outside of buildings), features, and clusters.
The first step in the Çatalhöyük Living Archive project has been the transformation of a significant portion of the data from a relational model to experimental graph representations. Foremost is a data model and instance data described by an RDFS/OWL ontology, within a Sesame triple store. The graph structure facilitates the «reconstitution» of excavation contexts including units, spaces, features, building, clusters, and areas, permitting researchers to more easily identify patterns of co-location?for example, of neonatal burials and hearths, or of zoomorphic figurines and animal bones.
The graph structure also enables locating objects according to complex attribute criteria, grouping them, and asserting alternate interpretive categories, such as adornments, tools, or ritual objects. Some other key elements of the Çatalhöyük Living Archive project include: 1) flexible spatial

and temporal views on the data; 2) an application programming interface (API) facilitating integration in comparative studies; 3) textual analysis of diary entries and research reports, and 4) an interactive interpretive application demonstrating empirical support for increasing levels of entanglement? the dependence and dependency relations between people and things (Hodder 2012; 2011).

Session 08

The third and fourth dimension in archaeological data modelling

(Friday 25th 14h-16h45 Pantheon S2)

Chairs : Eric Desjardin[1], Berdien De Roo[2], Robert Vergnieux[3],

1 : Centre de Recherche en Sciences et Technologies de l'Information et de la Communication (CRESTIC)

Université de Reims - Champagne Ardenne : EA3804 UFR Sciences Exactes et Naturelles

2 : cartogis

Department of Geography, Ghent University,

3 : ARCHEOVISION UPS SHS 3D PESSAC - France

Archaeological data are fundamentally linked with the vertical and temporal dimension, although many data models in archaeology do not fully incorporate these aspects. Analysing archaeological data in their spatio-temporal context requires an adequate data modelling. The last few years, the number of 3D models intended for visualization is increased significantly; however, this session will focus on the geometrical modelling of the data in regard to data exchange and storage. Nevertheless, not all archaeological findings can be located in space via their coordinates, e.g. because of their limited shape. Therefore, topological relations are of importance as well. Moreover, topological relations not only occur with regard to spatial locations, but also concern the temporal dimension. In addition, data imperfection is linked to the temporal dimension as to all other facets of archaeology. Incorporating all these issues and other not-mentioned data particularities makes the development of an archaeological information model a challenging thought process.

This becomes further complicated due to the variety of research questions, site objects, time periods and scale levels. Therefore, archaeological standardization is currently mostly defined by local organizations and rather consists of formats than real standards. Developing a single data model to standardize all archaeological data might not be feasible. Nevertheless, a standard data model which is suitable for part of archaeological data may facilitate the data exchange among various parties. During the development of such a standard, issues such as subjectivity and multivocality may be tackled as well. In this context, integrating the third (spatial) and the fourth (temporal) dimension in archaeological data modelling is inevitable.

Consequently, this session attempts to bring together innovative research in the discipline of archaeological information modeling and archaeological data exchange. This way, the state of the art about the 3D or even 4D data modeling in archaeology is questioned. At the same time, this session could be a forum for the exchange of knowledge and ideas or stimulate further collaboration on this topic.

From the state of the art on 4D data modeling to the archaeologists' dream for the future

Desjardin Eric [1*], De Roo Berdien [,2], De Maeyer Philippe [,3], Bourgeois Jean [,4]
1 : Centre de Recherche en Sciences et Technologies de l'Information et de la Communication (CRESTIC)
Université de Reims - Champagne Ardenne : EA3804
UFR Sciences Exactes et Naturelles Moulin de la Housse BP 1039 51687 Reims CEDEX 2 FRANCE
http://crestic.univ-reims.fr/index.php
2 : cartogis
Department of Geography, Ghent University, Krijgslaan 281, S8, 9000 Gent
cartogis.ugent.be
3 : Ghent University Departement of Geography
4 : Ghent University Departement of Archaeology
* : Corresponding author

Nowadays, exchanging data between various parties has become indispensable and is even taken for granted. In many disciplines, data models have been developed to facilitate the exchange of data. CityGML, for instance, is increasingly used in the domain of urban planning and tourism to describe and exchange city and landscape models in the three spatial dimensions. Such standardized ways of data storage and exchange have undisputable advantages with regard to database consistency and integration of information. In archaeology, the use of a standardized model to describe and interchange data may, besides the previously mentioned advantages, reduce the subjectivity and avoid that data are left behind. The benefits notwithstanding the nature of archaeology imposes some difficulties to the development of a standardized archaeological data model. Both the third, spatial, and the fourth, temporal, dimension needs to be incorporated in the model. Besides this spatio-temporal relationship, the modeling is further complicated by the multitemporality and the data-imperfection which have influence on different part of archaeological data ranging from temporal uncertainty to incomplete geometric data, etc. Furthermore, the discipline is characterized by a large variety of sites types which can be studied on diverse scale levels. In addition to these steps, the use of visualization interface like 3D geographic information systems questions about the interaction between the graphical modeling tools and knowledge management. Hence, integrating these complex elements into one standard, which is suitable for all archaeological data is probably utopian. However, a standard which applies to a part of the discipline, such as built heritage or excavations of West European sites, may be feasible. In order to interpret the archaeologists' dream for the future, this paper starts from the current state of data modeling in archaeology and a panorama of their use in restitution platforms. In this way, a thorough backbone for outlining future steps in archaeological data modeling is provided.

Managing Time Dimension in the Archaeological Urban Information System of the Historical Heritage of Roma and Verona

Basso Patrizia [1,2], Belussi Alberto [,3], Serlorenzi Mirella [,2], Migliorini Sara [,3*], De Tommasi Andrea [,2], Grossi Piergiovanna [1]
1 : Department of Time, Space, Image, Society, University of Verona
http://www.dtesis.univr.it
2 : Soprintendenza Speciale per i Beni Archeologici di Roma
archeoroma.beniculturali.it
3 : Department of Computer Science, University of Verona
Verona
http://di.univr.it
* : Corresponding author

During the last three years the Italian project SITA, which has been developed in Rome by the « Soprintendenza speciale per i beni archeologici di Roma» with the name SITA@Rome => SITAR and extended to Verona by «Soprintendenza per i beni archeologici del Veneto» becoming SITA@Verona => SITAVR, has produced a huge amount of data describing the archaeological findings and related information sources regarding the historical heritage of these two famous Italian urban centres. A conceptual schema of the database content has been produced by means of GeoUML tools and will be available as project documentation. A navigation of the schema will

be provided by GeoUML Catalogue Viewer.
Time dimension has been handled in the GeoUML schema in different ways: (i) it is a feature of any archaeological finding, but can be specified with different granularities, or even considering different calendars; (ii) it is a feature of a reconstruction hypothesis where life time of the reconstructed object is derived from the combination of other observations; (iii) it is a feature of any information source (excavation, ancient document, map, ...); but also (iv) eras are defined in the schema in order to identify well-known historical periods, moreover (v) also building techniques are related to specific periods, not always identified as a known era and finally (vi) a given archaeological finding can have different time periods associated to it due to stratification existing in its structure (i.e.: building period, usage periode, falling periode).
ISO standards and in particular ISO 19108 Temporal Schema contains fundamental formal tools that aims to provide a common set of concepts for dealing with time in different contexts. Thus also in the archaeological data representation we can use them effectively.
In this paper we describe the time dimension modelling issues highlighted during the SITAx project, considering all the above listed cases. Moreover, we also present a first attempt of the semantic mapping between SITAx schema and ISO 19108 .

Towards an Archaeological Information system: improving the core data model

Van Ruymbeke Muriel [1*], Carré Cyril [,2], Delfosse Vincent [,2], Hallot Pierre [,2], Pfeiffer Michelle [,2], Billen Roland [,2]
1 : CARE Réseau des bibliothèques, University of Liege
2 : Geomatics Unit, Department of Geography, University of Liege
* : Corresponding author

Grounded on archaeological information modeling works [1] undertaken at the Geomatics Unit of the University of Liege, this paper goes a step further in handling time and function imperfection, interpretative sequences and people interacting with historical objects.
Designed in 2011, the initial model already gathered both geometrical and historical information. It was partially based on the urban data standard City GML mainly for interoperability purposes. Its specificity, the version concept, allowed multiple geometries experiments. That property enabled us to handle geometrical ambiguity and incompleteness. To validate this model, and in a showcase purpose, a first prototype has been realized. One year later this prototype's model has been improved to manage in a better way all objects' versions and possible representations. Until now, this model integrates and manages imperfect archaeological data but only partially: the version concept being only dedicated to express geometric ambiguity or imprecision. Henceforth, with the version notion widening, we propose to encompass function and time imperfection as well. It is an important progress because on an archaeological point of view, time and function are quite generally incomplete, uncertain, imprecise or contradictory. Another enhancement must be highlighted: the agent enlistment. Historical characters, on one hand, and contemporaneous people (like authors, archaeologists etc.) on another hand are key elements of archaeological game pieces. Finally, we will describe the way of structuring versions into interpretative sequences.
With those improvements, we wish to carry on feeding the scientific debate as much as drafting Archaeological Information Systems.
[1] Billen R., Carré C., Delfosse V., Hervy B., Laroche F., Lefevre D., Servieres M., Van Ruymbeke M.,, « 3D historical models the case studies of Liege and Nantes », in Billen R., Caglioni M., Marina O., Rabino G., San José R., "3D issues in urban and environmental systems", Società Editrice Esculapio Srl., Bologne, 2012, http://hdl.handle.net/2268/126687; Pfeiffer M., Carré C., Delfosse V., Hallot P., Billen R., « Virtual leodium: from an historical 3D city scale model to an archaeological information system », CIPA 2013 Symposium Recording, Documentation and Cooperation for Cultural Heritage, Strasbourg, 2013, http://orbi.ulg.ac.be/handle/2268/157663.

3D/4D archaeology: the scientific future of documenting the past

De Reu Jeroen [1], De Clercq Wim [1], Laloo Pieter ,[2]
1 : Department of Archaeology, Ghent University
Sint-Pietersnieuwstraat 35, B-9000 Ghent.
2 : GATE bvba
Eindeken 18, B-9940 Evergem.

The application of 3D recording techniques in archaeological excavation practice has drastically increased in the last decade. These techniques have documented a wide variety of sites, features, and artifacts. However, how can the 3D recordings be used in the interpretation and understanding of an archaeological site and how can a 3D recording be used as an analytical tool for archaeology, as opposed to a means of simple visualization?
This paper will focus on how image-based 3D modeling can aid in the study and interpretation of archaeological excavations, how it can increase the scientific value of the excavated and digitally preserved heritage, and how it opens new research opportunities that have been difficult or even impossible to investigate through traditional recording techniques. The goal is to discuss the new possibilities (and limitations) of image-based 3D reconstruction in the recording of entire archaeological excavations, and its impact on the workflow of the excavation process and the post-excavation processing. How can the 3D data be used in the field and how it aids the interpretation of the excavation. The paper will discuss the integration of the 3D models in a 2D (horizontal orthophotos, vertical ortho-images and digital surface models) and in a 3D GIS environment. In the 2D/3D GIS environment, the 3D recordings can be linked with other excavation data, such as artefact find spots, sampling locations and feature descriptions and interpretations. The GIS integration of the 3D recordings also allows the detailed study of the stratigraphy of the site and the mutual, chronological relationships between individual archaeological features which leads to a better understanding of the archaeological site. Ultimately, we aim to discuss how image-based 3D modeling improves the quality of the archaeological research. The recording of the 3D shape and the texture of the archaeology, combined with the high accuracy of the recordings, leads to a significant increase of the quality of the excavation recordings and the 3D data proved to be a powerful analytical tool for the study and interpretation of the archaeological site.

Must Farm: A Contextual Modelling of a Palaeochannel

Horne Donald
Cambridge Archaeological Unit (CAU)
34a Storeys way, Cambridge, CB3 0DT

This paper presents the methodology used to create a series of 3-dimensional models reconstructing the contextual detail of a Bronze Age palaeochannel at Must Farm, Cambridgeshire. Excavated in 2011 by the Cambridge Archaeological Unit, the channel revealed a range of immaculately preserved artefacts: eight log boats, half a dozen fish weirs and a myriad of fish traps, worked wood and metal work. These finds, which relate to the changing way the river was utilised in the Bronze and Iron Age, were distributed along different stretches of the channel and at different stratigraphic levels in the silting sequence. However, because of the character and scale of this landscape feature, and the conditions under which it was excavated, it was not possible to adopt a conventional single context recording methodology. As such, new approaches for documenting the site had to be developed to solve the issues of how artefacts would be related back to the contexts observed in plan and section.
This paper provides an overview of the novel approaches adopted, and the methods developed to retrofit finds and feature to key milestones in the channels lifespan. Although not directly chronological, the models presented build a temporal topological history of the palaeochannel and the activities commensurate with it. As such they provide a detailed reconstruction of the alluvial environment, not only over time or space, but time and space.

Space Syntax for intra-site analysis: Social logic of domestic space in La Casa del Estrígilo of Segeda site (Zaragoza, Spain)

Fernández Gloria, Burillo Francisco
University of Zaragoza
Pedro Cerbuna,12 50009 Zaragoza - España
http://www.unizar.es/EN

The aim of our work is to undertake the study of the domestic architecture from the point of view of the articulation of the inner space to get closer to the implicit social logic of constructions. Space syntax provides us an approach of intra-site analysis focusing in the architectural contexts and making a social interpretation of them. These analysis are based on graphics of networks representing the house syntax.

Domestic space studies in archaeology have been driven by the development of the space analysis in archaeology due to the reduction of the scale and the possibility of focusing in the micro-space as a new subject of study. Space syntax analysis has been introduced as an interpretative model for urban grid and buildings by the Hillier and Hanson theory (1984). The roots of this theory reflect the confluence of methodologies and concepts from different disciplines. First of all, the concept of space as an architectural element that is perceived through the senses. Secondly, the research of significance elements in dwellings as proposed A. Rapoport through a translation of structuralism to architectonic analysis. And finally, the Environment Behavioural Studies on the ways in which the spatial configuration of the built environment is related to the behavior of human beings.

Recent applications in archaeology deliver us a new opportunity for intra-site analysis and for explore data of archaeological buildings (Sánchez 1998; Mañana Borrazás et al. 2002; López García 2012, Bermejo 2009; Gutierrez 2012; Grahame 1997). Aspects analyzed in these applications are the movement and the visual perception, with access and spatial trajectory analysis for the former and visibility analysis for the latter. Core elements taken into account are thresholds or gates for their properties for control accessibility, communication, circulation and visibility.

In this study, we propose to test this methodology in the archeological context of «La Casa del Estrígilo» in the Segeda site in north Spain, close to the Ebro Valley. The problem that arises from the discovery of this 283m2 central courtyard house unique in the celtiberic cultural context, is the comprehension of social changes in the late celtiberian period (III and II century BC) for the adoption and implementation of new forms of social representation based on the courtyard house linked to Hellenistic architecture.

Different graphics of visibility, circulation and gamma analysis can be used for quantifying syntax relations such as the study of access. Concretely, values can be extracted from the calculation of ratios of control and depth into the dwelling. A first application of these methods in «La Casa del Estrígilo» enables us to understand and confirm some features of its space distribution. We also propose a comparative study with others central courtyard dwellings contemporary with the aim of searching patterns of behavior.

Session 09

Strategy, Practice & Trends in Online Archaeology

(Wednesday 23th 10h30-18h Pantheon S1)

Chairs : Virginie Fromageot-Lanièpce[1], Judith Winters[2],
1 : CNRS (CNRS - UMR ARSCAN) MAE NANTERRE - France
2 : University of York - United Kingdom

There is always more to learn about where the key challenges and opportunities lie for archaeology in terms of the internet, its technology and its applications. Institutional and cultural change alongside experimentation, testing and consultation are all required. This session will explore how archaeologists are collaborating, implementing and using web-based technologies (databases, WebGIS, journals, blogs etc) and will try to address questions such as:
- How do we build, implement, and sustain online archaeological resources?
- What are the important digital archive / preservation issues we need to consider?
- How do we integrate and re-use digital data in heritage resources?
- Where is the development and application of open data leading us?
- How do we use the web to promote awareness and monitor usage and reach a wider public?
- What are the current web-based applications for archaeological fieldwork, studies, publishing, conservation and site management?

Archaeological open access journals: the case of “Archeologia e Calcolatori”

Caravale Alessandra*, Piergrossi Alessandra*
CNR, Istituto di Studi sul Mediterraneo Antico (ISMA) Via Salaria km 29,300 - 00015 Monterotondo Stazione, Roma http://www.isma.cnr.it/
* : Corresponding author

Our paper intends to provide an overview of archaeological open access journals - with particular reference to Italy, starting from the experience of “Archeologia e Calcolatori” - and offering a comprehensive survey of the situation in France and the Anglo-Saxon countries.
The Internet is now recognised as an important tool for the dissemination of knowledge and research exchange; all sectors are adapting to this new environment, including classical studies, which more than others remains attached to traditional forms of knowledge transmission and publication.
Alongside published journals, online open access journals (of which we describe some examples related to the above-mentioned geographic areas) are increasing considerably, and are acquiring an important role in the publication of scientific results.
In the archaeological sector, a distinction can be made between journals conceived in electronic format, generally in recent times and others, in paper format, that make the full text available online, and finally those, generally with a longstanding tradition, that share online only part of their contents.
For fully open access journals, an important reference is the website Directory of Open Access Journal (DOAJ19, http://www.doaj.org/), a repertoire of electronic journals freely available online, created by the University of Lund, which currently includes more than 8,000 titles, belonging to different disciplines. The aim of this initiative is to increase visibility and promote the use of open access resources. The number of journals has steadily increased, emphasizing the growth of this important publishing industry.
“Archeologia e Calcolatori” is included among the Italian journal in DOAJ. This journal began in 1990 in paper format only, and since 2005 has joined the Open Archives Initiative (OAI) and is also published online. All articles published since 1998 are available in PDF format. The articles are shared in the circuit of the Open Archives, allowing harvesting from OAI service providers. Items are also deposited in the database of CNR SOLAR (Scientific Open-access Literature Archive and Repository, http://eprints.bice.rm.cnr.it/) and can also be retrieved from the PLEIADI portal, the national platform for centralised access to scientific open access literature (http://www.openarchives.it/pleiadi/).
Our study also provides a brief overview of open access features and Creative Commons licenses.

The Internet and Open Access in Archaeology

Rocks-Macqueen Doug [1,2]
1 : University of Edinburgh
South Bridge Edinburgh EH8 9YL
http://www.ed.ac.uk/home
2 : Landward

Open Access (OA) has recently become very relevant to many archaeologists as more organisations and governments now mandate OA publication as a condition of funding. The concept of Open Access is inseparable from the Internet, it is in the very definition of Open Access:
«By ‘open access’ to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself...» Budapest statement on Open Access
While this paper will briefly review OA and its relationship with Archaeology and the Internet, the main focus will be how the Internet and OA in Archaeology are growing and changing with the advances in the Internet. Specifically, it will examine how:

- with the website Open Access Archaeology I am using «bots» to disseminate Open Access Archaeology journal articles on different social media platforms, like Twitter and Tumblr. - the number of Archaeology Journals, most Open Access, are growing exponentially because of the Internet and the advances made in software development e.g. Open Journal Systems, OCR, etc. I will share experiences setting up a OA archaeology journal with OJS and OCR.
- the nature of publishing is changing with «data papers», «born digital», and interactive changing how we present our information. I will share some experiences with these different new forms of publishing, some of which are from Do It Yourself (DIY) experiences.

Open Access and Documentary Tools : The EMA Database on Child Graves in Antiquity and its bilingual recording system

Fromageot-Lanièpce Virginie
CNRS (CNRS - UMR ARSCAN)
CNRS
MAE 21 allée de l'université 92023 NANTERRE

Through the EMA project (Death and the Child in Antiquity) case study, this presentation relates to how archaeologists use a variety of technologies to record and disseminate data. Three french teams, Centre Camille Jullian of Aix-en-Provence, the Archaeology and Science of Antiquity UMR of Nanterre (ArScAn) and the Center of Alexandrine Studies of Alexandria, have created a database for children's graves, funded by the French National Agency for Research for four years (2008-2011).
Born in the context of a study of the status of the child, the EMA Research Project has covered the ancient Greek and Roman world from the beginning of the 1st Millennium BC to the end of Antiquity. The database gives access to 4.000 records on the graves of children, with a variety of elements such as topography, location of the grave in funerary or other areas, markers, graves, containers related to each individual and goods. The contents have been prepared in cooperation with a research network of various institutions in Italy, Greece and Egypt.
The database is accessible on line in open access (http://www.mae.u-paris10.fr/ema/). More than 90 % of the documentation is available for consultation, after the consent of each of the concerned contributors. The languages of both database and website are French and English. The website functions with MySQL-PHP. The project considers actually the opportunity to notify the community about the resource.
The presentation relates to the achievements of the EMA System : collaborative database, structure and data model, international vocabulary, pictures digitalization, data preservation, digital publication. The focus will be on the possibilities to develop the access to the website and it is envisaged that a study of users needs and web practices will be developed.

Data publication - the new black

Winters Judith
University of York
University of York, King's Manor, York, YO1 7EP, UK

The awareness and concept of a 'data paper' or a data journal seems to be gaining some traction in the archaeological community. Sometimes the level of recognition gained from depositing your archaeological research data with an accredited repository is limited and so a data paper enables the author/creator to get academic credit for publishing their data, making it accessible and sharing it with the community. Closely linked with the Open Access movement, data publication is still in its infancy and collaborations and developments are already taking place. Situated within the context of the wider digital publication landscape, this paper will look at the trend of data publication but also looks at how this trend may affect the character of archaeological narrative.

Communicating and interpreting archaeological heritage in social media: passion for archaeology on Facebook

Vosylūtė Ingrida*
Vilnius University Faculty of Communication (VUFC)
http://www.kf.vu.lt/en
* : Corresponding author

This paper attempts to address the subject of archaeological heritage communication and interpretation in social media within informal groups, viewed as communities of practice, by taking the case study of Lithuanian archaeological communities on Facebook. The concept of communities of practice, originally defined by J. Lave and E. Wenger (1991), has been widely discussed among scholars. A community of practice is a special type of informal structure usually formed by people, who have a common sense of purpose and need to share their experiences. This paper seeks to understand how particular communities driven by a shared passion for archaeology engage with archaeology through Facebook.

The research topic of social media usage within archaeology is a new one and still developing. In the recent years, the subject was approached by several authors, who tried to grasp particular aspects of its use (Morris, 2011; Whitcher Kansa & Deblauwe, 2011; Pett, 2012; Richardson, 2012; Sanchez, 2013; etc.). In addition, questions of social media archaeology were more widely discussed during the main archaeological conferences, as well as in minor seminars, and also addressed by different researchers on blogs, forums, etc. It is acknowledged that community engagement has been always relevant to archaeology as public interest in the field has been always evident. Recent approaches of public archaeology and various other forms of social participation through social networks suggest that social media serves as a facilitator for further public interests to be expressed. Moreover, these practices could shape ways in which we perceive archaeology.

The case study on Lithuanian archaeological heritage practices in social media showed that communities of practice are the most engaged in disseminating and generating archaeological content. This fact suggests that in order to understand a successful adoption of social media for archaeology, more diverse archaeological communities and informal organizational structures should be considered. Thereby this paper attempts to contribute to this new topic of research by analyzing social media networking practices based on community engagement and social participation, which are directly relevant to the field of archaeology.

Specifically, in my paper, I will present 25 national communities of practice that strongly rely on archaeological data (experimental archaeology, heritage interpretation and history living communities) and discuss their activity in social media in order to show how social media space, e.g. Facebook, fosters archaeological communication and interpretation of archaeological content. I will also discuss particular aspects of this activity, such as interactions between individual actors (amateurs/professionals) and wider public, forms of participation, the nature of shared and generated content, and also explore main issues arising from this kind of community engagement.

Presenting Archaeology in Real-time: The Use of Blogging, webcams, and 3D Modeling for Engaging a Public Audience

Fischer Lisa, Poole Meredith
The Colonial Williamsburg Foundation (CWF) P.O. Box 1776 Williamsburg, VA 23187 www.history.org

Reaching out to public audiences is critical for educating them about archaeological findings and showing the relevance of the discipline to modern life. Social media and other online technologies allow archaeologists to make their work much more visible to the public and give audiences the opportunity to follow the excavation process as it is unfolding rather than simply learning about the findings at the end once an investigation is completed.

Dedicated to interpreting Virginia's eighteenth-century capital during the American Revolution, Colonial Williamsburg has had a long tradition of public archaeology. Onsite guests have been encouraged to watch ongoing archaeological investigations and to ask questions about what the archaeologists are finding. Over the past five years, however, our approach has evolved to include a range of web 2.0 approaches. This paper will discuss two reconstruction projects involving archaeology and how web technologies have been used to bring the public into the excavation

process. In 2008 and 2009 Richard Charlton's Coffeehouse was reconstructed. From 2010-2013, James Anderson's Blacksmith Shop and Public Armoury complex was rebuilt.
Archaeological research was critical to our understanding and the reconstruction of both sites. While onsite guests were able to visit the excavations in person, guests anywhere in the world could follow our progress and understand how the archaeological findings were being incorporated into the physical reconstructions. Each project had a blog, and archaeological updates were regularly featured. The blogs facilitated direct communication between the public and audience through the comments in which questions could be posed directly to the research team. The projects also employed live webcams transmitting a new image every five seconds to allow people to watch the reconstructions and archaeological investigations. Both sites have also been modeled in 3D to multiple time periods and the virtual reconstructions have helped to explain how the sites changed over time, something quite difficult with just a physical reconstruction. With the completion of the Armoury reconstruction, we will be launching a new blog to provide regular updates on the archaeological research as we work on different sites around the town.
This paper will explore this integrated approach of using blogging, webcams and 3D modeling to present archaeology in «real-time» and what we have learned about using these methods for effectively engaging a public audience.

Strategy for the future? Present practice in online archiving of archaeological data

Hardman Catherine, Moore Ray
Archaeology Data Service (ADS)
Archaeology Data Service, Department of Archaeology, The King's Manor, University of York, York YO1 7EP United Kingdom http://archaeologydataservice.ac.uk/

This paper describes the development of ADS easy, an online system for facilitating the deposit of digital research data with the Archaeology Data Service (ADS), a trusted digital repository for the UK historic environment sector. ADS easy provides an online costing tool and a mechanism for the upload of data and metadata files. The semi-automation of the deposit and ingest process will reduce costs but will also give users great control of their archiving. It is argued that this may, in turn, lead to greater engagement with selection and retention decisions.
The growing dependence on digital data in archaeology has raised awareness of the need for long-term preservation of the datasets resulting from archaeological research. The ADS is the mandated repository for many organisations within both commercial and academic sectors within the UK, providing archiving services for the digital outputs of archaeological fieldwork and research. The ADS has been able to harness over fifteen years of experience in preserving and disseminating archaeological digital data, to develop an online system that will both streamline and enhance elements of the archiving process. ADS easy, an online tool to allow depositors to estimate archiving charges and to upload files and metadata to the ADS repository, will reduce archiving costs and make digital preservation an economic reality for those working within the archaeological community. At a time when the UK historic environment sector is suffering from reduced funding the need to develop a sustainable funding model is an imperative.
ADS easy was developed under the SWORD-ARM project, and has been funded by the Joint Information Systems Committee (JISC). Within the project the ADS has refined and enhanced the archive ingest and charging processes, using systems that will both streamline and semi-automate the deposition process. Using ADS-easy will deliver real benefits to depositors in terms of their ability to deposit data, create and validate metadata, and engage in the process of selection and retention. It will also allow them to manage single and multiple deposits and, perhaps most significantly, to manage cost estimates and accounts. ADS easy also presents the opportunity to enhance ADS data management systems and to build upon existing business infrastructure and role as a discipline-based repository.

Ready for archiving and publishing research data online? A survey about needs, desires and obstacles in Germany done by IANUS

Fless Friederike [1], Dally Ortwin [1], Schäfer Felix ,[2*], Heinrich Maurice ,[2]
1 : German Archaeological Institute (DAI)
Deutsches Archäologisches Institut Podbielskiallee 69-71 14195 Berlin-Dahlem
www.dainst.org
2 : IANUS - center for research data in archaeology and the study of the ancient world
IANUS - Forschungsdatenzentrum Archäologie & Altertumswissenschaften c/o Deutsches Archäologisches Institut
Podbielskiallee 69-71 14195 Berlin-Dahlem www.ianus-fdz.de
* : Corresponding author

IANUS is a project, funded by the German Research Council (DFG) and coordinated by the German Archaeological Institute (DAI), which aims to build up a national digital archive for archaeological and related data in Germany. IANUS is currently under construction and its primary goals will be the long-term preservation, dissemination and aggregation of digital data. Furthermore IANUS will offer manuals, advice and best practice examples for handling digital data in classical and ancient studies.

Based on expert talks with members of existing national and international data centers, software repositories and relevant technical systems, the conceptual framework for the structures, the workflows and the services of IANUS is worked out at the moment. Building upon this an organizational structure will be developed in the second phase of the project so that in the end a national center for research data in archaeology and the study of the ancient world exists.

In the current phase IANUS has also conducted a survey in order to find out what the German archaeological community expects from a digital archive. The survey was directed to a broad audience, to almost all archaeological institutions in Germany (e.g. universities, research institutes, academies, state offices for cultural heritage, museums, etc.) and was conducted from Mai to October 2013 with an online form, allowing for anonymous participation. On the one hand, the questions covered the current practices in the use of digital research data and its management. On the other hand, they tried to elicit needs, requirements, obstacles and expectations of the scientific community in regard to the planned services by IANUS.

As one of the first outcomes from the conceptual phase of IANUS, we will present the results of this stakeholder analysis. The talk will give an insight into the creation, implementation and above all the answers of the survey and will discuss its implications for the future design of IANUS.

Possible open questions to be answered will be, such as: What conclusion can be drawn from the results? What questions remain unasked? How, where and when will the results be published? How does the practice of research data management in Germany look like? Can we increase the acceptance of a new research data center by integrating user needs and wishes?

View and share geo-referenced data at different scales : Chronocarto

Gruel Katherine [1], Buchsenschutz Olivier [1*], Cartereau Michel ,[2*], Dabas Michel ,[3], Riahi Yadh ,[4*]
1 : Archéologie et Philologie d'Orient et d'Occident (AOROC)
CNRS : UMR8546École normale supérieure [ENS] - ParisÉcole Pratique des Hautes Études [EPHE]
CNRS : UMR8546 - Ecole Normale Supérieure de Paris - ENS Paris - 45 Rue d'Ulm 75230 PARIS CEDEX 05 http://www.archeo.ens.fr/
2 : AgroParisTech
AgroParisTech
INRA-UMR782 Génie et Microbiologie des Procédés Alimentaires, 78850 Thiverval-Grignon
3 : Geocarta Geocarta www.geocarta.net
4 : YEBNI
http://www.yebni.com
* : Corresponding author

Chronocarto is a tool for sharing geo-referenced data online through the web. It is developed within the framework of a scientific partnership between UMR AOROC (CNRS- Ecole Normale Superieure) and Geocarta SA. France. Different departments from ENS (Antiquities, Geography, Geology) have joined together in order to operate and publish their spatial data using the same media.

At the beginning, Chronocarto was developed at a 'settlement' level, for areas from 1 to 100ha. It enables an easy overlay of different data layers (geography-survey-excavation- interpretation-

geology- seismic faults) and to publish them on the web. First developed within a private network of researchers, Geocarta has evolved quickly into a collaborative tool with specific needs from different communities. In particular, specific applications were developed both for large or small scales with different public interfaces corresponding to specialized topics. At the site or intra-site level, Chronocarto viewer is able to publish online and superpose different types of documents which can leads to the detailed analysis of a territory.
For a specific approach at a large-scale, we have create a Chronocarto ?s derivative on the form of automatic atlases
These Atlases are an additional tool to our paper publications, allowing us to enter the multi-media era. In first, the Iron Age Atlas was developed in order to display for the public a 15000 sites data base for France. It should be extended soon to all over Europe. The dynamic display of the maps is the result of a combination of questions «where? When? What?».
These automatic mappings show the distribution of sites as points, but in a second part, more elaborated maps are proposed to the user as a more global response to the “What” questions. These thematic maps are elaborated by researchers and also points to different hyper-links (. pdf, .jpeg, Date base, etc.). The qualitative objective is to present a rapid statement of the question in the most varied themes.

The Virtual Cilicia Project - How to use Google Earth as a visualization environment in an archaeological context

Rutishauser Susanne*, Arni Tim, Rosenbauer Ralph Christian
Institute for Archaeological Sciences, University of Bern
www.iaw.unibe.ch
* : Corresponding author

Since 2005, a particular research focus at the Institute for Archaeological Sciences in Bern has been on the exploration of Cilicia, specifically on the settlement clusters in Cilicia Pedias. This research coincides with three surveys and excavations (Magarsos, Sirkeli Höyük, Uzuno?lan Tepesi). The reconstruction of the paleo-landscape is a primary goal of the collaborations of Instanbul Üniversitesi and Çanakkale Onsekiz Mart Üniversitesi. Namely the knowledge of the ancient river courses as well as the water supply and irrigation networks plays a crucial role in the comprehensive understanding of the historical development within the plain of Cilicia. In addition, the evaluation of the relationships among the city states within the settlement clusters requires an inseparable link to research on street networks and exchanges during the associated time period. To visualize the development of this complex region at the crossroads among Anatolia, the Levant, and Syria during the different epochs and to provide a better understanding for laypersons, new approaches are necessary. New methods of knowledge transfer should not be limited to a linear narrative structure; rather, they give users the chance to interactively explore the interplay between environment and settlement patterns. This offers the user the possibility to adapt the provided information to her or his state of knowledge and specific interests. To achieve these goals within the so-called «Virtual Cilicia Project» a Google Earth based approach was chosen. The use of a virtual globe as a tool for archaeological visualization allows for the integration of heterogeneous data sources, thus providing the opportunity to compare ancient and modern states. Since Google Earth uses KML 2.2, an open standard XML notation, it is simple to add one’s own content. In addition, KML became an increasingly common standard within geographic information systems and online tools, therefore becoming a well-documented future-proof solution. The integration of a timeline directly into Google Earth makes it a perfect instrument for the visualization of historical developments.
This paper recapitulates the special benefits of virtual globes as a media in historical and archaeological research and presents the particular approach of the «Virtual Cilicia Project». It develops a perspective toward a best practice approach for the use of Google Earth as a valuable tool in knowledge transfers for infotainment.

Web GIS development on the archaeological site of Delos (Cyclades, Greece)

Fadin Lionel [1], Voileau Laure ,[2], Briquet Quentin ,[3], Mulot Louis ,[4]
1 : Ecole française d'Athènes (EFA) EFA 6 rue Didotou 10680 ATHENES www.efa.gr
2 : École Normale Supérieure (ENS)
Ecole Normale Supérieure de Paris - ENS Paris
3 : Ecole Supérieure des Géomètres et Topographes (ESGT)
École Supérieure des Géomètres et Topographes (ESGT)
4 : Ecole française d'Athènes (EFA)
www.efa.gr

From 2003 to 2011, the French School at Athens (FSA) has regularly supported some field missions in Delos, in order to draw up an atlas where you can find all the ruins from the prehistoric period to the Byzantine period but mainly from the classical antiquity in their present state. This atlas will be published in 2014 in the collection of «Exploration Archéologique de Délos». Since 2006, we have been looking for a way to convert this atlas in GIS. But it's only in 2012 that we thought of a web GIS solution, an innovative tool which targets both researchers and the public, and simplifies data management.
After two five months internships, we propose a complete web application, which provides all functions characterizing a GIS: capture, display, modeling, analysis, storage of spatially- referenced data. It is built on client-server architecture through GeoServer, a server for geospatial data, which implements the OGC Web Services (WMS, WFS and WFS-T). Data is stored in the PostgreSQL database management system and its spatial extension PostGIS. The interface is constructed by using HTML and CSS, and webmapping functionalities are implemented as calls to JavaScript libraries such as OpenLayers, GeoExt and Heron MC, customized given the specifications of this web GIS.
We lead a broader reflection on how to collect and match data from the various researchers associated to the FSA, who work on Delos and come from different institutions and countries. This has led us to focus on forming services for the interoperability of data, both internal to the « Delian» community, and respecting the international geomatics standards.
This web GIS is available for consultation on the FSA's website at: http://www.efa.gr

Beyond the map : a dialog between paper and connected devices. The example of the GIS of the archaeological site of Western Thebes (Luxor, Egypt)

Pimpaud Alban-Brice*
Egyptian Ministry of State for Antiquities / Ministère français des Affaires Etrangères (MSA / MAEE)
CAIRO
* : Corresponding author

The archaeological area of Western Thebes, inscribed on the World Heritage Sites list of UNESCO, has recently received a mapping project held by the Egyptian Ministry of State for Antiquities (GIS Center) in cooperation with the French Ministry of Foreign Affairs. The carrying out of this map, a GIS/Geodatabase initially designed for an internal use, has taken benefit from many tools released in the very last years, while many analogical and digital material became more accessible and usable for the archaeological community. Thus, maps, plans, satellite imagery, aerial photographs and Digital Elevation Models were used in order to synthesize the global knowledge of the site, when GPS surveys and terrestrial photogrammetric campaigns were undertaken to record and update its archaeological and topographical current condition. Although the main public outputs of this project happen to be printed materials (Archaeological Atlas and Maps), a reflection has been initiated on the modalities of exploiting and disseminating its native and genuine digital contents towards different audience.
In the first place, the internationalized and compartmentalized archaeological missions operating on the field expresses a tremendous need for putting into perspective their own archaeological results with those of others, i.e. proceeding from their own local grid towards a global system by using a common technical language. In the second place, the visitors, by having access to such

a rich and vast archaeological area, may claim for a localized and detailed information while they are experiencing the site or are about to discover it. And in the last place, the authority in charge of the site management and preservation should have access to an user-friendly tool helping at monitoring with the condition of the area.

In an attempt to fulfill these needs, a webmapping platform is currently implemented and experimented, using the Open Web Services defined by the Open Geospatial Consortium. Therefore, any computer operating a GIS or CAD software might be retrieving data through the standardized Web Map Services of Web Feature Services. Moreover, any device equipped with a web browser is turned as a terminal for the display and the request of archaeological information; likewise, the recent class of GPS-enabled smartphones are eligible to display and request the same kind of data, but dynamically localized. And finally, the use of these devices with cutting- edge Augmented Reality applications opens new ways in the comprehension of the site, in situ, and also while standing in front of the traditionally published map.

Finds of Roman Coins in Poland ? a new database

Smagur Emilia*, Kopij Kamil
Istitute of Archaeology, Jagiellonian University (IAUJ)
11 Go??bia St. PL-31007 Kraków
http://www.archeo.uj.edu.pl/
* : Corresponding author

The main goal of the project Finds of Roman Coins in Poland is to create a complete database of the findings of the Roman coins in Poland. The project covers the territory of both modern Poland and some parts of the 1st Rzeczpospolita (1st Polish Republic till 1795): Eastern Galicia (currently north - western Ukraine), and the Duchy of Prussia (currently Kaliningrad district). As for the chronological range, the project covers the finds of the coins of the Republican origin as well as Imperial, Provincial and Early Byzantine ?i.e. ranging from the 3rd century BC to the 6th century AD. It is directed by prof. Aleksander Bursche from the Warsaw University and funded by a grant from The National Programme for the Development of Humanities of the Polish Ministry of Science and Higher Education.
The project focuses mainly on creating the Internet Database of all of the findings of Roman coins in Poland and some adjacent territories. This Database that will be gradually supplemented is intended as a tool of search queries, statistical analysis and mapping overviews. We are going to catalogue coins which are stored in Polish museums, universities collections, local branches of the Institute of Archaeology and Ethnology of the Polish Academy of Sciences and conservation centres. The project involves the search quarries in local divisions of the National Heritage Board of Poland, museums and archives as well as literature query and field verification of coin finds. During our project we are using the same software as RGK DAI in Frankfurt and NUMISMA standards. We are also cooperating with The Oxford Coin Hoards of the Roman Empire Project. Finally we are going to include the coins into the standardised system of Die Fundmünzen der Römischen Zeit.
The Database will serve both numismatists as well as historians and archaeologists. It will certainly be also a very useful tool in the studies of the contacts between the Roman Empire and the Barbaricum both economic and political. Moreover the Database will enable researchers to do analysis of the importance of the impact that ancient Mediterranean cultures had on the inhabitants of Poland in ancient times. It’s also crucial that the open source database will be available online for both Polish and foreign researchers.

Session 10

Archaeology at large: embracing massive audiences for online applications

(Thursday 24th 8h30-13h Pantheon S1)

Chairs : J. Andrew Dufton, Müge Durusu-T anr ıö ver, Susan Alcock 1
Joukowsky Institute for Archaeology and the Ancient World, Brown University (JIAAW) United States

As we reach over 20 years since the Internet truly arrived to a wider public, it is no longer a mere tool for the dissemination of information. Online applications are now also easily used for the active engagement of massive audiences. Although archaeologists have long relied on the web for the spread of archaeological data, have we been as successful in creating a sphere of online interaction for the general public? To achieve the democratic potential available online, archaeologists need to not only present information to a passive audience but also to encourage the direct involvement of this audience with archaeological materials.

As online technologies continue to develop, some new phenomena have emerged aimed particularly at fostering this type of direct involvement. For example, Massive Open Online Courses - or MOOCs - have the potential to drastically alter the way in which previously

'academic' information is conveyed. What ethical questions does the spread of 'MOOC fever' raise about the impact of opening up the academy to an unpaying audience? Crowdsourcing and crowdfunding initiatives similarly look to existing public interest to support archaeological projects. Yet how can we maintain professional standards or legitimacy when archaeological work is undertaken by the general public? Interactive museums open collections to a global community, but how can we structure the archaeological narrative to such a varied audience? With the positive trend toward greater and greater engagement, we must also take time to ask the hard questions about the potential impact of our choices to embrace these new online tools.

This session invites contributions from projects using digital media specifically to actively engage larger groups. Of particular interest are discussions of successful - and also unsuccessful - techniques for harnessing global communities or untapped potential. This may include examples of online teaching, crowdsourcing initiatives, interactive museums, or other approaches. We ultimately hope to open a timely dialogue on the potentials and pitfalls of these new online tools for a truly interactive online archaeology.

A MOOC for Portus

Earl Graeme [1], Keay Simon ,[2], Mladenovic Dragana ,[3], Smith Tamsyn ,[4], Wheeler Peter [1]
1 : University of Southampton, Archaeological Computing Research Group (ACRG)
Southampton SO17 1BF
http://acrg.soton.ac.uk/
2 : Archaeology, University of Southampton (Southampton, UK)
3 : Archaeology, University of Southampton (Southampton, UK)
http://www.southampton.ac.uk/archaeology
4 : CITE, University of Southampton (CITE)
https://www.cite.soton.ac.uk/

This paper will introduce the Portus Massive Open Online Course (MOOC), and in particular it will examine the technological challenges and opportunities posed by massive communities of online archaeological learners.
The University of Southampton will be launching a MOOC in 2014 prior to the CAA 2014 conference focused on the site of Portus. It will be run by the University of Southampton in partnership with FutureLearn (https://www.futurelearn.com/). The Portus MOOC will focus on the archaeological site of Portus. It will provide learners with an introduction to the history and archaeology of the Roman world in general and the Mediterranean region in particular. It will encourage learning through doing archaeology online via access to research data from the site and experts in the field. The MOOC builds on the Portus Project's previous work to widen access, including the BBC/ Discovery programme Rome's Lost Empire, and on its many technological innovations and interventions including work on computer graphics, digital narrative, research data management and dissemination, data capture through scanning, imaging and surveying, social media and GIS. The MOOC will make use of these diverse technologies.
The paper will provide an overview of the MOOC design process with an emphasis on technology, and also consider the ways in whcih technology can support learning of multisensory archaeological methods, materials and ideas. Further information is available at http://www. portusproject. org/education/portus-mooc/ and by following @portusmooc

Archaeologists as audience? The Day of Archaeology, a grassroots online archaeological resource

Ogden Jessica [1] ,[2*],
1 : L - P : Archaeology London www.lparchaeology.com
2 : ECS Department - University of Southampton
Electronics and Computer Science (ECS) Department Highfield, Southampton, SO17 1BJ
* : Corresponding author

The Day of Archaeology (DoA: www.dayofarchaeology.com) is an annual event which offers a window into the working day of archaeologists worldwide, with the aim of addressing the question «what do archaeologists do?» The 'behind-the-scenes' and unscripted approach to the project has created a resource focused on archaeological practice and discourse, as well as highlighted the sense of archaeological discovery and mystery that is so prevalent in popular media. This project aims to move the public understanding of archaeology beyond the 'Indiana Jones' model of artefact discovery, to one that also appreciates the vital work undertaken by professionals and volunteers to protect, preserve and interpret our shared pasts. The DoA is not driven by commercial interest - it is free to join, free to read and managed by a team of dedicated volunteers committed to creating an archaeological community in the most cooperative, accessible and equitable way possible.
Between 2011 and 2013, 1,067 registered users have contributed 1,100+ blog posts, 3,000+ images and films, 10,000+ Tweets and Facebook shares, some with successful interactive components such as «archive bingo» and «ask an archaeologist». The web statistics suggest an upward trend in visitors to the site each year, with the majority of them based in the United Kingdom, the United States and Spain. From an organisational level, several questions have arisen as a result of the participant statistics, specifically regarding how to encourage users to return each year (both the audience and participants), and whether or not funding is necessary to increase

publicity and international awareness about the project.
This paper will use the DoA as a case study for examining the methods by which digital engagement initiatives create online communities. It will discuss how we might further extend the impact of our discipline though this digital resource and promote interactivity between its audience and archaeologists. It will additionally consider how to diversify participation (geographically, culturally, and professionally) and extend the impact of the DoA without detracting from the «ground-up» approach that has contributed to the success of the project thus far. How might archaeological professionals use such a resource to not only generate value and public enthusiasm for the sector, but also as a collective mechanism for bringing together archaeologists who are often separated by the inherently multi-disciplinary nature of the field? Furthermore, we will explore how the archaeological community might use the resource to examine the annual state of the discipline, and highlight trends or topics of interest to the wider global community.

The Portable Antiquities Scheme: digitally recording our past

Pett Daniel [1,2]
1 : The British Museum (BM)
Great Russell Street, London, WC1B 3DG
http://britishmuseum.org
2 : Portable Antiquities Scheme (PAS)
The British Museum, Great Russell Street, London WC1B 3DG
http://finds.org.uk

The United Kingdom's Portable Antiquities Scheme (PAS) has been in operation since 1996 and aims to encourage the voluntrary reporting and recording of archaeological objects found by the public within England and Wales. Since its inception, the PAS has liaised with over 23,000 individuals (many from outside the UK) and recorded details for over 900,000 objects in a publicly accessible, open source database (fully developed by the author and available at http://finds.org.uk). This facility is now used by over half a million people annually, with a massive rise from 10,000 annual visitors back in 2003.
This paper will discuss how the PAS has developed its online presence to service such a large and diverse audience, how we have changed working practice and how we analyse usage of the resources provided. It will show how the research community is now using these data that are curated by the PAS's network of Finds Liaison Officers and Finds Advisors under the direction of the author. These data are used for a wide array of research, ranging from personal research projects to large scale, nationally funded projects: for example the Arts and Humanities Research Council project investigating coin hoarding and Leverhulme funded research into biases prevalent in the programme. Reference will also be made to several digital initiatives that the PAS has participated in, one that could possibly be viewed as a failure (a children's resource - http://pastexplorers.org.uk) and the recently commenced crowd-fuelled archaeological research (Micropasts - http://micropasts.org). The latter project has also attracted AHRC funding and will be formally presented in The author will also briefly discuss how the PAS has shaped its social media strategy around these outputs, how it has grown an audience, developed its content strategy and worked with audio-visual collaborators to increase engagement (for example on the second series of Britain's Secret Treasures and finally how this innovative programme fits into the larger aims of the British Museum's delivery of Partnership UK and other activities.

TrowelBlazers: A collaborative, crowd-sourced project born on social media

Pilaar Birch Suzanne [1*], Herridge Victoria [,2], Wragg Sykes Rebecca [,3], Hassett Brenna [,2]
1 : Joukowsky Institute for Archaeology and the Ancient World, Brown University (JIAAW)
60 George Street, Providence, Rhode Island, 02912
http://brown.edu/Departments/Joukowsky_Institute/
2 : Department of Earth Sciences, Natural History Museum, London (NHM)
Cromwell Rd, London SW7 5BD, United Kingdom
www.nhm.ac.uk
3 : de la Préhistoire à l'Actuel, Cultures, Environnement, Anthropologie (PACEA)
Université Sciences et Technologies - Bordeaux ICNRS : UMR5199Ministère de la Culture et de la Communication Bâtiment B8
Université Bordeaux 1 Avenue des Facultés 33405 TALENCE CEDEX http://www.pacea.u-bordeaux1.fr/
* : Corresponding author

In April 2013, a discussion began on Twitter about the lack of a non-academic, accessible online resource about women in archaeology. After being challenged to do something about it by a fellow user, emails began to fly between the four of us, and TrowelBlazers was born. We decided to include women in paleontology and geology and launched our Tumblr blog, Twitter and Facebook accounts in May 2013.
To date, TrowelBlazers (trowelblazers.tumblr.com) has over 50 posts, and nearly half of these have been contributed by guest bloggers. Our Twitter account has close to 1,500 followers and over 750 likes on Facebook at the time of writing. We have had online coverage including CNN, The Guardian, and Science Grrl. We recently wrote a chapter on women in archaeology and paleontology for a popular audience book, A Passion for Science: Stories of Discovery and Invention. Through our online activities we have become active in projects that reach out to young audiences: collaboration with a performance artist, consulting with a toy company, and a book review.
We have a large (and growing) audience, but a key to our social media and online presence is interaction. Twitter users suggest names and leads on little-known individuals; guest bloggers write posts for us; and we have fostered a number of relationships with archives and repositories through seeking image permissions for photos used on our blog. Some of these interactions have led to academic collaborations for those involved. In addition, we routinely get comments on Twitter from individuals searching for a resource like our blog.
In October, TrowelBlazers organized a Wikipedia Edit-A-Thon at the Natural History Museum, London and took part in another Women in STEM Edit-A-Thon at Brown University, US. As a result, over 20 women were added to Wikipedia or had entries expanded, further increasing the impact of the project to users outside Twitter, Tumblr, and Facebook. One entry was recently featured on the front page of Wikipedia and garnered over 4,000 hits in just one day. The conception of the project was serendipitous, and this is reflective of the nature of many of the interactions that we have experienced on Twitter since starting the project: a comment is made about a hard-to-find resource, retweeted, and invariably we get a helpful response. Throughout this process, we have learned several lessons-including the need to be flexible-but it is possible to connect with large audiences online and create a sense of community and engage both academic and non-academic members of the public.

Massive Open Online Archaeology, Massive Open Online Opportunity: Toward a Worldwide Community of Archaeological Practice

Emanuel Jeff
Harvard University [Cambridge] (Sr Fellow, HarvardX; CHS Fellow in Aegean Archaeology and Prehistory, Harvard Center for Hellenic Studies)
125 Mt Auburn Cambridge, Mass. 02138 http://harvardx.harvard.edu/

While the World Wide Web has provided the public at large with heretofore-unimagined access to information, the egalitarian ? and frequently anonymous ? nature of online content creation has also provided an unprecedented opportunity for the spread of misinformation and misinterpretation alike. Archaeology is no exception to the double-edged sword that is the 21st century web, as the opening of museum collections, the ability to conduct armchair «surveys » via tools like Google Earth, unfettered access to uncontextualized images via simple Web search, and similar developments have combined to confront a new generation of avocational and aspiring archaeologists with myriad explanations and interpretations of artifacts, archaeological data, and history writ large. While certainly ? and literally! ? not a deus ex machina, the rise of the MOOC (both in its traditional definition as «massive open online course,» and in its growing use as a repository for massively-accessible online content) may help counter this current state of affairs by providing a structured mechanism for professionals across the academy to reach, interact with, educate, and learn from an ever-growing online audience. This is of particular importance for archaeology, a field in which standards of conduct and interpretation are keys to sound and ethical practice. The open, inclusive nature of MOOC-based learning experiences can allow them to compete with similarly free and open sources of information about archaeological topics that are broadly accessible on the public Internet. Further, in the MOOC environment, experts leading open online learning experiences can draw in new participants, while simultaneously ensuring that the facts, techniques, and practices conveyed in their particular learning experience represent accurate scholarly interpretation and understanding, as well as the most up-to-date professional standards and methods. Successful participants, in turn, may go on to serve as international and intercultural hubs from which accurate, professionally-conveyed information can flow outward to various peripheries, while at the same time the multicultural nature of MOOC audiences may also serve as a mechanism for improving the professional practice of archaeology, in part by creating a feedback loop via which practitioners can be exposed to viewpoints and cultural interpretations that might not be commonly considered.

While distance education is not a new phenomenon by any means, the combination of open learning opportunities and 21st century technologies has allowed «non-traditional» education to take a decidedly non-traditional turn of its own. New technologies and techniques allow learners to be provided with interactive experiences, while teachers can be provided the ability to keep their fingers on the pulse of the participant collective, ensuring that knowledge and understanding are being effectively communicated to the community of learners, and that the feedback loop between participants and practitioners remains firmly in place. This paper considers the role of MOOCs in this «new academy,» with two open learning experiences offered by HarvardX/edX in 2013 serving as case studies to evaluate and demonstrate the opportunity presented by the MOOC phenomenon not only to engage students online, but to take steps toward creating a true worldwide community of practice.

Conceptualizing the Virtual Museum

Chapman Sarah [1*], Graves Carl [,2*]

1 : University of Birminham

2 : University of Birmingham

* : Corresponding author

This paper presents a new and innovative Virtual Museum of Egyptology, created by Carl Graves and Sarah Chapman. The inspiration for this virtual museum occurred after it came to light that no consensus could be reached regarding the definition of a virtual museum. We propose that a virtual museum is by the strictest sense an online and globally accessible space that hosts exhibitions around a related theme. Thus, we created our Virtual Museum of Egyptology in order to provide an interpretation of a virtual museum, seeking to be but one example of the form a virtual museum can take. The virtual museum we are creating incorporates a wide range of media. The current exhibition, “Bes: Development of a Deity” utilizes photography and 3D models. Planned in progress exhibitions will not only include these elements but also video, imaging techniques, graphic art, and sound files. The Virtual Museum of Egyptology is also innovative in that we welcome outside submissions for new exhibitions. In this way, the virtual museum serves as a platform to collect and display side by side an unending variety of interpretations of the virtual exhibition. We believe this feature also allows for a level of interconnection and scholarship never before possible. The virtual museum also allows for a new and innovative way of displaying objects that is not as easily executed in a physical space, for example combining of various museum collections.

This paper discusses the various aspects of creating a large-scale interactive virtual museum, including web design and technology, audience engagement, submissions and exhibitor guidelines. In particular we will highlight the way in which the virtual museum platform makes archaeology globally accessible. In our discussion we will address the importance of targeting an audience, use of multimedia, exhibition design in a virtual space and how it compares and differs with physical space, and publicity for online exhibits.

The Call of Lovecraft: Using H.P. Lovecraft to Connect Communities with Urban Heritage.

Margrave Paul [1]
Center for Public Humanities, Brown University Providence, Rhode Island 02912 http://www.brown.edu/

The rise in affordable, accessible mobile technology has created exciting opportunities for cultural and heritage nonprofits to expand into new territory and engage their publics in innovative ways. The learning curve is steep and the challenges are tough, but the potential rewards for embracing these tools are equally strong. Despite scarce resources and a limited budget, WaterFire Providence was able to launch The Call of Lovecraft in summer 2013 as an experiment in creative place-making. Negotiating the opportunities and pitfalls of the project proved to be a learning process for an organization more used to engaging the public through cultural activity than heritage work. The Call of Lovecraft is a self-guided, digital walking tour of Providence, based on the life and works of local writer, H.P. Lovecraft (1890 ? 1937), and accessed through a mobile device. The project was entirely funded through the IndieGogo crowdfunding platform, offering creative rewards to funders ? even including the opportunity to have a 'digital cat' embedded in the application's content named in their honour. While exploring physical sites of historical relevance, the user is presented with background information about each site and offered creative content paralleling the events of one of Lovecraft's most renowned short stories, "The Call of Cthulhu." As users follow the walking tour, they are pulled further into the fictional narrative, eventually reaching a gruesome conclusion in the heart of the city.
The tour consists of a multimedia archive of content delivered via a mobile application and a cloud-based database. The tour application uses augmented reality to enhance the user experience, and is built using the pre-existing platform, "Aurasma". To address tensions between the site- specific, geo-based application ? limited to users with mobile devices able to visit Providence in person ? and a desire to make the work accessible to wider audiences, a supporting website was created. This website acts as a gateway to the mobile application and a channel for social media content. The website will also serve as a central hub for future expansion of the project to greater historical research and crowdsourced contributions.
Working with emerging technology offers new and often frustrating challenges to small, under-resourced nonprofit organizations, but also provides new opportunities to engage a larger public with local heritage. Using The Call of Lovecraft as a case study, this paper will outline innovative methods for connecting new audiences to urban heritage. Through the active exploration of creative, site-based interventions, mobile technology can create unique and personal memories that connect users to their surroundings and introduce broader questions of identity, history, and place to the urban landscape.

Moving Instruction Beyond the Museum's Walls: Priorities in Online Public Education at the Oriental Institute

Kenyon Catherine [1], Grossman Kathryn [,2], Lorenz Megaera [,3], Hayden Brittany [,3]
1 : The Oriental Institute of the University of Chicago
2 : Bradley University
3 : The University of Chicago

This paper presents the results of the first two years of a new program of online museum education at the Oriental Institute of the University of Chicago. The Oriental Institute is an American research organization and museum devoted to the study of the ancient Near East. The Public Education and Outreach Department has long been a key part of the Oriental Institute, advancing its educational mission and helping both to grow the membership and to deepen members' connection to the institute. In 2011, the Office of Public Education at the Oriental Institute began developing a series of online courses as a complement to a long-standing program of non-credit, continuing education courses for adults.
In this new initiative of online education, the Oriental Institute has offered two completely web-based courses, hosted through the University of Chicago's Chalk (Blackboard) system. The first was a general overview of Mesopotamian history and culture, and the second a survey of Egyptian art and architecture. A third course on Egyptian hieroglyphs will be offered for the first time in

February of 2014. These courses have been small ? capped at 25 students ? in order to retain the extensive dialog between student and instructor that the University of Chicago is known for and that Oriental Institute's students have come to expect. The web-based courses have, nevertheless, dramatically expanded the global reach of the Oriental Institute, with students enrolling from Europe, South America, North America, and Australia.

Through detailed pre- and post-course surveys, we have been able to judge our effectiveness at conveying the desired content, as well as the degree of student satisfaction with the courses. In both cases we have been resoundingly successful. Even without such surveys, however, we could gauge the courses' success on the degree of student interaction. Weekly discussion boards were incredibly lively, sometimes with a class of 25 writing as many as 300 posts in a single week. This degree of student interaction is rare in traditional face-to-face classes at the Oriental Institute. This is one of the real benefits in shifting to this new educational format.

Plans are for continued expansion of the online learning initiative. Our goal is to use this new medium to connect students from around the world with the Oriental Institute's major research projects ? such as the Demotic Dictionary ? museum collection and leading scholars. For example, the new course, Deciphering the Past: Beginning Egyptian Hieroglyphs will bring students directly into the Oriental Institute Museum via video segments that supplement the lesson. The education staff is also in discussions with the University about developing an archaeology focused MOOC, a collaboration with between the Oriental Institute and other University of Chicago faculty. The MOOC would include a flipped classroom component where the instructor uses the MOOC as part of an undergraduate course. The Oriental Institute sees online education as an important frontier in reaching a global community of learners who wish to develop deeper connections to the world's global history.

Massive Open Online Archaeology: A first expedition into the world of MOOCs

Dufton J. Andrew*, Durusu-Tanrıöver Müge*, Alcock Susan
Joukowsky Institute for Archaeology and the Ancient World, Brown University (JIAAW) Brown University Box 1837 / 60 George Street Providence, RI 02912 http://brown.edu/Departments/Joukowsky_Institute/
* : Corresponding author

Massive Open Online Courses, or MOOCs, have recently electrified, mobilized, and ? in some cases ? terrified the world of higher education. The early success and institutional backing of MOOCs has led to a lively debate on the role of online education and the future of the university classroom. Over the summer of 2013, Brown University joined the growing list of MOOC creators and offered three such classes. One of these three was an introductory archaeological class entitled Archaeology's Dirty Little Secrets (ADLS), offered by Sue Alcock of the Joukowsky Institute for Archaeology and the Ancient World.

The response to the course was remarkable: more than 40,000 students enrolled, from over 100 countries and across all age brackets; 1.1 million videos viewed; 25,000 exercises submitted; 5,700 forum participants. These figures raise some interesting questions. What about ADLS resonated with our online audience? And what can we learn from this first experience about how to harness the power of the MOOC phenomenon for the field of archaeology?

From the outset, the team designing ADLS confronted some of the many ethical concerns surrounding MOOCs. What are the potential risks they bring to the future employment of young researchers in higher education? How permanent is the content created by MOOCs, and who owns the intellectual property rights? What copyright permissions are needed for dissemination to such large audiences? What is pedagogically lost with the lack of face to face, real time conversation? Since the MOOC phenomenon is still in its infancy, most of these issues are still actively debated. The ADLS team chose to approach the course as a balance between public outreach and academic discourse, being neither heavy on data nor archaeological theory, and addressing some of the more common misconceptions about our discipline.

The attrition rate in free, online education is often seen as a considerable barrier to effectively reaching massive audiences. Broadly speaking, most classes are finished by less than 10% of all enrolled students. To keep the ADLS students engaged, our design of the course dwelled on the principles of flexibility, accessibility, and interaction. Addressing the different learning styles inevitably presented by over 40,000 students, we deliberately offered variety in our course requirements. We also actively engaged, much more than is the norm in most MOOCs, in the online discussion forums as a way to interact with the students, as much and as frequently as possible. As a result, our ?completion' rate reached 13.6%, though we worked to make it clear to the class that any level of participation in the course was welcome.

The phenomenon of the Massive Open Online Course is just beginning, and seems likely to play an increasing role in education in the future. Using the experiences of the ADLS team as a case study, this paper aims to start a wider conversation on the potential of MOOCs for bringing academic archaeology to mainstream audiences and for finding ways to engage this large, interested and intelligent population with our discipline.

Session 12

Community Archaeology and Technology

(Thursday 24th 14h-19h Pantheon S1)

Chairs : Eleonora Gandolfi[1], Nicole Beale[1, 2],
1 : Archaeological Computing Research Group, University of Southampton (ACRG)
2 : Web Science Doctoral Training Centre, University of Southampton

Our purpose in this session is to estimate the viability and applicability of advanced technologies (in recording, management and/or communication of cultural heritage) for archaeology in a collaborative environment working together with communities.
Hi-specification technologies are increasingly becoming an essential element of archaeological recording, interpretation and dissemination, with previously expensive equipment such as laser scanners becoming cheaper. In addition to this, there has been a rapid development in low-cost technological solutions, with tools such as photogrammetry, Reflectance Transformation Imaging, 3D printing, and mobile device apps becoming popular amongst archaeologists. These technologies offer substantial improvements to the ways that archaeologists and communities can work together.
In light of these new opportunities for affordable technologies, the relationship between communities, cultural heritage organisations and universities has become increasingly pertinent. Budgetary constraints are becoming increasingly significant, and we are reminded on an almost daily basis of the importance of incorporating successful collaborations into the management of archaeology. These projects often use technologies for the recording of material culture and landscapes, the interpretation of data, and the communication of ideas. Methodologies for technology use are often decided along the way, and most projects have an emphasis on expertise remaining with those providing the equipment. There is an opportunity, with new technologies that adapt and adopt existing equipment, such as computational photography methods with open source software options, to transfer knowledge of highly sophisticated technologies over to communities.
Many in academia are calling for increasing forms of engagement between researchers and communities, and this session is an opportunity to discuss this move towards long-lasting relationships between communities and archaeologists within which technology is a central factor. Examples might include projects that have used web-based communication to maintain contact with a community, or projects that have relied heavily on open source solutions for recording.
Although the use of new technologies such as non-intrusive recording techniques, social media, can facilitate this type of engagement, this session welcomes submissions addressing legal, ethical and communication issues. We encourage participants to critically reflect upon their projects' use of technological solutions, the many forms of engagement, and the impact of these approaches on our vision of the past.

Community archaeology and geophysical survey: reflections on the Sensing the Iron Age and Roman Past project

Lockyear Kris [1*], Shlasko Ellen [1*], Bevan Andrew [,2]
1 : Institute of Archaeology UCL
http://www.ucl.ac.uk
2 : Institute of Archaeology, UCL
https://www.ucl.ac.uk/archaeology/people/staff/bevan
* : Corresponding author

Over the last three years the British Arts and Humanities Research Council has funded a series of projects under a cross-council funding scheme entitled Connected Communities. The aim of these grants were to enhance the connections between the academic sector and community heritage groups enabling, on the one hand, the universities to support these groups through training and other means, and on the other hand to undertake new joint research projects co-authored with members of those community groups. In archaeology «community heritage groups », in the form of archaeological societies, have a long history often predating the development of academic and professional archaeology. With increasing specialisation within archaeology and the rising costs of excavation and post-excavation, these more traditional forms of research are increasingly difficult for local societies to undertake. The success of the budget TRCIA resistance meter has made geophysical survey an attractive addition to types of work local societies can undertake. Resistance survey is by nature, however, slow, dependant on weather/ soil conditions, and usually undertaken at a low data density (e.g., 1 reading per square meter). In contrast, magnetometry is fast, can have a higher data density and is not seasonally dependent which has led it to be the technique of choice for commercial archaeology whenever possible. Access to the equipment remains a problem for community groups.
The Sensing project has enabled an alliance of archaeological societies from Hertfordshire to collaborate with UCL, local museum services and the Historic Environment Record to undertake a series of surveys, principally of the Roman town of Verulamium. The project purchased a Foerster four sensor cart system which will remain available to the collaborating community groups beyond the end of the project. This paper reviews the work of the project, including the people involved, the advantages and problems of the hardware and software involved and the planned online open access publication with direct links to the project's data archive.

The Phoenix Project: Using Heurist to Resurrect the MARTA Archaeological Collection and Atlanta's Past

Glover Jeffrey [1*], Johnson Ian [,2], Powers Alexis [1]
1 : Georgia State University
2 : University of Sydney
* : Corresponding author

During the 1970s Georgia State University (GSU) archaeologists conducted systematic excavations associated with the construction of the Metro Atlanta Rapid Transit Authority (MARTA) rail lines. This project recovered the material remains of Atlanta's past, and these materials represent the single most comprehensive archaeological collection of Atlanta's history. In addition, the excavations themselves are among the pioneering projects of urban archaeology in the then nascent field of CRM (Cultural Resource Management). Thus, just the excavation archive, which is part of the collection, is invaluable for the history of archaeology in the US, especially the burgeoning new field of urban archaeology. The entire collection (469 medium- sized «banker» boxes housing over 100,000 artifacts and all the accompanying documentation and excavation archive) has recently been returned to GSU. Showcasing significant «moments » in the life of the city, including several Civil War sites associated with the Battle of Atlanta, the majority of the collection corresponds to the late 19th and early 20th century, the time of Atlanta's rebirth as a major metropolitan area.

The greatest effort associated with this project is the digitization of the collection. The digitization includes data entry, scanning of field notes, reports, and maps, as well as the transformation of those data into an accessible dataset via the web. An archaeological project is only as good as its notes and records. This is particularly true when working with legacy data. The people working on the project today are not the ones who did the excavation, which can make the interpretation of the materials challenging. For that reason creating easily accessible and interpretable digitized field notes to accompany the other digital data is critical and is the reason GSU has joined forces with the Heurist team at the University of Sydney. Arts eResearch at the University of Sydney has been developing a flexible web-based database - Heurist - for Humanities data for the past 6 years. This database has been used in numerous research and public outreach projects. Heurist is unique in integrating and linking a wide variety of data, from quantitative data on artifacts and trenches through notes and photographs to mapping data and annotation of resources. Apart from providing a multi-user, web-based interface with different levels of security for different users, Heurist provides facilities for republishing the data for both professional and public access using a variety of output formats, from lists, maps and timelines to data feeds for input to other software or consolidator sites. The Heurist software went Open Source in 2013, and the database is being made publicly accessible. This paper discusses how Heurist has allowed this long-forgotten collection to finally shed light on the development of the Southeast's largest city and to engage the public about the benefits of archaeology in ways that were not even dreamed of when this project began in the 1970s.

Tablets and Tides: Excavation, data-sharing and community involvement on the Northwest Coast of British Columbia, Canada.

Kessick Sarah
Millennia Research Limited
http://millennia-research.com/

An extensive archaeological data recovery project involving Millennia Research Limited and two Coast Tsimshian communities, Metlakatla and Lax Kw'alaams, took place in 2012-2013 in Prince Rupert Harbour, BC, located on the northern Northwest Coast of North America. First Nations individuals participated in the excavation as both professionals and as ?junior archaeological assistants' who had no formal training in archaeology. Through the use of advanced data recording methods and real-time data sharing between Millennia Research and the remote (boat access) First Nation communities, the expedient dissemination of significant finds, such as human remains and formed artifacts, was achievable. This real-time data sharing greatly contributed to transparency of archaeological findings, and community awareness of the excavation.
The eight month excavation, primarily accomplished during the cold, wet and windy winter months typical of the northern Northwest Coast, challenged the technology designed to expediently record data. Tablet computers functioned despite being damp and dirty while cold fingers managed to operate them much easier than writing in soaking wet notebooks. Barcode scanners, used to link total station spatial data to attribute information recorded on tablet computers, saved time and reduced errors. Most First Nation ?junior archaeologists', with their knowledge of popular technology were able to make immediate contributions to data gathering and transmittal.
Throughout the project, the evolving interest and understanding of the junior archaeologists regarding the purpose of extensive and accurate data gathering became apparent. The ?juniors' watched demonstrations showing the progression of total station points into shaping 3D representations and on first viewing this, several exclaimed «this is just like I imagined it would look». The junior archaeologists assisted with setting up and maintaining the WiFi systems that linked tablet computers to cloud computers. One junior archaeologist with aptitude became expert in laser scanning of artifacts and in microscopic imagery; this allowed new ways to share imagery of artifacts and incorporation of artifact scans into GIS.
The advancements in technology and the participation and support from First Nation communities in archaeological data recovery projects is considered crucial to the proper management of archaeological resources as trade-related development accelerates on the Northwest Coast of Canada.

Public Archaeology

Richardson Lorna
University College London - London's Global University (UCL)
Gower Street - London, WC1E 6BT
http://www.ucl.ac.uk/

The growth of social media brings with it the ability for archaeological news to be shared and re-shared, re-shaped, reformed, and reinterpreted, within seconds. Sensationalist archaeological headlines makes great entertainment, and the nature of the Web means these stories do not go away. The information landscape of the Internet, especially when explored via search engines, privileges popularity over the ?low-circulation-high-quality' information that heritage professionals provide. Discrimination between ?authentic' credible archaeological information, and populist, inaccurate and misleading archaeological sensationalism, or even pseudo- archaeology, requires an ability to apply critical thought to information retrieved online. How do we, as professionals, promote our expertise, authenticity and authority to the Internet-using public?
This paper will look at case studies of inaccurate archaeological information pitched as 'tabloid titillation' and entertainment online and will ask if new landscapes of participatory digital media can fundamentally threaten the authority of archaeological organisations and knowledge? Can the use of the Internet as a form of entertainment misrepresent of archaeological knowledge in the public realm, and should we fear of the use of the Internet for the presentation of alternative archaeologies?

Developing 'Crowd and Community-fuelled Archaeological Research': methodological, technical and ethical challenges

Bonacchi Chiara [1], Pett Daniel [,2], Bevan Andrew [1]
1 : University College London - London's Global University (UCL)
Gower Street - London, WC1E 6BT
http://www.ucl.ac.uk/
2 : The British Museum

This paper will reflect on crowd-sourcing and crowd-funding as methods for engaging already established communities of interest in archaeology alongside a wider network of contributors, not only to co-produce archaeological data, but also to co-design original new research agendas and micro-finance them. We will introduce and critically discuss any inter-related methodological, technical and ethical challenges encountered in the set-up phase of an AHRC funded project conducted as a collaboration between the UCL Institute of Archaeology and the British Museum. As part of the project, we are testing the use of crowd-sourcing to enable different kinds of archaeological enthusiasts to co-create archaeological data and knowledge, and to attract funding through individually small but collectively significant donations. The paper will address the issues arising from the initial stages of the research on two main fronts. Firstly, we will examine the technological methods employed to build the crowd-sourcing platform micropasts. org in order to support a wholly participatory, rather than merely contributory, model of community engagement with archaeology. The project will be using completely open source tools and software solutions such as Wordpress, CrowdCrafting (Pybossa) and Discourse. Data generated through this project will also be released under a Creative Commons licence (CC0) and will be amalgamated with relevant resources and repositories (for example the Portable Antiquities Scheme database). Secondly, we will illustrate the ethical and methodological challenges of developing a framework for the evaluation of our co-production efforts. For example, we will show how the tension between the need of allowing contributors to remain anonymous and that of gathering data for the study of participant motivations, attitudes and behaviour has been dealt with. We will also present the ethical considerations that have informed the choice of what methods to use for collecting, storing and analysing personal information about our contributors. Conclusions will offer insights useful to support researchers and practitioners with the desire of using crowd-sourcing to foster collaborative kinds of community archaeology.

Making community-driven, open source investment work in archaeology

Ducke Benjamin
Independent researcher and software developer (IR/SD)
Berlin
http://www.gvsigce.org

Modern archaeology invariably involves software, and in most cases also Free and Open Source Software (FOSS). Apart from the critical importance of source code availability for fully transparent and reproducible data processing, there are also obvious economic incentives for using free software. However, while archaeologists benefit from an ever-growing FOSS repository, investment into the same remains minimal, especially compared to what is routinely paid for proprietary, closed-source licensing fees. This is regrettable, as FOSS offers a superior platform for technological collaboration and an alternative, non-redundant investment model that is more sustainable in the long term. Comparatively small individual contributions, pooled together, allow a community of investors to develop a rich library of free software, tailor-made and without usage restrictions. In theory, these are ideal preconditions for the diffusion of modern technology among communities of professionals, academics and hobbyists alike. In practice, however, there still seems to be widespread doubt about the quality, cost and feasibility of FOSS development.
Collaborative software development, from initial idea to usable program, remains a difficult task, not only in terms of mastering technological challenges, but also in terms of managing organisational complexities and social dynamics. Some FOSS projects fail because their initial design was too ambitious, others fail because they do not manage to attract a loyal base of supporters and simply run out of ressources. However, there is now more than sufficient evidence that a community the size of the archaeological one is well capable, in principle, of building its own "software commons" based on FOSS.
This paper looks at the economics of open source software, with special consideration to the structure of the archaeological software market. Insights into the aspects of planning, developing and sustaining customised software development under open source licenses will be provided. Some important lessons learned from a decade of contributing to open source software projects will be shared, and typical pitfalls will be discussed. Supporting the arguments made in favour of FOSS investment, two successful projects of relevance to this session, the surveying tool "survey2gis" and the full-featured FOSS GIS "gvSIG CE", will be showcased. This paper will provide the audience with some real-world facts on developing costs, time frames and socio- technological complexities that are hard to come by in the academic literature.

The ACCORD project: Archaeology Community Co- Production of Research Data

Jeffrey Stuart
Digital Design Studio, Glasgow School of Art (GSA) The Hub Pacific Quay Glasgow G51 1EA http://www.gsa.ac.uk/

This paper introduces the AHRC funded ACCORD project, a partnership between the Digital Design Studio at the Glasgow School of Art, Archaeology Scotland, the University of Manchester and the Royal Commision on Ancient and Historical Monuments of Scotland. The ACCORD project examines the opportunities and implications of digital visualisation technologies for community engagement and research through the co-creation of three-dimensional (3D) models of historic monuments and places.
Despite their increasing accessibility, techniques such as laser scanning, 3D modelling and 3D printing have remained firmly in the domain of heritage specialists. Expert forms of knowledge and/or professional priorities frame the use of digital visualisation technologies, and forms of community-based social value are rarely addressed. Consequently, the resulting digital objects fail to engage communities as a means of researching and representing their heritage, despite the now widespread recognition of the importance of community engagement and social value in the heritage sector. The ACCORD project addresses this gap through the co-design and co- production of an integrated research asset that encompasses social value and engages communities with transformative digital technologies.

ACCORD is creating a permanently archived open-access dataset of community co-produced 3D digital models of archaeological sites and monuments, integrated with expressions of social value and contextual documentation. The project actively engages community groups that have ongoing relationships to heritage places in the process of creating 3D records and models of those places. With the support of visualisation technologists, community engagement practitioners, and experts in social value, each community group will design, direct and produce their own 3D objects. The use of digital technologies to enhance and generate forms of social significance will be an important outcome, adding distinctive value to existing heritage assets and our understandings of them.
Evaluation will include a review of the transformative aspects of the process, investigating changes in attitudes to 3D recording technologies during the life of the project, as well as the forms of significance, authenticity and value acquired by the resulting 3D objects. Ultimately, through the co-production of an open-access dataset, and the creation of a 'community of communities' engaged in sharing skills and experiences, ACCORD seeks to broaden capacity for the creation and reuse of digital visualisation technologies in community heritage activities and research.

Create Once, Consume Anywhere: Curating Accessible Archaeological Content for Mobile Apps

Charno Michael [1], Zukowski Ed ,[2], Jeffrey Stuart [1]
1 : Archaeology Data Service (ADS)
2 : British Library

The Archaeology Data Service (ADS), founded in 1996, is a national repository for digital data from the UK historic environment sector. The ADS has a mandate to provide a digital repository for outputs from research funded by national funding bodies within the UK, which has led to a considerable archive of data and metadata related to the archaeology of the UK. While preservation is one pillar of responsibilities at the ADS, dissemination also plays a key role in the ADS's activities. The ADS supports a number of methods for disseminating data, most obviously via its website [http://archaeologydataservice.ac.uk], but also via OAI-PMH targets, SOAP web services, Linked Open Data, and even the humble CD-in-the-post. Mobile apps were recently investigated to compliment the existing methods of dissemination for ADS data. Mobile apps in particular were seen as a more accessible way to engage with the general public, a group which the ADS usually does not specifically target.
The development of the app, «Archaeology Britain» was a collaboration between the British Library and the ADS to create a general audience app with unique and interesting content from both organisations. Archaeology Britain contained curated content to try and portray rarely seen perspectives of British archaeological sites. The content within the app was a combination of open data from the ADS and «closed» data from the British Library and other heritage institutions. Disseminating this kind of mixed content is a function the mobile app as a platform is well suited. Until an open data utopia is realised, it will be argued that mobile apps can provide greater access to «closed» data, counter intuitively due to the propeitary nature of their distribution. Providing easy access to «closed» data is an important aspect of engaging with the community and telling them the archaeological story.
Before developing Archaeology Britain, the ADS supported a mobile app based on the England's Rock Art archive, which comprised of outputs from a volunteer project. This experience was a precursor to the development of Archaeology Britain and lessons from that project will be explored. This paper will then go on to discuss the process of producing an archaeological mobile app for a general audience, from the planning and inception to the release and promotion. Many challenges were presented while trying to curate an app targeted at the general user instead of the more academic user the ADS usually targets. Practical lessons of taking this often complex ADS content and curating it for a general audience will be discussed. A more controversial topic, platform choice, will be visited as well as the fallout, which ranges from user exclusion to fanboy rage. Many of these lessons aren't specific to mobile apps, but rather apply to a broader objective of disseminating archaeological knowledge and information to the public.

Co-Production of alternative views of lost heritage: Crowd-sourced Photogrammetry in Heritage recording

Wilson Andrew [1*], Roberts Jonathan [1], Karl Raimund [,2], Tiddeman Bernard [,3], Edwards Ben [,4]
1 : School of Computer Science, Bangor University Bangor University - Bangor -Gwynedd - LL57 2DG http://www.bangor.ac.uk/
2 : History, Welsh History and Archaeology, Bangor University Bangor University - Bangor -Gwynedd - LL57 2DG http://www.bangor.ac.uk/
3 : Computer Science, Aberystwyth University
4 : Department of History, Politics and Philosophy, Manchester Metropolitan University
* : Corresponding author

Being able to examine objects, sites and buildings three-dimensionally is a crucial element in interpreting many, if not most, heritage assets. This is reflected in modern heritage survey and recording techniques like topographical surveying, ground-based and/or airborne laser scanning of objects, sites and buildings, or three-dimensional geophysical survey methods (e.g., GPR), which are increasingly being used in archaeological fieldwork.
There is a huge opportunity to put these metric-sensing devices into the hands of the public to enable more crowd-sourced data. Crowd-sourcing in this way, has vast potential for heritage. It could enable a comprehensive coverage of metric scanning that would be impossible to be achieved by one or two research groups. It also encourages the wider public to become excited over our heritage, and ?get involved' in our historical environment.
On the one hand, while the cost of (say) laser scanners are decreasing rapidly they are still viewed as a research tool, or maybe a keen hobbyist, and are out-of-reach of the general public. On the other hand, the digital camera has become ubiquitous (everyone now has a camera); with smart-phones demonstrating mega-pixel counts on their cameras there is a huge opportunity to utilise cameras to perform metric survey.
Modern photogrammetric software solutions allow automated 3D rendering of objects from several 2D pictures taken of the object at random angles and distances. Using such solutions to create 3D renderings of excavation trenches and other objects has been successfully tested in the past few years (Roe 2010; Doneus et al. 2011; Verhoeven et al. 2012). This research has confirmed that the results are sufficiently accurate for archaeological recording interpretation. While such solutions have successfully been applied to current archaeological excavations and surveys, they have not yet been used by a wider audience, for crowed-sourcing of metric data. Naturally, not every suite of photos creates a good 3D model and therefore not every user's data will provide good metric data. However, with an online tutorial and guidance of best-practice, we believe that it is possible for a wider public to achieve high quality results. In addition, with the Wikipedia model of peer reviewing we believe that the ?management of quality' would be self-regulating, and that the better versions of a particular asset would be kept. Wikipedian's pride themselves on keeping quality and accurate articles, and likewise we propose the same pride and quality will occur here.
The Co-Production of alternative views of lost heritage project aims to use photographs taken by local community to create a comprehensive and accurate 2D, 3D and geo-location record of local heritage to provide a research-based asset of enduring value.

Session 13

Databases on cultural heritage and their geographic visualization

(Friday 25th 10h50-17h Pantheon S11)

Chairs : Michael Maerker [1, 2], Espen Uleberg [3], Volker Hochschild [4]

1 : Heidelberg Academy of Sciences & Humanities (HAW) Germany
2 : Department of Earth Sciences (DST) Firenze, Italy
3 : Kulturhistorisk Museum, Dokumentasjonsseksjonen OSLO - Norway
4 : Eberhard Karls University of Tübingen, Institute for Geography (EKUT) - Germany

As a follow up of the last CAA we would in this session like to bring together scientists working on different issues of visualization of data stored in Databases that are related to archaeology and cultural heritage. This comprises the technical prerequisites of DB-systems such as interface solutions that pass geographic, geodetic and 3D data to visualization tools (e.g. Postgis) as well as tools and interfaces that allow the visualization of these data like web based portrayal services, GIS systems, etc.. In addition, we want to discuss visualization issues related to metadata and data formats like vector, raster and voxel formats and also geographic data projections.
Moreover we will focus on open source solutions and would like to show some application examples in order to give an overview on state of the art solutions. Finally we will also discuss how user requirements can be considered already in the design of these systems to guarantee sustainability and acceptability of the targeted user. Here questions of visualization versus interaction might be focused.

ROAD Evolution - From Collecting Comprehensive Data to the Development of an Early Human Environment Simulation Tool

Hochschild Volker [1*], Märker Michael [1], Queneherve Geraldine [1*], Kanaeva Zara [1*], Hertler Christine [,2*]
1 : Physische Geographie und GIS Geographisches Institut Universitaet Tuebingen
2 : Universitaet Frankfurt Senckenberg Forschungsinstitut
* : Corresponding author

The assessment of early human expansions in a spatial, cultural and biological context must be supported with a variety of spatial datasets including variables and formats from different scientific sectors in vector, raster as well as text formats. Consequently, sophisticated geo relational spatial information systems are normally applied to handle the required information. In this paper we focus therefore not only on the spatial data and their visualization, the web- based ROAD database has been presented already on the previous CAA conferences. The focus was on querying the database in order to search for Early Hominin find places and related animal bones or jewelry etc.

This time we will focus primarily on the opportunities of the spatial system to simulate and predict early human developments and expansions through time by analyzing spatial relationships of find places and geo scientific criteria like relief (topography), ancient climate or distance to water supply, etc. By combining a cartographic representation with an interactive time slider, the final version should enable the user to visualize possible early human movement within and out of Africa into Eurasia in order to integrate the heterogeneous interdisciplinary knowledge of early human environments.

Archaeology in a context. A Key to an Administering Archaeology Information Heritage

Le?bychová Olga [1*], Kosarová Zdenka [,2], Jindáček Milan [,3]
1 : Institute of Archaeology of Academy of Sciences of the Czech Republic, Brno
Královopolská 147, Brno, 612 00
2 : Masaryk University
Kamenice 126/3, 625 00 Brno, République tchèque
https://www.muni.cz/
3 : SmartGIS, LLC
Tovární 42A, 779 00, Olomouc
* : Corresponding author

What do we handle and whom should we open it up? What sort of information and what sort of user groups do we operate with? There were these two basic questions at the beginning of our project in our archive of Institute of Archaeology. We wanted to effectively administrate information in the present, preserve information for the future and provide a comfortable access to information for the professionals and public. A community participation was a key word too. It was in 2009. By now we have been using our information system called The Central Evidence of Archaeological Excavations and the Digital Archive of Moravia and Silesia for three years.

I see its main benefit in enabling us to keep information from archaeological excavations in context and creating a central information source with interconnected information. It means we follow the life of an archaeological action (from detecting an action to closing the action by the accomplishing archaeological organisation) and keep all possible documents and information interconnected (from documents of National Heritage agenda to a final archaeology excavation report, photos, maps and so on). Except the archaeological action part and digital archive for documents, there are various other functions that simplified and improved our work and work of users too. An internal message system speeds up and streamlines communication of the archive and archaeological organisations, information system simplifies paperwork and administering of information (for the archive, National Heritage departement and licenced organisations), system provides a possibility to lead own agenda by licenced organisations and archaeologists («My Ac-

count»), user can access it by internet or by desktop, map modul enables direct visualisation of the excavation in a map and overall it improves foreknowledge and a mutual transparency of whole AE community (mapping field activities and existence of documents in the archive).
There is a pedagogical outreach of this project in EduMegalit which is a training modul of the information system used for students of archaeology. We also have experience with linking with other project ? Internet Encyclopaedia of Brno History - which lies in sharing some data from our information system in encyclopaedia database. Communication with other information systems of public administration is possible thanks to a support of communication interface XML ? RPC, web services and REST interface. In terms of technical solution, we successfully joined the commercial platform Megalit with open source products PostgreSQL, PostGIS, UMN MapServer. All functionality and capacity of the system is distributed on the internet in the form of «cloud ». All registered users create together a community, create together valuable data and safely spread them among themselves.
The client application for administering data and the digital documentation was written in Java language and is supported by all available operating systems. A robust solution allows off line work as well. The possibility to join own cooperating modules to the present system by organisations means that this information system has got ambitions to become a spine for other in-house systems of memory institutions

Reinventing the wheel? Data management system for archaeological collections

Pagi Hembo [1*], Sikk Kaarel [,2*]
1 : NGO Arheovisioon
http://wwww.arheovisioon.ee
2 : University of Tartu (UT)
http://www.ut.ee

We often think that we can do better than our predecessors. Over the last five months we have been working with a new archaeological data management system (called TARA) for the Archaeology Department of the University of Tartu in Estonia. Are we reinventing the wheel? Some years ago Stuard Eve presented the Archaeological Recording Kit (2008), a very flexible system, which can handle differently structured archaeological data. There are several other open source systems available. Time has passed and many new and useful web technologies are outperforming the classic PHP/MySQL approach.
Our goal was to create the system where all the data structure could be modified without the need of a developer or writing any line of code. At the same time we strive to provide a good user experience and flexibility. Main keywords to describe the design principles of TARA: unrestricting, unstructured, extendable, interconnectable (with non-textual media), fast, scalable. At the moment all of the department's data management is done using MS Excel spreadsheets. The main task of the the project is to get rid of the spreadsheets and merge it into system which provides a similar user experience via a web-based user interface. About 95% of the users are consumers of data, hence finding something fast is of utmost importance. The group of users acting as collection managers are doing data entry and for them very simple data-entry forms and workflows are created.
The technical approach has taken benefits from many new web technologies and approaches. The RESTful API ensures all the data being easily accessible from outside the application and enables us to create different output layers, such as OIA-PMH. The database system is a non-relational and no-SQL database, which makes many data-related procedures more flexible and faster. For a better user experience client-site data rendering is used. This is based on different . js-frameworks. All technologies used are open source - so is our project outcome. The project team contains developers who are specialised on museum- and cultural heritage related web-applications and two archaeologist with computer science background.

Integrating complex archaeological datasets from the Neolithic in a web-based GIS

Bruhn Kai-Christian [1], Engel Thomas [1*], Kohr Tobias [1*], Gronenborn Detlef [2]
1 : i3mainz - Institute for Spatial Information- and Surveying-Technology, University of Applied Sciences Mainz (i3mainz)
http://www.i3mainz.fh-mainz.de
2 : Römisch-Germanisches Zentralmuseum (RGZM)
http://web.rgzm.de/
* : Corresponding author

In course of a joint research project the i3mainz and the Römisch-Germanisches Zentralmuseum Mainz (RGZM) work on an archaeological information system serving for complex landscape-based settlement structure analyses. In the past decade a series of heterogeneous datasets of the West-Central European Neolithic have been generated through numerous MA-theses and dissertations but also various research projects. A key challenge is the integration of these complex project-specific data models with one-dimensional data tables of a Web GIS.
This paper will suggest potential ways to join archaeological data from various researchers and to combine relational data structures providing spatial access on the data to enable further analysis. This scenario entails multiple problems that are prototypical for similar projects, which still lack a general solution.
First of all, the data originates from research- and state crm-generated databases, covering different periods of the Neolithic as well as a variety of spatial extents. Each of these datasets was created to meet individual academic or public concerns, which is reflected in differing heterogeneous modeling of the archaeological information, in particular regarding space and time. Integrating these concepts is a complex task that needs a deep understanding of the underlying data models and attribute values. While, for instance, one dataset focus on the question of settlement continuity, another one has been assembled to tackle state preservation objectives. In order to address the challenges of integrating data with a long and diverse history of acquisition and maintenance a modular solution is proposed. It will be discussed in which dimensions and to which extent this modularization of data can be achieved ? bearing in mind the typical inaccuracy of crucial parts of archaeological datasets. The goal is to minimize 'data-noise', generated by aggregation, while keeping as many details as possible and necessary.
En route to implementing an information system the paper will evaluate potential open source frameworks with special focus on Arches, HeuristScholar and GeoNode: Arches as a framework designed for archaeology from an administrative point of view allowing for complex data structures complying to the CIDOC-CRM. In contrast, HeuristScholar addresses a wider audience by providing functionality for maintaining data and integrating several research and collaboration tools with less emphasis on GIS-features. Finally, the GeoNode framework has emerged from the geospatial community and has a strong focus on collaboration, data sharing and the use of OGC Web services. All frameworks will be evaluated concerning their strengths and shortcomings on the current, though prototypical, use case.
The paper addresses issues that concern several archaeological projects and illustrates approaches as to how these may be overcome. It suggests a modular data concept that is transferable to similar projects. At the same time it reviews qualified frameworks that allow for implementing an individually tailored data model into an archaeological information system with GIS capabilities.

Visualization based on the Norwegian university museums' database

Uleberg Espen [1], Matsumoto Mieko [2]
1 : Museum of Cultural History, University of Oslo (KHM) P.O. 6762 St. Olavs plass, N - 0130 Oslo - Norway http://www.khm.uio.no
2 : Museum of Cultural History, University of Oslo (KHM) P.O. 6762 St. Olavs plass, N - 0130 Oslo http://www.khm.uio.no/

This paper presents the most recent results from our on-going project «Dynamic Distributions », an investigation of relations between humans and landscapes in prehistory based on the archaeological collections at the Museum of Cultural History in Oslo. Earlier results from the project have been presented at CAA-Norway 2012 and CAA 2013. Landscape analyses of Stone Age artefacts from three counties in South-Eastern Norway and the relation between scale levels and precision were discussed. The five Norwegian university museums with archaeological collections contribute to a common, national database to register all finds, and this database is the main source for our project. While the database is only at the disposal for professionals, the general public have access to the archaeological collections for all of Norway through the website www.unimus.no. Metadata can also be freely downloaded as open data. At present, October 2013, the webpage gives access to more than 800 000 entries. The majority of the artefacts are registered with coordinates.

In the database, finds are registered with several coordinate systems, but on the webpage the coordinates are given in UTM 33, WGS84 and lat/long. The option to download the coordinate lists makes it possible for everyone to create their own distribution maps.

The coordinates for the sites have different precision levels. The precision levels reflect the known provenience and are therefore qualitative rather than quantitative levels (e.g. precise coordinates, exact site, administrative units like cadastral unit or parish, and geographical areas like fjord or mountain).

The precision is of vital importance for the types of analyses that can be based on the material and at what scales it will be meaningful to include the different objects; for instance an analyses of altitude or distance to water needs precise coordinates, while less exact provenience can be adequate for a nationwide distribution map at a courser scale. Recent plans for a common webservice for finds and the national sites and monuments register in Norway (Askeladden) actualize considerations on how to treat the different precision levels. At CAA2014 we will extend the analyses to a larger geographical area than in the previous work.

This context makes it possible to discuss the challenges of visualization when data with different precision levels are included in the analyses. The choices made on inclusion of different artifact groups and other map elements at different scale levels are crucial in understanding the use of prehistoric landscapes. The immediate interpretation of a map is guided by the aggregation of artefacts and landscape elements. Meaningful patterns can emerge when the archaeological material and landscape elements are shown at certain scale levels. In the search for meaningful scale levels, GIS will be the tool for Explorative Data Analyses. In this way, we move towards a deeper understanding of the Dynamic Distributions of artefacts in the landscape.

A digital heritage inventory development at Bronze Age sites at Bat, Sultanate of Oman

Kondo Yasuhisa [1*], Cable Charlotte [,2 ,3], Thornton Christopher [,4 ,5]
1 : Research Institute for Humanity and Nature
457-4 Motoyama, Kamigamo, Kita-ku, Kyoto, 603-8047 JAPAN
http://www.chikyu.ac.jp/
2 : Michigan State University (MSU)
http://www.msu.edu/
3 : Ministry of Heritage and Culture (MHC)
http://www.mhc.gov.om/
4 : National Geographic Society (NGS)
http://www.nationalgeographic.com/
5 : University of Pennsylvania (UPenn)
http://www.upenn.edu/
* : Corresponding author

Digital heritage inventory (DHI) is a database system with mapping functions, specially designed for cultural resource management. It is noteworthy that open source DHI applications, such as Arches (Myers et al. 2012), have rapidly been developed in last few years. DHI is potentially useful for archaeological projects to manage records of excavation, survey and other approaches applied in the fieldwork. Based on this idea, we applied a DHI to our archaeological fieldwork at Bat, Oman. This paper presents a preliminary result of this case study.

Bat is located in the interior of Oman, and known as the best-preserved oasis town and necropolis of the Bronze Age (ca. 3200?1000 BC) in the Southeast Arabian Peninsula. It was inscribed to the UNESCO World Heritage List with neighbouring archaeological sites of Al-Khutm and Al-Ayn in 1988. The American-Japanese Bat Archaeological Project (AJBAP) has carried out the field campaign since 2012, succeeding the American expedition (2007?2011). The project applied a combination of archaeological excavations, GPS-aided surveys, satellite remote sensing, over-head photography, and close-range airborne photography using a hexacopter camera in order to

document monuments such as circular platforms (called ?towers') and truncated-conical shaped cairn tombs (also called ?beehive tombs'). A number of specialists in various fields of research and based at various institutions participated in the project, and generated a massive volume of data and documents in various formats, dispersed in different places and hard drives.
As the first step to organise the dispersed data, we digitised paper-based documents (excavation sheets and drawings for example). Every file and archival entity (pictures, drawings, and documents for instance) was tagged with an international resource identifier (IRI, formerly called URI or uniform resource identifier) on the web. Records of monuments were implemented to a DHI, and linked to the related documents by referring to IRI. The organised data were shared with project members, and will be ready for further data sharing with governmental authorities, international researchers, and the public in the future.

A GIS-related Inventory of Lucanian Heritage

Duplouy Alain [1], Capozzoli Vincenzo [1], Costa Laurent [,2], Zambon Alessia [,3]
1 : Université Paris 1, Panthéon-Sorbonne (UP1)
Pres HesamUniversité Paris I - Panthéon-Sorbonne
12 place du Panthéon - 75231 Paris Cedex 05 http://www.univ-paris1.fr/
2 : Archéologies et Sciences de l'Antiquité (ArScAn)
Université Paris I - Panthéon-SorbonneCNRS : UMR7041
Maison René Ginouvès Boîte 3 21, allée de l'université 92023 NANTERRE CEDEX
http://web.mae.u-paris10.fr/recherche/arscan.htm
3 : Université Versailles Saint-Quentin en Yvelines (UVSQ) Université de Versailles Saint-Quentin-en-Yvelines (UVSQ) http://www.uvsq.fr/

The Department of Classical archaeology of the University Paris 1 has a long research tradition in the field of Greek and indigenous southern Italy, as well as a expertise in developing web- related GIS and databases in fieldwork archaeology (see for example the Itanos survey project, http://prospection-itanos.efa.gr and http://hyperion.ims.forth.gr/itanos_2011/Default.aspx). Benefiting from this experience, we are now involved in the project «Ancient Lucania: Archaeology and national heritage», funded by the City of Paris (Emergence).
Ancient Lucania, which covers southern Campania, the most part of Basilicata and northern Calabria, is the home of a pre-Roman civilization, whose acme is to be set between the 5th and the 3rd c. BC. Beside literary texts, we favoured an archaeological approach of this area. In order to understand and describe the process of Lucanian ethnogenesis, which is related to multiple transformations in the material culture from the end of 5th c. on (emergence of fortified settlements and sanctuaries, new pattern of rural settlements, appearance of arms and armours in tombs, etc.), we aim at compiling an online «Gazetteer of archaeological sites of Ancient Lucania». This tool will be offered to scholars as an online database (using FileMaker Pro 12) related to a GIS platform (using Dynmap 8) hosted on the Huma-num web server. By the end of the project in
2015, it will eventually contains the large number of archaeological sites discovered or investigated on a large scale in the second half of the twentieth century, in particular since the creation of the Soprintendenza of Basilicata fifty years ago. It will also help us to describe the complex pattern of variable material cultures of ancient Lucania as a polythetic assemblage. Forged by D. Clarke (Analytical Archaeology, 1968), the polythetic model offers an interesting tool to explain archaeological diversity by allowing variations in the definition of a specific culture. These variations and local peculiarities will be mapped and analysed through the GIS. As part of the former realm of Naples, which temporarily went into Napoleonic control, Lucania was already well explored by French travellers and cartographers during the 18th and 19th c. French antiquarians also contributed to the constitution of Lucanian collections in Parisian museums (Musée du Louvre, Cabinet des médailles, Musée du Petit Palais). Studying these antiquities is also part of the project. In association with curators, we are developing and compiling an «Inventory of Lucanian antiquities in Paris», as part of the Lucanian heritage database and GIS-platform. The scope of the project is to trace the itinerary of these objects through the history of collections, and to re-contextualize them in their archaeological culture.
In this paper we will present the development of the GIS-related inventory of Lucanian heritage, both from a technical and an archaeological perspectives.

MAPPA Open Data Metadata. The importance of archaeological background.

Gattiglia Gabriele, Anichini Francesca,*
MAPPA Lab - Dipartimento di Civiltà e Forme del Sapere - University of Pisa (MAPPA)
Via Trieste 38 56126 Pisa - Italy
www.mappaproject.org
* : Corresponding author

The MAPPA project set itself another highly innovative aim, quite revolutionary for Italian archaeology: lifting out of the archives the documents containing the data of archaeological investigations and making this information easily accessible to everyone and for any need: from research to protection, from urban planning to quality tourism, or even just for simple learned curiosity. This is how MOD (MAPPA Open Data archaeological archive) was conceived, the first Italian archive of open archaeological data, in keeping with European directives regarding easy access to Public Administration data, and to Research data. The MOD allows users to download the raw documentation and the grey literature of archaeological interventions. Originally conceived to collect the documentation of the excavations carried out in Pisa, the MOD considerably grew as the months went by. Also in consideration of the results of a survey promoted by the MAPPA project on «Open data and Italian archaeology», which showed how the need to share data is strongly felt by the majority of the archaeological community , the MOD, a little at a time, has become the open data archive of Italian archaeology, where archaeologists can publish excavation data, in fact entering archaeological documentation in the MOD is a publication to all effects, whose authorship is protected by a DOI (Digital Object Identifier) code and a CC BY or CC BY SA license.
The first step was to create a 1 (Tim Bernard Lee) star archive and to transform it step by step to a 5 star repository. This year the MOD entered in the list of recommended repositories of the Journal of Open Archaeological Data. So the new step was to provide the MOD with a standardised management of the metadata referred to the single dataset, defining a minimum set of information so as to guarantee correct use of the data. Each archaeological intervention is associated with all the related data, from archaeographic documentation, the structure and format of the digital data, according to a schema that describes the history of the archaeological intervention, the sources used for creating the dataset, the method and the structure of the data and the physical data relations. The MOD Metadata schema is based on Dublin Core and the ISO 19115 schemas. A particular relevance in the schema is given to the description of the methodological background of the archaeological intervention: who direct the intervention, in which year, with what kind of method and so on. This part of the metadata schema is fundamental to translate to future generation of archaeologists the subjective part of the archaeological record, because only the comprehension of the methodological background permit a real semantic interoperability.

Coin Iconography and Geographic Visualization: the ? Digital Iconographic Atlas of Numismatics in Antiquity' (DIANA)

Caccamo Caltabiano Maria [1*], Salamone Grazia [1], Celesti Antonio [1], Nucita Andrea [1]
1 : University of Messina
* : Corresponding author

Coins, as public and official documents of a homogeneous nature, are ideal for identifying the subjects and themes of the figurative culture of antiquity. Through coin images the issuer achieves a process of clear and concise communication, directed at a wide public. The presence of one or the concentration of more iconographic subjects, helps us to view coin images as historical documents of the cultural environment which produced them, and to identify culturally homogeneous geographical areas.
The Digital Iconographic Atlas of Numismatics in Antiquity (DIANA) is a web application that allows to analyze «coin iconographies» according to time and space through digital maps.
Our archive highlights the geographical distribution of the issuing cities and their diachronical

activity in striking coins in order to:
- create a digital INDEX of the ancient Mediterranean mints (Greek and Roman Periods);
- codify their NAMES;
- display their TOPOGRAPHICAL DISTRIBUTION on digital maps;
- identify the PERIODS OF MINTING ACTIVITY;
- simplify the INTERPRETATION OF COIN ICONOGRAPHY;
- reconstruct the RELATIONS AND INFLUENCES BETWEEN PEOPLES in the Mediterranean. The DIANA's digital archive is based on a relational Data Base Management System (DBMS). The web application is developed combining both server-side and client-side programming languages. The server-side is developed using the PHP language, whereas the client-side is developed using Javascript. In order to provide users a good degree of reactiveness, DIANA has been developed adopting the Asynchronous JavaScript and XML (AJAX) programmingtechnique. In order to build digital maps, the system uses the Google Maps Platform as a Service (PaaS). By means of AJAX requests, data are retrieved on the DIANA's digital archive and they are sent in XML format to the user's web browser. After that, the web browser processes the received data and it forwards a second AJAX request to Google Maps that returns a digital map displaying the mint and ancient coins. Compared to other existing web applications, strength is the standardization of all the 'voices' to be used for the description of the coin iconographies. The entries are the types surveyed within the Lexicon Iconographicum Numismaticae (Universities of Messina, Bologna, Genoa and Milan), including Personages, Animals/Monsters, Flora and Objects. All the other search options are standardized.

The DIANA project responds to a real need, since there is no general work providing organized documentation in the field of coin iconography and also to the well-known need in the archaeological field for a concise and immediate picture of the figurative subjects and themes adopted in official contexts, to verify their appurtenance and coherence with the cultural heritage of the country. In the future it will be possible extend the project's scope to cover wider periods of history and geographical areas. Such a digital ?library' allows to disseminate easily the results achieved and also to put into motion dynamics of identity within the common cultural figurative heritage ofthe ancient Mediterranean and to facilitate promotional initiatives linked to the territory and sustainable development.

The Authors will present a case-study on the City Personifications.

Handling interdisciplinary data in an archaeological research project: A case study from Northern Germany

Mennenga Moritz
Lower Saxony Institute for Historical Coastal Research (NIhK)
Viktoriastraße 26/26, D-26382 Wilhelmshaven
www.nihk.de

The application of databases to store and process archaeological data has been used for many years. Archaeological data is often also spatial data, in conventional databases this spatial aspect can be neglected. In both cases of, the recording of finds and features during the course of fieldwork and of literary research, the management of these huge quantities of (spatial) data is nearly impossible without a good digital storage structure.

Within the project «Settlement and land use in Neolithic northwest Germany» a lot of data has been collected, this was based on earlier excavations, new research excavations, commercial excavations, geophysical and palynological research. This project is part of the German Science Foundation's priority program 1400 «Early Monumentality and social Differentiation». To visualise and analyse this data quickly and efficiently a system was developed that is almost completely based on open source programs and enables an on the fly handling from the excavation to the visualization and the analysis. A further development of the work is the inclusion of data from other project partners like the integration of geology, soil science and finds restoration. In this way it is possible to generate a virtual workspace which follows the standard of interdisciplinary research and give the possibility for a combined spatial statistical analysis.

On the excavations and for the input of the data Microsoft Access and AutoCAD was used, the database was a PostgreSQL system with a Postgis plugin, the visualisation was implemented with QGIS. Although proprietary software was included it is possible to use solely open solutions, these are tested and will also be presented

Session 14

Practising Digital Cartography in Archaeology: What is at Stake?

(Friday 25th 8h30-13h Pantheon S1)

Chairs : Piraye Haciğüzeller[1, 2] , Gary Lock[1]
1 : University of Oxford
2 : Univeristy of Leuven

There has been a rapid proliferation and popularisation of digital mapping technologies and related practices over the last two decades mainly thanks to the advances in GIS and in internet mapping (Haklay et al. 2008). The implications of digital mapping technologies are certainly far-reaching in terms of sharing and creating spatial knowledge. These technologies are likely to have brought changes to cartography which are as profound and broad as the popularisation of printing in the fifteenth century (cf. Pickles 2004).
Various types of digital mapping practices ubiquitously take place in archaeology today. With the introduction of geographical information systems (GIS) to the discipline in the 1990s, digital mapping has quickly proliferated and replaced traditional pen-and-paper mapping within research contexts. Yet, scrutinizing the implications of digital cartographic practices for the discipline is a pending challenge as the topic is so vast. Related technological developments show no sign of slowing down thus enabling new digital mapping practices to develop continuously. Moreover, coming to terms with the theory-laden nature of digital technology has historically and notoriously been a slow process in archaeology and there is certainly a large unexplored terrain there for future research. Specifically, while archaeological GIS has received some degree of attention for its epistemological implications, this attention has almost exclusively been paid to the analytical component of GIS and rarely the technology's cartographic capabilities (i.e. the way in which it displays spatial information). Also, it has often been overlooked that there are other, non-GIS, agents routinely involved in the digital mapping of archaeological information which also significantly shape the processes of carrying out archaeological research (e.g. image editing software, tablet computers, GPS). Indeed, if we are to accept the insight from science- technology-studies that technologies shapes us and effect what we (want to) do (cf. Pickering 1995), there is still a detailed discussion to be had on the ways in which this happens within the context of archaeological digital mapping. Accordingly, this session aims to focus on two main issues: how various digital cartographic technologies and practices shape the way in which we do archaeology (in comparison to pen-and-paper mapping), to what extent are the ways we think spatially and represent spatial relationships controlled and constrained by these technologies, what theoretical approaches would enable the archaeological implications of these technologies and practices to be opened to critical scrutiny.
As such, the session welcomes contributions that address possible social theoretic approaches (e.g. science-technology-studies) which can be employed to critically reflect upon digital mapping phenomena in archaeological contexts. The session also welcomes case studies that aim to critically re-think the impact of digital mapping technologies on the ways in which we do archaeology.

Maps that move: integrating intangible and living heritage into archaeological representations of multi- scalar landscapes.

Thomas E. Jaydeyn [1,2]
1 : The University of Queensland (UQ)
The University of Queensland Brisbane St Lucia, QLD 4072
http://www.uq.edu.au/
2 : James Cook University (JCU) Cairns http://www.jcu.edu.au/sass/aas/

Archaeological sites are not isolated islands of information. They are always emplaced in landscapes of social memory, cultural construction and interconnectedness between their past creators and their present consumers ? the viewers of sites who give meaning to this heritage. A crucial step in the process of cultural heritage management surveys of sites and landscapes is the representation of places and of the knowledge and significance of places held by Traditional Custodians (descendants of the original creators of heritage places) and a range of stakeholders, including the general public and people making development decisions under heritage laws. This paper will discuss the effect of integrating multiple forms of heritage (tangible, intangible, living, and management) through 3D animated mapping of heritage places, using ArcGIS point data and Blender animation software packages. I also explore how the use of a new digital medium for presenting and re-presenting integrated heritage maps may change the understanding and interpretation of Australian Aboriginal heritage places. I use a specific case study to illustrate my methods ? the Gummingurru stone arrangement site on the Darling Downs of southern Queensland, Australia.

Archaeologists and heritage practitioners working at the Gummingurru stone arrangement have engaged with this place at a range of different levels: on the artefactual-scale of each individual rock's measurements, position and appearance; through the site-scale of yuree (totemic) motifs and intangible heritage knowledge of the Jarowair Traditional Custodians; to the regional-scale of journeying interconnections throughout southeast Queensland and northern New South Wales. Archaeologists and heritage professionals have investigated, interpreted, represented and engaged with each of these scaled elements within multiple dimensions of geographical and cultural knowledge.

Gummingurru is currently a 5ha site and was once a secret-sacred men's Initiation place, where responsibilities were imparted at different life stages and where disputes were resolved and trade and other social interactions were undertaken. The last known use of the site for these purposes was in 1893, after which the Jarowair people were forcibly removed from their land and sent to missions around Queensland. Today, the site is owned by the Jarowair Traditional Custodians acting as the Gummingurru Aboriginal Corporation and is used as a reconciliation place for the education of school children and the general public - a resurrection and reworking of its original purposes. Mapping each individual stone on this living heritage site was undertaken between 2006 and 2010, where the position and cultural context of each motif were recorded using a phenomenological counter-mapping framework. This approach has supported an engagement with place that has successfully produced several counter-maps integrating movement, interconnections and pathways between various sites and places in the Gummingurru cultural landscape. The maps have been developed in 2D and 3D digital environments, and are used as the basis of general public outreach and as part of teaching kits designed to be integrated into the Australian National Curriculum for all school levels.

Geosophical Information Systems

Gillings Mark*
University of Leicester
School of Archaeology and Ancient History, University of Leicester, University Road, Leicester, LE1 7RH
http://www2.le.ac.uk/departments/archaeology

* : Corresponding author

«Few archaeologists would now deny that it is necessary to consider issues of meaning and subjectivity to achieve a full understanding of archaeological landscapes, and further that they would accept the starting point of the phenomenological tradition, namely, that understanding human experience is necessary but is not a commonsense undertaking» (Johnson 2012: 279). Johnson's claim highlights a growing acceptance of the value of experiential considerations in helping to structure our investigations of past social landscapes; considerations that stress the explicit interpretative value of sensory and bodily engagement. The aim of this presentation is to establish whether cartographic techniques (and in particular digital cartographies such as GIS) have any role to play in realising and effecting this agenda.
Since the introduction of such perspectives in the early 90s in the guise of landscape- phenomenology, there has been an almost pathological aversion to the practices of mapping in general (deemed an unnecessary second order mode of representation) and technologies such as GIS/VRM in particular (cast as objectivist tools indivisibly wedded to the tenets of modernity). Put simply, digital cartographies were argued to have nothing to offer experiential landscape study. This was despite the existence of an often remarkably creative body of digital cartographic work that directly cited landscape-phenomenology as its inspiration.
I intend to argue that not only does GIS-based cartography have a place, but that its use can yield wholly new ways of framing and shaping such studies. This is through the mapping not of properties of the landscape or features placed upon it, but instead the relational affordances that may have existed between people and the landscapes they inhabited; affordances that can be material, sensory, experiential, psychological or all of the above. This is not so much a cartography of authoritative representation, as one of provocation, stimulation and consideration. A tool to think with.
To frame this I introduce the term ?Geosophical Information System', drawing explicitly upon the idea of ?Geosophy' introduced by the Geographer John Kirtland Wright (1947). Wright suggested that we needed a term separate from Geography, to refer explicitly to the science of local, contingent spatial knowledge ? how individuals and groups understood and communicated the spatiality of their own lived worlds. Explicit in his formulation was the idea of multiple geosophic maps (as opposed to a single, authoritative geographic map) and how we might use these to explore the spatiality of the world as it was understood by those living dwelling within it. Through some provisional case-studies (drawing on influences as diverse as Geomorphometry and Psychogeography) I aim to show how we can use GIS to generate precisely the kind of maps Kirtland pondered, not only to inform our on-going experiential studies, but also feed back into field practices in order to fashion a new kind of experiential landscape study. In introducing Geosophical Information Systems my aim is not to burden the discipline with yet another discrete pathway or acronym but instead to offer a rallying point around which emerging debates and applications can cohere.

What do we do when we map? Critical auto-ethnography of map making

Mlekuz Dimitrij
University of Ljubljana (SLOVENIA) (Uni-Lj)

In archaeology, as in every other science, knowledge is not discovered, but constructed, produced, crafted through scientific practice. Work of landscape archaeologists employ diverse series of practices, tools, technologies, theories and skills through which we produce knowledge about landscapes. Mapmaking is thus ?motleys' of practices, instrumentations, theories and people, more or less successfully brought together.
Archaeological mapping or map making is an engagement with past landscape, a practice of landscaping, practice by which we fix, define certain relations in landscape and leave other fluid. When we map, our practice of map making become intertwined with the practice that left the traces in the landscape. By mapping we are also involved in the production of landscape. Map making is therefore a "landscaping", set of practices, habits, actions and events, ongoing processes

of relating and unrelating that create past landscapes. But maps are not fixed at the moment of production. Map making should be seen and practiced as an open ended processes, «detachable, reversible, susceptible to constant modification.» As such, maps and mappings are both representations and practices simultaneously. They are are open to interpretation, contested, and mutable.
Paper offers critical auto ethnography of map making, an reflexive account on how we painstakingly construct past landscapes, stitch them together imperfectly, with tools, data, theories that we have at hand.
It focuses on issues of symmetry between map makers, maps, tools and technologies involved and production of past landscapes. It focuses on practices such as movement as essential in the weaving the maps together.
Thus an account how landscape can be viewed as a product of practices, movements, trajectories, interrelations and flows. In this sense map becomes a continuous weaving, relating and associating, forever in the making. This also prompts us to shift thinking about past landscape in practical and processual terms, as something that was in a perpetual state of becoming, made and remade by practices. It makes us focus on the ways in which people routinely and creatively interact ? with landscapes in their daily lives, along with associated embodied and technologised practices.

On the Potential Contribution of Material Culture Studies to (Digital) Cartographic Theory

Hacigüzeller Piraye*
University of Oxford (UK)
* : Corresponding author

Since the end of the 1980s, with the influence of «linguistic» and «cultural» turns in the social sciences and humanities, cartographic theory has been dominated by post-structuralist deconstructions of «the map». In this context, geographer J. B. Harley's 1989 paper, Deconstructing the Map, has been influential and pioneering.
More recently, however, there have been calls for moving beyond such deconstructivist approaches and rather, put the ontological security of maps into question. More specifically, the call has been for questioning whether maps ever are (i.e. fully and permanently become) instead of being in a continuous process of becoming in a world itself that comprises relations that are never fixed and ever changing (cf. Kitchin et al. 2013). As a result, the knowledge about mapping processes is becoming a more valid and sought after one in cartographic theory than the knowledge about representational qualities of maps (e.g. accuracy, scale, projection, symbolisation, readability) and their fixed meaning (e.g. in relation to the political agenda against which they were produced) . Given this theoretical background, it should come as no surprise that the implications of various novel digital cartographic practices are also considered more often within this new epistemological framework that prioritises digital mapping process over qualities of digital maps as «immutable» representations (e.g. Perkins 2013).
After elaborating on these points regarding state-of-the-art in cartographic theory in general and implications of novel digital cartographic practices in particular, it will be highlighted in the presentation that the «material culture studies» in archaeology and anthropology has much to contribute to the type of «processual thinking» that is sought after in today's cartographic theory. While this point is being highlighted, the main emphasis will be put on two approaches that are often devised in material culture studies to treat «artefacts as processes»: biographical approach (cf. Kopytoff 1986; see also Morgan 2012) and operational sequences approach (cf. Dobres 2000). Finally, the potential usefulness of operational sequence approach for understanding the implications of archaeological digital cartography (in comparison to pen-and-paper cartography) will be illustrated through a case example carried out within Çatalhöyük Research Project (Konya, Turkey).

Heisenberg and the archaeological map: what quantum theory can teach us about the nature of cartography.

Green Chris*
Institute of Archaeology, University of Oxford (UoO)
University of Oxford, Institute of Archaeology, 34-36 Beaumont Street, Oxford, OX1 2PG.
http://www.arch.ox.ac.uk/
* : Corresponding author

Quantum theory is the science of the very small, the sub-atomic structure of all matter in the universe. Key to the explanatory potential of quantum theory is Heisenberg's uncertainty principle, first outlined in 1927. This states that the more accurately one is able to measure the position of a particle, the less accurately one may measure its speed. Positional uncertainty multiplied by uncertainty in velocity can never be smaller than a specific quantity known as Planck's constant. How one measures the position or speed has no effect on this limit, nor does the type of particle. The uncertainty principle is «a fundamental, inescapable property of the world» (Hawking 1988: 62-63).

Used metaphorically, the uncertainty principle can help to understand certain equally fundamental features of modern GIS-based and web-based cartography. Specifically and especially, it elucidates the effects of how a cartographer is able to legibly combine more than one mapped attribute of any given distribution and the effects of changing spatial scale on this process. For example, the more precision one applies to one attribute (e.g. time period), the less precision one can apply to another (e.g. site type), if one wants to produce a readable map output (which should be an unquestionable goal). As one moves from broad to narrower spatial scales, the amount of detail that can be included on any given map is increased, as is the spatial resolution at which features can be mapped, but with an inevitable loss of wider contextual information.

We have entered an age where aesthetically pleasing (on the surface at least) digital maps can be produced by any reasonably computer literate person (e.g. programming using the Google Maps API requires little beyond some knowledge of Javascript and HTML), but lack of awareness of the quest for cartographic clarity can make many of these modern maps next to useless if one attempts to apply them for any kind of research or exploratory purpose beyond a casual browse. Broader knowledge of the effects of this metaphoric uncertainty principle upon how much detail can be legibly presented to a reader (whether online or in print) should help to bring computer cartography (where practiced poorly) back to a point where results can be more easily and readily understood by our audiences.

This paper expands upon ideas initially presented in a wider ranging paper at CAA in 2013.

The archaeological distribution map: where are the emperor's clothes?

Verhagen Philip [1]
1 : Research institute for the heritage and history of the Cultural Landscape and Urban Environment (CLUE)
VU University Amsterdam Faculty of Arts De Boelelaan 1105 1081 HV Amsterdam
http://clue.nu/

The use of automated cartography and database management systems in regional archaeological studies has in general led to better designed maps, but not to a drastically different approach to mapping. The distribution map, that has been a favourite visual and analytical aid of archaeologists for at least 50 years, has become easier to produce; and various aspects of site distribution, in particular chronology and functional type, are now more quickly mapped. In fact, with the increased use of high-precision mapping using GPS and LiDAR, the focus seems to be more and more on collecting all the dots on the map. However, the concept of the site or settlement as a fixed point in geographical space with precisely known attributes and boundaries has generally not been challenged, despite the lip service that is habitually paid in regional settlement studies to the uncertainties involved in mapping and interpreting archaeological sites. This is surprising, since geographical theory regarding uncertainty has been around for at least as long as GIS; and modern cartographic tools allow us to visualize the uncertainties of our interpretations.

The issue therefore surely is not just a technological one; there is a reluctance, or maybe even resistance within the discipline to deal with uncertainty in archaeological site data. Instead, we are trying to make uncertainty disappear by using ever more precise mapping tools. Uncertainty

is however a complex topic that not just involves measurement errors, but all kinds of ambiguities that cannot be easily captured in quantitative terms; furthermore, it is a dynamic property, since new research is often carried out in order to reduce uncertainties in existing data. And while some researchers have tried to deal with this, e.g. by using the concepts of fuzzy logic (e.g. Green 2008; Nicolucci and Hermon 2010; De Runz et al. 2011), aoristic analysis (e.g. Crema 2011), or by using more complex data models (e.g. Rodier and Saligny 2008), an approach to comprehensively address uncertainty in archaeological mapping still has to be developed.
In this paper, I will approach the issue from a practical point of view. The Dutch national archaeological database ARCHIS is a major source of archaeological information in The Netherlands. Yet, its quality is considered to be below the standards needed for scientific archaeological research purposes. Using an example dealing with settlement data from the Roman period, I will highlight the problems of systematically addressing this quality issue, but also how we can use this knowledge of uncertainty to advantage in publication and analysis. I will specifically focus on the problems of dating, reliability of location and reliability of interpretation of finds.

The Rise of the Machine': the impact of digital tablet recording in the field at Çatalhöyük, Turkey.

Issavi Justine [1*], Taylor James [,2 ,3]
1 : Stanford Archaeology Centre
Anthropology Department, Stanford University.
https://www.stanford.edu/dept/archaeology/cgi-bin/drupal/justine-issavi
2 : Çatalhöyük Research Project
Stanford Archaeology Centre, Anthropology Department, Stanford University, US.
http://www.catalhoyuk.com
3 : Department of Archaeology, University of York The King's Manor, York. YO1 7EP. http://www.york.ac.uk/archaeology/research/research-students/james-taylor/
* : Corresponding author

This paper critically examines the process of the adoption of tablet based primary recording of archaeology at the complex Neolithic tell site of Çatalhöyük, in south-central Turkey. From its inception the Çatalhöyük Research Project has always striven to engage with new technologies and digital solutions to archaeological site recording and data management, and has always actively encouraged experimentation in this field by core team members and various independent researchers in an effort to understand how they might help make the process of recording both more efficient and potentially more reflexive.
Recently the project has begun to move towards a model of ?paperless recording', seeking to do this within its well-established framework of reflexive methodologies. To date the focus of this paperless approach has been upon the graphic elements of the archive, and here we aim to outline how increasingly affordable and robust tablet and software solutions have allowed us to harness our intra-site GIS in the field, alongside on-going experimentation with 3D technologies in the field, both as an aid to recording and interpretation.
The case study presented here aims to explore the epistemological implications of the creation of archaeological knowledge at Çatalhöyük, as the use of tablet technology in the field begins to replace traditional hand-measured and hand-drawn approaches to the generation of the graphic archive. What do we sacrifice and what do we gain from moving away from traditional methods of graphic recording? How close are these technological solutions to being viable in the field, and where are the sticking points? Our critique examines these technologies and their impact upon the primary recording process from a theoretical perspective, considering both their advantages and disadvantages, in terms of how they affect our interaction with the archaeology, the implications of technological elitism and their importance as tools for harnessing, storing, compiling, and analysing ?situated knowledge' as a fundamental part of the interpretative process.

Cartography and monuments: past practice and future potential for mapping Scotland's cultural heritage

Mckeague Peter [1]
1 : Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS)
16 Bernard Terrace, Edinburgh, Scotland, EH8 9NX
www.rcahms.gov.uk

In Britain, responsibility for the depiction of 'antiquities' - archaeological and architectural significant monuments - on maps published by the national mapping agency, the Ordnance Survey (OS) rests with English Heritage, and the Royal Commissions on the Ancient and Historical Monuments of Scotland and Wales (RCAHMS and RCAHMW). Information published is drawn from survey work undertaken by each organisation. As publisher, the OS retains overall editorial control for publication of mapped detail. This formal relationship has been maintained through the transition from paper to digital both in the availability of alternate large-scale mapping and orthoimagery products coupled with an increase in the range of technologies and number of organisations collecting data.

To understand the potential that digital cartographic approaches offer for presenting the historic environment, the governance and the constraints for the depiction of antiquities on OS maps and the limitations imposed through the medium of paper maps will be discussed before exploring the opportunities and challenges digital cartography offers in providing much richer spatial datasets. Benefits of digital spatial data are easily demonstrated through web-GIS browsers, such as PastMap (www.pastmap.gov.uk) which presents a range of statutory datasets from Historic Scotland alongside data from RCAHMS and most of the local authority Historic Environment Records in a single portal. PastMap has the potential to consume Web Map and Web Feature Services, such as those mandated through the INSPIRE Directive which defines minimum standards for common themes across Europe. Subject to copyright, these same services could also be consumed directly into end users systems integrated with their own data and background information or displayed against popular browsers such as Google Earth. In the future, moves towards Open Data will further encourage novel approaches to sharing and reusing data. However, the supply of spatial data forms only part of the equation. Commercial archaeology now plays an increasingly significant part in mapping Scotland's heritage, for instance in response to afforestation proposals or renewable energy schemes. Yet the potential of the data gathered by the private sector is not recognised. Focus is inward, on completing individual projects without contributing to a wider vision of mapping the historic environment.

Through community engagement projects like Scotland's Rural Past (http://www. scotlandsruralpast.org.uk/), RCAHMS provides guidance to help groups participate in contributing accurate and consistent records to the national record and archive.

In the context of a national body of record, digital cartography enables the publication of comprehensive spatial datasets far beyond that possible through paper maps. It also enables information to be shared much more easily and integrated with other datasets. Digital technologies, coupled with the growth in professional archaeology, research and community projects have resulted in the creation of a much greater wealth of spatial data though the requisite data standards are missing. However standards do exist in the form of the CIDOC-CRM and Midas Heritage but the linkage between database and cartography is often overlooked although they form a single continuum.

Example of strategy for an optimized digital mapping of an excavation. Implementation in the site of Puig Ciutat, Orista, Barcelona

Pujol Angels [1*], Tamba Robert [2,3], Garcia Ekhine [4*], Padrós Carles [1,5*], Sala Roger [1,3*]

1 : Associació GIRA (GIRA)

2 : Universitat de Barcelona (UB)

University of Barcelona Gran Via de les Corts Catalanes, 585 08007 Barcelona

http://www.ub.edu/web/ub/en/index.html?

3 : SOT Archaeological Prospection (SOT)

http://www.sotprospection.com/eng/index.php

4 : Universidad del País Vasco - Euskal Herriko Unibertsitatea

5 : Institut Català d'Arqueologia Clàssica (ICAC)

* : Corresponding author

The digital mapping of features during the excavation process with total stations, photogrammetry or referenced ortho-rectified photography has been in expansion in archaeology. Nevertheless, the use of such tools requires a strategy that would help to fully benefit of their power and decrease properly the amount of post-processing usually needed for the manual recording of the data.

In this paper we present the methodology implemented at the archaeological site of Puig Ciutat, Oristà, Barcelona. The objectives were to identify and separate the different categories of elements that needed to be mapped and to find a format that would enable an easy export to a GIS platform. These objectives had to consider the specific needs of the archaeologists in order not to lose the advantages of a manual recording of the data.

The digital mapping of the excavation was divided into categories which can be site dependent. The defined categories were: elements to be mapped (artefacts, stratigraphic units, sediments samplings), referenced photography associated to the elements, archaeological sections and global references (fixed origin and end of the sections, reference points for photogrammetry, delimitation of the excavation areas). The nomenclature of the acquired data was decided with the objective of an easy export and to avoid redundancy. It is divided in two fields. The name identifies the acquired point and is divided into an identifier and a number separated by a fixed special character as a hyphen. The code identifies the stratigraphic unit to which it belongs.

The result of an acquisition can then always be described with 3 fields which is a fixed format and a unique identifier. It can be directly displayed by category in the GIS platform for post- processing. The export and control of the data was done on a regular base during the campaign. The post-processing that is needed includes the completion of the description fields implemented in the global database, the georeferenciation of the photographies, the integration of the sections, the transformation of the planimetries into 2D polygons and 3D surfaces. The use of the ortho-photography during the interpretation of the data allows the recovery of the detailed information that can be missed during the digital mapping.

The use of total stations, ortho-photography and photogrammetry for the documentation of an excavation can generate a great amount of data with long post-processing. Furthermore, It does not imply an improvement when compared to a manual methodology. It is only with an adapted strategy that states when and how to apply each technology that the post-processing can be optimized and an actual improvement can be noted. It is to be stated that the applied methodology would be more efficient if the global database of the excavation is designed beforehand. The integration of the information in the Z direction still needs to be improved. In particular vertical variations of archaeological sections are difficult to record with a total station and should be combined with laser, photogrammetry or manual recording.

The role of multidimensional GIS in the production of excavation space

Merlo Stefania [1]

1 : University of the Witwatersrand (WITS)
Private Bag 3 2050 WITS Johannesburg, South Africa
http://web.wits.ac.za/

Despite the perceived innovation that digital technologies should bring to any discipline making use of them, including archaeology, their application in the context of excavation has for the most mirrored traditional practice and recording standards and has perpetuated their limitations, unable to move beyond the paper record (in terms of conceptualisation). All too often GIS projects have simply consisted of a mere digitalisation of traditional context sheets, plans and section drawings and have taken for granted that single context excavation and planning are ?the only way to see' (Harris 2001). Suggestions as to how to go beyond the tendency to objectify and fossilise the archaeological context or the unit have been proposed by Lucas (2001) and need to be incorporated into a critical use of GIS as a space of archaeological practice.
Routine ways of spatially measuring and describing the archaeological record using metrics, Euclidean geometry, and mapping reference systems are not under attack here. Nevertheless, I wish to raise a series of question marks over the role of space in excavation. I will do this by exploring, in particular, the effects that thinking and recording excavation in two dimensions have had on the practice of excavation. I will in particular criticise some concepts used in excavation practice, namely stratigraphy and the use of Harris matrix, contexts, mapping and dimensionality and finally mimics (in the sense developed by Shanks and Webmoor (2009)). Finally I will propose that conceptualising and recording the space of excavation multidimensionally may offer a truly innovative platform not only for the practice of digital archaeology but for the generation of the multi-faceted thinking and analysis characteristic of mental maps.

Session 16

GIS, a new trowel for archaeologists? The challenges of using GIS in preventive archaeology

(Wednesday 23th 10h30-18h Pantheon S15)

Chairs : Anne Moreau[1], Xavier Rodier[2], Anthony Corns[3]
1 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
2 : Centre National de la Recherche Scientifique (CNRS) Université François Rabelais - Tours
3 : the Discovery Programm

The current context of preventive archaeology leads to the introduction of GIS and its widespread use. Indeed, GIS can be seen as an efficient tool for both research and legal obligations of data's conservation and restitution. GIS are nowadays one of the common tools that archaeologists use to manage, analyse and explore the archaeological data as shown by many communications at previous CAA conferences. Most experiments and special developments, more or less integrated into the research process, have been led in selected archaeological operations. However, most of these experiments were carried out in the course of operations with high financial support, which strengthened the idea that only big or important operations deserved using GIS.
The French National Institute for Preventive Archaeological Research– which carries out more than 2000 operations a year – began considering the use of GIS in preventive archaeology in 2006, in collaboration with the French association ISA (spatial information in archaeology). Since then, the institute has launched an unprecedented programme to promote the use of GIS and to train archaeologists in the new practices involved. Indeed, getting from local experiments to a massive use in thousands of operations has brought up several questions such as :

- the consequences of the data digitalisation form the start of the process
- the changes raised by GIS in the ways of working, the organisation of work, the occupations...
- relationships between the scientific problematic and the system contrived and used the new graphic representations of archaeological data in the GIS compared with the traditional habits
- the exploitation of stratigraphy with GIS
- the tools used
- the aims of the systems used (management of the operation, data exploration, cartographic results...)
- the development and use of GIS by the different organisations of preventive archaeology in the world ...

The session aims at concentrating case studies dealing with the questions above. The communications will focus on the operation's scale without excluding the questions raised by the exploitation of archaeological data in multiscale approaches.

The implementation of geomatics tools for recording and interpretation of funerary deposits. The example of the graves of the 2nd century BC to the 2nd century AD of La Haute Cour at Esvres. (France, Indre-et-Loire)

Badey Sylvain [,2 1*], Chimier Jean-Philippe [1 ,2*]
1 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr
2 : Cités, Territoires, Environnement et Sociétés (CITERES)
CNRS : UMR7324Université François Rabelais - Tours
33 allée Ferdinand de Lesseps BP 60449 37204 Tours cedex 3 http://citeres.univ-tours.fr/
* : Corresponding author

Funerary assemblages at the site of La Haute Cour, Esvres The funerary assemblages of the site of la Haute Cour at Esvres are known thanks to the publication of the first excavation in 1909. Four developer funded excavations have been carried out on the site between 2008. They have allowed the study of 74 tombs, mainly of children, datable to the 2nd century BC to the 2nd century AD. The Haute Cour site is probably just one part of a much larger burial ground belonging to an occupation known from the actual village. The bodies are often placed in wooden coffers, the walls of the pits sometimes being lined with planks assembled with nails or wedged with stones. Characteristically, the burials have grave goods. In the tombs dated to the turn of the 1st century, these objects, the pottery in particular, are often mutilated: cut up, pierced, broken... Recording the data and spatial analysis The high proportion of broken objects amongst the grave goods and the near absence of skeletal remains limited the taphonomic analysis of the tombs. Specific recording methods were therefore developed for the site using a geographical information system (GIS) at the level of the individual burial. It is based on a relational database, geo-referenced topographic data and the use of orthophotos and digital elevation modeling (DEM). This data is then processed using an open source geographical information software (QGis) whilst the ortho photos and the digital terrainmodeling are created

How GIS transforms the way Cultural heritage works in the discovery, management and research of Archaeology

Berg Evy
The Directorate for Cultural Heritage (RA)
Directorate for Cultural Heritage Dronningensgate 13, Pb. 8196 Dep., 0034 Oslo, Phone: 22 94 04 00, Fax: 22 94 04 04
Email: postmottak@ra.no http://www.riksantikvaren.no/English/

Collecting data, storing them and the use of those data has changed heavily from the introduction of GIS as platform for recording archaeological sites, and in the further process of management, excavations and conservation. Changes raised by GIS in the ways of working will be described and shown by examples from Norwegian cultural heritage management. Organisation of work has changed in significant ways as a result. The problem of getting a number of organisations to transform their working processes, understanding what qualifications is needed and getting the competence necessary will be addressed. In this context the importance of standards is crucial. Plan for certifying users on the main GIS production system will be outlined.
The relationship between the scientific problematic and the system contrived will be discussed at the level of: how easy/difficult is it to use the data recorded for scientific study and how may the results of studies reflect on the system and better it? Also, do the data gathered contain the information interesting for research? Or must researcher do a lot of additional work and processing to utilise data? The examples here will show that not one system alone handles everything, but the data are processed in several systems. Data therefore needs to be put together for research tasks. The challenge is not so much finding data to work with, but to estimate whether the data quality necessary for further research and usability for new insights is there.

12000 years of human occupation, 3 meters of stratigraphy, 12 hectares... A geographical information system (GIS) for the preventive archaeology operation of Alizay (Normandie, France)

Mazet Sylvain*, Marcigny Cyril, Aubry Bruno
Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr
* : Corresponding author

An archaeological operation carried out by INRAP (The French National Institute for Preventive Archaeological Research) revealed that banks of the Seine river at Alizay (Normandy, France) were occupied during 12000 years. In an extensive area of twelve hectares, archaeologists had to pass through a three meters deep stratigraphy covering the Middle Age, the Iron Age, the Neolithic, to finally reach the earliest settlement from the upper Palaeolithic. The specifications of the excavation were to study these various occupations applying the proper methodology to each major period.
A Leica TS15 robotic total station was used to record very quickly archaeological features and store directly in the field pre-formatted GIS data such as number ID, stratigraphic unit, nature of the artefacts, etc. The aim of the process is to inventory and study during the excavation the 120 000 exhumed artefacts using a Microsoft Access database linked to a geodatabase in Esri ArcGIS.
This specific archaeological information system was designed to guide the earth removal by producing digital elevation model of each stratigraphic contexts, facilitate the management and inventory of artifacts and spatialize data produced by specialists as palynologist, malacologist, geomorphologist, geophysicians, archaeologist (lithic, pottery), etc.
Beyond technical and methodological aspects, this GIS is aimed to produce new informations that could enrich our understanding of human occupations at Alizay such as habitat, burials or activity areas, through time. The present communication will explain the entire archaeological data process insisting on its different steps such as field recording, database design and management and GIS use for a large scale archaeological excavation.

The recording and the spatial representation of archaeological information in the context of a rescue excavation: the case of Quincieux (Rhône-Alpes, France)

Segain Ellébore, Vachon Véronique, Widlak Wojciech, Ramponi Cécile, Moulin Bertrand
Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr

In the particular framework of rescue archaeology in France, our aim is to identify and analyse the archaeological information from sites concerned by development projects. Archaeological information (spatial and descriptive), eco- and artefacts collected during this excavation will be the only remains left to document each site after its destruction, and, therefore must be preserved for any future study. In the rescue problematic, cost and time are important brakes to the collection of the spatial and descriptive data on the field, and also during the post-excavation investigation. In this context, various internal reflections led to the establishment of an experimental operating chain. Our team developed a process which allows to record and study most archaeological information (spatial and descriptive), and help managing the excavation. The aim is to optimize the collection's and investigation's time, and to use this system for studying in depth the archaeological information.
The protocol, until now used only in evaluation steps, have been experimented in the excavation of Quincieux «Grange Rouge» (Rhône-Alpes, France). The high points of experimenting on this site are the following: different human settlements are expected, from Neolithic to Modern Age, on a very large area (91 000 m²); the GIS use was planed before the beginning, with a motivated staff. Furthermore, the evaluation of the site had been made with a similar protocol.
This approach is based on collecting and archiving information into a database (DBMS), using

PC-tablet on the field, in association with a GIS implemented with the latest archaeological survey for the spatial information.
The result is a coherent system that helps the archaeologist to deepen his management and investigation, from the field to the exploitation of the data and the publication of the results. The study of data is optimized by standardization and early computerization thanks to the DBMS in the PC-tablet. The latest surveys are immediately transformed in GIS files in order to be used directly on the field, especially for managing the staff, the machine, and to evaluate the work's progression. In the laboratory, the GIS allows various analytical studies that help the interpretation of the remains, but also the edition of final maps for the report. The eco- and artefacts can be also integrated (as data) in the system, and can be presented and analysed in a spatial dimension too.
This presentation exposes in details the operational scheme and process from the setting up of the project to the edition of the final report, and the conception of the archaeological database up to the graphical restitution of the spatial information, as well as the type of tools used. The benefits and the issues of this system are also detailed.
This experimentation, still in progress, is an important step for our team regarding the way of managing the excavation, but also the way of collecting information and working on the field as archaeologist.

Looking for the best. A comparison between GIS and PageRank based algorithms for preventive archaeology in urban areas

Dubbini Nevio [1*], Gattiglia Gabriele [,2], Palombini Augusto [,3]
1 : Department of Mathematics, University of Pisa
2 : MAPPA Lab - Dipartimento di Civiltà e Forme del Sapere - University of Pisa (MAPPA)
Via Trieste 38 56126 Pisa - Italy
www.mappaproject.org
3 : CNR - Istituto per le Tecnologie Applicate ai Beni Culturali (CNR-ITABC)
Via Salaria km. 29,300 00015 Monterotondo St. (Roma)
www.itabc.cnr.it
* : Corresponding author

The MAPPA project produced a map of archaeological potential by means of a specifically developed mathematical model based on PageRank, a ranking algorithm originally intended to work for web pages. The rationale was that of imitating the modus operandi of archaeological practice, in order to reproduce the relations (links) between the different natural and anthropogenic elements. The case study was the urban area of Pisa. Archaeological potential represents the probability that specific areas preserve a more or less important archaeological stratification. The definition of archaeological potential entailed the algorithmic representation of a number of variables, ranging from the type of archaeological finds and their informative value, to the functional and topographical relations among finds.
In this paper we present a comparison between the MAPPA algorithm and some more standard predictive models implementable within the GIS, i.e. kernel density, kriging/co-kriging and r- finder. The different models are applied on the same dataset, that of the MAPPA algorithm. The comparison is performed to highlight the differences between the methods, in order to indicate their respective usefulness for preventive archaeology.
Kernel density estimation (KDE) is a non-parametric way to estimate the density of a random variable. It belongs to the point pattern analysis family. In KDE a 2-dimensional probability density function (kernel) acts among observed values to create a continuous approximated distribution. The result is an approximate idea of spatial structure of data, which in our case means an approximate distribution of the concentration of finds.
Kriging is a geostatistical weighted interpolation method, based on autocorrelation. It is generally applied when both the distribution and the density of points are irregular. Co-kriging, moreover, allows to add further spatial information, improving the interpolation. Although archaeology is closely related to geographical/spatial aspects, geostatistical tools have not been used to a large extent. In the case of Kriging and co-Kriging methods, geostatistics allow to describe spatial variations as the product of deterministic and stochastic components, based on dependence and spatial self-correlation, i.e. on the fact that observed values are related to each other.
r.finder is a GRASS-GIS script created to check the analogies among the places where some

known items (archaeological finds in our case) are located, in terms of similar cell-values in the frame of a series of thematic raster maps. The method outs a map showing the level of similarity (i.e. probability of new findings) of any cell in the whole region. Its suitability for predictive archaeology is enhanced by r.finder's different approach to quantitative maps (with continuous value scale, such as DEMs or slope maps) and qualitative maps (showing discrete and scale-unrelated ones, such as soil type maps).

The role of GIS in geomorphological and archaeological studies of Paleolithic occupations: applications to preventive excavations of the Canal-Seine Nord Europe.

Font Caroline*, Hérisson David, Goval Emilie, Coutard Sylvie, Locht Jean-Luc
Institut national de recherches en archéologie préventive (Inrap)
INRAP
http://www.inrap.fr
* : Corresponding author

Since 2008, archaeological surveys have been carried out as part of the future development of the Canal-Seine Nord Europe and have brought to light several Paleolithic occupation levels. To date, three extensive excavations have been conducted and three others are on hold, pending access to the sites.
These three excavation operations took place on the communes of Havrincourt (Pas-de-Calais, director: E. Goval) and Etricourt-Manancourt (Somme, director: D. Hérisson). They revealed lithic industries, associated with fauna at two sites, in clear stratigraphic contexts with fully identifiable taphonomic phenomena. One of the advantages of these operations is that they make it possible to explore Paleolithic occupations over extensive surfaces (2,000 m², 4,100 m² and 4,300 m²). The results from each of these excavations bring vital information for our understanding of human occupations from the end of the Lower Paleolithic to the beginning of the Upper Paleolithic. They also provide new data on the settlement modalities of northern regions in diverse climatic contexts.
These field operations were conducted as collective projects, with discussions between the director, the operating team and the technical unit before fieldwork. Different kinds of data acquisition processes (archaeological, geological, logistic) were set up in order to process scientific data according to the defined issues. Alongside the archaeological exploration, the excavation team thus disposed of a thematic cartographic production related to the main questions, designed around a first Geographic Information System (GIS).
During the study, all the geological, logistic and archaeological data from these sites were incorporated into a geographic and relational database. This database can be operated easily by archaeologists for scientific descriptions as well as spatial, statistical and analytic studies. For example, with this database it was possible to conduct a 3D reconstitution of the sedimentary and morphological dynamics, as well as an effective statistical spatial analysis, which was of great assistance for the spatial study of these sites.
The examples presented in this communication are just one element of the Scientific Activity Project (PAS) conducted by the Inrap in Nord-Picardie. The overall ambitious aim of this project is the setting up of a geographic database designed around a GIS for the whole of the north of France. It comprises a corpus of geological and archaeological data which will allow for different approaches to the site: on a regional scale, at the scale of the site (data issued from archaeological excavations), or even site indexing (using data issued from archaeological surveys). This database will lead to the mapping of superficial Pleistocene formations, will reveal the dynamics of geomorphological evolution and will record all the sites and evidence of Paleolithic occupation in the north of France.
The aim of this communication is to present the results of the application of the GIS to the Paleolithic excavations along the Seine-Nord Europe, as well as the perspective of integrating these data in a much wider framework, as part of the ongoing Scientific Activity Project.

Chrudim: There and Back Again. Contributing the Preventive Archaeology (CONPRA Project).

Gál Luká? [1*], Koštial Jozef [1*], Marić Miroslav ,[2*], Lužnik Nika ,[3*]
1 : TerraVerita
http://www.terraverita.cz/
2 : University of Belgrade, Faculty of Philosophy
http://www.f.bg.ac.rs/en2
3 : University of Ljubljana (SLOVENIA), Faculty of Arts, Department of Archaeology
Univerza v Ljubljani Filozofska fakulteta Oddelek za arheologijo Aškerčeva 2 P.P. 580 SI-1000 Ljubljana Slovenija
http://arheologija.ff.uni-lj.si/si_index.html
* : Corresponding author

The project focuses on an approach to increase protection and/or conservation of archaeological sites in this particular case in the area of planned motorway bypass around Chrudim, Pardubice region, eastern Bohemia. The project began under the initiative of the CONPRA project which focuses on the challenges in the development driven archaeology. We've combined the company's experience enriched with the academic knowledge of associates from University of Beograd, Serbia and University of Ljubljana, Slovenia in order to establish and apply a working GIS based predictive model for the discovery of archaeological sites. With regard to the unique composition of different geographical units the goal is to combine the most effective methods for the purpose of discovering archaeological sites in the specific area of Polabi lowland with its specific geomorphological construction and historical background. The main question we are facing is if there is a possibility to deduct information from different sources to a one comparative and verifiable analytical level. The second consideration is if the obtained data is actually reliable and to what extent since the data from every source is filtered through numerous human actions extending from experience to recognize an archaeological feature to undocumented agricultural acitivities.

To answer these particular problems various methods were integrated. First step included cabinet work which consisted of reviewing old excavation data, different types of maps (e.g. Franciscean land register
from the early years of the 19th century, geological, hydrological maps) and results of remote sensing of the region in question (aerial photography, for the first time the company also included LIDAR data to achieve an even more thorough inspection of the ground relief features).

Later stage of the project involved ground thruting which consisted of a systematic field survey of the whole area in order to complement the results of the cabinet work.

The project is still in progress and is yet to be concluded with the comparison of all analysis and determination of sites of archaeological interest and production of a possible predictive model. The advantage of the chosen area of research is that due to the construction works it's going to be excavated at all archaeological sites and this way enabling the validation or refutation of our conclusions.

With presentation on the conference we would like to present the progress of the use of non invasive methods in archaeology in the Czech Republic, with the emphasis on the work of the company TerraVerita, one of the leading institutions in this field of expertise in the country, and as part of the feedback gaining new suggestions and constructive critics of our work.
from a photogrammetric survey which, with the GiS, allows for the analysis of the tomb.

The "Arc of Dierrey" Gas main : an example of linear path managed by GIS and a case study of Staff implication in archaeological écraft" (Champagne- Ardenne, France)

Sanson Luc, Durost Raphael,*, Duda David *, Achard Guillaume,*, Desmarchelier Virginie,*, Gaillard Antony,*, Lemeunier Sophie,*, Serafini Pierre,*, Toussaint Perrine,*
Inrap
Institut national de recherche en archéologie préventive
* : Corresponding author

The project of development of the Gas main «Arc of Dierrey» link Dunkerke to Fos-sur-Mer and crosses 180 kilometers of Champagne-Ardenne region. This project aroused, and still arouses this day an intense preventive archaeological activity. Following the multiple phases of diagnoses (diag-

noses divided into lots, sounded, each time, 10km of the gas main), the State departments notify excavations on the zones where archaeological remains have been detected and identified. The procedure approved to follow and manage daily this complex operation requests constantly the appeal to the Geographical Information System (GIS).
The deployment of the geomatic practice had to bring in the whole archaeological team within an operating chain freshly conceived and validated. From the archaeologist in charge of excavation to the computer graphic designer, from the topographer to the technician, the different «crafts» have completely integrated the all-embracing geomatic approach and practice. The appeal combined by a relational database, on one hand, and the software of GIS, on the other hand allowed to record the totality of the components stemming from the field operation (units of recording, documentation and artefacts...). Furthermore, almost all of the tasks concerning the geographical data were realized exclusively by open-source GIS software.
The operation of the Gas main «Arc of Dierrey» was thus driven in its totality by adopting a GIS approach which aimed to be inter-operable, «democratizing» and «globalizing». She announces future operations where the GIS will be considered as a tool, used on a large scale and in all its potentialities.

Where do we stand - exactly? Site identification and GIS for preventive archaeology in Hungary.

Stibrányi Máté, Mesterházy Gábor, Pethe Mihály, Soós Eszter
Hungarian National Museum - National Heritage Protection Centre (HNM-NHPC)
1113 Budapest, Daróci u. 3.
http://www.mnm-nok.gov.hu/

In Hungary the need for more accurate spatial delimitation of archaeological sites was basically established for the needs of preventive archaeology, although the use of GIS was typical mostly for documenting excavations only. However, using GIS-based systems are essential during site identification as well, and can save significant amount of time and financial cost.
The Hungarian National Museum - National Heritage Protection Centre (HNM-NHPC) is responsible in Hungary for the coordination and execution of large-scale construction's heritage assessments since 2013. Our task is to establish and test a GIS-based method which is effective in large-scale investments (mostly motorways) and ? due to financial constraints ? relies mostly on non-invasive methods (field survey and magnetic measurement).
Considering the large proportion of ploughed areas and the large number of archaeological sites in a mostly rural agricultural landscape, field survey (plough walking) is the first and foremost ? and formerly usually only ? method of site prospection, although it is widely considered fairly inaccurate. However, using plough walking systematically and GIS-based level (in other words making it measureable and comparable) can make a significant difference in delineating archaeological features before constructions. Performing magnetometer surveys within these areas ? including areas with no surface finds but high potential for archaeological features ? we could narrow down the actual archaeologically involved areas. Afterwards we validate this data with trial excavations. Due to recent legislative changes financial funding are very limited, so we have to make sure to spend the latter and most expensive method wisely, meanwhile trial trenching is not an accepted evaluation method.
Our current scope is to examine whether plough-walking is a reliable method for site identification if done strictly systematically within a GIS-basis. Followed shortly by magnetic survey and trial excavation we are able to compare the results and evaluate the pros and cons of field survey. Surface finds are naturally already in a secondary position and their relation with the actual features are a much debated question. Without the claim to settle this question we would only like to examine its practical utility through some recent case studies for preventive archaeology.

Session 17

From stats to storylines: computational approaches to archaeological spatial data and its interpretation

(Friday 25th 8h30-13h Pantheon S2)

Chairs : Phil Riris[1], Patricia Murrieta-Flores[2]
1 : Archaeological Computing Research Group (ACRG) University of Southampton - United Kingdom
2 : Lancaster University Bowland College - United Kingdom

All archaeological information has an intrinsic spatial component, a fact which has been appreciated for as long as the discipline has existed. The significance of this property of our data has greatly increased in step with the general availability of powerful computing and specialized software packages in recent decades. In the drive to adopt, adapt, or invent techniques that directly address the spatial dimension of the material record, archaeologists have looked towards other fields as diverse as epidemiology, astronomy and landscape ecology for inspiration.
While many commonalities exist in data structure, vocabulary and toolkits, it remains the case that archaeologists mostly employ spatial methods which were not developed with the explicit intention to pursue questions meaningful on a cultural or human scale. As such, this crucial element in the study of past societies can easily be lost in the transition from analysis to interpretation. This is to the detriment of our objects of study, to the broader dissemination of spatial analysis within archaeology, and to the effective communication of results to a wider audience.
This session aims to bring together scholars who are actively seeking answers to social questions through spatial analysis of archaeological, historical or environmental information. The focus of our interests is how to articulate the relationship between the fabric of space as a culturally-constituted, socially experienced entity, and our understanding of these properties using quantitative analytical methods. To this end, the interface between analytical scale, data resolution and the unfolding of fields of social action in the past may provide a backdrop for answering critical questions about how to approach the human factor in spatial analysis. Additionally, explorations of these topics may be considered from a theoretical perspective, provided the emphasis is on applied spatial analysis with archaeological information.
Papers likely to be accepted may draw from an exhaustive variety of spatial approaches (including spatial statistics, data mining, simulation and numerical modelling), employing such methods to explore and create interpretations that generate a narrative on a past society. Researchers developing new platforms, environments or techniques are particularly encouraged to present. Overall, we seek the recognition of dynamism and variability in human culture, and hence the strengthening of our interpretations through rigorous analysis and interpretation of the broad range of data that we as archaeologists are capable of leveraging in our research.

Churches and boundaries. A case study of Xtent analysis for reconstructing medieval settlement pattern in c. Fejér, Hungary

Stibrányi Máté [1*], Padányi-Gulyás Gergely ,[2]
1 : Hungarian National Museum - National Heritage Protection Centre (HNM-NHPC)
1113 Budapest, Daróci u. 3.
http://www.mnm-nok.gov.hu/
2 : Lechner Lajos Knowledge Center Non-profit Ltd. (LLKC)
1111 Budapest, Budafoki út 59. E/3. ép.
http://www.lltk.hu/
* : Corresponding author

It could be said that basically all spatial distributional research of archaeological sites can be separated into two branches: accessibility (connection) and delineation (distance and hierarchy). The latter inspired archaeology mostly in its processual phase, the concept of site catchment analysis was one of the most widely spread approach to model it ((Vita-Finzi ? Higgs 1970). However, there had always been another approach presented to this question (Hodder-Orton1976), based on a simple geometric operation called Voronoi (Thiessen) polygons. This application necessarily divides the entire available area but by default no weighting is possible. Addressing this problem, C. Renfrew and E. Level created the concept of Xtent analysis combining the advantages of central place theory and Voronoi polygons, although its emphasized use was to plot hypothetical (political) boundaries basically (Renfrew-Level 1979).
B. Ducke and P. Kroefges made an upgrade to those Xtent analysis in 2007, creating a GIS model which could be suitable to modelling hypothetical geographical boundaries as well (Ducke-Kroefges 2007). An algorithm, called r.xtent, working in an open-source GRASS GIS environment consist the original Xtent formula, but the distance variable was replaced by a cost distance analysis based on a digital elevation model (DEM).
The Xtent algorithm provides an easy to use and fairly well-defined model to interpret the relationships between contemporary sites. Naturally, the most significant practical obstacles should not be omitted. These are linked (1) with the observability of the sites (we could not expect to find all of those), and (2) the problems of dating based usually only on surface finds (we could not expect to date all contemporary sites without any doubt).
In the case study we made the Xtent analysis of a 4300 sqkm area (a county) based on the known medieval churches to examine the hypothetical medieval villages extents, boundaries and land use. In the case study area most of the medieval churches were formerly demolished so location is usually possible with archaeological methods only. However, in an environment where the majority of the medieval heritage could only examined archaeologically, the localisation of the former church serves a good basis to identify the central place of a medieval village. An Xtent analysis, based on those locations could be used to model the territories, boundaries and extents of the medieval settlements in the area, using only environmental factors and the exact ? and relative ? positions of the central places.

A tomb with a view? Visual properties and archaeological narratives in the Brú na Bóinne WHS, Ireland.

Davis Stephen, Meegan Eimear
University College Dublin (UCD)

Brú na Bóinne (The Bend in the Boyne) is one of the most important Neolithic landscapes in Europe. It is home to over 40 passage tombs, including the great mounds of Newgrange, Knowth and Dowth, over 30% of all megalithic art in northern Europe, up to eight henge monuments, and significant later prehistoric and early medieval archaeology. It is a landscape in which visibility and sometimes lack of visibility is clearly significant: particular monuments are clearly located with the visual properties of the landscape in mind, and even the modern boundaries of the WHS are partly defined by viewsheds and visibility. It is also a landscape in which movement is paramount: the great tombs of Knowth and Newgrange are each constructed of non-local materials from multiple sources at a distance of tens of kilometres. It is also a landscape in which significant remote sensing effort has been concentrated over the last two decades, including multiple geophysical surveys, ALS-based prospection and use of multispectral satellite imagery. This paper uses ALS data, informed by palaeoenvironmental information to address two interlinked themes: visibility and movement within Brú na Bóinne. Routes of movement within Brú na Bóinne are apparent, most obviously the River Boyne itself, but also the River Mattock, Newgrange cursus and multiple routeways identified through analysis of ALS data. How do these routeways relate to the monumental landscape, and how do the visual properties of landscape change as these routes are traversed? Can we use this combination of ALS and palaeoenvironmental data to suggest possible routes for the transport of building materials within Neolithic Brú na Bóinne? Multiple viewshed analyses are utilised, focusing on total landscape visibility as well as specifically on both routeways and monument classes to attempt to better define visual aspects of landscape in Brú na Bóinne. Similarly, multiple least cost path analyses are used to suggest potential routes of resource movement between the river and the great tombs. Althouth a great deal of remotely sensed data has been acquired over the last two decades within Brú na Bóinne, there has been surprisingly little effort to incorporate these data within archaeological narratives. This paper seeks to utilise multiple spatial datasets to address archaeological questions that go beyond prospection.

Three Methods for Detecting Past Groupings: Cultural Space and Group Identity

Tremblay Cormier Laurie [1*], Nakoinz Oliver [2], Popa Catalin [3]

1 : Université de Bourgogne
UMR 6298 - ARTeHIS
6 bd Gabriel, 21000 Dijon

2 : Christian-Albrechts-Universität zu Kiel - CAU (GERMANY)
Johanna-Mestorf-Straße 2-6, D-24118 Kiel

3 : University of Cambridge, Department of Archaeology and Anthropology
Downing Street, Cambridge CB2 3DZ

* : Corresponding author

The paper discusses the means through which past groupings can be uncovered through the archaeological record. Three methods are proposed and compared, each of them involving a combination of statistical modelling and GIS procedures. The methods are presented through individual case studies and compared by illustrating their results when ran on a common set of data. The groupings identified in this manner are interpreted as the result of past cultural connections across an area or as group identity solidarities.
The term grouping refers to a planned arrangement of things and/or people within a group. It describes any observed non-random pattern of commonness. In archaeology, identifying groupings in the material record is a useful method for understanding the patterns of past human interaction. Depending on the approach taken to the material record, and on the question around which the methodology is shaped, such groupings can refer to different phenomena. Our paper illustrates how they may be related to cultural space and group identity.
In the first case study, a crossed statistical- and spatial method was developed for studying the material dating to the Late Bronze Age and the Hallstatt period in an area going from Lyon (FR) to Koblenz (DE). It involves dividing the area in a grid of 60 cells. Each of these cells was characterized through its archaeological remains and analysed using correspondence analysis. The results show a strong geographical logic behind the obtained statistical groups, which were interpreted as referring to cultural spaces.
The second case study focuses on the area of Rhine-Moselle region during the Hallstatt period and Baden-Württemberg during the Hallstatt period and Early Latène period. The method involves sampling the density value of different types of archaeological finds and at regularly spaced points. The vectors of density thus obtained for each of these points ('Typenspektren') were grouped using a two-stage cluster analysis, which served to determine groupings and fuzzy borders. Such groupings were interpreted as referring to cultural spaces.
The third case study deals with the Eastern Carpathian Basin during the final part of the Late Iron Age. The funerary evidence from this area was compared based on functional and typological features using a contextual, weighed similarity evaluation procedure, and then put through several clustering algorithms. By connecting the obtained clusters with other archaeological evidence

and written sources, it was concluded that the groupings refer to large group identities, probably linked with social status and in some cases with ethnicity.
These three methods were adapted to a special research objective with certain assumptions. To evaluate their range of application, each of them will be applied to a common set of data from Rhenish Hesse (DE) dating to the Early Iron Age. The obtained groupings will be compared and evaluated for their usefulness and possible interpretations. Linking them to cultural spaces and group identities respectively will provide novel insights into the relationship between culture, space and identity in the past.

From counts to frequencies. Some problems regarding the quantification of spatio-temporal distributions of archaeological data

Achino Katia Francesca, Barceló Juan A., Capuzzo Giacomo
Universitat Autònoma de Barcelona (UAB)
UAB Campus 08193 Bellaterra (BARCELONA) SPAIN
http://www.uab.es/english/

Quantitative Archaeology Lab, Department of Prehistory, Autonomous University of Barcelona, Faculty of Philosophy and Letters, Building B, 08193 Bellaterra (Barcelona), Spain katiafrancesca.achino@uab.cat;giacomocapuzzo@gmail.com; juanantonio.barcelo@uab.es Traces of past human social actions are fossilized in discrete aggregations of artefacts, bones, stones, and debris, which can be used as an inference about past behaviour. Nevertheless, the simple enumeration of the number of observed evidences in the present hardly gives us any information regarding the way the action was performed in the past. The action may have been performed once, and all remains are just material consequences of it, or the action may have been performed repeatedly many times, and all observed remains be a kind of palimsest. The inference about the historical relevance of that action can be addressed only whether we translate observed counts of different kinds of materials into the historical frequency of that action: an expression of the number of times in which a certain event took place in relation to the length of the time range during which the event was repeated. These ideas are not very usual in archaeological research. Counts are used as direct evidences of the historical relevance of actions, without taking into consideration the probabilities of repeatedness or syncronicity of different actions nor the duration of the processes. In this paper we present a general theory on formation processes and a quantitative methodology for assessing the assumption of sampling homogeneity. Our goal is to understand whether the archaeological record we observe in the present is the result of a homogeneous process that happened in the past. If this were the case, observed data (counts) should fit a theoretical distribution (Poisson process), and only then we would assume the Markov condition, which would allow us to consider the number of observed evidences in terms of the time needed to generate that accumulation (frequencies). Only then, the amout of observed data (total or relative) can be statistically used to infer the nature of the historical event. In this paper we present a preliminary geostatistical analysis of the abandonment processes at the pile dwelling site of Villaggio delle Macine (Rome-Italy), across the shore of the volcanic Albano Lake, dated around the Early-Middle Bronze Age (19th-16th c. BC). In this case study, we test the assumption that observed archaeological data can be understood as the realization of an homogenous process (abandonment), and accumulated during an uniform temporal span in arelatively homogeneous way. In the light of the results of such hypothesis testing, we propose theoretical and methodological approach for the study of homogeneous accumulation processes detected in the archaeological record. Furthermore, this model takes into account the problem of the post-depositional effects which carried out a central role in the case study analyzed.

Site and Reference of Placenames Inscribed on Taiwan's Tombstones: The Implications of Scale, Time and Networks

Oliver Streiter [1], Goudin Yoann ,[2]
1 : National University of Kaohsiung, Taiwan (NUK)
700, Kaohsiung University Rd., Nanzih District, 811. Kaohsiung, Taiwan, R.O.C
http://www.nuk.edu.tw
2 : Institut National des Langues et Civilisations Orientales (INALCO)
INALCO
2 rue de Lille 75007 Paris http://www.inalco.fr/

In this paper we discuss the necessity and problems of a two-fold representation of placenames in archeological data, distinguishing the 'site', which is the place where the placename has been used, and the 'reference', which is the place or region referred to. Using the data of the 'ThakBong' archive of Taiwan's gravesites, which comprises currently about 45.000 tombs on 500 gravesites, we show, for example, that in Holo communities in Taiwan, placenames on tombstones, referring to the origin of migration from the coastline of south-eastern China, as used during the Qing Dynasty, gave way during the Japanese colonial period (1895-1945) either to local Taiwanese placenames, this happened mainly in the Tainan area, and to mythological placenames referring to regions on the lower reaches of the Yellow River, in most other parts
of Taiwan. As this example shows, two spatial representations have to be handled at the same time to describe and understand the processes involved, the site ('Tainan area' and 'most other parts of Taiwan') and the reference ('coastline of south-eastern China' and 'lower reaches of the Yellow River'). The challenge of finding and representing a systemic relation between site and reference increases with the number of sites and references in the data set, due to the existence of partially conflicting factors that affect the choice of a placename. In our case about 500 sites and 1000 references are involved. To achieve at least a minimal understanding of the development in history, 'scale' ('south-western Taiwan'), 'time' ('Japanese colonial period') and 'networks' ('Holo communities') become indispensable dimensions for an analysis, not only for the site, but equally for the reference. As for the site, the scale distinguishes the community, the village, and the region of the gravesite. The time period summarizes the political condition and the transformation of social identities at the time the tomb has been set up, e.g. Qing Dynasty border society, early Japanese colonial rule, Japanese assimilation policy, the martial law under the Chinese Nationalistic government, and finally democratization. Networks identify subset of tombs through their association with families, stone-carvers or governmental or religious structures. As for the reference, the scale describes the specificity of the placename reference, e.g. reference to a city versus reference to a village, the time characterizes the segment of a migration history that is evoked, e.g. 2000 years, 200 years or 20 years ago, and networks describe the subsets of tombs that are identified through a community of origin. For each of the six dimensions, we develop graphical representations which describe and quantize the relation of these dimensions to the observed placenames before and after a transformationof placenames, separating thus potential causes for a transformation from the observed effects of the transformation.

BLT Mapping: Bringing out social functioning from urban form comparatively

Vis Benjamin
University of Leeds
Woodhouse Lane ; Leeds ; LS2 9JT
http://www.leeds.ac.uk/

On an interpretive level the built form (including architectural styling) and layout of (urban) settlements have regularly been at the centre of social or cultural interpretation. Rules, allegiances, or symbolism are thought to be reflected in the spatial ordering observed; a perspective usually leaning on anthropological and ethnohistorical arguments. These representative mirror image analogies have the effect of deflecting attention from the evidence the material presence of built structures and physically constructed spatial divisions provide, with regard to the social functioning of the inhabitation of settlements. The human and social reality of materially transforming our environment for inhabitation permits a comparative perspective on the ? archaeological record'

of settled life in the past and present.
On an empirical level (digital) mapping technology helps us to document spatial patterns, which subsequently can be measured. Dissatisfied with the reductive nature and limited social theoretical grounding in, respectively, the narrow correlative evidence-base and speculative probability outcomes of urban space syntax analysis, the spatially passive distribution and locating approach of (urban) historical GIS, as well as the contextually dependent history of city building analysis in urban morphology, I developed a new methodology from a perspective on the material presence of the boundaries shaping built environments.
This vector GIS based, conceptual mapping method, called Boundary Line Type (BLT) mapping, leads to formal redescriptions of the urban built environment, which also enable an array of spatial analyses. Conducting such analysis forms a critical exploration into the affordances and affective experiences of socially functioning within urban form, both synchronically and diachronically, which are interpretively guided by the theoretical framework BLT mapping itself arose from. Some of the interpretive potential of this method and its first purposively devised geocomputational tools will be exemplified, using examples in both western and Maya urbanism.

Territoriality and Commensality: Modelling the social context of southern proto-Jê funerary monuments in the eastern La Plata basin

Riris Phil
Archaeological Computing Research Group (ACRG)
Building 65a, Avenue Campus Department of Archaeology, University of Southampton SO17 1BF
acrg.soton.ac.uk

This paper presents the results of a focal mobility network analysis carried out on a selection of southern proto-Jê monuments located in the regions of Misiones (N Argentina), Pinhal da Serra, Ubirata, Urubici and Campos Novos (S Brazil). Pre-columbian communities of this cultural affiliation erected and maintained monumental earthworks, displaying a multiplicity of different layouts, orientations, and placements in their landscapes. Societies in the transition from relatively unstratified forms of organization towards more strongly structured socio-political systems typically develop more intensive historical ties to the region or landscape they inhabit, for instance cemented by ancestral claims to land. The southern Jê monumental tradition has been widely studied as an example of such a process (Copé; 2006; Iriarte et al. 2008; Riris 2010; Copé and De Souza 2011; Iriarte et al. 2013).
As such, discussions of the significance of monumentality among these groups figure prominently in the regional literature. This paper proposes that a deeper understanding of this archaeological phenomenon may be gained by testing certain interpretations through a supra-regional comparative analysis of a sample of different architectural complexes. The function and meaning of planned monumental mound and enclosure complexes has been figured in terms of increased territoriality, an emergent concern with social integration/exclusion and the reinforcement of a regional ethnic identity through ritual participation. The implication that monuments performed both an exclusionary (territorial) and inclusionary (ritual-commensal) role leads us to question to which segments of society these differing factors applied. In other words, it is proposed that developing an understanding relative accessibility to a cultural location can demonstrate how emergently-complex societies become spatially, as well as socio-politically, structured through new forms of marking the landscape.
The construction of a geospatial model is presented in order to explore these structural properties of five published monuments and their physical settings. The results are interpreted with an index of relative accessibility, providing insight into a key conditioning factor of how the southern proto-Jê interacted with these inhabited landscapes. Further, the significance of the results is set in the context of our archaeological understanding of pre-Columbian social complexification in lowland South America.

A Re-evaluation of the Early Bronze Age Collapse in Upper Mesopotamia

Kalayci Tuna
Institute for Mediterranean Studies (IMS)

This study investigates the relationship between rain-fed agricultural production and stability of settlement systems in Upper Mesopotamia during the Early Bronze Age (Third Millennium BCE). This time period in the area is characterized by a rapid urbanization period and intensification of agricultural production. Towards the end of the millennium, the urban system dissolved into new conditions ?or «collapsed».

Rain-fed agricultural production was the backbone of the Early Bronze Age economy in Upper Mesopotamia. Agricultural production was intensified, most probably due to a set of complex developments in the region, including urbanization and aridification of climate. In this complex socio-environmental setting, variations in agricultural production levels must have ?directly or indirectly? affected the components of the brittle Early Bronze Age economy.

As for the methodology, first, Early Bronze Age precipitation levels are estimated by using modern day associations between the eastern Mediterranean coastal areas and the inner regions of Upper Mesopotamia. Next, these levels are integrated into a remote-sensing based biological growth model. Also, a CORONA satellite imagery based archaeological survey is conducted in order to map the Early Bronze Age settlement system in its entirety as well as the ancient markers of agricultural intensification. Finally, ancient agricultural production landscapes are modeled in a GIS.

The study takes a critical position towards the traditionally held assumption that large urban settlements (cities) in Upper Mesopotamia were in a state of constant demand for food. The results from this study also suggest that when variations in ancient precipitation levels are translated into the variations in production levels, the impact of climatic aridification on ancient settlement systems becomes less visible in the archaeological record.

From the Aegean Sea to the Parisian Basin. How Spondylus can rearrange our view on trade and exchange

Windler Arne [1*], Nakoinz Oliver ,[2], Lorenz Luise ,[3]

1 : Institute of Archaeological Science at the Ruhr-Universität Bochum
Am Bergbaumuseum 31 D-44791 Bochum
http://www.ruhr-uni-bochum.de/archaeologie/

2 : Institute of Pre- and Protohistoric Archaeology at the Christian-Albrechts-Universität zu Kiel
Institut für Ur- und Frühgeschichte Christian-Albrechts-Universität D - 24098 Kiel
http://www.uni-kiel.de/ufg

3 : Institute of Pre- and Protohistoric Archaeology at the Christian-Albrechts-Universität zu Kiel
Institut für Ur- und Frühgeschichte Christian-Albrechts-Universität D - 24098 Kiel
www.uni-kiel.de/ufg

* : Corresponding author

There are two main purposes about the analysis of spatial data in archeology: the reconstruction of pathways and the distinction of trade patterns in prehistoric times.

Colin Renfrew (1975) correlated the quantity of artefacts in a certain distance from the source with ten different modes of exchange. He connected different «fall-off curves» with a prestige good exchange, a commercial trade or a trade between individuals. This method was criticised shortly after its publications by Ian Hodder and Clive Orton (1976).

A «Fall-off» curve does not show any commercial trade or a prestige good exchange: It only represents the cost for transportation in relation to the distance from the source and the market potential of a material. Furthermore «fall-off» curves can be improved by GIS-methods, like the application of cost layers and a least-cost path analysis. In this paper three different measures of distance are compared: the cost distance, the length of a least cost path and the Euclidean distance.

The reconstruction of pathways is often connected to intuitive interpretations. For example, the Danube is mentioned as a natural trail from Southeastern to Western Europe in prehistoric times. Different statistical methods can be used in order to get more comprehensive results.

The reconstruction of pathways with statistical methods was performed with a Kernel-Density-Estimation (KDE): A KDE was used to get the density of every point in the working region. Afterwards the highest values (the ridges) of the density estimation were extracted to reconstruct possible pathways. This method is more replicable than the older «story-telling» approaches. Both methods will be discussed and applied to the distribution of Spondylus Gaederopus during the second half of the sixth Millenium BC. The shell from the Mediterranean Sea was distributed over the whole of Europe, from Greece to Central Germany and from the Ukraine to the Parisian Basin. Different interpretations about the distribution of Spondylus artefacts exist: The Danube was often mentioned as a possible pathway and it is considered as the exchange of prestige goods par excellence. Statistical methods help us to rewrite the story of Spondylus artefacts and their distribution over prehistoric Europe.

Petrified landscapes? Megaliths and the modelling of prehistoric territorial structures in Neolithic Northern Germany

Schafferer Georg

Roman-Germanic Commission of the German Archaeological Institute (DAI-RGK)
Palmengartenstrasse 10?12 60322 Frankfurt am Main
http://www.dainst.org

Megalithic graves are the most familiar monuments of the Early and Middle Neolithic Funnel Beaker Culture in Northern Central Europe and Southern Scandinavia. The tombs used to serve as sturdy markers of communities' identities and territories. The architecture of megalithic graves and their construction history represent two distinct aspects that reflect social, political, and economical meanings and processes, all incorporated in the grave monuments. The tombs have to be recognised as part of a built environment, constructing and structuring cultural landscapes. A key issue is the question whether those landscapes are caused by chronological, chorological or cultural structures, and if these structures can be observed regularly across the whole Funnel Beaker Culture or just in a regional context.

Recent research has been increasingly engaged in the quantification of human activities in prehistoric times and in gaining estimation values of sizes of social groups on a trans-regional level (Shennan et al. 2013; Hinz et al. 2012; Zimmermann et al. 2009). The temporal depth and intensity of the activities is measurable in many ways. Apart from the communities' material culture information derived from geological archives with their specific environmental data is to be used as proxies to assess the human impact.

An ongoing comprehensive recording and mapping project has resulted so far in about 6,000 megalithic graves only within Germany. Within this spatial framework, for selected regions additional sources are also available that indicate settlement locations. Spatial data concerning the features of natural landscapes form a third category of sources.

To test the mentioned premise of a specific, socially constructed meaning and function of the tombs, it is necessary to identify regions with higher and lower densities of graves, especially against the background of different source filters and naturally caused influences. Potential territories, or settlement and activity areas, can be distinguished. Here, the crucial point is the interpolation of the punctual location data to generate areal information. For this purpose, various methods of interpolation and their results are compared and combined with further information mentioned before. By presenting examples, the methods of the largest empty circle (LEC), kernel density estimation (KDE), and point pattern analysis (PPP) are applied, discussed and evaluated (cf. Zimmermann et al. 2004; Herzog 2012; Baddeley/Turner 2006).

The spatial comparison of the grave and settlement areas are key aspects for the modelling and reconstruction of activity zones of prehistoric communities. Further, the comparison reveals cultural traditions archaeologically tangible and territorial structures. The case study of North- Eastern Germany shows that the settlement and grave areas are mutually exclusive. The environment is divided into different, culturally defined landscapes. Correspondingly, the diverse territories are also characterized by divergent traditions in burial architecture.

Session 18

How to deal with time in order to understand the dynamics of societies?

(Friday 25th 8h30-10h35 Pantheon S11)

Chairs : Xavier Rodier[1], Ian Johnson[2], Alfredo Maximiano Castillejo[3], Laure Saligny[4]
1 : UMR7324 CITERES-LAT CNRS-Université François-Rabelais, Tours / Gdr MoDyS, France. xavier.rodier@univ-tours.fr
2 : Faculty of Arts and Social Sciences The University of Sydney, Australia. ian.johnson@sydney.edu.au
3 : IIIPC The Cantabria International Institute for Prehistory Research.THE UNIVERSITY OF CANTABRIA, Spain, alfredo.maximiano@unican.es
4 : USR3116 MSH de Dijon CNRS-Université de Bourgogne / Réseau ISA, France. laure.saligny@u-bourgogne.fr

Archaeologists must come to terms with the temporal dimension of the data they manipulate. During excavation, temporal links between entities are handled through relative chronology. Direct dating or correlation with other dated material may then be used to align this sequence with real dates. At a broader territorial scale, archaeological structures are typically clustered into time ranges, more or less wide according to the nature of the study. This results either in snapshots, with expedient time limits, or in regular time spans, which might be described as a temporal grid.

Ideally, time contributes to the analysis and explanation of the spatial phenomena investigated. Time is a neutral space in which historical objects are established. When phenomena are discussed in a spatio-temporal perspective, time is one of the elements that structures space. In short-period studies, this approach is used to explain processes, trajectories, or dynamics. The consideration of time is so closely linked to space that the question of its own modeling does not arise. The omnipresence of time in the phenomena under investigation even hinders its formalization and its modeling in historical sciences. Moreover, archaeologists have rarely formalized their temporal approach beyond the scale of the excavation and dating issues.

The aim of moving from a neutral space, to spatial interactions, then to the study of spatial dynamics, has strongly contributed to the formalization of spatio-temporal processes and their methods of analysis. Archaeologists, who have naturally based their understanding of space on the work of geographers, have also addressed the question of spatial dynamics. The results represent significant progress from a methodological point of view, while offering an improved understanding of archaeological phenomena. However, systematically subordinating time to space does not allow us to account for multiple temporalities in historical objects. The objective of this session is therefore to discuss how to approach time in archaeological information systems, in order to observe the dynamics of transformation of societies.

This session is in line with those previously organized at CAA2009 “Why Did It Take So Long? Spatio-Temporal Modeling and GIS”, at CAA2013 “Is there time for archeology? Understanding time through modeling and representation” and at EAA2013 “Towards a real representation and interpretation of spatio-temporal data in Archaeological Record”. It is supported by the MoDyS group of research investigating challenges raised by the modelling and representation of time, through interdisciplinary contributions encompassing various scientific communities (archaeology, but also architecture, geography and geosciences, computer science).

The proposals expected will focus on: spatio-temporal analysis, dynamic mapping, graphical modeling, statistical models, descriptive models of dynamics, dynamic models, simulation tools.

Timing Things Right: stratigraphy and the modelling of intra-site spatiotemporality using GIS at Çatalhöyük.

Taylor James [1,2]

1 : Department of Archaeology, University of York The King's Manor, York. YO1 7EP. http://www.york.ac.uk/archaeology/research/research-students/james-taylor/

2 : Çatalhöyük Research Project
Stanford Archaeology Centre, Anthropology Department, Stanford University, US.
http://www.catalhoyuk.com

This paper presents current research exploring the inherent temporality embedded within the stratigraphic sequence of the complex Neolithic tell site of Çatalhöyük, south central Turkey. As a means of grouping the sequence temporally, conventional approaches to stratigraphic analysis, and particularly phasing, can be perceived as a static mode of temporal modelling. In particular at Çatalhöyük, with such a complicated sequence of deposition and truncation, phasing can be even more problematic. It is not always clear how best to group the stratigraphy temporally given that many relationships and notions of stratigraphic contemporaneity can be ambiguous and open to interpretation. Furthermore slow transition of the material culture through time can also make it difficult to use this to inform phasing process.

This paper outlines the methods used to extract a more nuanced corpus of temporal data from the stratigraphic sequence by analysing conventional Harris Matrix diagrams in more detail. Recent field-seasons at Çatalhöyük have also seen comprehensive efforts to digitize all the single context excavation data, with a focus upon full integration of all aspects of the digital archive into an intra-site GIS as an aid to analysis and interpretation. Utilizing a relational data structure and the temporal capabilities of ArcGIS 10 to generate an intra-site spatiotemporal model, the aim of this research has been to both visualize the stratigraphic sequence in a more dynamic and intuitive way (beyond conventional methods of phasing and periodization), and develop a spatiotemporal model that is robust enough to support fully integrated spatiotemporal analysis of the excavation data and associated material culture. The temporal information is then combined with the spatial data so that we can examine the way the site changes in space - through time. Can advances in computing help us to do this in a more nuanced, thoughtful and clear way? Can they help archaeologists (and the public) understand the development of the site more clearly?

OH_FET : a computer application to compare urban dynamics over long time spans (longue durée)

Huet Thomas [1,2,3*], Saligny Laure [1,2,3*], Granjon Ludovic [1,2,3*], Lefebvre Bastien [2,3,4], Simon Gaël [2,3,5], Rodier Xavier [2,3]

1 : Maison des Sciences de l'Homme de Dijon (MSH Dijon)
Maison des Sciences de l?Homme de Dijon, USR 3516, CNRS, Université de Bourgogne, Dijon, France
6 esplanade Erasme - BP 26 611 - 21 066 Dijon cedex http://msh-dijon.u-bourgogne.fr/

2 : Réseau Information Spatiale et Archéologie (ISA)
Réseau inter-MSH
http://isa.univ-tours.fr/

3 : Modélisation des Dynamiques Spatiales (MoDys)
CNRS : GDR3359
http://modys.univ-tours.fr

4 : Travaux et recherches archéologiques sur les cultures, les espaces et les sociétés (TRACES)
CNRS : UMR5608Université Toulouse le Mirail - Toulouse II
Maison de la Recherche, 5 Allée Antonio Machado 31058 Toulouse Cedex 9 http://traces.univ-tlse2.fr/

5 : Cités, Territoires, Environnement et Sociétés (CITERES)
CNRS : UMR7324Université François Rabelais - Tours
33 allée Ferdinand de Lesseps BP 60449 37204 Tours cedex 3 http://citeres.univ-tours.fr/

* : Corresponding author

OH_FET model have been designed to analyze urban fabric over long time spans (Rodier, Saligny 2010, Rodier et al. 2010). This model has been grounded on the notion of Historical Object (OH) which isdefined as the Cartesian product of three elementary dimensions: the social use (what), space (where) and time (when). OH_FET model allows to analyze changing of space's use across time (spatio-functional, spatio-temporal) and to understand modalities of urban phenomena's

transformations (Rodier, Saligny 2010). Although heuristic potentialities of the model have already been demonstrated for studies of two cities: Tours, and more recently, Vendôme (Lefebvre 2008, Lefebvre et al. 2012, Simon 2013), the constraints for data management and designing the database , imposed by the model, had represented a difficulty for its use.
Model's implementation has been realized by the Maison des Sciences de l'Homme of Dijon, with the support of Europe (Feder) and the Burgundy region. OH_FET application has been developped in Python programming language, independently from any other software in order to be spread to the scientific community. The application allows to manage automatically the designing of spatial and temporal features like Historical Objects component, to normalize and automated calculation of indicators about urban transformations, to create automatically graphic or map representations arides from temporal analysis. As an example, it is possible to interrogate the database quantitatively on functional transformations during time and across space, (how many social use for a date ? in such a place ?) or to interrogate qualitatively (what are the changes of of social uses across time for a particular place ?). While, most of these analysis have been introduced by precedent works, automating of processing and application's easy-to-use allow today to compare urban transformations of different urban areas. Through case studies, we will present the functioning of OH_FET application and perspectives of analysis offers by the application to study urban fabric.

An "alphabet" to describe the spatio-temporal dynamics of a settlement system: a relevant representation of time ?

Ouriachi Marie-Jeanne [1*], Bertoncello Frédérique [1*], Nouvel Pierre [,2], Nuninger Laure [,3], Fovet Elise [,3], Alix Stephane [,4]

1 : Culture et Environnements, Préhistoire, Antiquité, Moyen-Age / GdR Modys (CEPAM)
Université Nice Sophia Antipolis [UNS]CNRS : UMR7264
Université Nice Sophia Antipolis Campus Saint-Jean-d'Angély - SJA3 24, avenue des Diables Bleus 06357 Nice Cedex 4 http://www.cepam.cnrs.fr

2 : Laboratoire Chrono-environnement / MSHE C.N. Ledoux (LCE)
CNRS : UMR6249Université de Franche-ComtéMSHE C.N. Ledoux UMR 3124
UFR SLHS 30, rue Megevand 25030 BESANCON Cedex http://chrono-environnement.univ-fcomte.fr/

3 : Laboratoire Chrono-environnement / MSHE C.N. Ledoux / GdR MoDys (LCE)
CNRS : UMR6249Université de Franche-ComtéMSHE C.N. Ledoux UMR 3124GdR MoDys
UFR SLHS 30, rue Megevand 25030 BESANCON Cedex http://chrono-environnement.univ-fcomte.fr/

4 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr

* : Corresponding author

This paper presents a work in progress within the ANR project Archaedyn, which concerns the development of an 'alphabet' designed to characterize and compare the evolution of the settlement pattern in several microregions of Southern and Central France during the Roman period. The 'alphabet' is a composite indicator, built from several criteria relating to the quantitative, hierarchical and spatial evolution of the settlement structure. The first criterion allows to identify 9 theoretical situations of quantitative stability/instability of the settlement system according to the ratio of newly created settlements and abandonned settlements per century. The other criteria concern the evolution of the hierarchical profile of the settlement system and of its spatial structure (spacing). The different combinations of these 3 criteria form the ?letters' (or signs) of the ? alphabet?. The evolution of the settlement system of each microregion between two periods can then be written as a chain of letters and it is possible to compare these ?signatures' of the different microregions through time.
All of these criteria have a strong temporal dimension, as they are designed in terms of stability/instability, continuity/break with the previous situation. We will discuss the statistical tools used to treat synthetically these different criteria. We will then raise the issue of time and the difficulties encountered when building the ?alphabet'. For example, the criterion based on created/abandoned settlements is calculated per century while the other criteria are built on sequences of two centuries. The succession of ?letters' produces a linear representation of time, although the studied processes take place in more complex temporalities. The temporal sequencing, inherent of the coding of our data, implies to think time both as continuous (as symbolized by the chains of letters) and discontinuous (since there is juxtaposition of letters). The challenge is to create a tool

to characterize the changes of the settlement's structure in its different dimensions - quantitative, qualitative and spatial-, by using an indicator developped on the same criteria and synthetic enough to allow comparisons both in time and space.

GIS-based modeling of the dynamic development of central places

Tolnai Katalin
University of Vienna, Initiative College for Archaeological Prospection
Vienna Franz-Klein-Gasse 1/III A-1190
http://ic-archpro.univie.ac.at/

The historical development within the sites of a landscape can be observed on both intra-site and landscape scale. Data from archaeological excavations are traditionally used to determine the dynamics within a site, while landscape elements are mainly recorded by prospection and topographical survey methods. The integration of different kind of data can be performed using GIS in which spatial and temporal modeling methods help to analyze how people acted in the landscape and how land-use reflected in the environment (Allen et al. 1990, Neubauer 2004, Wheatley & Gillings 2002).
In this paper I will present the potential of prospection data in the determination of spatial organization of archaeological sites within a larger landscape context in order to detect their dynamic development within time. I will analyze the formation and fall of Viking Age central places from the Mälar region, Sweden. In Scandinavia, settlements were founded mainly along trading routes and they were often connected to each other by waterways. Beside this, their development was a response to their immediate hinterlands to which they were closely connected (Clarke & Ambrosiani 1991). The region around Lake Mälaren, the northern agricultural zone of Scandinavia, witnessed the rise of the Swedish kingdom from the seventh century. In this region a great number of different types of late Iron Age and Viking Age remains were found. The research is based on different datasets forming different scales of information. Data integration and visualization is performed with GIS. In order to be able to better interpret the features at a given site, additional comparison of the features of the same kind is needed. Therefore intra-site data is extended with large-scale prospection data and descriptive secondary sources to determine geological, archaeological and environmental parameters of the studied landscape. On landscape-scale, an evaluation of the already published material is integrated into the GIS database, providing a tool for complex archaeological interpretation. Spatiotemporal visualization methods are studied in order to evaluate the possibilities for modeling the dynamics or the processes of an area, and to determine the site distribution and site hierarchy. As a result of the archaeological interpretation the dynamics of the land use will be analyzed and visualized for the landscape.

The time, a modeling tool of ancient landscapes.

Scelza Francesco Uliano [1,2*]
1 : Università degli Studi di Salermo
via Ponte Don Melillo 84084 Fisciano (SA) Italia
http://www3.unisa.it/
2 : VU University Amsterdam
Main building VU University Amsterdam De Boelelaan 1105 1081 HV Amsterdam The Netherlands
http://www.vu.nl/en/index.asp
* : Corresponding author

The paper describes a proposal for modeling the temporal dimensions of archaeological data by presenting a new tool for managing chronology within a GIS platform. Conventional GIS does not always correspond to the needs and to the objectives of archaeological studies. In particular a point of weakness regards the absence of care of aspects related to temporality. In most cases, temporality can be expressed only as individual fixed states, or as a series of distinct stages and superimposed. In other words, the temporal detail is generally alien to most common conventional GIS. These limits of a timeless space involve problems of conceptualization and representation. The problem is to give shape to the time as a tool of analysis. The inadequacy of GIS involves at least three main aspects. The first is related to the origins of cartographic of the technology that operates with fixed attributes and non-dynamic. Secondly, the inability to represent the reasons of change that exist between different states, since the representations of space overlap only in discrete terms. Finally, its dependence on a relational table structure in which each data item is associated with stable values prevents from exceeding the staticity of the GIS. This contribution addresses theoretical questions about the meaning of time in archaeological research and technological problems related to the construction of practical solutions. The work starts from a PhD research just ended. The research investigates the organization of the ancient societies between the seventh and third centuries BC settled in Campania and Calabria. This portion of territory is the object of Greek colonization and the seat of advanced indigenous communities. The general aim is to postulate the presence structured settlement patterns. Not only. To articulate the patterns of the population to be able to locate and follow the reasons of evolution and change. The research assumes that the temporality helps to define the meaning of the forms of territorial organization, their genesis, evolution, change and outcome. From this point of view the introduction of the time-dimension in a plane of spatial relationship characterizes the distance between a geographical system of population and a mere geometric framework of representation. The instrument is a four-dimensional model in which 3 coordinates are used for the spatial location and one for temporal dimension. In this way, the tool is able to perform spatial-temporal analysis, and answer to topological questions about the position and size of documents and about chronological sequences. In brief, the tool allows to overcome the limitations of fixed and predefined periodizations. Rather it is intended to build a dynamic tool to read and interpret the landscapes.

Session 19

GIS methodologies, applications and regional Case studies

(Thursday 24th 8h30-19h Pantheon amphi2B)

Chairs : Claira Lietar, Julie Boudry, Laurent Aubry
CNRS-Université Paris 1 UMR TRAJECTOIRES Nanterre France

Archaeologists are increasingly asked to use their data within a geographic information system to cross examine and analyze multivariate data. The aim is to answer specific archaeological issues and also to advance understanding about the spatial and territorial organization systems, and socio-cultural organizations. An archaeological study in a macro-regional or regional level often integrates multidisciplinary GIS data (archaeological, geological, geomorphological, etc..). It is more difficult, or at least less accurate at a smaller scale. At the site level, the structural organization of the territory is of course not graspable. Querying and analyzing data collected in simultaneous ways, georeferenced and integrated into the GIS will provide a comprehensive approach to modeling societies and their settlement. In order to examine and address the issues of different axes of research (relationship between site and environment, reliability of distribution sites, site's function, distribution of artefacts, socio-cultural organization), a multitude of analyzes are available to us, from the simpler (Kernel density for example) to the more complex (reconstruction of agricultural potential, etc..). Yet one must still use pertinent analysis based on the data and address issues raised in archaeological research.
We propose here to provide an overview of the different spatial analysis useful in archeology,
covering all periods, through specific applications to regional case studies. The presentation will be focused on methodological processes arising from such studies. Examples of specific spatial analysis will be presented as well as “chaînes opératoires” or chains of thoughts, in other words global processes used to answer spatial and territorial organization issues (data, tools and analysis and their concomitant use). The question of interchangeability of “chaînes opératoires” and of the limits in understanding archaeological settlement systems lies at the heart of this session.

Is there a connection between the cemetery and the habitat? Test considerations on the settlements analysis of the recent prehistory through the example of the Nord- Charente during Middle and Late Neolithic

Pillot Lucile [1*], Ard Vincent [,2*]
1 : Archeologie, Terre, Histoire, Sociétés (ARTeHIS)
MIN CULTUREUniversité de BourgogneCNRS : UMR6298
6, Bd. Gabriel 21000 Dijon www.artehis-cnrs.fr
2 : Travaux et Recherches Archéologiques sur les Cultures, les Espaces et les Sociétés (TRACES)
CNRS : UMR5608Université Toulouse le Mirail - Toulouse II
MAISON DE LA RECHERCHE 5 Allée Antonio Machado 31058 TOULOUSE CEDEX 9
* : Corresponding author

In many European areas, the Neolithic period corresponds to the development of architectural monumentality which left important marks in the landscape, as well as the land clearing and the cultivation by the first agro-pastoral societies. This monumentality can be observed in the domestic sphere, particularly by the edification of enclosures with various functions and surfaces, and in the funeral and ritual sphere, by the development of many megalithic or premegalithic cemeteries. It is noteworthy that the concomitant development of these monumental sites reveals the complexity of cultural, symbolic and socio-economic practices of Neolithic societies. These monumental sites probably reflect socio-cultural dynamic systems in which the notion of territory seems to be a fundamental concept. Obviously, in many areas of Europe, Neolithic people have appropriated their surrounding landscape, exploited or not, by the edification of these monumental sites. In this way, they probably sustain their control over a definited territory. That's why burial, domestic or even defensive monumental sites, must be jointly analyzed in order to understand the organization of these Neolithic spaces, in which enclosures and cemeteries can structure a territorial network.

We conducted a spatial study of the distribution of the neolithic monumental sites in the Nord-Charente (France), which is placed in the continuity of the recent spatial analysis of megaliths of this area conducted by Elias Lopez Romero and Luc Laporte (in press). In this area, many space was used for the installation of many sites (necropolis, enclosures) which, according to recent studies (PCR "The Nord-Charente during Middle and Late Neolithic : causewayed enclosures, megalithic tombs and territories", coord: V. Ard), are dated of the Middle and Late Neolithic periods. Through the application of varied spatial analysis (distribution, dispersion, visibility, etc.), we attempt to know if:

Is-it possible to determinate an organization of the occupied space? What characterizes this territorial organization? Can we suppose that these monumental sites reveal a new way of appropriating space? What are the patterns of territorial organization, in which enclosures and cemeteries have a fundamental role?

This paper will be an opportunity to present the first results of this study and to discuss the concept of landscape appropriation, combining domestic, symbolic, economic or natural spaces.

From the excavation to the territory: contributions of GIS tools to the study of the spatial organization of the archaeological site of Argentomagus (France, Indre, Saint-Marcel/Argenton-sur-Creuse)

Le Goff Emeline[*], Laüt Laure,*, Rabaste Yoann,*, Dumasy Françoise
Association pour la Sauvegarde du Site archéologique d'Argentomagus et Amis du Musée (ASSAAM)
Association pour la Sauvegarde du Site archéologique d'Argentomagus et Amis du Musée
9 rue de la Belle Étoile 36200 Saint-Marcel http://www.argentomagus.fr/index.php
* : Corresponding author

The site of Argentomagus, which is located in the Midwest of France, extends over the current municipalities of Saint-Marcel and Argenton-sur-Creuse (Indre), where a total of 120 archaeological sites have been identified, distributed on a surface of 20Km².

Over centuries, the territory of Argentomagus had been the place of an oppidum, of an antique secondary urban area, and then of a medieval and a modern village. Within the scope of the study of this territory, a Geographical Information System (GIS) was used to homogenise, to compile and to analyse all the available documentation. The archaeological map thus created with a GIS software allows now the display of all the sites identified from the 1960s (during unexpected discoveries, programmed or rescue excavations). This dataset also contains all the information about each site, and thus offers numerous possible representations and spatial analyses.

The Collective Research Program «Argentomagus» is organised around two themes: the spatial distribution and the functional characterisation of archaeological remains on one hand; the relationships between a site and its environment on the other hand.
The first research theme focuses on a diachronic perspective at scale of the intra-site. At this level, two types of studies are particularly important: the geo-referencing of the former data from excavations or from pedestrian surveys, but also the interpretation of the geophysics data. These latter significantly improve the information provided by excavations because they allow to clarify the extension and the organisation of the different dwelling areas or craft industry production areas. Requests from the spatial database permit the elaboration of time-phase maps offering a renewed vision of the successive transformations of this territory, in particular concerning the evolution of antique urban organisation. Combined with topography, the archaeological data allow to better understand the medieval city expansion and why during Modern Times this city (on the current municipality of Saint Marcel) has been gradually deserted to the benefit of a new modern city (Argenton-sur-Creuse).
The second axis concerns the scale of the whole territory and the analyses related to the implantation of sites on the relief: analyses of visibility, especially for the construction of buildings, but also analyses of distances. In this purpose, two sources were exploited: the BD- Alti of the IGN (the French national geographic institute), then a Digital Terrain Model (DTM) stemming from a micro-topography survey realized in 2013 on the plateau of Mersans. Among others, this approach aimed to better define the plan of the Gallic rampart. Moreover, hydro- morphological analyses were realized in order to validate the hypothesis of the anthropogenic planning of a former thalweg.
To summarise, this paper will present the methods used for the study of an antique city within all its spatial extension and also within its chronological thickness. Surveys performed to record and to inventory the data will be explained together, with spatial analyses and results obtained in methodological terms; because these approaches (which combines information gathering and database management) are about to be systematically applied to the study of archaeological sites.

The role of the Late Roman rural sites in Vasilikos Valley, Cyprus. A GIS perspective.

Kyriakou Niki
The Cyprus Institute (CYI)

During the 4th-7th centuries A.D. the rural landscape of Late Roman Cyprus experienced an economic and social growth. This prosperity is reflected in the increasing number of rural sites and basilicas appearing in the hinterland of urban centres. The current paper attempts to explain the role of the rural sites in the economy of Late Roman Cyprus and their relationship with the urban centres. The case study discussed is the rural sites network of Vassilikos Valley, developed in the east frontiers of Amathus urban centre.
Vasilikos Valley sites dating in the Late Roman period are extensive and range from the coastal areas of Vasiliko and Zygi up to the north of Kalavasos Dum. In order to give further insights to the role of the Vasilikos Valley rural sites a GIS- Cost Surface Analysis,(CSA), approach is adopted. The GIS-CSA enables to visualize and analyze the relationship of the rural sites with the neighbouring urban centres. Additionally CSA is implemented in order to acquire the catchment areas of the rural sites and to understand their role and function within their environmental and social context of Late Roman Cyprus.
The GIS-CSA results are statistically explored with Principal Components Analysis to identify possible trends in sites locations preferences and to underline site's functions within the Vasilikos Valley. The GIS and Statistical analysis aim to explore the spatial relation of the rural sites to the

urban centres and coastal highway, and to the environment i.e. arable land, water and mineral resources.

Cities in the the Desert: GIS Applications in the Study of the Shan Shan Kingdom

Hanus Kasper Jan [1], Smagur Emilia ,[2]
1 : Department of Archaeology, the University of Sydney (USyd) Quadrangle Building A14 University of Sydney NSW 2006 http://sydney.edu.au/arts/archaeology/
2 : Istitute of Archaeology, Jagiellonian University (IAUJ)
11 Go??bia St. PL-31007 Kraków
http://www.archeo.uj.edu.pl/

The Kingdom of Shan Shan (called Kroraina by the Gandhara people) was a small oasis kingdom, which stretched about 800km along the southern route of the Chinese part of the Silk Road, all the way from the site of Niya, to the salt lake Lop Nor. It flourished in the 3rd and 4th century AD. Shan Shan, along with the other Silk Road kingdoms, played a crucial role in the intercontinental trade and cultural exchange between Han China, Indian subcontinent and Mediterranean world. Despite this fact our knowledge about its history and material culture is obscure and shattered. There are two major factors causing such situation. Beginning with on the one hand geographical conditions (Taklamakan Desert in one of the driest places on Earth) and on the other hand incomplete and fragmentary previous archaeological survey. Last comprehensive research on the regional scale was conducted by sir Mark Aurel Stein in the beginning of the XX century. Since then western scholars base their knowledge about Shan Shan on the small artifacts and texts written on the wooden tablets in the Kharosti script which were brought by Stein to the European museums.
In our opinion the GIS software is an especially helpful tool when comes to such a rough terrain as Taklamakan Desert. It allows us to create an extremely precise virtual cultural landscape as the Taklamakan Desert is still relatively scarcely urbanized. Arid climate with a lack of vegetation has helped to preserve structural elements such us mudbricks and wooden constructions. Many buildings are still clearly visible on the surface, even if they are covered with sand.
Our database combines, among others, plans of structures and terrain maps done during Stein's expeditions, in situ locations of small artifacts and the results of interpretation of the Satellite images. Spaceborne remote sensing is of the great importance as it allows us to review historical plans and identify new structures. We are able to conduct limited groundtruthing using contemporary surface photos and GPS coordinates obtained courtesy of International Dunhuang Project. After creating the database we can analyze the digital landscape and cityscape. One of the most important things is to establish the extent of these oasis cities which can be based on the reach of the water management systems. The analysis of spatial patterns of individual cities could give us a clue about the model of urbanization. The most interesting questions are: how big are the archaeological sites, the scope of monumental architecture and settlement districts. Also such a database is a great platform for any other procedures that are usually employed for archaeological interpretation.
In our presentation we are going to show how GIS environment could be applied to conduct an archaeological research on urbanization and settlement pattern in Shan Shan, both as self- sufficient virtual reality and as a great help during preparations for ground survey that we are planning to conduct in the future.

Use of Burgundy stone from Ancient history to our days

Buttner Stephane [1,2], Montagne Delphine [2,3], Saligny Laure [3]
1 : Centre d'études médiévales Auxerre (CEM)
CNRS : UMR6298
3, place du Coche d'Eau - 89000 Auxerre http://www.cem-auxerre.fr/
2 : UMR 6298 «Archéologie, Terre, Histoire, Société» (UMR ArTeHiS)
CNRS : UMR6298
Université de Bourgogne - 6 bd Gabriel - 21000 Dijon http://www.artehis-cnrs.fr/
3 : Maison des Sciences de l'Homme de Dijon (MSH Dijon)
Maison des Sciences de l?Homme de Dijon, USR 3516, CNRS, Université de Bourgogne, Dijon, France
6 esplanade Erasme - BP 26 611 - 21 066 Dijon cedex http://msh-dijon.u-bourgogne.fr/

The quality and diversity of Burgundy stone are widely acknowledged and their use was continuous from Ancient history to today. Adapted to the various requirements of construction and sculpture, their use has so far been inventoried by researchers. But the scattering of inventories prevented any comprehensive and global approach. Therefore an inventory of these data was undertaken with the aim of renewing studies in diverse topics (archeology and history of architecture, socio-economic history and history of art). The project is currently limited to the Burgundy region but it aims to extend further the diffusion zones borrowed by the stones to their final site on the entire French territory, and beyond.

Under the project of a mutualized platform on use of Burgundy stone, a partnership was established between different laboratories of the University of Burgundy in order to ensure the validity of archaeological and historical data (ArTeHiS), to develop an open collaborative working space under the shape of a Wiki (LE2i), to design a GIS to analyze the diffusion of Burgundy stone since the beginning of our era (MSH Dijon).

The complex structure of the platform (Wiki, database and GIS) was designed to describe the relationships between quarries and the use of stones over time and space. This tool also has the advantage of being collaborative and long-lasting, offering the opportunity to work on a corpus that is sure to get rich in the future.

In a first part, the paper will present the spatial database and GIS implemented to study the use and dissemination of Burgundy stone in the long term. The spatial data of this database result from the general inventory, accommodated by the Wiki. The database integrates stones used in construction or as objects (statues, sarcophagi, etc...). Theses stones have to be characterized localized (spatial data) and dated (temporal data). Quarries and stones in the region are also integrated. The link between these archeological and geological inventories is established by the geological characterization of the material. This characterization can be exact by the ?geological facies' or relatively imprecise with regional appellations by 'geological formation'.

In a second part, we present the spatial analysis and results on the circulation of the stone and dissemination areas. The results highlight on one hand the phenomena of concurrence evolving in time and on the other hand the catchment area of archeological sites. Another analysis deals with cost distance category in order to compare a theorical model built with topographical constraints and the historical facts described by sources.

The mapping and spatial analysis allow to explore data, to verify some hypotheses, to check the validity of certain data corpus, to highlight some errors and incoherence of the inventory, and also, to provide new perspectives of research.

Potentials and limitations of available global 3d terrain modeling for landscape archaeology in the prehispanic Andes: 3 cases study from Peru, Bolivia and Chile.

Saintenoy Thibault [1*], Ajata Rolando [2], Villanueva Juan [3]
1 : Centro de Investigaciones del Hombre en el Desierto (CONICYT, chile), CRNS Archéologie des Amériques UMR8096 (CIHDE-CONICYT, Chile; CNRS ARCHAM UMR8096, France)
CIHDE: Av. General Velásquez 1775, Of. 403 - Arica CNRS ARCHAM: Maison René-Ginouves. 21 allée de l'Université. Nanterre www.cihde.cl
2 : Universidad de Tarapaca, Programa de Doctorado (UTA)
www.uta.cl
3 : Universidad de Tarapaca, Programa de Doctorado (UTA)
* : Corresponding author

Ethnographic and archaeological evidences leave no doubt about the fundamental geo-symbolic role played by mountains in the socio-spatial configuration of Andean prehispanic territories. Forming both orientation landmarks and cosmological figures, mountains have been the object of landscape architecture projects in many Andean cultures. Many examples of site location and architectural orientation related to landscape mountain scenery have been evidenced through subject-centred experience field observation studies.

Recent 3D terrain modeling development allow to study these archaeological landscape architecture achievements through quantitative spatial analysis data. Simulations of visibility and pedestrian movements based on digital elevation models offer an agent-based perspective on ancient territories and territorialities. However, these simulations heavily depend on DEMs resolution and accuracy while the 3D modeling of the Andes - the largest mountainous area on earth - is still a great challenge for geomatics and geomorphometry.

Three cases study developed in both slopes of the Andean mountain range and in the Altiplano illustrate the potentials of 3d terrain modeling for the landscape archaeology of prehispanic territories. Cumulative viewshed analysis show how a significant criteria was the visibility of mountain peaks in the settlement pattern of Inca palaces and royal estates around Choqek'iraw and Machu Picchu, and in the location of the funerary sites in the Caranga Altiplano in Bolivia. DEM-based locational analysis of the pukara (hilltop settlements) of the Arica sierra in northern Chile produce pertinent data to explain the socio-spatial configuration of the complex multiethnic territory settled in the region during the late prehispanic and early colonial periods. Despite of the positive results of these geomatics based studies, the conducted landscape archaeology routine-analysis evidence, at the same time, serious inconsistencies in the quality of the available digital elevation models and thus some limitations for the archaeological study of past behaviors in the pixelated ecumene.

From Field into Computer - Understanding Pre- Columbian Elite Burial Patterns from Castillo de Huarmey

Giersz Miłosz [1,2*], Chyla Julia [,2], Pimentel Nita Roberto [,2], Prządka-Giersz Patrycja [,2,3*], Więckowski Wiesław [,2 1*]

1 : Institute of Archaeology, University of Warsaw, Poland (IA, UW) Krakowskie Przedmie?cie 26/28, 00-927 Warsaw, Poland http://www.archeo.uw.edu.pl/

2 : Castillo de Huarmey Archaeological Project http://www.andeanarchaeology.com/home/Research.html

3 : Faculty of “Artes Liberales”, University of Warsaw, Poland (Artes Liberales, UW) http://www.obta.uw.edu.pl/eng.php

* : Corresponding author

Is paper still needed to interpret excavation's results? To answer this question one would like to show workflow, analysis and results of excavations on an endangered site of Castillo de Huarmey, Peru.

Between August 2012 and September 2013 the Polish-Peruvian team has discovered and excavated an intact burial chamber under an imperial mausoleum at El Castillo de Huarmey site, north coast of Peru. This discovery exceeds in both, number and quality, any other previous find related to the Wari and Tiahuanaco cultures. The excavated burial chamber, cut into the bedrock, formed the first, subterranean level of a multistoried, tower-like orthogonal mausoleum, built on top of a rocky hill. Found intact for the first time, the unlooted burial chamber contained the interments of 64 high status individuals, adored with gold, silver, semi-precious stones and elaborate ceramics. The number of registered artifacts exceeds 1300 items. Due to complex nature of the burial context and serious time constrains the traditional ? «analog » paper documentation was replaced with nearly fully digital one. All excavated layers and features were photographed and documented as ortophotographs. Artifacts were also documented in 3D with the use of Total Station. Only sketches based on ortophotgraphs with georeference points used to document skeletons' layout and new features were on paper. Any additional information and measurements were being successively added to them at the time of excavation. Obtained data was digitized and stored in the, designed for that use, data-base. Next, in-lab, step as to vectorize and organize collected data and prepare it for analysis. Using georeferenced photos and aforementioned sketches, each individual was presented within context of burial chamber, along with associated artifacts. Ortophotographs were used to create 3D models of all layers of architecture and burial chamber. Work flow developed in such a way was used, examined, and proved to be an excellent way of documentation during the following season. Collected data was used for basic, statistical analysis and visual interpretation of the burial context. Main goal of the spatial analysis was to find patterns and the association between artifactsand individuals. Another research question was to find out is it possible to distinguish statistical correlation with such huge amount of the data deposit in small space. This study, as well as grouping issues pertaining to archeology, bioarchaeology and anthropology, is based on the results of the analysis of artifacts (including ceramic vessels, textiles, metal, bone and wooden objects), burials, architectural features and iconographic sources of pre-Columbian origin and also on the taphonomical, bioarchaeological and biochemical analysis of the human remains. Results of the analysis give an opportunity to fully understand this set of globally unique archeological sources, and to reconstruct sophisticated rituals of ancestor worship, as well as geographic origins and the social status of the pre-Columbian Wari elites from El Castillo de Huarmey.

Hybrid Three-Diminstional Viewshed Analysis

Wilson Andrew
School of Computer Science, Bangor University Bangor University - Bangor -Gwynedd - LL57 2DG http://www.bangor.ac.uk/

Geographical Information Systems are generally considered a two and a half dimensional environment. This is in reference to the fact that most, but not all, Geographical Information Systems (GIS) lack a true z axis. This results in many GIS only being able to utilise a single z value at any given point within the environment. This can result in a large amount of underlying problems with the standard tool kits when used as part of a discussion into other types of visual properties. Due to these issues with the standard GIS analysis, the viewshed calculation is unable to include any additional types of overlying z axis based datasets, such as environment or atmospheric conditions. As a consequence most analyses are produced in a barren research environment void of any type of human or social aspects of the landscape. Within archaeological research, this is coupled with an overall lack of knowledge by the end users of the underlying workings and limitations of the viewshed analysis, producing very poor quality, statistically unsound results.
Attempts have been made by archaeologists to relate standard GIS operations to the concepts of cognition and human perception, however, the standard GIS tool-kit alone is insufficient for examining these ideas of human spatial interaction and the concepts of perception and cognition. As most examples are simply based on theoretical ideas applying different models to the standard viewshed results. Other more advance statistical examples can be seen in the enhanced viewsheds of Wheatley and Gillings (2000); Gillings and Wheatley (2001) and the fuzzy viewsheds of Fisher (1992a,b); Fisher and Farrelly (1997) and Llobera (2001a, 2003, 2007). Many of these examples, however, fail to recognise one of the more predominant problems within GIS analysis - its two dimensional nature. In order to incorporate any type of humanistic aspects, be it perception or cognition, the two dimensional nature of GIS needs to be addressed. Also, in order to develop a truer sense of human vision within a GIS, a whole new mindset, as well as new tools and calculations need to be developed. To date, these problems have had little research, with most projects failing to address any of the issues surrounding GIS visibility analysis. Outside the realms of academic archaeology, examples of three-dimensional visibility research can be found in many different fields such as Geography, Psychology and Anthropology. Research examples can also be found in areas of architecture and related subjects such as Landscape and Urban development. But the most directly relevant research can be found in the ideas and processes of scenic beauty (visual quality, scenic quality, or visual aesthetic value) prediction modelling, used and developed in the field of Forestry and Urban Management.
The following paper develops these ideas of human spatial interactions, by attempting to answer some of the problems currently impeding research in archaeological-based visibility studies. This is made possible through the design and implementation of a full three dimensional visibility analysis, incorporating features lacking in current calculations and concepts.

Locating and Digitizing Archaeological Features using GPS with Scanned Historical Maps in the Field: Applications for Historical Archaeology

Madry Scott [1*], Tickner Amanda, Jones Elizibeth
University of North Carolina at Chapel Hill (UNC-CH)
250 East Franklin Street
http://www.unc.edu
* : Corresponding author

A group of interdisciplinary researchers has been working in the Burgundy region of France for over 30 years, studying the long-term interaction of human societies and the landscape. GIS and spatial data have been a part of our work since our first database in 1986, and our work continues to evolve and utilize new technologies as they become available. Recent work has been done collaboratively, working in an interdisciplinary team including archaeologists, historians, geologists, ethnobotanists and GIS specialists.
The work to be reported in this paper utilized a Garmin GPS and software that allowed the incorporation in the GPS display in the field of a set of 14 scanned and georeferenced historical maps of the area dating back to 1759. Fieldwork conducted in 2013 used this approach successfully to identify, investigate, and map into our GIS database numerous features in the region, including old roadways, structures, mills and dams that are no longer visible in the modern landscape. This paper will present the approach of this work and the process for incorporating the historical maps into the GPS display, including the specific equipment and software used. The benefits and limitations of the current approach will be presented, along with the role of this work within our larger project. Examples of the field work, sites documented, etc. will be shown. Finally, the future potential of this work for archaeological research in a collaborative and interdisciplinary perspective will be discussed.

Assigning function to survey data using multivariate geospatial modeling

Newhard James M.I.*, Levine Norman*
College of Charleston (CofC)
* : Corresponding author

Within landscape archaeology the assignment of function to small, ephemeral distributions of artifacts is a time-worn problem. Oftentimes, these features are intuitively assigned functional attributes based upon size or the presence of a particular class of artifacts, or are based on understandings of presumed regional patterns based on proximity to other known features in an area. The assignment of function in many way is the application of intuition and experience.
It is assumed that certain land use activities occur in spaces that are suitable for their execution by the function of their natural and/or social geography. The operationalization of these assumed characteristics can occur, by recognizing that each a land use activity has a different set of definable relationships that can be expressed as measurable geographic criteria. Additionally, archaeological and historical data (e.g. types of ceramics or the presence/absence of built architecture, textual evidence) can be included to move beyond the geographic factors. The idealized relationships of these criteria can be represented graphically, and then modeled within a GIS. The application of the model can then prove to be a powerful tool for understanding functional groups across the landscape.
The process presented in this study allows for a comparison of feature characteristics against explicitly stated assumptions for site function. The approach enables and encourages the process of defining variables into measurable factors. This explicitness in stating assumed functional characteristics while preserving the sparse and fragmentary nature of the recovered evidence allows for a powerful understanding of functionality across the landscape. Cached within a GIS modelling environment, the method allows for an approach where assigning functional criteria can be altered based upon changing understandings of the society in question as well as changes in our understanding of past environments.

The ancient rural settlement structure around Pompeii ? Inferred from spatial statistics and predictive modelling on villae rusticae

Vogel Sebastian [1*], Domenico Esposito [,2], Maerker Michael [,3], Seiler Florian [,2]

1 : University of Tuebingen c/o German Archaeological Institute (DAI)
Podbielskiallee 69-71, 14195 Berlin
www.dainst.de

2 : German Archaeological Institute (DAI) Podbielskiallee 69-71, 14195 Berlin www.dainst.de

3 : Heidelberg Academy of Sciences and Humanities c/o University of Tuebingen
Ruemelinstr 19-23, 72070 Tuebingen
www.uni-tuebingen.de

* : Corresponding author

The build-up of a comprehensive GIS database of archaeological evidence of the pre-Roman and Roman period in the hinterland of Pompeii has, so far, yielded a dataset of more than 500 entities. About 150 of them were assigned to Roman farms (villae rusticae) which are believed to have played an important role in ancient rural life and economy of the Sarno River plain. This involves agricultural production not only of food to supply the urban centers Pompeii, Stabiae and Nuceria but also of goods (e.g. wine) to be exported to Rome as well as to the western and eastern Mediterranean.

To gain a more detailed understanding of the ancient rural settlement structure of the Sarno River plain, the dataset on villae rusticae was used to carry out a series of quantitative GIS-based spatial analyses. At first spatial statistics aimed at recognizing spatial patterns, trends and relationships of the distribution of villae rusticae to validate the first simply visual impression of a clustered organization around the urban centers Pompeii and Stabiae. Subsequently, a predictive modelling approach aimed at determining the potential area that may have been occupied by villae rusticae and agricultural production. This includes paleo-environmental parameters and also tries to quantify some socio-economic parameters that may have controlled the spatial distribution of villae rusticae. For that, a pre-AD 79 paleo-landscape model of the Sarno River plain was utilized characterizing the ancient topographical conditions before the eruption of Vesuvius in AD 79.

The integration of landscape processes in archaeological site prediction in the Mugello basin (Tuscany/Italy)

Maerker Michael [1,2], Schmaltz Elmar,*, Rosner Hans Joachim

1 : Heidelberg Academy of Sciences and Humanities (HAW)
c/o Geographisches Institut der Eberhard Karls Universität Tübingen Rümelinstr 19-21, D-72070 Tübingen
www.roceeh.net

2 : Department of Earth Sciences University of Florence (DST)
Dipartimento Scienze della Terra Università degli Studi di Firenze Via G.La Pira 4 Firenze 50121, Italy
www.dst.unifi.it

* : Corresponding author

The objective of this work is to detect and discuss possible find locations of Palaeolithic artefacts of early homo sapiens in the intra-montan Mugello basin in Northern Tuscany, Italy. For this purpose, both landforms and the respective landscape forming processes based on hydrological and sediment dynamics, including soil erosion, deposition, and transport processes were investigated. The recent terrace landscape of the Mugello Basin shows three main Pleistocene terraces. The oldest and highest terrace indicates one of the Palaeo-surfaces. Mainly Middle Palaeolithic stone artifacts are found. The middle terrace is the second oldest terrace and stone artifacts from both the Middle and Upper Palaeolithic were exposed on the surface. The youngest terrace contains rearranged artifacts from the Middle and Upper Palaeolithic. In general, the fresh edges of the artifacts collected on the higher terraces show that they have been minimally transported. On the contrary the archaeological material from the lower terraces is more rounded, indicating water transportation and erosion processes. A remarkable fact is that collected artifacts from the intermediate terrace system show only minimal evidence of transportation (1%). Middle Palaeolithic artifacts were made by classic Neanderthals using the Levallois technique. Predominantly cores were found, the smaller flakes are hard to spot in the landscape. Various techniques were applied to create a diversity of end products. The cortex on the bases on most of the cores suggests that river pebbles were used as raw material. The patination and the size of the artifacts decrease from the highest to the lowest terrace. The preservation describes to which degree artifacts were exposed to transport (e. g. fluvial). In general the Middle Palaeolithic assemblages outbalance the Upper Palaeolithic. The latter consist basically of platform cores that modern humans used to produce linear flakes. These platform cores were smaller than the Levallois cores. There were as well found a few tools in the Upper Palaeolithic artifact selection. In order to understand the present day as well as the ancient landscape dynamics and the respective distribution of artifacts a hydro erosive model approach based on the unit stream power concept was applied. Moreover a detailed terrain analysis was performed. Both static information as well as dynamic model information was utilized to explain the present day spatial distribution of artifact assemblages. Finally we trained a stochastic model (boosted regression trees) to predict potential artifact sites in the Mugello valley. The distribution of potential sites reflect Palaeo- topography and areas characterized by geomorphic stability.

Settlement patterning in the Lesser Antilles: A study of changes in settlement patterning across the historical divide

De Ruiter Samantha [1*], Corinne Hofman ,[2]
1 : HERA - Faculty of Archaeology, Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/
2 : NEXUS1492 - Faculty of Archaeology, Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/
* : Corresponding author

As part of the HERA-CARIB project, this study focuses on the analysis of Amerindian and Colonial settlement patterning in the Lesser Antilles in which characteristics, continuity, and changes in site locations are investigated in the cultural and social context of the islands. This study focuses particularly on the islands of St. Kitts and Grenada on which the first fieldwork campaign will take place, which mainly consists of surveys. Archaeological landscapes in the Late Ceramic Age and Early Colonial period are investigated by GIS analyses and are reconstructed using ethnohistoric and archaeological data, present day maps and GPS data collected during fieldwork. The impact of early colonization on settlement patterning on these ecologically and culturally diverse islands is the focal point of analyses, placing the ?Island Carib strongholds' at the centre of this study. It was on these islands, among a number of other islands of the Lesser Antilles, that the Island Carib fought their last battles against the European settlers. Furthermore, all collected data will be incorporated in a geo-referenced database, culminating into a firm base for the construction of a predictive model. Both the database and the predictive model will serve as tools for heritage management. These tools can be used by local agencies in their efforts to ensure the protection and endurance of local heritage which is of major importance in the Caribbean. Not only natural threats such as hurricanes endanger the archaeological sites, but also the ever developing tourist industry is a large factor in the obliteration of the archaeological record.
The project is part of the HERA-CARIB project directed by Prof. dr. Corinne L. Hofman and financially supported by the HERA Joint Research Programme in Cultural Encounters (www. heranet. info), agreement n° 1133. The HERA-CARIB project focuses on inter-community social relationships and transformations of island cultures and societies in the Lesser Antilles.

From tradition to Archeology: Approach to salt's production potentiality via solar evaporation in the Iberian System during the Iron Age

Terán Jonathan
University of Zaragoza
Facultad de Ciencias Sociales y Humanas, Campus de Teruel, 44003 Teruel - España
http://unizar.es

Industrialization has led to diminishing the importance of common salt in human societies. We are currently lacking enough knowledge of salt production in the Iberian Peninsula during Prehistory for two main reasons: its «invisibility» as a good that seldom gets documented in archeological registers, and the assumption that climate conditions in the Peninsula allowed for production via solar evaporation since Prehistory. Our research tries to shed some light on this problem with a series of cartographies on production potentiality in the Iberian System, an area with an extensive salt-mining tradition, in the Iron Age. Production potentiality has been obtained from calculations of the variables that affect production -geology, insolation, precipitation regime, temperature and altitude- in traditional salt mines; calculations of variables' values based on the available data on paleoclimate for the Iron Age; and finally, the development of a multi-criteria model that has allowed us to assess salt's production potentiality via solar evaporation. The analysis of the cartographies we obtained has shown great differences in production potentiality in the study area due to the varied climate conditions. Key words: production, salt, solar evaporation, Iron Age, Iberian System, multi-criteria analysis.

r.finder: A GIS tool for predictive analysis in archaeology

Palombini Augusto*
CNR - Istituto per le Tecnologie Applicate ai Beni Culturali (CNR-ITABC)
Via Salaria km. 29,300 00015 Monterotondo St. (Roma)
www.itabc.cnr.it
* : Corresponding author

r.finder is a GRASS-GIS script created for predictive analysis in archaeological, although it is generally suitable for any kind of geographical-based study. In its different functions, r.finder can be applied to analyze the existing record and check which key-factors (if any) may be considered of relevance in influencing the archaeological presence, as well as to find the areas whose features combination is closest to the one of the existing records, and applying the model to other geographical regions. r.finder is freely available, together with a detailed tutorial, at: http://www.palombini.net/sw/finder and will be soon available on GRASS-GIS users wiki site : http://grass-wiki.osgeo.org/wiki
The main function of the script is to identify the areas more similar to the ones in which some archaeological findings are located, on the basis of the values of a series of raster thematic maps. r.finder considers the values of the cells where input elements are located and outs a map representing the degree of similarity of any part of the region to those.
Such thematic maps are analyzed in different ways distinguishing between quantitative (if cell values represent a continuous sequence, as DEMs, slope maps, etc.) and qualitative (when values correspond to independent categories, as for geological unities). For qualitative maps only the single cell values where sites fall are considered, as for quantitative ones, the analysis is performed checking for cells inside the whole range between the lowest and the highest value (or, optionally, according to the standard deviation of the distribution).
Other r.finder functions are aimed to the elaboration and visualization of statistical analysis on thematic maps meaning, and to create rules text files to store the results of successful analysis in order to apply the same operation to other geographical areas.
r.finder is a script in the frame of GRASS-GIS software, under GPL licence, open source and freely available. It is here presented together with some case studies on its application.

Navigating Pompeii's bibliography through a map: The Pompeii Bibliography and Mapping Project.

Poehler Eric
University of Massachusetts (UMASS)
300 Massachusetts Ave Amherst, MA 01002
http://www.umass.edu/

Landscapes, both literal and figurative, have incredible power in structuring thought and interpretation in archaeology. With funding through both the NEH Digital Humanities' Start-Up grant program and the ACLS Digital Innovation Fellowship, the Pompeii Bibliography and Mapping Project is building a unique resource to leverage the physical landscape of Pompeii as a means to navigate and query the ancient city's bibliographic landscape. Because Pompeii lacks both a single, searchable bibliography and a standard, up-to-date map, the creation of a resource that solves these problems and simultaneously offers new and powerful search methods will revolutionize research on the ancient city. The Pompeii Bibliography and Mapping Resource (PBMR) is a web-based research environment composed of three parts: 1. Bibliographic Database and Full-Text Document Repository, 2. Geographical Information System (GIS) and 3. User Interface. At base, the PBMR is a research tool that affords the user the ability to navigate Pompeii's urban topography and discover an extensive account of the information about each location. The GIS component provides a powerful mapping tool that can generate custom maps for diverse user groups. Users working on a particular building can create both overview and detailed maps to illustrate their study, which could be based on information provided by the PMBR as a research tool. The most powerful use of the PBMR is as an analysis tool, allowing the user to vacillate between bibliographic analysis tools and spatial analysis tools. For example, one might search for the term «House» in the bibliography, narrow those results to houses of less than 200m2 using the GIS, and then return to the bibliography to search this subset of results for houses published in the last 30 years. Thus, the PBMR permits one to ask a series of questions and receive data-rich answers impossible to achieve in any other method. Finally, although focused on the novel means of delivering the scholarship of a particular archaeological site, the anticipated users will not be limited to the academics who study that site. Similarly, the specific content of the project ? Pompeii ? will not limit its application by other aspects of classics or other subjects in the humanities. We propose to present the PBMR at the Computers Applications and Quantitative Methods in Archaeology 2014 conference (CAA 2014) to share the project's concept, functionalities, and design as well as to expose those attributes to critical feedback. Such feedback will be of particular value to our project as we begin the final months of funding following the CAA 2014.

Towards a new methodology of studying flints, by using GIS and a geo-referenced database in the South of France

Tufféry Christophe [1,2*], Tallet Pascal [3*], Davtian Gourguen [4*], Bressy-Leandri Céline [5*], Affolter Jehanne [6*], Bazile Frédéric [7*], Bracco Jean-Pierre [5*], Caverne Jean-Baptiste [3*], Delvigne Vincent [8*], Dessaint Philippe [9*], Foucher Pascal,*, Gaillot Stéphane [9*], Liagre Jérémie [9*], Millet Françoise,*, Millet Dominique,*, Morala André [8,10*], Piboule Michel,*, Picavet Régis [3*], Schmidt Patrick [11*], Tomasso Antonin [4*], Turq Alain [8,10*], Raynal Jean-Paul [8,10*], Binder Didier [4*], Fernandes Paul [3,8*]
1 : Cités, Territoires, Environnement et Sociétés (CITERES)
CNRS : UMR7324Université François Rabelais - Tours
33 allée Ferdinand de Lesseps BP 60449 37204 Tours cedex 3 http://citeres.univ-tours.fr/
2 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr
3 : Paleotime
Paleotime
6173 rue Jean Séraphin Archard Picard, 38250 Villard-de-Lans http://www.paleotime.fr/
4 : Culture et Environnements, Préhistoire, Antiquité, Moyen-Age (CEPAM)
Université Nice Sophia Antipolis [UNS]CNRS : UMR7264
Université Nice Sophia Antipolis Campus Saint-Jean-d'Angély - SJA3 24, avenue des Diables Bleus 06357 Nice Cedex 4 http://www.cepam.cnrs.fr

5 : Laboratoire méditerranéen de préhistoire Europe-Afrique (LAMPEA)
CNRS : UMR7269Ministère de la Culture et de la CommunicationAix-Marseille Université - AMU
http://lampea.cnrs.fr/
6 : UMR 5594 AR-GEO-Lab Université Neuchâtel
7 : Université de Montpellier 3, UMR 5140 Archéologie des Sociétés Méditerranéennes
Université de Montpellier 3, UMR 5140 Archéologie des Sociétés Méditerranéennes
8 : de la Préhistoire à l'Actuel, Cultures, Environnement, Anthropologie (PACEA)
Université Sciences et Technologies - Bordeaux ICNRS : UMR5199Ministère de la Culture et de la Communication Bâtiment B8
Université Bordeaux 1 Avenue des Facultés 33405 TALENCE CEDEX http://www.pacea.u-bordeaux1.fr/
9 : Service archéologique de la ville de Lyon
Service archéologique de la ville de Lyon Mairie de Lyon - 69205 Lyon cedex 01 http://www.archeologie.lyon.fr/archeo/
10 : Musée National de Préhistoire
Musée National de Préhistoire
11 : Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters Eberhard-Karls Universität Tübingen
* : Corresponding author

Research is in progress to produce a digital map including the main deposits containing flints in the South of France. It is the result of the collaboration between researchers involved in provenancing of flint and includes the results of their systematic and targeted surveys in five regions (Auvergne, Rhône-Alpes, Provence-Alpes-Côte d'Azur, Aquitaine). It contains information and data from a large number of documents:
- 529 geological maps at 1 /50, 000 and notes;
- more than 200 records from the BSS database of BRGM, which permits visualization of logs or scanned documents;
- research articles and articles dealing with flint deposits in the South of France.
The map is divided into three superimposed layers:
- a map of deposits or primary deposits;
- a map of alteration and remnant surficial deposits;
- a map of alluvial formations.
The map exists in two easily updated digital versions:
- a dynamic PDF version;
- an interactive GIS version.
The naming of geological formations respects the international stratigraphic chart ICS G. Ogg 2010. Colors are those of the key of the 1/50 000 geological map of France (2003). All formations containing the same type(s) of flint are taken into account, the designation of a formation denoting a group with common characteristics, which can be mapped. Every identified formation has a simplified note describing the layering and types of flint that can be found with it. These descriptive and explanatory notes contain images at all scales (large-scale features to submicroscopic). Geological and archaeological references complement each record. The full version of these notes will be available as an atlas. This project will enable archaeologists and geologists to have fact sheets for each type of flint and its formation, information essential for analytical diagnoses (structures, textures and mineralogical compositions).

Transformation of analog data to digital information. Integrated interpretation of archaeological data using GIS

Tolnai Katalin
University of Vienna, Initiative College for Archaeological Prospection
Vienna Franz-Klein-Gasse 1/III A-1190
http://ic-archpro.univie.ac.at/

The paper presents the GIS-based modeling of an archaeological site, from Visegrád, Hungary. Here, a Late Roman fortification with its Eleventh-century reuse was recorded during the excavations. The excavation documentations, as it was recorded manually during the different field seasons, were transformed and imported into a GIS database. The archaeological and functional determination of the features is now available therefore both temporal and spatial determination of each archaeological feature can also be recorded in the database.
Besides the excavations in 2010 a geophysical survey was carried out in the framework of a co-operation between Falko Daim (Römisch-Germanisches Zentralmuseum, Mainz) and István Feld (University of Eötvös Loránd, Budapest). The measurements were carried out by a team Archeo Prospections® directed by Sirri Seren (Zentralanstalt für Meteorologie und Geodynamik, Vien-

na). 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. Interpreted features, identified layer by layer in the GPR data, were also digitized and stored in a geodatabase. Base heights and descriptive information were also given to each feature in order to recreate their spatial arrangement. With the help of GIS tools it is possible, to combine depth information with horizontal data and the measured depths in the GPR with the stratigraphy recorded at the excavations. The aim of the comparison is to determine the relative chronological ordering of the features from GPR data using the stratigraphical position which can be then presented in the three dimensional space. Thanks to a ground-truthing excavation in August 2013, the evaluation of the previous results of the geophysical measurements and their interpretation methods can be performed with the help of the GIS database.
Besides the excavation and prospection data topographical measurements are also available from the site, therefore a complex site plan presenting all the relevant material creates the basis for further research. Based on the field measurements and cadastral and topographical maps, elevation model and land-use system of the site is also available which creates the framework for the 3D re-modeling of the excavation data and helps to understand the site on a larger scale. The research is a part of my PhD research at the InitiativeCollege for Archaeological Prospection at the University of Vienna.

Digital Encounters in the Caribbean ? Diverse GIS approaches to map indigenous landscape transformations in the pre- and early colonial period and how this heritage is perceived today

Sonnemann Till [1], Herrera Malatesta Eduardo [1], De Ruiter Samantha ,[2], Slayton Emma ,[3], Stancioff Charlotte Eloise [1], Vermeer Julijan [1], Corinne Hofman [1]

1 : NEXUS1492 - Faculty of Archaeology, Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/
2 : HERA - Faculty of Archaeology, Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/
3 : NWO - Faculty of Archaeology, Leiden University Reuvensplaats 3-4 2311 BE Leiden http://www.archaeology.leiden.edu/

The Caribbean in the late 15th century was a complex landscape of Amerindian island cultures, interacting through maritime exchange networks. Despite the already present diversity in the long history of the Amerindian societies, the arrival of the Europeans severely altered existing landscapes and exchange networks. The impact of this encounter on the indigenous population is the focus of three interdisciplinary research projects hosted at Leiden University in collaboration with the universities of Konstanz, Amsterdam and Leuven.
A common goal for these projects is to identify cultural, social, economic and political changes as a result of the influence of European presents. Research foci for this poster are transformations of: Amerindian settlement patterns and cultural landscapes; exchange and trade between the islands; local traditions in the early colonial period. And how does the archaeological knowledge, traditions and historic sources connect to current issues in local communities?
To approach these research problems we will apply different methods and theories. Firstly, GIS is one tool to investigate these topics, and provides a platform to connect the very diverse research approaches, to ultimately create a data base for heritage management. Second, any kind of exchange within the Caribbean islands was only possible through seafaring. By implementing seasonal current and wind data, these pre- and early colonial trading networks can be modelled on base of a least-cost-pathway algorithm and may provide further understanding of the inter-island network. Identifying potential arrival spots on the islands may assist in the identification of more Amerindian settlements close to the coast. For this, an area in the northern Dominican Republic and several islands of the Lesser Antilles are used as sample cases to map potential changes in settlement patterning. Thirdly, Aerial and satellite remote sensing analysis of different scales, resolution and type provide a base for surface models of the current landscape. To provide information on settlement types, data from on-site survey evidence of material cultural will be used in combination with historic maps, literature and archaeological excavations. And finally, Spatial Statistics, such as point pattern analysis and predictive modelling, extend this analysis to reconstruct the diverse cultural landscapes. The different inputs will aid in the creation of the micro-environment in the excavation areas across the historical divide.
Today's Caribbean population is a vibrant cultural mix of Amerindian, European, and African

origin. A key to raising awareness, and sustainable management of the various aspects of the indigenous cultural heritage is community engagement. Through crowdsourcing, digital maps will display the potential of participation and sustainability in modern heritage management. The use of GIS attempts to combine and complement the different methods to uncover aspects of past and present Amerindian environment and society.
This research is supported by the ERC-Synergy NEXUS 1492 (ERC grant agreement n° 319209), HERA Joint Research Programme in Cultural Encounters (grant no. 1133), and the research project Island Networks (NWO grant no. 322-60-005).

Evolution of the Parisian îlots through the Geographic Information System and the historical cartography

Gherdevich Davide
Laboratoire de Médiévistique Occidentale de Paris (LAMOP)
CNRS : UMR8589Université Paris I - Panthéon-Sorbonne
1 rue Victor Cousin 75005 Paris http://lamop.univ-paris1.fr/

Historical Cartography allows, in some aspects like a photo, the study of a city's urban evolution ; in our case we have been studying the urban evolution, from age to age, of Paris. Thanks to the GIS software we have been able to associate a variety of information for the purpose of examining how in some cases the urban city morphology has either evolved or remained the same over the centuries. The scope of this study is the evolution of the city of Paris from the XVI century to the XIX century: we have taken into consideration the map of Truchet and Hoyau (called Bâle) dated 1553, the map of Gomboust dated 1652, the map of Delagrive dated 1756 and the cadastral map of Vasserot and Bellanger dated 1836. Essentially, we have focused our attention on pre-Haussmann renovation Paris. We have started the vectorization the the îlots from the map of Bâle , after we have subdivided the îlots in three different land use typologies ? urban, intermediate and rural - all depending on the level of land human occupation. The îlots are the same for the city block containing the building in urban areas and the fields in rural areas. The Bâle îlots (vectorized and with the land use attributes) have been geo-referenced on the Gomboust map; we had a difficult job because the Bâle map is a bird's-eye view map and the shape of Paris is idealized. The circularity of the city shape is accentuated. On the other hand, the 1650 Gomboust map is the first non bird's-eye view representation and it can be considered the first geometrically correct map of Paris. After the îlots have been geo-referenced with the other two maps, analysis is enabled of their evolution. For example, the same rural Îlot in the map of Bâle a hundred years after they had already blended into the urban fabric of the city, and some retain their shape until 1836. Some ilots undergo numerous changes over the centuries: several when they join with other Îlots. Others will be often split into smaller Îlots that will create new road networks. This study was inspired by another project based on the diachronic analysis of the urban area of Paris (the project ALPAGE), and he tries to provide new evidence on the evolution of the urban area of the city, taking advantage of cartographic sources and the well-known potential GIS.

The territorial organization of the Terramare culture (Bronze Age, Italy): application of a GIS methodology to serve societal issues

Boudry Julie [1,2]
1 : Université Paris 1-CNRS UMR TRAJECTOIRES
Université Paris I - Panthéon-SorbonneCNRS
21 allée de l'université 92023 NANTERRE Cedex www.trajectoires.cnrs.fr
2 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr

As part of this talk, I will present the methodological process used to answer some territorial issues regarding one culture of the Italian Bronze Age: the Terramare culture. The emergence of this culture is partly due to movements of population into the Emilian plain, south of the river Po, followed by an intensive exploitation of this new environment. Around 1150 BC., five centuries after its formation, the Terramare culture experienced a generalized collapse. The aim of studying forms of settlement in this area is to provide a better understanding of these particu-

larities. The work I will present was achieved in the framework of a phD thesis defended in 2012. Through the reconstruction of the Bronze Age drainage network (realized using a crossed analysis of preexistent geomorphological data and aerial photographic observations within a GIS), this study showed close links between terramare and watercourses, notably including diversion of streams into the ditches surrounding the sites. This activity was probably linked to the development of irrigation and drainage. Based on this re-established environmental context, several spatial analyzes were implemented to examine settlement strategies. These issues were addressed according three main axis.
The first axis is about the spatio-temporal evolution of the occupation of space by this population. I used to answer it spatial statistic such as the Ripley's Correlogram and spatial analysis such as deviational standard ellipse and their barycentre, kernel density.
The second axis queries the hierarchical organization between sites of the Terramare culture through weighted Kernel density, spatial distributions of specific artefacts, settlement duration and architectural features.
The third axis deals with the special case of mountains sites and offers a new typology for them, based on data from a DTM (slopes, accessibility, visibility, slope exposure, altitude, solar radiation, etc.).
The common interpretation of the results of each axis reveals patterns of circulation and exchange, involving both terrestrial and fluvial routes. These routes structure the three territories identified. These findings led to propose hypotheses about social organization, shedding light on certain ritual and votive practices, in a context where this kind of data is quite rare. Lastly, the sudden appearance and decline of this culture were put into perspective.

Perception and Adoption of Landscape: Recent Model and Its Use in Study of Prehistoric Settlement Strategies

?ulíková Lucie [1], Zikova Tereza [1*], Kristuf Petr [1*], Svejcar Ondrej [1*]
1 : University of West Bohemia in Pilsen (ZCU)
* : Corresponding author

Landscape may be perceived by past as well as recent populations as a result of human activities. Landscape is a socially constructed space created by man or people who inhabit and form this given space. It is necessary to pay attention to landscape and its interaction with human cultures in study of recent and past populations.Use of landscape was very intensive already in Prehistory. We are able to work with models derived from spatial archaeology that characterize use of the landscape by past populations. A landscape used by one community was divided into various areas of activities which could overlap spatially and which served various purposes. A set of these areas formed so called settlement area of the community which stretched in a given space. This space created by each society is a frame in which the human memories exist and to which people often return. Certain question rise: How did members of a Prehistoric community define themselves in relation to the space around them? What other meanings were brought to them by this space? Answers to these questions may not be studied directly in the Prehistoric populations because of lack of possibility to do so. However, it is possible to study the way how the space in recent populations is structured, how the frame which co-defines the collective identity is created and how it is possible to understand the complex concept of «home«. Therefore, a model of landscape adoption may be created on the basis of study of recent populations which may be used in study of the past communities.The poster presents results of research focused on 2 villages in North Bohemia. The manner how the agricultural landscape was understood and respected by the past humans was researched on the basis of historical surveys. The methodology was based on georeferencing of cartographic materials and digitalization and interpretation of the observed agricultural structures.Furthermore, anthropological research in form of observation and half- structured interviews with informants was conducted in both villages. Data obtained during the interviews related to real places in space was further processed in GIS. An area was defined through spatial statistics which is perceived as home of the informants. Binary overlap of individual areas helped us create a map of adopted landscape of a local group which co-defines the local group identity.As it was found out, the limitation of the «own» landscape is influenced by various factors ? visibility is of a great importance in agricultural landscape as well as relations to other communities and boundaries of the fields. In the second model area characterized by hilly and forested Czech borderland where the wood is the most important mean of subsistence, the forested environment plays a key role in individual as well group perception of landscape. It was observed that the subsistence strategy plays a very important role in the process of landscape adoption. It is also clear that the whole used settlement area is not regarded as «own» in the recent populations.

Micro-regional approach to territorial organization of Neolithic societies between middle of the middle of the fifth millennium and the beginning of the fourth millennium. New methodology developed with G.I.S.

Lietar Claira
Université Paris 1-CNRS UMR TRAJECTOIRES
Université Paris I - Panthéon-SorbonneCNRS
21 allée de l'université 92023 NANTERRE Cedex www.trajectoires.cnrs.fr

From the middle of the fifth millennium appears in Europe the first strongly hierarchical kind of chiefdom (tombs of Varna and Morbihan). Similar processes seem to develop in some areas in the Paris Basin with monumental tombs of Passy in the recent phase of Cerny's culture. This phenomenon continues with a widespread movement of regionalization which can be observed through the cultural traditions of pottery production. Northern France is divided between various cultural groups, with multiple affinities and borrowings, but strongly individualized. It was also during this period that the enclosures are multiplied. Around 4000 B.C. the exploitation of flint in procurement sites is intensified as mining.

Despite increasing archaeological data broadly confirms the transformation of societies from the mid-fifth millennium and the beginning of the fourth millennium, the understanding of the societies' organization remains problematic. We know numerous enclosures, but their function is not totally understood because they are not entirely excavated and when they are, the data don't provide fully answers to this question. Few houses are known for this period. On most discovered settlement, the activities practiced are difficult to identify.

Discuss the organization of the territory at the micro-regional scale is intended to better understand the function of the sites linked to the local territory and its management. We assume that these sites (when they are supposed contemporaries) form a network of activities at the local level. The methodology developed is striving at first to a critical analysis of the site's distribution to assess his representativeness with reliability and confidence maps.

The method is then inspired from the site catchment analysis. From the known data (archaeological sites), we define preferential environmental contexts for settlements. Environmental variables are multiple (types of soils, water and geological resources). Predictive modeling map of these contexts, elaborated with MaxEnt[1] software, provides finally tools to think on to the function of the settlements and activities practiced, and to discuss the function of environmental contexts and the resources they offer. A look back at reliability maps allows developing a critical analysis of knowledge of environmental contexts and their potential for discovering new archaeological data.

The protocol and results of this analysis conducted as part of a PhD will be presented to discuss the limits and perspectives of this methodology.

[1] ELITH J., PHILLIPS S.J., HASTIE T., DUDÍK M., CHEE Y.E., YATES C.J., 2011. A statistical explanation of MaxEnt for ecologists. Diversity and Distributions 17, pp. 43-57.

A GIS methodology for studying past land use changes

Fovet Elise [1,2*]
1 : UMR 6249 - Laboratoire Chrono-environnement (UMR 6249 - Laboratoire Chrono-environnement)
Université de Franche-Comtéumr 62
http://chrono-environnement.univ-fcomte.fr/
2 : Maison des Sciences de l'Homme et de l'Environnement Claude Nicolas Ledoux (MSHE)
CNRS : USR3124Université de Franche-Comté
32-36, rue Mégevand 25030 BESANCON CEDEX
http://msh.univ-fcomte.fr

* : Corresponding author

Agronomic potentials of soils are essential information for understanding the distribution of archaeological sites in rural landscapes. This is a key element to study the role of the agrarian component in the evolution of settlement system (especially when principally understood from settlement pattern data). This paper presents an original GIS methodology to analyse land use changes and to characterize the agronomic potentials from the perspective of ancient agrarian practices and activities.
Commonly, the criteria chosen to study the impact of the physical environment on the choice of site locations are considered independently, i. e. the position of settlements in relation to the contexts of soil, topography or liability to flooding are analysed separately. This study proposes an exploratory analysis based on the concept of the terroir: a tract of land defined from the point of view of agronomy. Each terroir is regarded as the association of multiple geographical properties. Typical approach in modelling past agricultural landscapes is most often organized in a stepwise manner: first a qualitative classification of soil is produced, and then position of cultural components, such as the distribution of sites, is examined. Our procedure, however, departs from a «blank state» and aims to find out what were the physical attributes preferred for the location of sites, in order to address issues critical for understanding the history of past land use. Its advantage is to distinguish more clearly, using multivariate analysis, the desired attributes or associations of attributes of the lands. This exploratory approach then allows the assessment of the agronomical significance of each of the selected criteria through the study the cumulative effect of these associations (e.g. aggravating or moderating combinations). Further on, it opens the discussion of agrarian practices, techniques, and land improvement that could have been - or should have been - made at the time to be considered.
This approach has been applied on a micro-regional case study situated in the eastern Languedoc (south-east of France). Given the specificities of the Mediterranean environment, this study is particularly concerned with the issue of so called available water capacities and soil drainage management. We have therefore made use of the resources of the medium-resolution satellite remote sensing to extract information on soil, in order to determine land behaviour during very wet and drought conditions. The index developed by remote sensing has been associated with other geographical parameters (e.g. geology, topography...) in order to model the terroirs, which have been used to analyze the implications of the changing settlement pattern in the study area, from the 1st c. BC to the 5th c. AD.

Remote Sensing Archaeological Analysis in Tai Lake basin

Yu Lijun [1*], Nie Yueping [1*], Yang Lin ,[2], Li Yaoguang ,[3], Yao Yueyin ,[2], Bai Xiaoyan ,[3], Zhu Jianfeng [1]

1 : Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences
2 : National Museum of China
3 : Center of Conservation and Restoration of Cultural heritage, Hebei Province
* : Corresponding author

Tai Lake is a large lake on the border of Jiangsu and Zhejiang provinces in China. Liangzhu culture which is about 5300-4100 years ago is the archaeological culture of Tai Lake and the lower reaches of the Changjiang River. The Liangzhu culture society is a mature society civilization with a more perfect management system and level. RS and GIS can help not only to find new archaeological sites and recognize archaeological site types, such as ancient archaeological sites, ancient roads and ancient trading routes, but also to research environmental change of ancient archaeological sites. The article collected multisource data including the aerial photographs, satellite photos, old topographic maps, geological data, DEM and the documentations about the climate and hydrography. Combining archaeological material and historical record, the spatial distribution and density distribution feature of Liangzhu culture sites around Tai Lake Basin by spatial analyst method was studied and the environment changes was detected around Liangzhu Ancient City using the information extraction. Viewshed analysis is a type of geographic analysis used widely in archaeology. The function and regional status of Liangzhu Ancient City was confirmed by the analysis of site visibility using data at different scales. According to the article, the choice of the location of sites has common significant features. The sites were always located in the relatively highland where it was convenient to get water and far away from the outlet of the catchment basin which ensure the safety of people and normal life during the rainy season and make the threat of flood less. It's fortunate that the traces of the river diversion remained vaguely visible in the old aerial photographs after the image enhancement and processing. According to the vague traces in old images, the Dongtiaoxi diverted from east-west to the north direction. And this change was related to the ground subsidence of Tai Lake Basin and the high tide of the Qiantang River. This can provide a better understanding of Liangzhu culture and its disappearance. The multi-discipline research methods were employed. The article made macro analysis and deeper explanation about the Liangzhu culture and Liangzhu Ancient City which combined archaeology, history, RS and GIS.

Written in Stone: GIS study of the cliff paintings in Ristiina Astuvansalmi, Eastern Finland

Niskanen Karen
University of Oulu

Much of the research on the prehistoric rock art in Fenno-Scandia has focused on interpretations based on cosmology and ethnography (c.f. Helskog 1999, Gjerde 2010, Lahelma 2008). Although our understanding of the intended meaning of the rock art symbols is, necessarily, incomplete, computer applications and GIS are tools which allow us to examine the spatial aspects of symbolic behavior associated with rock art. GIS, in combination with visual narrative analysis, enables us to describe the characteristics in the art ?such as the use of space and the organization of images? in terms of how (rather than what) the paintings mean.
In visual narrative analysis, Bal (1997) recommends ?reading' images by considering visual rather than linguistic signifiers, i.e. the framing of the image in space, the movement captured, the organization of the image, and the viewpoint taken by the artist/creator of the art. To extend the list of visual signifiers, one might add style, technique, materials, and genre.
This paper reports on the findings of a GIS study of the Stone Age and Bronze Age cliff paintings at Ristiina Astuvansalmi in Eastern Finland. Intra-site spatial analysis is utilized to examine the motifs and their distribution at the site, which dates to 3800-2200 BC. The red ochre paintings include more than 80 figures, and they cover an area of approximately 16.5 metres long and 5.5 metres high. The motifs include anthropomorphs, elk, boats, and handprints, and are found in several different clusters or panels. The attributes studied are: size (and size differentials, i.e. between humans and elk) distance between motifs composition (What goes together and in what order?) framing and use of natural formations and rock surface features By studying these attributes with the aide of GIS, it is possible to distinguish the most significant visual patterns found in the designs of the cliff paintings at this site.

Analyses of bone modifications on human remains: approach by a GIS

Ciesielski Elsa, Bohbot Hervé, Duday Henri
UMR 5140 Archéologie des Sociétés Méditerranéennes (ASM)
Université Paul Valéry - Montpellier III
390, avenue de Pérols 34970 Lattes

Analysis of fragmentation and cutmarks on human remains relies customarily on extensive textual descriptions, sketches on bone diagrams, recording in data tables, and most often on their combination. Each of these methods has disadvantages. Textual descriptions may be very detailed but rapid and relevant syntheses through computer tools are impossible. Storing bone-surface modifications in data tables cause significant data losses due to discretization, especially when it comes to describe fragments morphology and cutmark locations. As a consequence, it is usual to represent cutmarks on bone diagrams to complement data tables. In any case, summarizing large datasets of both graphic and textual data is merely difficult if not impossible.
Some zooarchaeologists have proposed workarounds to facilitate these charts analyses, and few authors have occasionally adapted them to human bones: it is a matter of using Geographic Information Systems (GIS) technology, where "base maps" are sketches of skeletons instead of geographical areas. Then, it became possible to estimate MNE (Minimum Number of Elements)

and to compare cutmark frequencies between assemblages by overcoming fragmentation issues (frequencies are corrected according to observed surface areas). Unfortunately, most of these methods were developed using now obsolete GIS software (ArcView 3.x). Moreover, even if authors raise the possibility to carry out finer analyses of fragmentation and bone-surface modifications, this approach appears to be not fully exploited. We undertake to optimize the GIS approach specifically for the purpose of human remains study. In addition to giving MNE and observed surface areas estimations, the method we set up provides a more accurate recording of fracture characteristics, thus enabling reliable analyses. In the end, we combined both the accuracy of sketch and description with computer analysis. The use of GIS techniques is fully justified because bone modifications are also spatial data (in terms of form and location) and should be treated as such, depending on their other characteristics. This method was applied to a set of Gallic severed heads coming from Le Cailar (Gard, France), an archaeological site that yielded about 2,700 specimens (including a thousand teeth) counting only skull elements. More than validating and optimizing counts made directly on bone material (NME, observed surface area), we propose a statistical assessment of the observed fracture patterns. This assessment is not biased by the assumptions made by the analyst when they define morphological groups a priori. Last, it is now possible to define standard patterns for fragments not coming from long bones, which was never done before to our knowledge. The aim of this communication is also to open debate on the use of this method in order to address scientific expectations and provide in the long run an efficient tool to the community.

Predictivity Vs. evaluation of post-depositional processes: the maps of archaeological potentiality in mountain territories

Monti Alberto*

archeologo libero studiterritoriali.eu (studiterritoriali.eu)

http://www.studiterritoriali.eu

* : Corresponding author

Through the implementation of planning instruments such as Piano Territoriale di Coordinamento Provinciale, the italian government has, in fact, made mandatory the creation of Maps of Archaeological Potential for all the municipalities. A Maps of Archaeological Potential, is a cartographic tool which divides the territory into areas where it is more or less possible that an excavation will lead to the discovery of unknown archaeological evidence and damage it. The attempt to discover the presence of unknown archaeological remains exceeds the simple urban planning: it is needed to integrate the known data, to reconstruct settlement patterns and functional ancient space, and thus to understand the behavioral and cultural backgrounds.

Regarding this aim differences, between Maps of Archaeological Potential specifically designed for anthropological/behavioral purposes and those made for territorial planning, there are substantial differences, both in methods and results: The first-ones focus to understand the ancient human behavior, the second-ones only infer the level of destruction or survival of the archaeological sites that may be present, based on considerations related primarily to geological phenomena. The result is, in the first case, the outcome of a series of spatial behavioral assumptions, while in the second “only” natural phenomena. The discriminating aspects are the intellectual and human cultural baggage, fundamental in the first case and absent in the other. This paper compares two cases of Maps of Archaeological Potential that we have achieved through GIS applications: they have the particularity to consider the same mountainous territory, and to be obtained with the same starting data, but also to belong to each one of the two types which we have just mentioned. The results are completely different; the shape, the distribution and the values of the areas at different archaeological potential are totally different. The experimentation that we are now conducting regards the refinement of both methods, which are used in different situations, but the final goal is to achieve an integration between them. This would make it much more reliable for urban planning, providing not only the level of survival of the sites that may be present, but, at the same time, that ones which really exist. This would greatly facilitate the experimental verification of behavioral assumptions, allowing you to carry out excavations focused only on survived sites.

Session 20

(Re)building past networks: archaeological science, GIS and network analysis

(Friday 24th 8h30-13h Pantheon S6)

Chairs : Thomas Huet[1], Sandrine Robert, Eric Mermet [2]
1 : Culture et Environnements, Préhistoire, Antiquité, Moyen-Age (CEPAM) Université Nice Sophia Antipolis – France - Website
2 Ecole des Hautes Etudes en Sciences Sociales (EHESS), Paris, France

How can archaeologists – and other social scientists such as historians – best (re) create the networks that constituted past societies? Networks of relationships – social, political, economic and biological – are now recognised as a key mode of description and analysis of societies both past and present. By bringing together researchers in these fields we will advance the state of both cooperation and knowledge. Key issues include:

- Integration of diverse strands of evidence
- Synchronic and diachronic aspects
- The possibility of interdisciplinary research/collaboration

GIS approaches are now commonplace in archaeology and methods based in the physical and biological sciences (XRF/pXRF, LA-ICP-MS, ancient DNA etc.) are becoming ever more widely used. GIS is a tool well suited to the integration of the inherently spatial data that underpin many networks – e.g., palæo-environmental variables, soil types, settlements, find- spots, chemical composition of ceramic samples, sources of clay, minerals or metals, pathways, rivers, landforms – across a variety of spatial scales. Combined with network approaches, such GIS-unified data offer us the potential to understand the synchronic and diachronic nature of past network phenomena such as sourcing, trade & exchange and even, perhaps, endogamy and exogamy.

GIS is, perhaps, less strong in dealing with time, tending to treat it as a series of snapshots: the diachronic reduced to a series of synchronic views. Simulation methods may offer one way to bring time more directly and appropriately into a GIS framework. A Multi-Agent Simulation, for example, can be seen to develop across both the spatial and temporal dimensions. Of course, the temporal dimension is still captured as a series of synchronic images but there are now formal mathematical/algorithmic links between the successive snapshots: this is not the case in more traditional GIS approaches to time.

GIS applications thus come in a variety of forms:

- Simple map-making
- Georeferenced databases
- Integration of spatial information of diverse forms as a prelude to analysis, probably with a network focus

Serious attempts to treat change through time as a phenomenon in some ways distinct from variation across space.

This session welcomes papers in the third and fourth of the above categories with any geographic or temporal focus: our aim is to bring together those who are trying to unify archaeological science, GIS (particularly but not exclusively applications where intertemporal change is modelled explicitly) and network approaches to the past. We welcome contributions focussed on both the empirical (e.g. case studies, applications and algorithms) and the theoretical (e.g., analysis of the relationships between well-established approaches like “taskscape” and what can be achieved through the combination of scientific and spatial methodologies).

Places, Periods, People, and Events: Integrating Space, Time, and Agency in the Digital Representation of Archaeological Data

Schloen Sandra
OCHRE Data Service, Oriental Institute, University of Chicago
Chicago, IL
http://ochre.uchicago.edu

As is well known, a typical GIS system is not well-suited to representing temporal periods and events. Archaeologists need a richer and more flexible kind of data-management system that explicitly models all of their entities and relationships of interest, including units of space, time, and agency. Such a system will incorporate GIS mapping and spatial-query functions but will not be dependent on the usual GIS organization of data according to map layers that represent complex spatial entities. Instead, it will be based on many individual data objects that represent explicitly, one by one, the following types of entities: (1) spatially situated units of observation (from regions to sites to architectural features, debris layers, artifacts, and components of artifacts); (2) temporal periods and sub-periods; (3) persons and organizations as active social agents; and (4) temporal events that affect all these other entities. Such a system will allow for various ways of relating individual entities to one another using hierarchies and non-hierarchical networks (i.e., multiple overlapping graphs of the same entities). Each entity will be able to draw itself on a map using its own vector, raster, or point data, or by virtue of being linked to a spatial entity that owns such data. Likewise, each entity will be able to place itself on a timeline that shows successive temporal periods through its linkage to data objects that represent those periods as entities in their own right. And each entity will be able to possess chronological events that provide another way to organize the entities temporally. Maps and timelines are not built into the system as permanent structures but are the result of queries that retrieve a set of entities of interest, which can draw themselves to display their spatial, temporal, and network relationships. An example of a flexible, integrative data-management system of this kind is the Online Cultural and Historical Research Environment (OCHRE) used by projects at the University of Chicago over the past ten years (http://ochre.uchicago.edu). This multi-project system is currently being used by 20 different academic projects at several universities. It is now being integrated with a powerful agent-based simulation system at the Argonne National Laboratory of the U.S. Department of Energy, for which it will provide an easy-to-use interface for scholars to establish starting parameters and run repeated simulations, and then inspect the simulation output -- which itself is stored in the same way as empirical data via data objects that represent individual (in this case simulated) people, places, periods, and events. This paper will explain how the OCHRE system works and illustrate its use by archaeologists for integrating and visualizing spatial data and temporal periods, and will comment on its value for heuristic data exploration involving network analysis and multi-agent simulations.

Rocky Roads or Aquatic Highways?: Contrasting GIS models of maritime routes in the North-eastern Caribbean to pre-colonial stone distribution networks.

Slayton Emma [1], Mol Angus [1*], Hofman Corinne [1], Knippenberg Sebastiaan ,[2]
1 : NEXUS 1492 - Faculty of Archaeology, Leiden University
P.O. Box 9515 2300 RA, Leiden
http://nexus1492.eu/
2 : Caribbean Research Group, Leiden University
* : Corresponding author

The North-eastern Caribbean, the case-study area of this paper, is characterized by a discontinuous distribution of natural resources. In the pre-colonial past, maritime transport involving paddled canoes must thus have been a highly important activity. Indeed, the archaeological record of the region shows evidence for a high frequency of inter-island transportation of people and goods. However, there are strongly divergent perspectives on the difficulties and opportunities that inter-island travel afforded. These are divided between proponents of the view that see inter-island

transport as a logistical challenge and those that consider island passages as something of a « highway» for the indigenous people of the islands.
This paper will discuss the logistics of inter-island transport by juxtaposing GIS-based least-cost models of and visibility models from likely maritime routes with archaeologically observed distribution transport networks. The latter have been re-constructed based on the presence or absence and quantity of stone material sources endogenous to the North-eastern Caribbean in site assemblages. These assemblages are temporally contextualized with the aid of an extensive C14 database. With this, lithic 2-mode networks can be traced over a time-span of 5000 years (3500 BC- AD 1492). Furthermore for a number of these materials a precise chaîne operatoire can be reconstructed that gives further insight into their production and (down-the-line) exchange. The result is a longitudinal view of 1-mode network models of lithic transport in the North- eastern Caribbean.
These archaeologically observed distributions will be contrasted with network analysis of the sites from which the material was recovered. This includes PPA and MDN network models as well as the use of GIS Platforms to model least-cost pathways. The later example will be constructed upon environmental variables, such as current, which can provide the basis for an interpolated surface from which pathways can be constructed directly on the sea. This allows for a direct comparison with the archaeological data on where these island networks would have been. In addition, visibility modeling was also carried out to compare when these pathways would have been in view of the island and vice versa. This can add a layer of stability, as it is likely to both aid in navigation, and enhance the mental connections between canoe rowers and the sea. By contrasting the network distribution of materials to likely maritime routes it will be possible to attest whether, in the case of lithic resources, transport was or was not strongly correlated to the efficacy of inter-island travel. This can shed led on the evolution of pre-colonial interaction networks and the development of distribution centers vis-à-vis expected ecological base-lines. This case-study may furthermore serve as a basis for understanding other types of material culture distributions in the archaeological record.

Reconstructing the past networks of birch tar : archaeobotany and archaeomaterials

Henry Aureade [1*], Rageot Maxime [,2], Davtian Gourgen [,2], Pasqualini Antoine [,2], Jouvenez Arnauld [,2], Delhon Claire [,2], Regert Martine [,2]
1 : CNRS- UMR 7209 AASPE, MNHN
CNRS- UMR 7209 AASPE, MNHN
2 : Univ. Sophia Antipolis, CNRS, CEPAM, UMR 7264
Univ. Sophia Antipolis, CNRS, CEPAM, UMR 7264
* : Corresponding author

The project «Exsudarch» focuses on the ancient use of exudates such as resins and glues. Among the latter, birch tar is an adhesive obtained from the heating of birch bark used for example for tool hafting, or for the repairing of ceramic vessels. It has been identified in many archaeological contexts from the Palaeolithic onwards. It is used throughout the Holocene, even in contexts such as the Mediterranean basin, where birch does not grow, except in very specific areas. This observation raises the question of the modalities of birch bark procurement (exchange and production networks) over time.
In the frame of the project, we developed a database containing archaeological and palaeobotanical (botany, chemistry) data covering the Northwest Mediterranean area. Their integration into a GIS allowed creating diachronic distribution maps of archaeological sites in which birch tar has been identified and of the surrounding vegetation. These distributions are then compared to a GIS model of the potential growth area of birch (Betula verrucosa). This first step is the groundwork for developing finer palaeoenvironmental models on specific, well-documented chronocultural contexts, for which the modalities of birch bark procurement may be tested through network analysis.
This paper will focus on the theoretical background of this research and particularly, on the issues arising when modelling past vegetation in terms of distribution and/or of productivity.

Neolithic Networks of the Tavoliere: New Evidence from Spatial Analysis of pXRF Data

Alexander Craig, Brown Keri, Tykot Robert
McDonald Institute for Archaeological Research
Division of Archaeology, Downing Street, Cambridge CB2 3DZ
http://www.arch.cam.ac.uk/directory/mcdonald

The Tavoliere (Puglia, Italy) was the site of dense settlement in the early Italian Neolithic (6200 BC - 5000 BC). There were at least 450 settlements, typically partially surrounded by a ditch, and some recent estimates put the number as high as 800 - not all, obviously, contemporaneous. The sites were initially identified immediately after World War II on the basis of aerial photography conducted by the RAF as part of wartime operations: analysis of aerial photographs has remained a key tool in the expansion of knowledge of the corpus of sites. Recent work in the area/period has included the phenomenological landscape work of Ruth Whitehouse et al's University College London team and archaeometric analyses of ceramics by Italo Muntoni of La Sapienza University, Rome and the Soprintendenza per i Beni Archeologici della Puglia. A new project, codirected by the three authors of this paper and working closely with Muntoni, began fieldwork in June 2013. Our aim is the reconstruction of Neolithic exchange networks on the basis of archaeometric analyses of ceramics - both finewares and coasrsewares from both field contexts and museum collections - and clay sources, interpreted in a network and GIS context. In particular, we use pXRF analysis to establish the trace element profiles of both ceramics and clay sources in order to both identify linkages between raw material sources and use and to investigate the distribution of finished ceramics across villages so as to address social archaeological issues such as craft specialisation and mobility. Network analysis, in combination with standard GIS cost models, will allow us to identify the exchange structures, whether they be region-wide or more locally focussed. During the 2013 field season we collected and analysed several hundred ceramic samples – each find spot being individually georeferenced - from more than 10 field sites and 6 riverine clay sources, as well as analysing the collections of the Foggia archaeological museum. At the time of abstract submission, analysis of the pXRF data is underway.

Ancient pastoral paths in mount Bego rock art area

Huet Thomas*
Cultures et Environnements, Préhistoire, Antiquité, Moyen-Age (CEPAM)
CNRS : UMR7264
Université Nice Sophia Antipolis Campus Saint-Jean-d'Angély - SJA3 24, avenue des Diables Bleus 06357 Nice Cedex 4 http://www.cepam.cnrs.fr
* : Corresponding author

Mount Bego's occupation starts very early for an Alpine site, during the Early Neolthic (Binder 2005), with some evidence of grazing in the Middle Neolithic and definite evidence of grazing at the beginning of Early Bronze age. But the site is particularly famous for its thousands of pecked engravings attributed to Late Prehistory and Protohistory. Located between 2,000 and 2,700 meters a.s.l., the rocks are still in the same place as when the engravings were made. Choices of paths for moving are limited due to the topography of the site. For the same reasons, only walking has been considered as a means of transport. So, it was particularly pertinent to study their spatial distribution with cost-weight analyses (Huet, in press). Between the numerous geographic variables that have been put together in multifactorial analyses (proximities to lakes, streams, areas of grazing, etc.), particular insights have been found for the proximities to pastoral paths. Theses paths have been drawn in 2008, on aerial photography, by Pascal Bonneville, a shepherd who has come for more than thirty years to the "Les Merveilles" sector with his flock. He mapped a typology of paths:
- type 1 "drailles": most common paths, used to reach principal areas of grazing;
- type 2 "chemins fréquentés", secondary itineraries to reach less important areas;
- types 3 "chemins peu fréquentés", short cuts or difficult paths between type 1 and type 2 paths;
A systematic analysis of concentrations of engravings and/or engraved themes with these pastorals path has shown that reticulate forms and skins (both types of geometric figures) are

found more often near type 1 paths (“drailles”) that any other engravings themes. The periodization of engravings, realized by studying together superimpositions and seriation effects, had shown that these type of engravings are among the most ancient. Along with archaeological remains such as Early and Middle Neolithic ceramics found in different shelters, and paleoenvironmental records, these proximities suggest an ancient use of the site as a pastoral area. We will employ quantitative and qualitative methods, linking geography, iconography of engraved rocks, superimpositions, archaeological and paleoenvironnemental results, to propose a diachronic reading of the occupation of the Mount Bego area.

Dynamic Geographic networks and cultural interactions in Bronze Age Crete

Paliou Eleftheria [1,2*], Bevan Andrew [,3]
1 : Institute of Classical Archaeology, Heidelberg University
http://eleftheria121.wordpress.com/about/
2 : Institute of Archaeology, UCL
3 : Institute of Archaeology, UCL
https://www.ucl.ac.uk/archaeology/people/staff/bevan
* : Corresponding author

Geographic networks have long been used in archaeology to explore the social structure of past cultural landscapes. Traditionally, they have been used to examine how physical routes could be associated with evidence for past human action and interaction (e.g. at the level of individual human settlements). While in most cases, the networks involved have been static features of the model, in recent years more dynamic versions have been proposed in order to explore the evolution of settlement patterns and networks of communication over time (Knappett et al. 2008; Knappett et al. 2011; Bevan and Wilson 2013). These dynamic models typically seek to begin with only very minimal archaeological information as input and to predict the flow of people or goods between settlements, the distribution of settlement sizes, the strength of links, and/or physical paths that are likely to have been used more frequently over time. While their modest requirements in terms of archaeological input data could be seen as a strength, ultimately it remains highly attractive to incorporate additional material culture evidence either as part of the model itself or as an independent point of comparison. This paper builds on previous work to explore further the analytical possibilities such models might offer for understanding cultural interactions in Bronze Age Crete, mainly focusing on inter-site communications within a sub-region of the island. At the same time it aims to bring to the front some wider issues related to the archaeological use of dynamic geographic networks, namely how can these models allow for analysis at different spatial scales, how best they might incorporate material culture evidence, and how they relate to other popular network approaches.

Reconstructing ancient road networks among the Near Eastern highlands: a simple GIS methodology

Bonzano Simone
Freie University Berlin (FU Berlin)
http://www.fu-berlin.de/

Landscape regional studies are becoming truly common in contemporary archaeology; we are moving toward an archaeology of exploded settlement networks, extended hydraulic works and long range communication netwokrs: actually archaeological science is every year more interests in networks, clusters and social systems than individuals. During this process specific softwares as GIS and AIS are becoming a more and more important tool for archaeologists; as consequence the need of related specific methodologies to use these software increases. And it is needed in specific restrained natural context as highlands.

Inside my PHD project of re-analyse of the Iron Age Lake Van region in Eastern Anatolia, I have build a comprehensive research on the ancient social system with a particular regard in the development of a specific GIS methodology. A large part of the work has interested the controverse relationship existing between the stable settlements on the regional plains and the seminomadic life in the highlands. Such duality is peculiar in the region to understand the formation of local identity.

To better the knowledge of this complicate relationship, the specific study has needed the complete reconstruction of all the possible paths that crossed and still cross the highlands: it is the only possibility to understand the relative historical social network. A simple study of the actual network was impossible for the hugeness of teh inquired region: a on-field survey should have required years of work and a large amount of fundings; a topographic inquiry on retrieved maps would have been incomplete due the flaws in the resolution scale. The only possibility remained was to use GIS, remote sensing and spatial analysis. This paper wants to present the specific GIS application used to reconstruct that complex highland network that existed and exists through around Lake Van. The development of this method has interested three main topics: anthropology, to define the socio-economical model of the highlands' exploitation; archaeology, to define the ancient social structure; and GIS application, to develop an effective methodology. The work has not required the specific programming of any algorythm in order to develop a better without spending any time on C++. As GIS, GRASS GIS has been used for core modelling and ARCGIS for presentation and data- blending. The use of GRASS and LANDSAT images, as well as other free data, has also helped the development of a low-cost methodology. As compendium of the paper, further experiments done with the same methodology in different context will be presented.

Exploring intervisibility networks : a case study from Bronze and Iron Age Istria (Croatia and Slovenia)

čučković Zoran
UMR 6249 - Laboratoire Chrono-environnement (UMR 6249 - Laboratoire Chrono-environnement) Université de Franche-Comté
Pôle Universitaire BP 71427 25211 Montbéliard cedex http://chrono-environnement.univ-fcomte.fr/

By using the rich archaeological record of the Bronze and Iron Age Istria (Croatia and Slovenia) we have attempted to build a structured approach for investigating intervisibility network among 480 hillfort sites. Intervisibility analysis draws on visual relationships, most commonly between discrete sites, and thus naturally lends itself to network analysis. Using a solid methodological framework in order to explicitly differentiate types of visual relationships (regarding the distance, size of the object seen and other circumstances that pertain to the spatial component of human perception), intervisibility analysis can be a powerful tool for understanding how individuals perceived their environment and interacted with one another. In this paper we first consider the qualitative aspects of intervisibility, i.e. what might have been
seen by citizens during the Bronze and Iron Age and what impact the visible landscape might have had on the observer. Following these considerations three basic types of intervisibility relationships are proposed: near, medium and far range, which correspond to distances of up to 3, between 3 and 7 and more than 7 kilometers respectively. Special attention has been given to the exploratory analysis of the visual connections, which enable development of specific indices of the insertion of sites into the visibility network. An index of visual neighborhood is, thus, proposed which refers to the subtraction (or ratio) of the average distance of hidden sites from the average distance of visible sites in a given area around each site.
The relationships obtained by the intervisibility analysis are examined regarding the properties of the network that they constitute (degree distribution, centrality measures etc.). Specifically, the problem of statistical testing will be addressed. From this we infer that the network of sites shaped cultural relationships, and that by understanding how these sites related to one another, we can understand key characteristics of Bronze/Iron Age Istria.

Analysing co-evolution between postal roads and cities on a long term period (France, 16th-19th centuries)

Bretagnolle Anne [1*], Franc Alain [,2*]
1 : Université Paris 1, Panthéon-Sorbonne (UP1)
Pres HesamUniversité Paris I - Panthéon-Sorbonne
12 place du Panthéon - 75231 Paris Cedex 05 http://www.univ-paris1.fr/
2 : UMR BioGeCo
Institut national de la recherche agronomique (INRA)
* : Corresponding author

This work analyses the complex relations between the dynamics of city systems and the dynamics of transportation networks, in France and over 3 centuries. The main hypothesis is developed in the framework of the research project Transmondyn (dir. L. Sanders) which focuses on different transitions in settlement systems, at different periods of time and in different regions of the world. The settlement transition that is studied by the authors of the present paper is the emergence of national city systems.

According to the historian Bernard Lepetit, we assume that this transition occurred in France before the apparition of railroad systems and industrial revolution. This work is based on two different databases, the nodes of the postal roads digitalized at 7 different dates between 1632 and 1833 (Bretagnolle, Giraud, Verdier 2010) and the populations of cities (at 5 dates, with more or less accurate data, depending on the quality of the historical sources).

We model coevolution of cities and transportation network as a process on a graph, with cities being the nodes and postal roads being the edges. An isolated relay station along a road is a node as well. Using different indicators or statistical models developed in graph analysis (resistance measures, power law distribution of the degrees of nodes, betweenness centrality, etc....) or city systems analysis (Reuilly model, Zipf law), we show that two different patterns emerge in the second half of the 18th century. This period is both characterised by urban growth (D. Roche, B. Lepetit) and by an increase in average speed transportation on the postal roads, due to better quality of the road surfacing materials and of the coaches.

The first emerging pattern can be detected in the northern part of France and is represented by new large scale regional city systems. Different hints allow us to track this major change, such as the relative reinforcement of medium-sized cities, especially advantaged by the new gains in average postal speed and by the increasing connectivity but also hierarchization of nodality of the postal network.

The second emerging pattern can be detecting at the national scale and is represented by new hub cities (like Limoges or Dijon) that become necessary transport stages between maritime ports, Atlantic or Mediterranean, and other large cities in France that have a demand for luxury goods trade.

Modelling Seascapes In The Caribbean: How modelling routes through the sea can illuminate island connections in prehistory

Slayton Emma
Universiteit Leiden
http://www.archaeology.leiden.edu/

This paper is an adaption of methods developed during my master's at the University of Oxford and continued as part of the research programme Island Networks, directed by Prof. dr. Corinne L. Hofman, which is financed by the Netherlands Organisation for Scientific Research (NWO). Seascapes have sometimes been overlooked in the study of prehistory. When viewed through the lens of landscape theory, they can be marginalized and interpreted represented a blank space in which movement has occurred but is untraceable. This problem is compounded when one considers that islands within larger chains, such as the Lesser Antilles, relied heavily on such avenues for human and animal mobility and the exchange of goods and ideas. These possible pathways may provide insight into which islands were central hubs of connection and which conditions best-facilitated travel and, thus, cultural expansion. In order to evaluate these connections I used surface modelling programs, such as ArcGIS, which is an underutilized tactic in regards to modelling prehistoric movement on the sea. This computer-based analysis would focus on exploring least-cost corridors of movement on the sea between islands connected by exchange. The methods to model movement on sea corridors are still emerging. GIS analysis can provide ways of independently modeling networks of interaction that can be checked against archaeological evidence of connectivity, such as the presence of foreign materials and the known distribution of sites. This type of interdisciplinary approach, including information provided by ethnographic sources and historical documents, is also useful in determining modeling constraints. As part of my analysis, I will model movement using variables, such as currents, to mimic those used for anisotropic Cost Surface Analysis on land. Using data from the National Oceanographic and Atmospheric Administration (NOAA) Global Drifter Program, which documents the change in position of specially released buoys around the world, it is possible to measure the strength and direction of currents from which a modelled interpolated surface can be extrapolated. It is also essential to enable anisotropic modelling of these pathways as traveling between islands may not always have the same cost when reversing the direction of travel. This can be combined with information concerning material exchange and settlements to create a broader view of changes in the location of water pathways and exchange networks over time. By evaluating the effect of currents on travel, it may be possible to judge not only seasonal travel patterns, but also the effect of changing currents, which may have affected the placement and use of sea corridors over time. This research will evaluate the possible constraints on island habitation and seasonal usage, as the ease of travel between specific islands throughout the year would have affected access to specific goods. This is reflected in the overall spread of archaeological material through the island of the Caribbean. In this way, the reality of seascapes and the canoe as a mobile site from which people fully interacted with their maritime environment can be better envisioned than if relying on archaeological evidence alone.

Session 21

Data mining in archaeology and historical sciences : new trends and developments

(Wednesday 23th 10h30-18h Pantheon S2)

Chairs : François Giligny 1, Stéphane Lamassé 2, Marie Cottrell 3
1 : Université Paris 1, Panthéon-Sorbonne - UMR Trajectoires (TRAJECTOIRES)
1 Université Paris 1 Panthéon-Sorbonne TRAJECTOIRES - France
2 : Université Paris1, Panthéon-Sorbonne LAMOP (LAMOP)
3 : Université Paris1, Panthéon-Sorbonne SAMM (SAMM)

Archaeology and History are disciplines in which the interdisciplinarity plays a large part and possess one very large number of interfaces with other disciplines: geography, sciences of the environment, the physical and chemical sciences, the linguistics, the philology etc. The data used in Archaeology and the History present besides peculiarities which have to lead(drive) to precise reflections on the methods and the used protocols. These data are registered first of all in a more or less long time, the absolute, even relative chronology of which is not still insured. They are sometimes indistinct, even incomplete.
The applications of the data analysis are anchored in the history and epistemology of each of our disciplines and are a part from now on of current methodologies. They allow methodological transfers between disciplines and to create also spaces of dialogue. We shall be interested in the recent developments of data analysis in terms of applications which favor the disciplinary footbridges.
Case studies will concern mainly the following themes :
- Complex serial models by data analysis,
- Regional spatial analysis, temporal spatial dynamics,
- Intrasite Spatial analysis (Artefacts and Contexts),
- Connections between graph modelling and statistical processing (Harris matrix, “operational sequence”, social networks etc.).

Decipheration of Hands Stencils in Rock Art : Data and Questions

Chazine Jean-Michel*
Centre de Recherche et de Documentation sur l'Océanie (CREDO)
CNRS : UMR7308Aix Marseille UniversitéEcole des Hautes Etudes en Sciences Sociales (EHESS) Maison Asie Pacifique - 3 place Victor Hugo - 13331 - Marseille cedex 03 http://www.pacific-credo.fr
* : Corresponding author

Since a couple of years, the question of deciphering hands tracks like fluttings or stencils, has become of major interest. Especially thanks to the re-discovery by Physiologist E.T. Manning of a specific ratio between fore and ring fingers (2D/4D), which is supposed to be different between men's and women's hands. Although this ratio has been identified at the end of the 19th century and re-activated in the 1980', some samplings have shown that a slight and variable difference would be present whatever the studied communities.
Based upon this hypothesis, a first software has been elaborated with A. Noury, which has begun to decipher hands pictures, first from Borneo, then from other sites of the world as much as contemporary ones. Almost everywhere, following Manning's ratio, women's hands were identified. Pr. E.D. Snow, has also proceeded to sampling measures and reached the same apparent results. Nevertheless, many questions concerning the ultimate use backwards in prehistory of such a ratio, the exact location of pointing tips, statistical value...etc, as much as women's roles in the Rock Art actions are still pendant.

Sampling in Archaeology: Making the Best of it

Snow Dean*
The Pennsylvania State University
321 Carpenter Building University Park , PA 16802
* : Corresponding author

Recent conclusions regarding the sexual classifications of hand stencils in the Upper Paleolithic cave sites of southwestern Europe have been received with skepticism. The issue is sample size. However, in the realm of archaeological inference there are typically two relevant samples, (1) the sample of the reference population on which inference is based and (2) the sample of archaeological unknown cases to which inference is applied. In the case of hand stencils the final reference sample size in my project was 221 modern hand scans. The adequacy of this sample is not disputed. A standard sample size calculator is used to show that sample size of 32 cases is adequate to determine the probable male/female ratio of known legible hand stencils in the caves of France and Spain. Although the examination of additional cases might move the proportion of males to females from 25/75 to something closer to 50/50, the hypothesis that the stencils were made mainly or exclusively by men and boys has been disproven. At a 95% level of confidence, at least 60% of the complete and legible hand stencils known are female.

MatriGraphe : tools for data graphic analysis

Desachy Bruno
UMR 7041 équipe archéologies environnementales
Ministère de la Culture et de la Communication

Except the case of only measures tables produced by the archaeometric specialized studies,the statistical data produced by the field archaeology can generally take the form of counting, as contingency tables, or as presence/absence tables which are particular cases of (binary) counting. Indeed, these contingency or presence/absence tables allow to deal with the qualitative or heterogeneous variables which frequently characterize the archaeological (and human sciences) data.
There are two complementary ways, today reliable and well-tried, to process such data tables : the first one is the statistical multidimensional analysis with as main tool the correspondence analysis (Djindjian 1991) ; and the second one, older and representing a long tradition in archaeology, is the graphical way of direct display of oppositions and associations between rows and columns by means of transforming data in graphic values and then by matrix rearrangement (Bertin

1967). In this second way, the author proposed ten years ago a computerized tool for graphic processing of contingency tables (Sériographe EPPM ? Desachy 2004) including an automatic process of rows and/or columns rearrangement, inspired by the Ford's diagram (Ford 1962) also called «seriograph». It was intended specially for the research of chronological seriations.
This paper presents a set of tools newly developed from the «sériographe EPPM», called « MatriGraphe», for a wider use of data analysis, and now in the form of an extension for the open and free software LibreOffice. A larger choice of different graphic representations of rearranged graphic matrix allows to avoid suggesting a priori a chronological interpretation (what a seriograph tends to do, with too naive users).
Indeed, it is necessary to mention the methodological precaution about using this sort of tools. If they are less powerful than the multidimensional statistical methods, the results appear (and are) easier to comment than the more abstract geometrical representation of a factorial analysis, at the risk of favoring uncontrolled, naive or «shamanic» statements about these results. So this paper will argue that whatever the used statistical and/or graphic techniques, a good approach of archaeological data analysis has to follow a rigorous process, in which a minimum of statistical culture is useful : verifying the statistical existence (or not) of the observed oppositions and associations, distinguishing the structure which they form (seriation ? i.e. phenomenon of continuous trend, not necessary chronological ? and /or partition), and interpreting this structure by means of extrinsic information (chronological, spatial, functional or social meaning).

Recognize temporalities from formalization of dating urban units: three case studies

Gravier Julie
Géographie-cités (GC)
CNRS : UMR8504Université Paris I - Panthéon-Sorbonne
13 rue du Four - 75006 Paris http://www.parisgeo.cnrs.fr

«Chronology is one of the first work of historian, which often serves as a framework for overall analysis.»[1] (Offenstadt, 2006: 23). However, if dating of items ? in a broad sense ? is often done in absolute time, the way it is determinated is not always clearly formalized by archaeologists and historians.
In this communication, we propose a method for the dating reasoning of the functional units which compose an intra-urban settlement. This method is based on textual, archaeological and iconographic documentation which is heterogeneous in itself (Galinié, 2000), but also according to time and to authors. Therefore, heterogeneity implies incomplete data and it is essential to take into account their uncertainty. Inherited from the reasoning of archaeological units by B. Desachy (Desachy, 2012), this formalization provides a graphic representation of the position of the units in absolute chronology. Applied to the development of urban space analyzed by functional urban entities, this method provides a way to understand the diversity of dating of each entity (impossible, possible, certain and estimated dating). Also it helps to explore «the source effects». This is a prerequisite for a diachronic approach of the city especially in light of an uneven documentation following periods.
Then a diachronic approach can be made using correspondence analysis of these urban entities by crossing time intervals with functional attributes. Such statistical processing makes it possible to identify urban trajectories. Thanks to factorial correspondence analysis and automatic classification methods (Sanders, 1990, Djindjian, 1991), we propose to study the case of the cities of Beauvais, Noyon and Saint-Quentin (located in Picardy, France). These statistical data analyses constitute means to discuss between disciplines since they require formalization of the data and assumptions. On the one hand they can be reflexive means forcing to reveal the implicit for those who employed them; on the other hand they are used to identify differences in disciplinary approaches, becoming a bridge between archaeologists, historians and geographers who's interested for settlement systems in the long term.
[1] French quotation: «La chronologie est un des premiers travaux de l'historien, qui sert souvent de cadre aux analyses d'ensemble.»

Deciphering the inorganic chemical record of ancient human activity using Multi-element soil analysis in the Yinxu site

Chunyan Zhao
chunyan zhao (cass)
Institute of Archeology, Chinese Academy of Social Sciences, Beijing 100710?China

In this study a method has been developed to classify archaeologically related soil samples by means of multivariate statistical analysis (principal component analysis) of determined trace and main component concentrations. The Inductively Coupled Plasma?mass Spectrometry (ICP-MS) technique was used for the determination of many elements, and good accuracy was achieved by calibration against a certified reference material. Soil samples from a late Bronze Age site, Yinxu. The Yinxu site is located in Anyang City, Henan Province, China. This site is large settlement site of the Shang dynasty, and it is dated to 1250?1050B.C?The site is currently known with the earliest Oracle, the largest palace building, the group of ritual bronzes, and bronze smelting workshops, and is so far to have confirmed as the site for the largest capital of kingdom? The archaeological context of Yinxu Soil samples and their significance for the archaeometallurgy research of the Late Bronze Age are discussed as well. Principal component analysis (PCA) was performed on all elemental variables as a first level exploratory data analysis. Results show that Soil element content from Yinxu in different locations, compared to the natural soil can be distinguished.

Iron reinforcements on the Mutte tower in Metz (France) : data mining, predictive analyses and spatial data treatment

Disser Alexandre [1], L'heritier Maxime ,[2], Arles Adrien ,[3] ,[4], Dillmann Philippe ,[5]
1 : Institut de Recherches sur les Archéomatériaux (IRAMAT)
CNRS : UMR5060Université de Technologie de Belfort-Montbeliard
2 : Université Paris 8, Vincennes-Saint-Denis (UP8)
Université Paris VIII - Vincennes Saint-Denis : EA1571
2 rue de la Liberté - 93526 Saint-Denis cedex http://www.univ-paris8.fr/
3 : Arkemine
Researche & Preventive archaeology
http://arkemine.fr/
4 : Institut de Recherches sur les Archéomatériaux (IRAMAT)
CNRS : UMR5060Université d'Orléans
5 : IRAMAT UMR5060 (LMC)
CNRS

The Mutte tower, the belfry of the medieval city is one of the most emblematic buildings of Metz. Its construction began in the middle of the 13th c. and lasted until the end of the 15th c. with the building of the upper stories including a stone spire in a short and well documented campaign between 1478 and 1483. According to a widespread practice in medieval architecture, iron elements (clamps, studs, rods,...) sealed in lead alloy were used for masonry reinforcement. Former studies led on other medieval buildings have demonstrated that it was possible, by specific chemical analyses performed on artifacts, to determine iron sources, and to describe metal trading modalities (Leroy et al. 2012). As Lorraine is an important ironmaking area during the medieval times, this study first aims to determine if locally-produced iron was used by the tower's building workshops. Moreover, a new ironmaking process (blast furnace & finery) spreads across Europe in the end of the Middle Ages. Determining whether iron artifacts of the Mutte tower were actually produced using this new process may enrich our perception of the quickness of its diffusion. Unfortunately, the building sustained many depredations throughout modern and contemporary eras, which led to frequent local restoration works. As a result, numerous iron reinforcements are now visible on the tower's facades, either medieval or modern. To ensure selection of the former, a specific data mining methodology, based on multivariate analyses of compositional data (Clustering analyses coupled to Principal Component Analyses), was developed. Results of cross queries performed on both compositional (iron elements and their lead sealing) and technical data were displayed using an intrasite GIS, in order to identify consistent patterns in ferrous reinforcements layout, which might most probably characterize building and restoration phases. Once the artifact set sorted, a predictive statistical method, based on linear modeling, was applied in order to determine through which ironmaking process each sample was produced. This was performed on compositional data of slag inclusions trapped in the metal. Our study showed that both processes could be identified among the sample set, suggesting that the late 15th c. constitutes a transitive period in Lorraine in terms of ironmaking processes. Moreover it was demonstrated, by comparing the artifacts' chemical signature to those of the local iron production centers, that some of the iron reinforcements were indeed produced in Lorraine, using Minette, a well-known sedimentary ore.

Ancient Messopotamian Glyptic Products, Statistics and Data Mining: A Research Proposal

Camiz Sergio, Di Ludovico Alessandro
Dipartimento di Matematica "Guido Castelnuovo" [Roma I]
Piazzale Aldo Moro 5, 00185 Roma
http://www.mat.uniroma1.it

The interpretation of figurative languages produced by cultures that are relatively poorly or discontinuously known is a complex issue, insofar as it exposes the scholars to the risk of heavy misunderstandings or easy mystifyings. A number of problems are implicit also in the (seemingly) most easy or obvious and clear observations. They are namely often related to interpretations that compromise the developments of the research project.
Besides being by themselves important and productive investigation tools, data mining and ? in general ? quantitative exploration models contribute to stimulate an explicit methodological and theoretical reflection, when used in research on ancient figurative productions. They have to do with the active critical approaches of the scholar to figurative languages and with the search of possible hidden codes or traces of mental organisational patterns in the artifacts.
What the authors of this paper want to present is a proposal for a stratified and complex investigation of the figurative language of a corpus of Mesopotamian glyptic artefacts. The methodologies adopted and the formal description of the products under investigation are actually the result of a series of past experimental works. In the past years two main problems have been faced: the proper translation into an adequately coded form of what could be observed on the artefacts and the choice and adapting of a specific investigation methodology. Both are, of course, complex problems, which require cross-disciplinary approaches and a number of experimental applications. The development of these researches has lead to the use of different models, and also to their parallel adoption, and to the comparison of the relevant results and logistic or logical weaknesses and advantages.
In the study that will be quickly presented here a further and more ambitious research course will be pursued. The corpus of late third millennium Mesopotamian figurative productions will be explored, in a single investigation process, through an integration of models that are inspired to - and based on - different logics.

Statistical and mathematical models for archaeological data mining: a comparison

Lödöen Adam [1], Dubbini Nevio [,2*]
1 : Bournemouth University (BU)
Talbot Campus Fern Barrow, Poole, Dorset BH12 5BB
www.bournemouth.ac.uk/
2 : University of Pisa
Lungarno Pacinotti, 43, 56126 Pisa
http://www.unipi.it/
* : Corresponding author

The last two decades has seen a huge increase in the amount of data held by archaeological data bases. For many datasets, a point has been reached where manual analyses of the data by individual researchers or even groups of researchers are impractical. Ultimately, modelling using manual means becomes impossible if the task is to model the whole dataset rather than individual parts. This is due not just to the huge amounts of data but also to its heterogeneous and complex nature. As a consequence, it is necessary to develop automatic, computer-based, methods to process and analyse the archaeological data. This poses a number of issues for the archaeological community.

Theoretical perspectives, questions regarding the purpose of the modelling, and methodological procedures move to the foreground.
In this paper, we focus on the choice of methodology. For automatic computerised analysis of data many possibilities exist in the general framework of statistical or mathematical models. Within the field of predictive modelling, statistical methods have been used since the 1980s and were pioneered by Kenneth Kvamme and others (e.g. Kvamme 1983; Scholtz 1981). As a consequence, these methods are relatively well understood by archaeological researchers. However, for the analyses of large amounts of heterogeneous archaeological data these methods may need to be adjusted and rethought. The use of mathematical methods for archaeological predictive modelling is a more recent development (see e.g. (Wheatley, Gillings 2002) and references therein), and much less well understood by the archaeological community. Though mathematical models are still uncommon in archaeology, mathematics increasingly find applications in many fields of science, including fields commonly thought of as far removed from mathematics, such as economics and finance (Roman 2004), medicine and biology (Epstein 2008), social networks and search engines (Langville, Meyer 2006). Here, we compare the potential of mathematical and statistical methods for archaeological prediction and analyses for landscape archaeology, through creating different models using statistical and mathematical methods, in analysing a small amount of real data from an HER (Historical Environment Record) relating to an English county. We then discuss the quality of the predictions, and the archaeological interpretability of the models.

Intentional Process Modeling of Statistical Analysis Methods

Ammar Aymen, Hug Charlotte, Deneckère Rebecca
Centre de Recherche en Informatique, Université Paris 1 Panthéon-Sorbonne (CRI, Paris 1)
Université Paris I - Panthéon-Sorbonne
http://www.univ-paris1.fr/centres-de-recherche/cri/

Statistical analysis methods are widely used in Humanities in order to find correlations between events, to make predictions or assumptions on facts or artifacts. However, the use of one method or another requires statistical knowledge. Statistical tools allow us to manipulate data and to run statistical methods but researchers need to be guided during this process and during the interpretation of the obtained results.
Moreover, humanities researchers have their own ways to deal with data: the collection, coding, analysis and interpretation are often specific to each researcher. These methods are not shared - each researcher is reinventing the wheel when he/she analyzes data without previous experience. Nevertheless, developing and sharing these methods should be useful to the research community and students in Humanities, but it is difficult to formalize them in an understandable way. In this paper, we present a model describing the different statistical analysis methods as processes. After building a state of the art on the statistical analysis methods, we conducted interviews among archaeologists and historians to understand their ways of working and collected information on the methods they used. The language used to define the processes is Map (Rolland et al., 1999). It is an intentional process metamodel that allows representing a process model as a graph, the nodes representing intentions and the edges the strategies to achieve these intentions. We then built the process model as a method family that consists in describing «a set of several organized method components for a specific domain» (Kornyshova et al., 2011). Figure 1 presents the obtained method family defined as an intentional process model. Each method component describes a part of the process and the result obtained. A component is composed of a source intention, a target intention and a strategy to achieve it. The statistical methods used to construct the method family are Principal Component Analysis, Correspondence Analysis, Multiple Correspondence Analysis, Hierarchical Clustering and Logistic regression
methods. For example, the component was extracted from the Logistic regression method. Some components are common to different statistical analysis methods. The component comes from the Principal Component Analysis, the Correspondence Analysis and the Multiple Correspondence Analysis methods. The components have been implemented in a wiki to allow humanities students of Paris 1 University to consult them and use them while enacting statistical analysis on their data. The next step of our researches is to provide an adapted guidance to each

user by taking into account their context - as the volume or type of data. We also want to extend the wiki to enable researchers to evaluate and improve the method family. Currently the proposed model is suitable for multi-dimensional methods, but we also plan to introduce other method families to analyze other type of data such as natural language or image.

Spatial intrasite analysis and data mining : case studies in the Paris Basin

Giligny François [1,2]

1 : Université Paris 1, Panthéon-Sorbonne
Université Paris 1
UFR Histoire de l'art & archéologie, 3 rue Michelet 75006 PARIS
2 : Trajectoires - UMR 8215
CNRS : UMR8215Université Paris I - Panthéon-Sorbonne
UMR 8215 Trajectoires MAE 21 allée de l'Université 92023 Nanterre cedex http://www.mae.u-paris10.fr/trajectoires/

Few intrasite spatial analysis have been done on neolithic settlements in the Paris basin. Case studies have been done almost by means of cartographic layers, simple frequencies calculations by material category, but rarely with statistical multivariate analysis.
Different cases can be recognised among published studies : a model built for one feature type, a site with juxtaposition of elementary feature, activity areas reconstitution within a settlement contemporaneous layer excavated extensively and registered by surface unit, comparison beetween domestic units content.
Two case studies have been recently analysed with the same methodology. They are early neolithic settlements located in the Seine valley, nearby Paris (Neauphle-le-Vieux and Poses) and both belong to the post Lbk culture in the Paris basin (Villeneuve-St-Germain), between 5000 and 4700 BC. The first one is a part of a small settlement with an occupation level and two pits. Distribution maps for each material category have allowed to identify three dump areas on the surface. A factor analysis points out differences within surface dumps and pits. Activity areas are then reconstructed and explained by means of tool functionnal evidences. The second one is a ten house village with material content in refuse pits. Quantitative and qualitative seriations are proposed to test the two phase chronology proposed by the excavators and points out some house specificities and probable specializations.

Statistic and spatial analyses of Iron Age data

Gruel Katherine*, Buchsenschutz Olivier,*, Batardy Christophe,*
Archéologie et Philologie d'Orient et d'Occident (AOROC)
CNRS : UMR8546École normale supérieure [ENS] - ParisÉcole Pratique des Hautes Études [EPHE]
CNRS : UMR8546 - Ecole Normale Supérieure de Paris - ENS Paris - 45 Rue d'Ulm 75230 PARIS CEDEX 05 http://www.archeo.ens.fr/
* : Corresponding author

The Basefer database lists about 15,000 published sites of the Iron Age (800 BC ? 1). They are recorded and documented in a GIS. The purpose is to compare general data on settlements, burials, sanctuaries, deposits, etc. of this period at the level of a region or at the level of France. Distribution maps mark out the land. The standard deviation ellipses permit to verify the balance of the overall site distribution. It is then possible to develop statistical and spatial analyses: density maps, trend analyses, correspondence factor analysis, hierarchical clustering. The possibility to superimpose different maps permits to come back to the primary data at any time and better understand the different contributions to the spatial analysis results. Beyond the state of the research and preservation conditions of the sites, maps and statistics reveal historical or cultural phenomena that had not been detected on this scale.

A way to formalize the dating of archaeological units

Desachy Bruno
UMR 7041 équipe archéologies environnementales
Ministère de la Culture et de la Communication

The present paper proposes a simple formalization of the reasoning of dating, developed from researches about formalized stratigraphic data processing (Desachy 2009, 2012).
This reasoning can be explicited by the way of intervals of inaccuracy including all the moments and durations of the stratigraphic units (i.e. points and segments on the line of absolute time : beginning, end of formation, duration of formation of the unit ; and duration "masked" by a stratigraphic relationship when there is a discontinuity of absolute time between two successive stratigraphic units). The usual Terminus Post Quem - Terminus Ante Quem interval (which is in fact the interval including the moment of end of formation of the unit) is so completed by a larger set of indicators (the lower and upper limits of the intervals).
Then, the heterogeneousness of the dated elements used to date a stratigraphic unit can be taken into account more effectively. Indeed, the diverse dating elements do not inform the same limits of the same intervals, according to the nature of these elements (historical data, typological dating, scientific analyses of materials, geoarchaeologic observations, etc.), and mainly according to their position with regard to the unit to be dated: directly related to its formation, contained in, or extrinsic (case of the historic documentation). In particular, dating from the artefacts contained in a stratigraphic unit requires to distinguish the temporality of the theses contained materials, and to take it into account explicitly, also by the way of intervals of inaccuracy. This approach is adapted to the heterogeneousness of the documentation but also to its gaps, provided that default values (« absolute » upper and lower chronological limits, including the whole studied occupation) are set for the unknown limits of intervals.
These intervals of inaccuracy can be then integrated with the stratigraphic relationships into systems of inequalities, which can be automatically processed (by the way of simple ? but boring to execute manually ? algebraic calculations), leading to a complete graphic representation of the units in the absolute time.
Inaccuracies involve logically, for each unit, time zones of impossibility of existence, of possibility of existence, and (sometimes) of certain existence. A fourth time zone of « estimated existence », between the possible and the certain, results from taking into account a difference of status (certain or uncertain) of the input data ; what allows to deal with the qualitative heterogeneousness of the data, and to test different hypothesis between the older one and the most recent one.
This process applicable to stratigraphic units is also applicable to a wider scale, to historic entities (who can, or not, arise from archaeological observations and in this case from one or several

stratigraphic units) whose chronology is imperfectly known. This change of scale supposes to move from the notion of duration of formation (of the stratigraphic unit) to the notion of duration of existence (of the historic entity), and to move from the strict notion of stratigraphic relationship to a wider notion of constraint of succession.

A case study: Danubian site Bucy-le-Long «la Fosselle» (Aisne - France)

Lemort Sophie*
Université Paris 1, Panthéon-Sorbonne (UP1)
Pres HesamUniversité Paris I - Panthéon-Sorbonne
12 place du Panthéon - 75231 Paris Cedex 05 http://www.univ-paris1.fr/
* : Corresponding author

Two spatial units are taken into account: pits and houses. Having identified the zones of concentration, the various categories of vestiges are submitted first to a factorial analysis then to an automatic classification. Their implementation are made within the Analyse software (which runs under R); what allows to highlight an excess or a deficit of artefacts categories and associate households, then put together households by activity, insulate or standardize them and so confirm the cartographic information and sometimes highlight several using phases of the area (Factorial Correspondence Analysis F.C.A. on ceramic decoration).
This study allows to invalidate or to confirm the observations mentioned during the post- excavation. It makes possible the graphic representation of the distribution of artefacts on the spot. Finally, it is the opportunity to highlight the particular natures of households and to take part in a global approach of the area of housing environment. A work around the graphic semiology, adapted to the intrasite spatial analysis of the housing environment, is also proposed, in terms of both cartographic and statistic point of view

Session 22

Reading between the lines: Computing applications for the analysis of archaeological and historical texts

(Thursday 24th 14h-19h Pantheon S11)

Chairs : Patricia Murrieta-Flores, Christopher Donaldson, C. j. Rupp, Ian Gregory
Lancaster University - United Kingdom

Over the past twenty years, the adoption of digital technologies within the humanities has revolutionized scholarly practice in disciplines that traditionally deal with textual sources such as History, Archaeology and Anthropology. From experimental methods for manuscript conservation to automated techniques for handling 'Big Data', this budding field of research offers many promising areas for further exploration. These include visualization and conservation technologies (such as Reflectance Transformation Imaging), data-extraction, management, and analysis tools (such as Text Encoding, Text Mining, Geoparsing and Geographic Information Systems). These approaches have been used by a number of research projects in both Europe and the United States. Examples include Lancaster University's Spatial Humanities Project (http://www.lancs.ac.uk/spatialhum), the Quijote Interactivo Project (http://quijote.bne.es/libro.html), Stanford University's Mapping the Republic of Letters (http://republicofletters.stanford.edu), Sheffield University's London Lives (http://www.londonlives.org),the Pelagios Project (http://pelagios-project.blogspot.co.uk), A vision of Britain Project (http://www.visionofbritain.org.uk), Locating London's Past Project (http://www.locatinglondon.org)and Google Ancient Places (http://googleancientplaces.wordpress.com), among many others. These projects are marked by their unique methods and aims, and by the fact that they work with texts and documents from different historical periods. Yet, when viewed collectively, they can each be understood as participating in a common scholarly agenda.

The aim of this session is to put this agenda into focus by bringing together the multiple theoretical and methodological digital perspectives established in the last years for the research of documents of archaeological and historical concern. By providing a wide platform for researchers with interest in the study of past texts, we aim not only to explore the achievements of present research projects, but also to examine potential lines of collaboration on this topic between fields such as (but not limited to) archaeology, history, literature, heritage management and computer science.

We welcome papers from projects and/or individuals at any stage of research that are implementing computing approaches to preserve, explore and analyse documents and texts of archaeological and historical interest.

Connect Forma : Linking Early Geospatial Documents with Pelagios 3

Leif Isaksen [1*], Barker Elton [,2], De Soto Pau [1], Simon Rainer [,3]
1 : University of Southampton
2 : The Open University (OU)
3 : AIT Austrian Institute of Technology
* : Corresponding author

Pelagios is a community-driven initiative that is annotating, linking and indexing place references across a wide range of online resources documenting the past. While previous phases of the project have focused solely on classical antiquity, Pelagios 3 is semantically annotating Early Geospatial Documents (EGDs): those that use written or visual representation to describe geographic space prior to the European discovery of the Americas in 1492. They include ancient and medieval geographic descriptions (geographiae, chorographiae and itineraries), world maps (mappaemundi) and sea charts, and are products of Greek, Roman, Christian, Islamic and Chinese traditions.

The project has three primary objectives. First it is creating an index of toponyms attested, and the places they refer to (where known), in all available EGDs, accessible both as Linked Open Data and via the Pelagios Web Service. These are connected to an ecosystem of aligned URI-base gazetteers, which make it possible for third parties to use and integrate the data while ensuring that disambiguation is maintained.

Second, it is developing a toolset that allows the scholarly community to enhance and refine the index incrementally, by annotating for themselves place references in further historical sources (written and visual) as and when they are digitized. This is largely based on an automate-then- correct principle, in which Natural Language and Image Processing techniques are used to generate a ?first-draft' annotation set, statistical and geographic visualization indicates likely errors, and one-click correction and auto-completion are used to rapidly undertake manual data correction.

Third is the production of an analysis workbench and embeddable Web tools that will enable researchers to bring together spatial documents in new and innovative ways. These will range from heat and network maps to compare the scope and connections within and between EGDs, to hyper-referencing of third part content, to widgets that embed results in external websites. This paper will reflect on all of these aspects of the project as well as the growing community of parallel Linked Open Data initiatives which are revolutionising the data landscape in classical archaeology and beyond. Pelagios 3 is kindly supported by a grant from the Andrew W. Mellon Foundation.

Exploring time and space in the annotation of museum catalogues: The Sloane virtual exhibition experience

Stead Stephen [1 ,2], Whitson-Cloud Jonathan [,3*], Oldman Dominic [,3*]
1 : University of Southampton (Southampton, UK) (ACRG)
2 : Paveprime Ltd (PPL)
3 : British Museum (BM)
* : Corresponding author

Modern digital museum catalogues differ from historic manual catalogues in that the record boundary is virtual, in the digital and physically on the page, for the manual. The history of the edits in digital systems can only be determined if the change history is explicitly recorded or if periodic snapshots of the data are preserved (although this only gives periodic aggregates of edits). In contrast the pre and post edit states of each edit and annotation are visible on the page in a physical catalogue volume. Card index systems vary in their completeness in this respect, as in some circumstances the card is replaced rather than updated. This has the effect of producing an aggregate of edits similar to a periodic digital snapshot.

Within the catalogue entries there are many possible interpretations of the use of geographical place names. For instance they can refer to the place of manufacture, the region of use, the place of collection, the region of a particular culture or the origin of the manufacturer. Each such interpretation has a different semantic meaning and consequently a different mapping to the CIDOC Conceptual Reference Model (CIDOC-CRM).

Similarly dates and other temporal appellations can have many meanings: date of manufacture, date of collection, date of accession into the museum, date of record compilation and/or editing or significant dates in the history or provenance of the object. Again these different meanings have different mappings to the CIDOC-CRM.

In addition to these content elements, there are spatial and temporal relationships between the catalogue entries and annotations in historic manual catalogues and between annotations in card index systems. These too have particular mappings to the CIDOC-CRM.

This paper addresses these different CIDOC-CRM mappings in the context of catalogues of the Sloane collection.

From text to context. Reconstructing medieval agrarian landscapes from administrative written sources in a Western Mediterranean Islamic society.

Negre Joan

Quantitative Archaeology Laboratory - Autonomous University of Barcelona (LAQu)

Laboratori d'Arqueologia Quantitativa (LAQu) Departament de Prehistòria Edifici B Facultat de Filosofia i Lletres 08193 Bellaterra (Barcelona)

http://grupsderecerca.uab.cat/laqu/

The present work proposes the restitution of the medieval Islamic landscape of the territory of Tortosa (Spain) in light of the study of its feudal administrative texts, written in the second half of the twelfth century, right after the Christian conquest. These sources allow us to understand the main productive spaces and the most important species cultivated in the last period of the Islamic occupation of this territory. We focus on the correct generalisation of punctual data above a continuous surface, mainly through the use of interpolation techniques and Artificial Neural Networks. This text expects to combine historical, archaeological and spatial data into a common framework in which we can analyse the final configuration of the main crops and the hydraulic infrastructures developed to improve its agrarian efficiency. Thus, the agrarian models created from this analysis allow us to study the agrarian potential of the urban hinterland in order to infer the demographic maximum which could be supported by this territory when the Islamic society was consolidated.

After four years of archaeological fieldwork, we were able to collect an important number of historical sources (written, archaeological and palaeo-environmental) so as to analyse the transformation of the lower course of the Ebre River landscape. The period of study was chosen because of its well-known settlement, transportation and production networks, identified in our archaeological surveys, which provide us with a large range of historical information. However, the topic that we are dealing with is not been analysed until now, turning our territory into the best experimental laboratory. Therefore, our proposal aims at implementing more than a thousand documents and a large piece of archaeological evidences into a common research project and it therefore tests new work hypothesis on what has traditionally been called Medieval Islamic Green Revolution. This kind of methodology, only useful for historical societies, prevents us from relying on other approaches, such as agrarian potential models among others that are more related to social structures not mentioned on the written sources. Consequently, the accuracy shown by our proposal exceeds by far other kinds of deductive and inductive models proposed by landscape and environmental disciplines.

Generating epigraphic letter charts in a database environment: a case-study in alphabetic Ugaritic mythological and administrative texts.

Prosser Miller

The OCHRE Data Service, the Oriental Institute of the University of Chicago

1155 East 58th Street Chicago, IL 60637

ochre.uchicago.edu

The goal of epigraphic study is to observe developments in the forms of signs and letters over time and in different scribal hands. With enough information, the idea is that one can posit the date of a text based on the forms of the signs or letters. If precise date ranges of texts are not possible, one hopes to establish a relative chronology, at least. In addition, one can attempt to establish scribal styles: styles by location, scribal school, genre, etc. The practice of epigraphy usually involves creating charts that take the form of line drawings of signs or letters. In a pre- digital context, a researcher would carefully sketch and ink letter forms, arranging them in columns for comparison. These charts are very helpful but very limited. In many cases, it is not clear to the reader if a given example is taken directly from a text or is a generalized form. Also, it is typically too cumbersome for the researcher to note the exact source of each sign. In a digital world now, it is time for epigraphy to evolve. This paper presents a radical and powerful new strategy for creating letter charts from an integrated database environment that includes textual, lexicographic, and archaeological data. The database environment provides complete integration between photographs, line drawings, text editions, lexical entries, find spots, and many other categories of analysis. The database environment that I will present is called OCHRE, the Online Cultural and Historical Research Environment. OCHRE can be accessed for free from any computer with an internet connection. So, any user anywhere in the world will be able to query text corpora and genres and generate letter charts.

I will use the alphabetic texts from Ras Shamra-Ugarit as my example corpus. The majority of the alphabetic Ugaritic texts dates to c. 1200 BCE. As such, diachronic epigraphic studies are not possible. However, one observes several distinct epigraphic styles that seem to correspond grosso modo to textual genres. The Ugaritic letter forms are produced with a fine and careful hand in the mythological texts (for the most part). The economic texts are characterized by a broad heavy hand in many cases. Also, the Ugaritic alphabetic letters exhibit morphological variation in their basic forms.

The paper presents the database environment, the data model, and the strategy for working on epigraphy in a database. The result is a dynamically updatable epigraphic chart of Ugaritic letters, some based on photographs of tablets, some on hand drawings. All of this data is generated from a database that is richly described with properties and links and can be accessed from any computer. The entire process is generic enough to be applied to any text corpora, whether alphabetic or syllabic, ancient or modern.

Digital research strategies for ancient papyri: a case study on mounted fragments of the Derveni papyrus

Kotoula Eleni, Earl Graeme
University of Southampton, Archaeological Computing Research Group (ACRG)
Southampton SO17 1BF
http://acrg.soton.ac.uk/

The present paper narrates the story of one of the most important papyri ever found in Greece, the Derveni Papyrus (DP) discovered in 1962 in the ancient Mygdonian city of Lete, on the pass of Via Egnatia (Themelis & Touratsoglou 1997; Kapsomenos 1963; Betegh 2007) in an attempt to show the potential of digital tools for the study of ancient papyri. It addresses the interventive conservation operations executed in the papyrus at the time of its recovery and the research strategy followed and discusses the advanced digital analogues available nowadays for revelation, investigation and dissemination. The interventive conservation techniques executed in the DP and in similar papyri elsewhere (Vanderpool 1962; Cronyn & Robinson 1990; Frosen 2009; Taylor et al. 2011), were discussed in parallel to digital micro excavation using 3d Computed Tomography (CT) and terahertz applications (Baumann et al. 2008; Bradley & Creagh 2006). Moreover, visual analysis, documentation and diagnostic examination image processing techniques were compared to reflectance transformation imaging (RTI) approaches (Mudge et al. 2005; Earl et al. 2011) in the visible and the infrared spectral (Caine & Magen 2011) area using both reflected and transmitted illumination and irradiation. The problems encountered during digital capture and processing as well as the way they were addressed were discussed. Results indicate that the combination of RTI, IR-RTI and Transmitted RTI is an enhanced methodological approach for non-destructive examination, documentation and presentation. Considering the low cost of the necessary equipment, the freely available software for processing and viewing *rti and/or *ptm files, the low level of expertise necessary for data capture in addition to the flexibility of RTI technology, which can adopt different set ups in order to cover the visualization needs of artefacts of different type, there is no doubt that RTI is a very useful methodology for documentation and recording. Recent application of the technique in the infrared spectral area demonstrate RTI's potential in diagnostic documentation and condition reporting, while trans illumination and irradiation RTI makes possible the visualization of features hidden behind backing materials.

Session 23

Modelling approaches to investigate population dynamics and settlement patterns over the long term

(Wednesday 23th 10h30-16h05 Pantheon S11)

Chairs : Laure Nuninger 1, Philip Verhagen 2, Tim Kohler 3,

1 : CNRS : UMR6249, Université de Franche-Comté Laboratoire Chrono-environnement / MSHE C.N. Ledoux UMR 3124, / GdR MoDys (LCE) - France

2 : Research institute for the heritage and history of the Cultural Landscape and Urban Environment (CLUE) VU University Amsterdam - Netherlands

3 : Washington State University/Santa Fe Institute/Crow Canyon Archaeological Center - United States

Understanding population dynamics and ancient settlement patterns has been one of the main goals of numerous spatial studies in archaeology since the 1970s. Questions addressed typically include the overall density, locations, and inferred interactions among sites, as well as the degree of hierarchical organization and the use of space.

Whatever the region or the period considered, or even the approach used, the results of the analysis provided by different cases of study over the world often show considerable regularity of spatial patterns and/or chronological series of sites sizes or inferred populations.

A typical regularity in Neolithic or protohistorical sequences for example is a tendency towards more aggregated settlement, which may often later be reversed before even larger aggregates appear. Another one, observed in European protohistory or Antiquity, is the trend of a rapid increase of scattered settlement quickly followed by a strong decrease. Reasons for these changes may be difficult to discover, especially in cases where some clustered settlements lasted only a few hundred of years while others grew and remained in place up to today. The various approaches that archaeologists apply to these questions focus on different aspects and take into account specific geographical, cultural and archaeological contexts. This makes it difficult to compare cases and to extract the causative factors for any possible regularities. Building process models (deductive models), for example based on palaeodemographical, anthropological, economical and geographical theory, is a promising path towards connecting the patterns recognized and the factors causing them.

Building models of this kind however remains a great challenge for archaeologists. Shared protocols, explicit concepts and common variables have to be defined in order to analyse different regional cases, to safeguard interpretation of analogies and to increase understanding of variation and change in ancient complex societies while striving for a common framework of analysis and explanation.

The aim of this session is to share experiences, concepts and methods for a normative analysis of ancient settlement patterns and population dynamics from various geographical areas in the world and different periods. Presentations may focus on agent-based or other types of deductive models, scaling studies, or comparative analysis of cases from different regions.

Of special interest will be papers which generate or analyze :

- population estimates from various proxies
- typical population growth rates and constraints on growth in various economic contexts/organizations

- settlement dynamics and ranking (rank-size curves, spatial distribution, network...)
- the role of the social and environmental factors in the success (durability or/and increase) or collapse of settlements and the impact on population growth or decline.

Upscaling population densities of sedentary societies

Zimmermann Andreas [1*], Hilpert Johanna [,2], Wendt Karl Peter [,2*]
1 : Institute of Prehistoric Archaeology, Cologne
2 : Rhein-LUCIFS, Institute of Prehistoric Archaeology, Cologne
* : Corresponding author

In a standardized upscaling approach developed for the Rhein-LUCIFS research project (funded by the DFG) the number of houses or graves is used to estimate population densities for the early Neolithic, Iron Age, Roman and Merovingian times as well as 1800 AD. The research area is the Rhineland with approximately 30.000 km².
Additionally considering periods of hunter gatherers (see presentation of Inga Kretschmer and Andreas Maier), a non-linear development of population dynamics is recognized, confirming the model of Gordon Childe with a «Neolithic», an «Urban», and an «Industrial Revolution». Within a millennial time scale, different stages of development are observed. Adaptive cycles however become visible within a centennial time scale.

The RhineLUCIFS-Project: Simulating and aggregating patterns of land use in sedentary societies

Hilpert Johanna [1*], Wendt Karl Peter [,2*], Zimmermann Andreas [,3*]
1 : Rhein-LUCIFS, Institue of Prehistoric Archaeology, Cologne
2 : Rhein-LUCIFS, Institute of Prehistoric Archaeology, Cologne
3 : Institute of Prehistoric Archaeology, Cologne

The international LUCIFS-research framework is an interdisciplinary cooperation of projects concerning the influence of land use and climate on fluvial systems. The main subject of the Cologne based project, funded by the German Research Foundation (DFG), is the river Rhine and the period under consideration covers a time span from ~ 5.300 BC (Bandkeramik) to 1830 AD (Pre-industrial Modern Times).
Within the scope of the archaeological part of the project a model for land-use systems was developed, drawing on demographic, archaeozoological and - botanical data as well as ethnographic figures. On one hand, human demand was balanced with the supply of nutrients by plants and animals. On the other hand, agricultural areas were simulated using GIS methods. On the basis of assumptions about food habits, the model reconstructs the size of fields and meadows as well as the stocking rate.
The preceding project about population densities provided data about settlement areas and the number of people living within (see abstract A. Zimmermann). A band width of demand and production volume was determined considering regionally differing conditions. The periods under consideration vary greatly regarding their economic and social organisation. They were chosen in order to analyse possible interrelationships. By way of example, demographic and economic cycles within 350 years became visible for the Bandkeramik times. The model proved robust and discloses not yet fully exploited possibilities of visualisation and comparative analysis.

Modeling Population Dynamics and Settlement Patterns at The Bronze to Iron Age Transition in Prehistoric Europe. A Geostatistical Analysis of the Radiocarbon evidence.

Capuzzo Giacomo [*], Barceló Juan A
Universitat Autònoma de Barcelona (UAB)
UAB Campus 08193 Bellaterra (BARCELONA) SPAIN
http://www.uab.es/english/
* : Corresponding author

The Bronze Age/Iron Age transition in Prehistoric Europe represents a perfect case study to test different and competing hypotheses of social dynamics and economic changes in small-scale

societies. The presentation discusses the possibilities of modeling what could have happened in Europe between 1800 and 750 BC., in terms of spatio-temporal dynamics. Different expansive phenomena have been traditionally detected for this time-span, like a possible population growth and the diffusion on a macro-scale of cremation burials and some particular pottery typologies (fluted pottery, handles with vertical expansion, etc).
Our aim is to evaluate different hypothetical scenarios of demographic growth and the probabilities of new ways of territorial organization during the 2nd and the beginning of the 1st millennia BC in Prehistoric Europe (Tumulus «culture», Hallstatt, Urnfield «cultures»). The main idea is to compare classic demic diffusion models (spread of population), cultural transmission models (spread of ideas) and technological innovation diffusion model (spread of goods). In this paper, we will refer to expansive phenomena as dynamic systems in which every location, at some well-specified underlying space, has a distinctive behavior through time. When a system expands through time, we can foresee a certain degree of dependence between locations, and this dependence is exactly what gives unity to the process. The data originate from the EUBAR database, which collects more than 1500 georeferenced and radiocarbon dated archaeological contexts of a period between the Early Bronze Age and the first Iron Age from an area including the North-East of Iberian Peninsula, Southern France, Northern Italy, Switzerland, Austria and Southern Germany. We start with a data structure consisting of a set of locations (s1, s2, etc.) in the studied area, R, where distinctive events (adoption of new burial practices, adoption of new kinds of artifacts, etc.) occurred at different moments of time. The goal of our analysis is to determine a meaningful relationship between difference-in-chronology and difference-in-location. This relationship, if it existed in that historical case, is essentially a measure of how population and/or economic/social structure changed through time and space.

Estimating Population Growth from Settlement Data: A Modeling Approach

Kintigh Keith*
Arizona State University (ASU)
School of Human Evolution & Social Change Box 872402 Arizona State University Tempe AZ 85287-2402
http://shesc.asu.edu
* : Corresponding author

In the northern Southwest, population is argued to be indicated by counts of pueblo rooms, which can often be effectively estimated from surface remains observable on archaeological survey. Population growth rates are ordinarily estimated by applying a standard compound interest formula to room counts attributable to successive temporal periods standardized by period length. The principal problem with this procedure is that we do not actually have momentary population estimates at the beginning and end of each period. The number of rooms occupied during a given period is, instead, an index of the cumulative population for the period. Dividing this index by the length of the period yields an indicator of a sort of population average during that interval. Application of the formula thus provides a growth rate from the average of one period to the average of the next. What we would prefer is a method that can assess growth within, rather than between periods.
This paper proposes a more nuanced, simulation approach that, assuming a standard use-life for rooms and a constant within-period growth rate, simulates room construction and abandonment, yielding a total number of rooms occupied at some time during a period. A starting population is specified for the initial period; each subsequent period begins with an inventory of rooms that had not reached the end of their use-lives by the end of the previous period. For each year of a period, simulated rooms that have reached the end of their use-lives are «abandoned» and replacement rooms are «built.» In addition, new rooms are built as dictated by the simulation run's hypothetical growth rate that is applied annually over the length of the period. At the end of the period, results are tabulated. Except in the terminal period, each room whose occupation spans a period boundary is assumed to date to whichever period has more of the room's occupation. The simulation is rerun for a range of hypothetical growth rates. The proposed model growth rate is then value at which the total of simulated rooms constructed most closely matches the cumulative room count for that period, as observed in the settlement data.

This model can produce quite different--and I argue, better--estimates than the standard formula, with important implications for demographic reconstruction. The method is applied to two areas we have systematically surveyed in the Cíbola area of the Southwest US. It reveals previously unrecognized demographic trends with substantial cultural significance. In two cases, the modeled growth rate appears too high to be accounted for by internal population growth, suggesting immigration must have occurred. In another, a period that was previously thought to be one of substantial growth is seen be one with a stabile population at a relatively high level.

Evaluating prehistoric population fluctuations: A simulation approach

Sundell Tarja, Kammonen Juhana
University of Helsinki

The study of past population dynamics involves assessing the population size and population movements through time. This is a complicated task which benefits from the synthesis of different lines of evidence that reinforce each other. Prehistoric demographic changes have been studied by e.g. investigating summed probability distribution of radiocarbon dates derived from different sites as well as evaluating the nutritional resources of the hunter-gatherers in the area.
Prehistoric population fluctuations and their consequence to the present day genetic diversity can be studied by population simulations where evolutionary forces i.e. mutation, migration and genetic drift are incorporated. Simulations are used to evaluate which population scenarios are most likely to be true. Our aim is to run the simulation with a putative demographic model and see if it produces the same amount of genetic variation that can be seen today.
In our previous studies we used a population simulation environment called simuPOP to simulate the population history of Finland. To follow the assumed demographic events as realistically as possible it is necessary to include geographic subpopulation division as well as consequent female-specific migration between subpopulations into the simulation model to produce a demographic model capturing the important features that shaped genetic diversity.
The results from these studies indicate that a severe prehistoric bottleneck has fundamental effects on genetic diversity, even today, after thousands of years. Moreover, the constant small gene flow seems to be a much more important factor than migration waves. While the migration waves have barely any effect, moderate constant gene flow can cause great differences to genetic diversity. Compared with our previous simulations, the female-specific migration brings the simulated genetic diversity closer to the observed contemporary genetic diversity in Finland.
SimuPOP inherently supports user-defined parameters in a simulation and is among the most versatile population simulation software available. In order to model population movement, we introduced a discrete measure of geographical distance between the simulated individuals. Due to the new enhanced version of the simulation tool, the software allows real-time simulation of neigbouring populations, the background gene pool. This allows simulation of multifold background populations which produces more dynamic migration and constant gene flow effects.

Multi-agent modelling of the Neolithic LBK

Bocquet-Appel Jean-Pierre [1], Moussa Richard ,[2], Dubouloz Jérôme ,[3]
1 : CNRS, Upr2147, 44 rue de l'Amiral Mouchez, Paris, and Practical School of High Studies (EPHE, Paris) France (CNRS and EPHE)
CNRS and EHE
44 rue de l'Amiral Mouchez, Paris http://www.evolhum.cnrs.fr/bocquet/
2 : UVSQ and PRES UPGO
UVSQ and PRES UPGO
15 Bergerie Nationale, Parc du Château, 78012
3 : CNRS, UMR 8215 (CNRS, UMR 8215)
CNRS
21 allée de l'Université, 92023, Nanterre Cedex, France

A modelling approach is presented in which archaeological data on the first farmers in Central and Western Europe, called the LBK (5600?4900 cal BC), are cross-analysed with the corresponding environmental data, at a geographical scale of 1.9 million km² (pixels). The purpose of this approach is to simulate the geographical and demographic expansion of the LBK culture and to gain insights into the reactiveness and resilience of its socio-natural system to climatic

impacts, and into its possible dissolution. This is done through multi-agent modelling of the LBK, based on ethno-archaeological inferences (one agent: one LBK house = one household; intensive farming system) and with input from :
- palaeo-environmental disciplines (estimations: fertility of Neolithic soils, climatic variations from core samples of river sediment, climatic thresholds analogous to those for current extreme variations),
- bio-archaeological disciplines,
- cultural archaeology (space-time distribution of sites, house size distribution, chrono-ceramic series),
- social anthropology (using mid-range modelling: scalar stress, ranging from Chayanovian household splitting to the limited local density of hamlets; buffering of food shortages due to climatic impacts through kinship and neighbourhood networks, emergence - or not - of a headman of the hamlet and its impact on the food buffer),
- palaeodemography (population settlement is density-dependent),
- economics (slash-and-burn in primary forest, cultivation on the best fertile patch, intensive farming using manure, expected production/consumption ratio in equilibrium with the household-demography plus a small food security margin).
A sensitivity analysis (SA) is performed with the simulated output variables (demographic, economic and archaeological) to assess their sensitivity to changes in the values of key parameters used as input. The AS produces a hierarchy of parameters potentially impacting the space-time expansion of the cultural area and LBK populations. Finally, a version of the Obresoc software is presented that can be customised to handle the environmental conditions relating to archaeological questions regarding farmers of the Neolithic type.

An agent-based modelling approach to Minoan land use in the Malia-Lasithi region (Crete, Greece)

Jusseret Simon [1,2*], Chliaoutakis Angelos [3,4], Wainwright John [5], Sarris Apostolos [3]
1 : Aegean Interdisciplinary Studies Research Group (AegIS-CEMA-INCAL), Université catholique de Louvain
Place B. Pascal 1, L3.03.13, 1348 Louvain-la-Neuve
2 : F.R.S.-FNRS Postdoctoral researcher
3 : Laboratory of Geophysical-Satellite Remote Sensing & Archaeo-Environment, Institute for Mediterranean Studies ? Foundation of Research and Technology (IMS-FORTH)
Melissinou & Nikiforou Foka 130, P.O. Box 119, 74100 Rethymno, Crete
4 : Intelligent Systems Laboratory, Department of Electronic and Computer Engineering, Technical University of Crete
University Campus ? Kounoupidiana, 73100 Chania, Crete
5 : Department of Geography, Durham University
Science Laboratories, South Road, Durham, DH1 3LE
* : Corresponding author

The Malia-Lasithi region (north-eastern Crete) has a long duration of prehistoric human activity spanning the Bronze Age (Minoan, c. 3000-1200 BC) period, with sparse evidence for earlier, Neolithic (c. 7000-3000 BC) occupation. Two major geomorphological units appear to have been preferentially settled by Minoan agricultural communities: the Malia Plain, a relatively narrow strip of hilly land bounded to the north by the Cretan Sea, and the Lasithi Plateau, an upland karstic plain surrounded by the summits of the Dikte massif. Little is, however, known of the way Minoan farming activities were organised in the Malia-Lasithi region. Although key insights into pre-mechanised land use can be gained from ethnoarchaeological studies, such approaches are inadequate to capture the dynamic interactions between human activities and environmental processes.
In this paper, we illustrate how an agent-based modelling approach may provide a heuristic approach to representing and understanding such spatially and temporally heterogeneous interactions. The MinoanLands model, developed in NetLogo, combines a cellular model of the physical landscape with an agent-based representation of household decisions. MinoanLands allows investigating interactions between vegetation, changes in erosion and deposition, wildfire dynamics and animal and household agents. It also focuses on the representation of two farming regimes that have been proposed in the literature for Neolithic and Bronze Age Greece, characterised, respectively, by high and low labour input per cultivated unit (i.e. intensive and extensive agri-

culture, cf. Isaakidou 2011 and references therein). The model also allows representing social norms in the form of matrilocal and patrilocal marriage rules in order to test their potential influence on land-use patterns.

We argue that the MinoanLands modelling framework may be fruitfully used as a heuristic tool helping to better assess the effect of variable forms of land use on long-term landscape evolution. At this stage, MinoanLands should therefore be understood as an attempt to integrate existing knowledge about prehistoric farming in the region of Malia-Lasithi and as a means to generate emergent spatial patterns that can be compared with field data. Eventually, MinoanLands may provide a way to objectively compare existing theories of prehistoric land use in the region of Malia-Lasithi.

Exploring the complexity ? system dynamics and agent- based population model of the late Iron Age settlement agglomerations

Danielisová Alžběta [1*], Olševičová Kamila [,2], Cimler Richard [,2]

1 : Institute of Archaeology of Academy of Sciences of the Czech Republic, PRague, v.v.i. (ARUP)
Letenska 4 118 01 - Prague 1
http://www.arup.cas.cz/

2 : University of Hradec Králové (UHK) Rokitanského 62 Hradec Králové 50003 http://www.uhk.cz/en-us/Pages/default.aspx

* : Corresponding author

On a transition from middle to late Iron Age period we encounter a transformation of the central European society which was represented especially by the new settlement forms ? the oppida. They appeared as a part of an economically advanced environment, together with a distinctive intensification of settlement patterns. When they emerged, being understood as «deliberate foundations rather than a gradual evolution», they represented complex systems with multiple functions. The central European sites share many characteristics, among them a distinct development of the population density: archaeological record shows that dynamics of the oppida occupation includes fast growth followed by even more rapid decline. Causes for gradual trend of depopulation can be seen in both endogenous and exogenous factors. However, their analysis is obstructed by the overall lack of detailed archaeological data. In this situation building of explanatory models is the only valid way of exploring the complexity of past societies.

Our objective is to explore the complexity of the population development at the end of the Iron Age using the combination of system dynamics and agent-based population dynamics model. System dynamics models provide an invaluable way to explore and test various general theoretical hypotheses related to the functioning of the settlements or the societal rules that are shaping them. Agent-based approach enables enhancing models with individuals having variety of behavioural patterns. The models are based on domain knowledge and general palaeodemographic patterns of birth-rates, mortality and migration. The simulation of synthetic population (size, structure and subsistence needs) is accompanied by the model of agricultural practices with the aim of investigating the sustainability of the long-term means of production and means of subsistence. The model was implemented in NetLogo and its System Dynamics Modeler. Results obtained with the simulation demonstrate limits of the sustainable economy practiced by a constantly growing population under particular environmental and societal settings. The immediate or gradual impact of the success rate in the food production and its potential influences on the economic and social processes including the oppida abandonment are also addressed.

Settlement Dynamics during the Early Bronze Age in the Beqa'a Valley, Lebanon

Safadi Crystal
University of Southampton (Southampton, UK)

Spatial analysis of settlement patterns in the Levant, in the exception of few studies, has been limited to selective methods such as rank-size distribution, K-means and nearest-neighbour analyses. These applications have inherent problems which affect the results and thereby archaeological inferences. The dimension of settlements is a dubious attribute especially when it is not supported by an excavation to point out its modification from one chronological period to the next. Moreover, K-means and nearest-neighbour analyses fail to identify the multiples scales of settlement clusters.
The Beqa'a valley in Lebanon attests for more than eighty Early Bronze Age I (EBI) and Early Bronze Age II-III (EBII-III) tell sites. These surveyed settlements are the main source of our knowledge on the Early Bronze Age (EBA) in the Beqa'a and they afford a substantial database of archaeological and spatial information. The valley itself reflects a complex heterogeneous environment. Although Lebanon is grouped with the Northern Levant, the Beqa'a valley in its natural diversity reveals a similarity to the Southern Levant and lies in vicinity to its investigated areas. This paper introduces diverse spatial and statistical methods to study settlement dynamics during the EBI and EBII-III in the Beqa'a that diverge from earlier approaches to the topic. Through global and local cluster analysis, enhanced territorial modelling and reconstruction of major communication routes, we can better understand the process of settlement nucleation known to have intensified during the EBII-III period, the level of integration of settlements, socio-economic organizations, community structure e.g. hierarchical or heterarchical, and the dynamics of change that unfolded from the EBI to the EBII-III.
Levantine scholars in recent years recognized the need for regional analysis that can respond to the environmental and social heterogeneity of EBA communities specifically in the southern Levant. Nevertheless, the potential of spatial analysis and statistics has not been fully embraced. This paper presents different methods to analyze settlement dynamics at different scales whose results may provide similar conclusions to earlier studies, but are fundamental to construct a robust framework of analysis highlighting the need to adopt an enhanced methodology for archaeological interpretations. The methods employed are unique in their application to the EBA in modern-day Lebanon and in the Levant at large.

Lucy and the Football- Settlement Patterning in a Harsh Environment

Rocks-Macqueen Doug [1,2]
1 : University of Edinburgh
South Bridge Edinburgh EH8 9YL
http://www.ed.ac.uk/home
2 : Landward

This paper presents research that uses agent based modelling to model the role environmental and social factors played in shaping settlement patterns in southeastern New Mexico. The area in question has long puzzled archaeologists as it did not develop large settlements like those seen in other comparable areas in the American Southwest. The use of agent based modelling to model hydrology and subsistence patterns has shed light on possible reasons why the area did not develop like others in the region. These models combined with ecological and anthropological data will demonstrate that environmental factors kept population numbers down except for brief periods of time. However, these brief periods of hospitable conditions were not long to establish larger population growth, as will be demonstrated in this paper.

Upscaling population densities of hunter gatherers

Maier Andreas [1*], Kretschmer Inga [,2*]
1 : Collaborative Research Centre 806 “Our Way to Europe” (CRC 806)
Bernard-Feilchenfeld-Straße 11 50969 Cologne
http://www.sfb806.uni-koeln.de/
2 : Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart; Collaborative Research Centre 806 “Our Way to Europe” (LAD BaWü; CRC 806)
Berliner Straße 12 73728 Esslingen
http://www.denkmalpflege-bw.de/
* : Corresponding author

Within the framework of the CRC 806 «Our Way to Europe», funded by the German Research Foundation (DFG), subproject E1 is concerned with the investigation of the development of population densities of prehistoric hunter-gatherers on a European scale. In this paper, we would like to present current research on the time between the Gravettian and early Mesolithic to shed some light on population dynamics in the context of the Last Glacial Maximum (LGM) and the onset of the Holocene. For our estimations, we use an upscaling approach based on site density and raw material catchments. An investigation of the latter allows to deduce foraging areas for single sites. Overlapping foraging areas of several sites indicate the collective exploitation of raw material sources. Ethnographic observations suggest that these overlapping foraging areas represent the minimum economic range of regional groups, which, in turn, consist of several local groups. At the scale of these foraging areas, a combination of GIS-methods is used to delimit settlement regions. Most important for the identification of these regions is the distance-based statistical analysis of site density and its visualisation by isolines. The upscaling process uses the size of the settlement regions divided by the average size of raw material catchments to estimate the number of local groups. Ethnographic data is taken to obtain a frame of reference for the number of people per local group, which is adapted to the specific archaeological period under investigation. The ethnographically observed groups selected as a reference sample are chosen regarding similarities between the ratio of hunting, gathering and fishing in the subsistence strategy of these groups and the archaeological record. The subsequently calculated margin between upper and lower quartile is used as valid range for the local group size used in our estimations. The number of persons from the lower scale level of local groups is then transferred to the scale level of settlement areas. Eventually, population densities are calculated on a local scale within the populated areas as well as a global scale within the whole of Europe.
Spatial and diachronic comparisons of the results will allow to identify sources, trajectories and sinks of diffusion processes. Furthermore, a comparison with climatic and ecological data will enable us to investigate human-environment interaction and to discuss pull- and push-factors of migratory events. Thereby human dispersal in the context of the LGM, during the recolonization of Central Europe and at the onset of the Holocene can be described and explained. Within the given error margins, the method provides reasonable approximations. The reliability can be assessed by comparing the results of different stages of calculations. It can be demonstrated that the increase of archaeological knowledge within 10 years produces only gradual changes in the size estimations of settlement areas and the consequential population densities.

An Interdisciplinary Research Project from the Mediterranean context: the long-term development of Menorca (Balearic Islands, Spain).

De Cet Monica
Graduate School Human Development in Landscapes- Kiel-

This poster focuses on the research results of my doctoral project started in April 2010. In particular, I analyse the effects and the characteristics of the long-term occupational, demographic, and socio-economic processes that occurred in the relative limited territory of ca. 700 km2 that the island of Menorca represents. Specifically, I illustrate the methodological background that allowed me to evaluate several aspects of settlement behaviour, palaeo-agrarian trajectory, and subsistence pattern from Prehistory to the 19th century AD. Furthermore, the poster demonstrates how a research design structured on a combination of diverse GIS modeling techniques, an historical-ethnographic approach, and nitrogen-carbon stable isotopes analyses can be an efficient strategy for archaeologists. Especially, significant results have been highlighted with respect to settlement pattern and location preferences (De Cet et al., in press), population numbers, subsistence needs, and modelled territories of cultivation (De Cet et al., forthcoming), and dietary trends between past communities. Finally, this methodology has provided us with a valid interpretative framework to address specific research questions related to fluctuation in site density, geographical distribution of the demographic and agro-economic focus, availability of subsistence resources, and sustainable development over time. The final aim is to contribute to the discussion regarding the potential of such an interdisciplinary approach in the socio-archaeological reconstruction of Mediterranean past landscapes.

Estimating trends in population dynamic using settlement pattern data

Nuninger Laure [1*], Bertoncello Frédérique ,[2*], Fovet Elise, Tannier Cécile, Ouriachi Marie-Jeanne, Alix Stephane, Favory François, Nouvel Pierre
1 : Laboratoire Chrono-environnement / MSHE C.N. Ledoux / GdR MoDys (LCE)
CNRS : UMR6249Université de Franche-ComtéMSHE C.N. Ledoux UMR 3124GdR MoDys
UFR SLHS 30, rue Megevand 25030 BESANCON Cedex http://chrono-environnement.univ-fcomte.fr/
2 : CEPAM / GdR Modys
CNRS : UMR7264
* : Corresponding author

Estimating Trends in Population Dynamics Using Settlement Pattern Data Estimating population from archaeological evidence is a difficult task. It is especially difficult when we are considering population dynamics over several centuries because the ratio between the size of buildings or settlements and the number of people are not proportional throughout time because of changes in architectural traditions, e.g. from simple buildings to complex structures with several storeys. Although it is possible to take changing architectural traditions into account where we have good evidence from excavations, this approach is not practical when working at a micro-regional level because 90% of the available data are derived from pedestrian survey. With these data there is no way to define number of rooms or hearths within a building or settlement, nor can we use statistics to propose estimates since there is almost no consistent reference data. In spite of these substantial obstacles, by plotting the number of sites occupied, grouped into one century periods, using pedestrian survey data for many micro-regions we can demonstrate general trends and cycles which are, interestingly, roughly similar to population dynamics estimates based on demographic and statistical approaches as defined by Zimmermann et al. or Varien et al., among others. In this paper we explore how survey data can contribute to our understanding of population dynamics at a large scale, using several micro-regional studies. The aim is not to make comparisons between periods, but rather to look at similar trends in several regions over time. This approach allows us to define several modes of settlement, defined by combining multiple spatial and rchaeological factors, rather than relying solely on the size of the settlement. The results inform us indirectly about population growth and decline and give a clear idea of the settlement density and/or human pressure in a given territory over time.

Rethinking archaeological landscape: Maxent application on Porto Conte area

Lorenzini Matteo, Rendeli Marco,*, Garau Elisabetta,*, Sanna Luca,*
Università degli Studi di Sassari (ArsLab)
Viale Umberto
* : Corresponding author

The most important characteristic of the research applied to archaeological landscape regards a global approach to the analysis of cultural and natural processes which have contributed to landscape formation. The refinement of methodology applied to landscape analysis has brought a rapid increase in predictive analysis of archaeological landscapes and geographic distributions of archaeological evidence through the use of a variety of standard statistical techniques. The research presented in our contribution concerns a landscape and coastal analysis of Porto Conte area in north west of Sardinia (Italy). Our analysis was concentrated on different settlement dynamics and natural or geological marker that have characterized the human settlement during prehistorical and historical times. We propose a study that applies MAXENT algorithm to analyze data acquired from previous archaeological researches carry out by the University of Sassari and Archaeological Suprintendence of Sardinia, and their geographical representation on GIS platform. Maxent is a general-purpose method for making predictions or inferences from incomplete information. Its origins lie in statistical mechanics following Maximum Entropy and Bayesian Methods, which explore applications in diverse areas such as astronomy, portfolio optimization, image reconstruction, statistical physics and signal processing. We introduce it here as a general approach for presence only modeling of archaeological site distributions, suitable for all existing applications involving presence-only datasets. The idea of Maxent is to estimate a target of probability distribution by finding the probability distribution of maximum entropy (i.e., that is most spread out, or closest to uniform), subject to a set of constraints that represents our incomplete information about the target distribution. The advantages include the following: It requires only presence data, together with environmental information for the whole study area. It can utilize both continuous and categorical data, and can incorporate interactions between different variables. Efficient deterministic algorithms that have been developed are guaranteed to converge to the optimal (maximum entropy) probability distribution. The Maxent probability distribution has a concise mathematical definition, and is therefore amenable to analysis. In our project MAXENT will be used for the development of a geostatistical model applied to the Sinis area. During the development social and environmental variables (e.g. geomorphological dataset, economic and social data etc.) will be considered, which have potentially contributed to the definition of a particular historical landscape. Distributive and predictive model will be represented on GIS platform integrating MAXENT algorithm with GRASS GIS, the most powerful open source GIS platform used for geo statistical analysis.

Centrality - case studies in Anatolia, Syria and Germany

Nakoinz Oliver [1*], Knitter Daniel [,2]
1 : Insitute of Pre- and Protohistory, Christian-Albrechts Universität Kiel (UFG/CAU)
Johanna-Mestorf-Straße 2-6 D-24118 Kiel
http://www.ufg.uni-kiel.de/
2 : Topoi cluster of excellence, Freie Universität Berlin, Physical Geography (topoi)
Malteserstr. 74-100, 12249 D-Berlin
http://www.topoi.org/
* : Corresponding author

Both Christaller's theory of central places and network concepts of centrality were used in archaeology. Both concepts leads to different applications in archaeological case studies which shed light on different aspects of settlement structures and spatial organisation. We attempt to integrate the different theories into a unified theory of centrality and apply associated methods. The concept is exemplified by three case studies from Anatolia, Syria and Germany. All three case studies deal with the problem of insufficient data and apply quantitative and semi-quantitative analysis which allow an interpretation which is connected with the above mentioned integrated theory of centrality. Theory Christaller describes a solution to supply a certain area with central functions. His solution is optimal for the minimization of transport costs. This theoretical model is usually applicable to regional and local scales and includes settlement hierarchies and territorial borders. Territories (complementary areas) are defined as areas which were exclusively associated to a certain centre. Network models do not offer a optimization but measures for centrality such as betweenness or alpha centrality. In most cases network centrality measures are on structural effort to connect to other nodes in the network instead of transport costs. Network models are usually applicable to regional and supraregional scales. The advantage of centrality is the synergy which can be gained by combining targets of interaction (Christaller model) or combining transports (network model). Both models are complementary organisational structures which belong together. Based on this only briefly described considerations we want to define centrality as concentration of interaction which can be realized with different organisational structures. The actual centrality is limited by a specific potential centrality which is determined by natural, cultural and structural factors. Method A first step is to estimate natural and structural centrality potential with semiquantitative scores and outline the path-dependent centrality development for a place. In a next step these results can be combined for a couple of interdependent

of places. Point pattern analysis, graph theoretical methods and network centrality indices can be used to the structural centrality potential and to detect different types of spatial organisation. The combination of such rather simple methods allows to analyse and interpret settlement patterns over the long term in terms of centrality respectively spatial organisation.
Case Studies : The first case study is concerned with present-day Bergama and Selçuk in Western Anatolia. This case study shows the interrelationship of different kinds of centrality and different places and the evident need for integrated research frameworks in the analysis of human?environmental relationships throughout time. The second case study is the surrounding of Aleppo in the Bronze Age. This example shows the combination of both the Christaller model and the network model as well as the path dependency of centrality. The third case study addresses the question whether the two fortifications of the Bronze Age at Lossow and Lebus at the Odra are monocentres in independent territories or polycentres in one territory.

Session 24

Modelling approaches to study early humans in space and time

(Friday 24h 14h-16h45 Pantheon S15)

Chairs : Michael Maerker[1, 2], Yasuhisa Kondo, Christine Hertler,
1 : Heidelberg Academy of Sciences & Humanities (HAW) University of Tübingen - Germany
2 : Department of Earth Sciences (DST) Firenze - Italy

At the last CAA in Perth, Australia, we have launched a session on the geospatial characteristics of early humans like Ardipithecus, Australopithecus, Homo erectus, Homo heidelbergensis, the Neandertals (Homo neanderthalensis), and early modern humans (Homo sapiens). Focus of this session was the spatio-temporal distribution, migration, cultural behaviour, and environmental niches of these early humans. Recently, an increasing number of papers have been published to discuss the spatio-temporal distribution and migration of early humans taking into account different types of environmental information such as paleoclimate, paleotopography, stratigraphy, lithology, paleofauna and -flora, and/or ecological niches. However, there are some problems to apply spatio-temporal analyses to early human archaeology. Firstly, in general, the older type of human species the fewer the archaeological assemblages. Thus, spatial and temporal resolutions of the data are often too coarse to extract any significant patterns at a reliable standard. Secondly, since early humans are truly interdisciplinary research topics, a great variety of approaches are employed. Therefore, data and results of projects are often managed and stored in large database systems of different origin and different technical background. It requires a common working platform (such as a common metadata format). Moreover we have to deal with different modelling approaches ranging from passive geo-statistics to active, actor based methodologies.
In this session we would like to continue the discussions initiated in Perth about techniques and methodologies to understand the spatio-temporal distribution of early humans, taking into account the current technical problems and constraints. Major topics of our session will include (but not limited to) i) the provision of spatial data in large-scale databases, ii) techniques to assess the spatial distribution of early humans, iii) techniques to deal with small statistical samples, and iv) theories and methods to generate meaningful information for spatio-temporal modelling by means of GIS, Remote Sensing and statistical modelling; v) different modelling concepts to assess expansions and niches. We welcome a wide variety of papers relevant to any of the above mentioned topics and are looking forward to fruitful further discussions on the technical issues of early human research.

Spatial characterization and prediction of Neanderthal sites based on environmental information and stochastic modelling: A model comparison

Maerker Michael [1,2], Bolus Michael
1 : Heidelberg Academy of Sciences and Humanities (HAW)
c/o Geographisches Institut der Eberhard Karls Universität Tübingen Rümelinstr 19-21, D-72070 Tübingen
www.roceeh.net
2 : Department of Earth Sciences University of Florence (DST)
Dipartimento Scienze della Terra Università degli Studi di Firenze Via G.La Pira 4 Firenze 50121, Italy
www.dst.unifi.it

We present a unique spatial dataset of Neanderthal sites in Europe that was used to train a set of stochastic models to reveal the correlations between the site locations and environmental indices. In order to assess the relations between the Neanderthal sites and environmental variables as described above we applied a boosted regression tree approach (TREENET) a statistical mechanics approach (MAXENT) and support vector machines. The stochastic models employ a learning algorithm to identify a model that best fits the relationship between the attribute set (predictor variables (environmental variables) and the classified response variable which is in this case the types of Neanderthal sites. A quantitative evaluation of model performance was done by determining the suitability of the model for the geo-archaeological applications and by helping to identify those aspects of the methodology that need improvements. The models' predictive performances were assessed by constructing the Receiver Operating Characteristics (ROC) curves for each Neanderthal class, both for training and test data. In a ROC curve the Sensitivity is plotted over the False Positive Rate (1-Specificity) for all possible cut-off points. The quality of a ROC curve is quantified by the measure of the parameter area under the ROC curve.
The dependent variable or target variable in this study are the locations of Neanderthal sites described by latitude and longitude. The information on the site location was collected from literature and own research. Since the spatial characterization of Neanderthal sites is essentially depending on the site accuracy we spend large effort in correcting the data by a twofold approach: i) we checked and transformed the coordinates to the same projection. In this case we use a Universal Transverse Mercator (UTM) WGS84 projection; ii) all sites were checked for site accuracy using high resolution maps and google earth. The study illustrates that the models show a distinct ranking in model performance with TREENET outperforming the other approaches. Moreover Pre-Neanderthals, Early Neanderthals and Classic Neanderthals show a specific spatial distribution only in part reproduced by the different models. However, all models show a wide correspondence in the selection of the most important predictor variables generally showing less climatic influence in site selection criteria from Pre Neanderthals to Classic Neanderthals.

HomininSpace - implementing hominins moving through time and geographical space

Scherjon Fulco
Leiden University, faculty of Archaeology

HomininSpace is an agent based modelling and simulation environment for moving hominin groups through a large scale geographical landscape. Changing carrying capacity in a reconstructed paleoclimate is the ultimate driving force behind dispersal in HomininSpace. Changing temperatures and precipitation levels influence the carrying capacity of the landscape, and are assumed to be the most influential parameter in the mobility of ancient hominins in the underlying model.
This research combines for the first time an environmental reconstruction driven by isotopic measurements with a year by year demographic model for Neandertal groups moving through North-west Europe. The Neandertals utilize the energy levels from the environment in the form of the meat from large herbivores. The aim is to assess conceptual models underlying the behaviour of Middle Pleistocene hominins in fluctuating climatic conditions, including severe stress

inducing environments. The research contributes to current research into past behaviours within changing environments. Two major types of behaviour driving movement were identified and are implemented in the simulations: a dynamic mobility and a static mobility. Dynamic mobility can be best described as hominins following their preferred habitat. Static mobility is an implementation of the source and sink model, where populations suffer from local extinction when the climate deteriorate and are replenished from remote source locations when conditions improve.

Simulations were run from 131 ky BP to 50 ky BP. For 14.948 grid cells (148 x 101) in each of 81.000 timesteps climatic parameters are reconstructed, including elevation, temperature (yearly average, warmest and coldest month values) and precipitation levels. From these values a (grid-based) environment is reconstructed through which groups of hominins move, driven by the inferred abundance of large herbivores, representing the energy levels stored in the local environment. For each simulation different parameters can be set through the user interface implementing different models and hypothesis on hominin behaviour.

Output of the simulation processes include density maps of hominin presence, density maps identifying areas where hominins died and statistical information on hominin groups including sizes, composition, foraging ranges, resource deficiencies, and ages.

Movement patterns of the simulated hominins are matched against archaeological dating information on Neandertal material taken from the literature. This data is collected in a comprehensive database which includes site name and GPS location, material dated, date assigned including accuracy and dating method, reference to the literature, and a confidence level. The archaeological data are included as Checkpoints in Space and Time of which 75 individual sites are included. Simulation results are summarized in key figures allowing assessment of the level of agreement between model and archaeology on different aspects.

Analysis of the simulations implementing static and dynamic mobility suggests that the archaeology of the Middle Paleolithic best matches hominins groups following a static strategy where they occupy an area and stay there even if the environment becomes less favourable. It is inferred that Neandertals would have followed at least partly this strategy and were maybe less mobile than previously thought. This paper describes the implementation of the HomininSpace tool.

Extrapolating the eco-cultural niche of Palaeolithic populations in Eurasia at 50?46 kya

Kondo Yasuhisa [1*], Sano Katsuhiro [,2], Kadowaki Seiji [,3], Naganuma Masaki [,4], Omori Takayuki [,2], Yoneda Minoru [,2], Nishiaki Yoshihiro [,2]

1 : Research Institute for Humanity and Nature
457-4 Motoyama, Kamigamo, Kita-ku, Kyoto, 603-8047 JAPAN
http://www.chikyu.ac.jp/
2 : University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 133-0033
http://www.u-tokyo.ac.jp/
3 : Nagoya University
Furo-cho, Chikusa-ku, Nagoya 464-8601
http://www.nagoya-u.ac.jp/
4 : Hokkaido University
Kita-hachijo Nishi 5 cho-me, Kita-ku, Sapporo 060-0808
http://www.hokudai.ac.jp/
* : Corresponding author

Eco-cultural niche modelling (ECNM) is a computer-based method to extrapolate past human niche based on the location of known archaeological sites and palaeoenvironmental factors such as temperature, precipitation and elevation. It has been applied to study spatial distribution of Neanderthals and anatomically modern humans (AMHs) in Europe (Banks et al. 2008a, 2008b, 2013). However, there is still room for improving scientific reliability of archaeological and palaeoenvironmental inputs and models (Kondo et al. 2012). This paper presents the preliminary results of ECNM for Palaeolithic populations in Europe and Siberia at 50?46 kya, the time period during which the first AMHs are presumed to have appeared in Europe.

The study area (20°W to 160°E, 0° to 90°N) covered the most parts of Eurasia. Archaeological sites were classified into five lithic industry groups??(1) the Late Mousterian in the Iberian Peninsula at that period, and (2) the Châtelperronean in Western Europe, (3) the Szeletian in central Europe, (4) the Uluzzian in the Italian Peninsula, and (5) Emiran-related industries, including the Emiran in the Levant, the Bachokirian in the Balkans, the Bocunician in Central and Eastern Europe, and the Kara Bom culture in the Altai.

Regarding the palaeoenviromental data, ETOPO-1 was used for digital elevation model. Temperature and precipitation at 50?46 kya were temporarily approximated by the 6 kya climate model of MIROC 3.2 because they were under calculation. Palaeoclimatic variability was indexed for each topographic cell by the difference between values at 21 kya (or Last Glacial Maximum) and 0 kya (present days) of the MIROC 3.2.2.

The maximum entropy model (MaxEnt; Phillips et al. 2006) was applied for calculating the niche probability. All models show that the diachronic variability in the coldest month temperature most contributes to the model. The geometric mean of the niche probability values of two different industries were considered as the niche overlap rate. The results show that high niche overlap rates are observed in Central Europe, where the Szeletian and the Bohunician were present. If we assume that the Kara Bom industry in the Altai derived from the Emiran in the Levant, the model indicated three possible niche corridors through Central Asia.

Session 25

Agents, Networks, Equations and Complexity: the potential and challenges of complex systems simulation

(Thursday 24th 8h30-19h Pantheon S2)

Chairs : Benjamin Davies[1], Iza Romanowska[2], Enrico Crema[3], Tom Brughmans[2]
1 : The University of Auckland
2 : University of Southampton
3 : University College London

Simulation is not new in archaeology. However, the last decade knew an increased focus among archaeologists in the use of simple computational models used to evaluate processes which may have operated in the past. Rather than all-encompassing reconstructions of the prehistoric world, models have been used as 'virtual labs' or 'tools to think with', permitting archaeologists to explore hypothetical processes that give rise to archaeologically attested structures. Computational modelling techniques such as equation-based, statistical, agent- based and network-based modelling are becoming popular for quickly testing conceptual models, creating new research questions and better understand the workings of complex systems. Complexity science perspectives offer archaeology a wide set of modelling and analytical approaches which recognise the actions of individual agents on different scales who collectively and continually create new cultural properties.
This session aims to bring together complex systems simulation applications in archaeology. We invite innovative and critical applications in analytical and statistical modelling, ABM, network analysis and other methods performed under the broad umbrella of complexity science. We hope this session will spark creative and insightful discussion on the potentials and limitations of complexity science, its many simulation techniques and the future of modelling in archaeology.

Agent-based model of great epidemics. Case studies: Wroclaw (smallpox, 1687-1691) and Warsaw (plague, 1624-1626)

Andrzej Jarynowski [1 ,2], Andrzej Grabowski [,2]
1 : Theory of Complex Sytetem Dep. Jagiellonian University (UJ)
Cracow
2 : Lab. of Virtual Reality, CIOP-National Research Insitute (CIOP-PIB)
Warsaw

Recent advances in complex system application to history and archeology have overturned our common sense understanding of human behavior and dynamics of historical societies. The area of epidemiology of infectious diseases is also widely explored by researchers from complex system. Mathematical models and computer simulation play significant role in prevention. However, agent based methods with network theory allow as to simulate outbreaks on spatial- temporal portraits also from history. In this study, we follow standard methodology, where categories of population are subgroups based on the model of SIR (Susceptible-Infected- Removed). Some medical properties of disease developing are known and used as parameters. Our model is based on pathogen spread between people of given city, once infective persons arrive there. Such a study has sense only if there are some data to calibrate model parameters (like contact rates within investigated society). We present two examples of Polish cities from XVII century where both register and excavation based data allow us to proceed analysis. While historical records are usually core data, archaeological sources like localization and volume of mass graves of epidemic victims could supplement research. The first mathematical model in history of science describes the epidemiology of smallpox in Wroclaw (presented by Daniel Bernoulli in Paris, 1760). While Bernoulli's main objective was to calculate the adjusted life table if smallpox were to be eliminated as a cause of death (from differential equation point of view), we try to learn something about contact network properties of given society. Hence Warsaw plague was well described by city major, who was a physician, much more information is available on geographical (evidences of infections by districts) or social structure (evidences of infections by professions) level. We propose an epidemiological model, where agents would represent citizens of Warsaw during the plagues linked to given location and characterized by their job attitudes. Network of contacts is represented by exponential random graph models. Preliminary results show geographical clusters of districts as well as professions particularly exposed to infection and burial in given cemetery. We suggest other potential application of our tools in ? visualization' of social complexity within museum exhibitions of post-epidemics mass grave excavations.

Evaluating demographic models for goat domestication using mtDNA sequences

Pascale Gerbault [1], Mark Thomas [,2*]
1 : University College London - London's Global University (UCL)
Gower Street - London, WC1E 6BT
http://www.ucl.ac.uk/
2 : University College London (UCL)
* : Corresponding author

After its emergence around 11,500 years before present (BP) in the Near East during the Neolithic transition, farming, including stock keeping, spread into Europe around 8,500 years BP. Studying the genetic diversity of livestock can help in elucidating some of the processes associated with the diffusion of the Neolithic, such as domestication. Archaeological and phylogenetic studies have indicated that domestic goat (Capra hircus) was domesticated from the bezoar (Capra aegagrus), which do not appear in the archaeological records before the arrival of the Neolithic into Europe. This ancestral relationship between both populations has been further underlined by studies of mitochondrial DNA showing that the diversity in European domesticated goats is a subset of that of the wild goat Capra aegagrus. Additionally, an ancient DNA study on Neolithic goat remains has indicated that a high level of genetic diversity was already present early in the Neolithic in northwestern Mediterranean sites.We have used coalescent simulations and approximate

Bayesian computation, conditioned on patterns of modern and ancient mitochondrial DNA diversity in domesticated and wild goats, to test a series of simplified models of the goat domestication process. Specifically, we investigate whether domestic goats descend from populations that were isolated prior to domestication. Although the models presented permit further refinement, preliminary results indicate that wild and domestic goats are likely to have descended from a single ancestral wild population that was managed 11,500 years before present, and that serial founding events characterise the spread of Capra hircus into Europe.

Hybrid Modelling of Complex Archaeological Sites

Wurzer Gabriel [1], Reschreiter Hans [,2], Pichler Philipp [,3*], Heinzl Bernhard [,3*], Bacher Anke [,4*], Popper Niki [,3 ,5*], Kowarik Kerstin [,2*]

1 : Vienna University of Technology Karlsplatz 13, 1040 Vienna www.tuwien.ac.at

2 : Natural History Museum Vienna (NHM)
Burgring 7, 1010 Vienna
www.nhm-wien.ac.at

3 : dwh Simulation Services (dwh) Neustiftgasse 57-59, 1070 Vienna www.drahtwarenhandlung.at

4 : University of Vienna Universitätsring 1, 1010 Wien www.univie.ac.at

5 : Institute for Analysis and Scientific Computing Wiedner Hauptstr. 8-10, 1040 Vienna http://www.tuwien.ac.at/

* : Corresponding author

Purpose: Computer simulation can help to analyse various kinds of questions in Archaeology, e. g. how tools were used, how resources were distributed or how spatial spreading took place. Each question has already a certain amount of complexity. To understand the function of a whole archaeological site, it seems to be important to understand the complex and dynamic interactions between the various subsystems. Still the combination of different simulation technologies leads to additional problems regarding computability, data exchange and last but not least lack of validation. We will try to show how it is possible to combine heterogeneous simulation models at runtime and what are the main pitfalls to avoid. The goal is to develop a first concept of a stable, dynamic simulation, which contains various aspects from spatial simulation, physical modelling and resource usage. The Bronze Age salt mines of Hallstatt in Austria (dated to 1458-1245 B.C.) represent an excellent «proof-of-concept» example. Due to the excellent preservation conditions in the mines, an extraordinary abundance of information exits. At the same time, the manifold technological aspects of underground mining and the complex economic structure raise a great variety of questions, which have been addressed using different simulation techniques. The coupling of these represents the main objective of this paper.
Methods: By employing certain hypotheses arising from excavated archaeological findings (e. g. pick handles, lighting chips, mine timber) together with additional assumptions and estimated data (e.g. crop, spatial distances, working time), we can develop a technological reconstruction in form of a mental model. Combination with other involved hypotheses increases the complexity as many properties intertwine and different dependencies have to be taken into account. Such aspects need to be formalized and demand a systematic methodological approach. A formal model will be implemented separating dynamically coupled and linearly coupled subsystems to keep the overall model as simple as possible. The simulation will contain dynamic feedback loops combining not only three different approaches (individual-based, network-based and equation- based simulation), but will mainly focus on the interfaces and coupling of those models, which are partly being developed by our group in other application areas. One problem to mention is aggregation and disaggregation for interfaces between individual-based and equation-based approaches.
Results: The presented simulations will show possibilities and problems of complex coupled (i. e. hybrid) approaches in a first «proof-of-concept» example. By doing so, further research tasks will be presented and both, methodological tasks and archaeological needs will be addressed.
Conclusion: One of the main tasks of future simulation technologies will be to improve the possible applications within archaeology. One important task is to make different modelling techniques not only combinable but also comparable. The presented work is an important step to introduce already developed approaches from other applications into archaeology and to introduce and improve new approaches.

Testing the Movius Line with Agent-based Modelling

Romanowska Iza
University of Southampton

The Movius Line controversy is one of the most persistent research themes in Early Palaeolithic Archaeology. A number of hypotheses have been put forward to explain the pattern of the spatial distribution of Mode 1 and Mode 2 industries. It has been suggested (Lycett & Von Cramon- Taubadel 2008; Lycett & Norton 2010) that in areas further away from the origins of the first ? Out of Africa' dispersal the population density was lower than in the zones closer to Eastern Africa. As a result, smaller and less well connected human groups could not sustain the sophisticated technological knowledge necessary to produce Mode 2 implements and reverted to simpler knapping strategies i.e. Mode 1.
An Agent-based model was developed to test the above hypothesis. It consists of an environmental reconstruction of South East Asia coupled with a dynamic simulation of the Sunda fluctuations in which large areas of dry land would occasionally (on a geological time scale) become submerged and reappear due to climatic changes, acting as an ?environmental pump' driving human movement.
The goal of this study is to compare population density in the Acheulean and Oldowan regions throughout the simulation to evaluate if the proposed demographic disparity between the two regions is plausible. If, under a wide sweep of realistic parameter values, the model will show no differences between the Mode 1 and Mode 2 areas in terms of population density then the aforementioned hypothesis can be rejected.

Agent based modelling and system dynamics ? the importance of replicating models of past economies

Danielisová Alžběta [1*], Olševičová Kamila ,[2*], Cimler Richard ,[2]
1 : Institute of Archaeology of Academy of Sciences of the Czech Republic, PRague, v.v.i. (ARUP)
Letenska 4 118 01 - Prague 1
http://www.arup.cas.cz/
2 : University of Hradec Králové (UHK) Rokitanského 62 Hradec Králové 50003 http://www.uhk.cz/en-us/Pages/default.aspx
* : Corresponding author

Our research attempts to discuss the applicability of agent-based social simulation as a tool for exploration the late Iron Age society, especially from the point of view of the population growth and related sustainability of production. We intend to demonstrate the ability to move from a static data set (archaeological and environmental records) to dynamic modelling that incorporates feedback mechanisms, system integration, and nonlinear responses to a wide range of input data. This approach can help to analyse past socio-economic processes, determine possible crisis factors and understand ecological and cultural changes.
The main objective of this contribution is to stress out the importance and benefits of replication of simulation models. Knowledge of how to replicate is not widespread within the social simulation community and is not included in agent-based modelling methodologies. But it is the replication of computational models what confirms that the experiments did not dependent on any local conditions and that the description of the model is complete. Moreover the replication is important for model verification, optimization and validation and it can foster shared understanding about modelling decisions. The replicated model can differ across at least six dimensions (time, hardware, languages, toolkits, algorithms and authors).
We present a case study of our own attempt to re-implement the model of the population dynamics and carrying capacity of the late Iron Age oppida in Bohemia. The model consists of two part (1) the system dynamics component is used to provide a way to explore and test various general theoretical hypotheses related to the functioning of the settlements and the societal rules that are shaping them, (2) the agent-based component enables enhancing the model with individuals having variety of behavioural patterns. The original model was created in NetLogo and tested using BehaviorSpace utility. The replication was designed by same authors using different Java-based toolkit - AnyLogic, the more complex multi-method simulation software.

Navigating Prehistoric Landscapes: building a wayfinding agent-based model in Netlogo for studying patterns of hominid dispersal

Guiducci Dario [1*], Burke Ariane [1], Steele James [2,3]
1 : Université de Montréal (UdeM)
Université de Montréal C.P. 6128, succursale Centre-ville Montréal (Québec) CANADA H3C 3J7
http://www.umontreal.ca/
2 : Institute of Archaeology, University College London (UCL)
31-34 Gordon Square London WC1H 0PY
www.ucl.ac.uk/archaeology
3 : University of the Witwatersrand (WITS)
Private Bag 3 2050 WITS Johannesburg, South Africa
http://web.wits.ac.za/
* : Corresponding author

The scope of hominin dispersals and their chances of long-term success must have depended upon the ability of individuals to plan and navigate their way through the landscape (wayfinding), communicate spatial information to others, follow established routes and recognise landmarks (Lynch 1960). In this paper we consider how landscape legibility could have affected the ease with which Middle Palaeolithic hominins developed cognitive maps, oriented themselves and navigated through the landscape.
Agent-based models that assess wayfinding behaviour have appeared (Raubal 2001; Hajibabai etal. 2007; McDaniel 2010), but are mostly contextualized for modern urban environments (with the exception of McDaniel 2010). None have been developed for archaeological inquiry. For our purposes, an agent-based model written in Netlogo was developed to test scenarios of agent-landscape interaction, with the specific aim of assessing whether successful wayfinding in natural environments is contingent on landscape legibility. Following Golledge (2003) we consider three aspects of legibility:
1) spatial coherence («legible» environments have spatial coherence, enabling object clustering and feature characterisation as well as hierarchical ordering of phenomena);
2) ease of travel (the facility with which people can move through an environment), and;
3) the way in which sociocultural meanings impart legibility (by imparting meaning to certain landmarks even though their physical characteristics would not normally distinguish them from similar, nearby features).
Of these three aspects of legibility, spatial coherence and ease of travel are already familiar to landscape archaeologists. Spatial coherence includes: the presence of salient landmarks, their hierarchical ordering and intervisibility (which can be assessed using existing GIS tools, such as cumulative viewshed analysis), whereas ease of travel can be explored using least-cost analysis. The third aspect of legibility is, arguably, difficult to study in a pre-Upper Palaeolithic context, but is nevertheless testable in an agent-based model. Added complexity comes from considering an agent's wayfinding motivation, strategy, and differential cognitive spatial abilities in conjunction with the elements of legibility already outlined. By operationalising these concepts, we seek to eventually apply them to geographically refined archaeological analyses of hominin dispersal patterns during the Late Pleistocene.

Spatial Interaction Simulation Methods for Ancient Etruscan Settlement Distributions in Central Italy

Oshan Taylor
University of St. Andrews Centre for Geoinformatic
School of Geography and Geosciences Irvine Building, University of St Andrews St Andrews, Fife, Scotland, KY16 9AL, UK
http://www.st-andrews.ac.uk/geoinformatics/

Spatial interaction as a driver of socio-economic growth has enjoyed considerable popularity within classical archaeological theory. Historically, spatial interaction models have been employed within archaeology to simulate settlement distributions with the key research focus being on hierarchical structures and their development. Rarely, though, do the simulations generate spatial interactions with the intended goal of analyzing the flows to answer research questions. Building models which aim to produce networks of relative spatial interaction amongst a distribution of sites enables researchers to weave together static archaeological remains in order to generate

relationships within a system which were truly dynamic in nature. Further, networks allow for an environment in which many individual actors or settlements interact with each other simultaneously, creating a summation of those influences at each node. By measuring specific attributes across evolving networks it is possible to gain insight into complex scenarios.
The purpose of this research is to explore the spatial distribution of early Etruscan states within a geographic network structure in order to shed light on how space conditioned their development. Specifically, this research will focus on how these spatial effects pertain to the site known as Poggio Civitate (Murlo), which is located approximately 25km southeast of Siena, Italy. By considering the entire region of ancient Etruria, which coincides heavily with the modern Italian province of Tuscany, it will be possible to examine Poggio Civitate's individual characteristics as well as its relationship to other settlements within a cohesive Etruscan society. It is hoped that new evidence will be contributed towards existing theories which seek to explain the nature of this wealthy settlement which was abruptly destroyed and has ultimately remained uninhabited. Additionally, this research will contribute towards the development of quantitative spatial methodologies within archaeology.
Three conceptually unique techniques will be employed in order to simulate relative spatial interactions amongst the sites in the study area: an agent-based model, a radiation analogy model, and a Hamiltonian gravitational model. As a consequence, each model provides varying interpretations of spatial interaction by approaching the problem from 3 different perspectives. A multitude of models offers the ability to compare and contrast different nuances of a phenomenon using the same spatial inputs. Furthermore, different representations that yield varying yet similar results validates that the intended actions are indeed being captured.
This paper will begin with a brief history of the Etruscans and how Poggio Civitate fits into that narrative. It will then introduce the concept of spatial interaction theory and spatial interaction modeling, followed by a review of spatial interaction studies within the field of archaeology and the selection of the three models that will be employed. Next, the necessary input data will be established and the appropriate metrics to analyze the output networks will be selected. Finally, the resulting networks and their properties will be reported which will be followed by a comparison of the three models, the implications each has regarding Poggio Civitate, and suggestions for future research.

Modelling tableware distribution in the Roman East: comparing different network-based approaches

Brughmans Tom, Poblome Jeroen
Katholieke Universiteit Leuven (KUL)
http://www.kuleuven.be/english

A particularly challenging issue in the study of tableware distributions in the Roman East is posed by the significant differences in distribution patterns of different wares. Some wares like Eastern Sigillata A (ESA) were distributed on a supra-regional scale for centuries, others were more of regional importance, whilst yet other wares were purely produced for local consumption. What were the mechanisms that led to these different patterns? Many contributing factors have been formulated to explain this (e.g. state involvement, redistributive centres, «pulling forces», commercial «piggy-back» trade, closeness to large-scale agricultural production). Since there is no lack of published hypotheses and contributing factors attempting to explain this pattern, our main research question becomes «what mix of factors is best supported by the available evidence? » and our main challenge will then be the search for an approach that allows one to distinguish between the impact and archaeological «signatures» of different hypothetical scenarios.
This paper aims to evaluate published hypotheses through a combination of an exploratory analysis of a collection of 30,000 tableware sherds (using the ICRATES database of tablewares, Bes and Poblome 2008) with computational modelling of hypothetical trade mechanisms. Tableware trade in the Roman East will be considered to function as a complex system, where the particular small-scale actions of agents making decisions to interact based on their limited knowledge of their social network, gives rise to large-scale patterns that can be compared to the combined archaeological record. This paper will focus in particular on the construction and results of an agent-based model (ABM) created to address this research question. This ABM uses the concept

of the «Roman Bazaar» developed by Peter Bang (2008) as a theoretical framework. The Roman Bazaar is based on the idea that markets in the Roman Empire were very weakly integrated and largely driven by the particular commercial opportunities of agents in the many trading places around the Empire. These opportunities were structured by the agents' social networks, leading to a relative unpredictability of supply and demand, high uncertainty of information, and many irregularities in prices and available products. The results of the ABM will be compared with the results of an exploratory network analysis of the collected tableware evidence in order to evaluate the potential role of different factors in giving rise to the observed pattern.

Bes, P.M., & Poblome, J. 2008. (Not) see the Wood for the Trees? 19,000+ Sherds of Tablewares and what we can do with them. In Rei Cretariae Romanae Fautores Acta 40, 505?514. Bonn

Why archaeological similarity? Experimenting the consequences of spatial aggregation and cultural concensus in Prehistoric agriculture societies

Barcelo Juan*, Del Castillo Florencia, Capuzzo Giacomo, Morell Berta
Universitat Autònoma de Barcelona (UAB)
UAB Campus 08193 Bellaterra (BARCELONA) SPAIN
http://www.uab.es/english/
* : Corresponding author

This paper describes the design and operation of an ABM that represents aspects of social dynamics in an agricultural society modeled after empirical data and archaeological hypotheses from European Late Bronze Age. The model explores the relative importance of both demic and cultural diffusion in different regions of Europe because in some areas both are likely to have contributed to the social and cultural change. The main purpose of the model is to explore how various assumptions concerning ethnicity affect the distribution of settlements, the population size and the level of aggregation.

The model is represented by agents designed as settlements witch interact in a world that has a seasonally-variable resource density, but is also modified as a result of labor (domestic vegetal resources, domestic animal resources). Agents must invest labor and technology to plant at the beginning of the productive cycle, invest additional labor and technology to harvest, and they should store what has been harvested until the next season. Livestock will also consume a part of stored vegetal resources, and it can be used from time to time as subsistence to social agents. There are no explicit labor flows between settlements, but possibilities of interaction that affect the way each agent obtains subsistence and reproduces socially. Interactions are modeled as links allowing or preventing the circulation of ideas, raw materials, instruments, prestige goods and even subsistence between interlinked settlements. To interact or not, and the specific kind and modality of interaction (neighborhood, kinship, ethnicity, political alliance, exchange, theft and war) is a social dilemma, modeled in terms of game theory. As a consequence of subsistence and exchange, social networks emerge affecting the way social groups consider themselves (ethnicity).

This computer simulation model is a tool of experimentation with complex systems which let identifying how interconnected variables of European LBA societies work, considering social variables such cultural consensus and social aggregation, as well as environmental variables such as land productivity. Our goal is to formulate a hypothetical model to explain LBA-Early Iron Ages historical transition. The model should be able to reproduce spatial patterns and social and economic effects of the introduction of new raw materials and new technologies. As well, permits explore the role played by iron metallurgy in the breakdown of exchange networks through which copper and tin circulated and, as a consequence, its adoption induced a collapse of the political system which represented the base of the Bronze Age economy. From that, we can argue that the introduction of iron did not represent just a change in technology, but a change in the social and economic strategies, in particular concerning the circulation of goods, ideas and people. It is not surprising then that the main features of this period would be a general trend towards settlement concentration, which is the background for the rise of Iron Age historical towns, and also the emergence of fortified sites.

Pattern from process: a spatial simulation approach to time-averaged surface deposits

Davies Benjamin
The University of Auckland
http://www.auckland.ac.nz

The archaeological record of Australia's arid regions is dominated by surface deposits, often consisting of scatters of stone artefacts and remnant heat-retainer hearths. Surface deposits have been notoriously difficult to interpret due to the mixing of artefacts from multiple time periods on to a common surface, with the outcome being a time-averaged palimpsest. Understanding this kind of record requires explanatory frameworks which reflect this time-averaging process in generating not only the samples we obtain from the surface record, but populations of artefacts and features from which samples are drawn. This study uses spatial simulation to examine the effects of differential place use and visibility on the distribution of lithic artefacts and heat- retainer hearths sampled from a surface setting. The manufacture, transport, and discard of stone artefacts and the construction of hearths are modelled using differential place use and distributions of resources. The roles of stratigraphic deflation and geomorphic visibility are explicitly considered. Simulations are then placed within a geographic context and compared to a known case study from arid Western New South Wales, Australia. Outcomes from different patterns of place use are presented, and spatial samples are compared to corresponding samples from the archaeological record. Through simulation exercises such as this, archaeologists can evaluate assumptions upon which our interpretations are built and gain a better appreciation for the behavioural and formational processes which might influence the character of surface deposits.

The Birth of Artists as Coordinators in the Prehistoric Times. ? Analysis by an Agent Based Model ?

Horiuchi Shiro
Shibaura Institute of Technology (SIT)

The important topic in archaeology is why and how the early modern humans had produced artistic artifacts, such as rock paintings found in Altamira or Lascoux cave, or venus figurines found in amounts of areas. The producers, or artists, did not likely have gained surpass profits from engaging in artistic behaviors. Rather they should have suffered from much opportunity cost. Why nonetheless some individuals engaged in producing artistic artifacts? A hypothesis is different groups could have communicated well owing to the artists; they worked as coordinators who connected individuals of different groups, encouraged their long-distance trades, and contributed to cultural accumulation of the whole population. Actually artistic artifacts and long distance trades are the index of the early modern humans, absent in the other human species such as the Neanderthals.

To test the hypothesis, we built an agent based model in which agents engage in whether artistic behaviors or occupational behaviors. Artistic behaviors or occupational behaviors contribute to accumulating art or commodity culture, respectively. The commodity culture contributes to fitness of the individuals while art culture does not. Individuals of different groups may communicate and learn commodity cultures from each other, as long as either individual is equipped with enough art culture.

The simulation shows that if individuals strongly need commodity culture of other groups, most individuals engage in artistic behaviors. As a result, all the individuals hardly accumulate commodity cultures; art culture rarely works as media. In contrast, if agents weakly need culture of other groups, a few individuals specialize in artistic behaviors while others engage in occupational behaviors. As a result, commodity cultures accumulate in the whole population, which are shared by most agents owing to a few artists as coordinators.

In the session we will test the effects of population density, migration, and landscape on the evolution of artists. We hope collaboration with archaeologists to create an elaborate model that may predict in which conditions, or when and where, we likely can find artistic heritage of the early modern humans.

A computer simulation to replicate the dynamics of settlement processes in Oceania.

Noury Arnaud [1], Di Piazza Anne ,[2]
1 : Independant researcher (Docteur (archaeology) computer developpement PM)
Independant researcher
Paris
2 : CREDO CREDO Marseille

While the settlement models of Oceania proposed by pre-historians are in general agreement about two phases of the migratory dynamics of Melanesia - West Polynesia on the one hand and East Polynesia on the other, the 2000 years hiatus in this process remains unexplained. We hypothesize that different aspects of Oceanic navigation such as performance of different types of Oceanic canoes and physical aspects of the environment (size and distance between islands, regional wind patterns), help reinvestigate this question.
We will use a computer model simulating trajectories of these different types of canoes sailing through these different wind patterns throughout Oceania to suggest that there were two «schools of navigation», one to the east and another to the west of Samoa.

Interactions and network analysis of a rock art site in Morro do Chapéu, Bahia, Brazil.

Etchevarne Carlos [1], Grégoire Van Havre ,[2]
1 : Laboratório de Arqueologia, Universidade Federal da Bahia (UFBA)
2 : PhD Student, Departamento de Arqueologia, Universidade Federal de Pernambuco (UFPE)
Av. Prof. Moraes Rego, 1235 - Cidade Universitária, Recife - PE - CEP: 50670-901.
http://www.ufpe.br/ppgarqueologia/

We analyse painted human representations from a prehistoric rock shelter located in the municipality of Morro do Chapéu, in the state of Bahia, Brazil. The set was classified by attributes shared by all the figures. We created a network that allows us to study the behaviour of specific patterned graphical elements and objects considered as salient identity markers.
The region of the Chapada Diamantina is located in the central part of the state of Bahia. Mostly above 1000 meters, with a rich vegetation, it is located in a semiarid area. The municipality of Morro do Chapéu lies in the north, on a sandstone belt separating two important hydrographic basins, São Francisco and Paraguaçu rivers.
Most rock art sites in the area have been identified in the last ten years. One of the few excavated archaeological sites, the Toca do Pepino rock shelter measures about 70 meters and is naturally divided in several spaces showing red and yellow paintings. Its most striking characteristic is the large number of human representations, manipulating objects and weapons or using clothes. Some complex scenes envolving social contexts are also pointing to other sites in different regions, namely the Serra da Capivara (Piauí) and Seridó (Rio Grande do Norte). While it wasn't possible to date any human occupation there, a neighbouring site, the Toca da Figura, had a chalk hearth dated to 2900 BP.
In order to analyze such a great diversity of human representations, we developped a classification based on shared binary morphological and technical attributes. A 2-mode network was then mounted to visualize the relations existing between all the elements and their variables. This method allowed us to identify clusters of similar figures and outliers, with original combinations of attributes. Furthermore, we wanted to verify this method, still new in rock art studies, against another statistical test. MCA, or Multiple Correspondence Analysis, offered us a geometric analysis of the same data. It resulted in fairly similar results.
The exploration of identity markers on both the network and the MCA plots gives us a measure of dispersion. Some markers are present in separate clusters, while others are concentrated in specific combinations of attributes. We also identify scenes showing figures with different markers interacting together.

Medieval Warfare on the Grid: complex behaviours

Murgatroyd Philip
University of Birmingham

Although historical studies are frequently perceived as clear narratives defined by a series of fixed events; in reality, even where critical historical events may be identified, historic documentation frequently lacks corroborative detail to support verifiable interpretation. Consequently, interpretation rarely rises above the level of unproven assertion and is rarely tested against a range of evidence. Agent-based simulation can provide an opportunity to break these cycles of academic claim and counter-claim.

This paper discusses the development of an agent-based simulation designed to investigate medieval military logistics so that new evidence may be generated to supplement existing historical analysis. It uses as a case-study the Byzantine army's march to the battle of Manzikert (AD 1071), a key event in medieval history. It describes the design and implementation of a series of agent-based models and presents some of the results of these models. The relationship between an army's size, its speed and the amount of supplies it requires is complex, where the micro-scale behaviours of individuals affect the macro-level progress of the whole army. Agent- based modelling is the most appropriate tool to investigate the relationship between the army as a whole and the individuals that comprise it. The Medieval Warfare on the Grid models show the dramatic effects of the organisation of the movement of the army, where the rules by which the army marches can cause significant changes in the overall progress of the force.

Agent Based Modelling and the Person

Rocks-Macqueen Doug [1,2]
1 : University of Edinburgh
South Bridge Edinburgh EH8 9YL
http://www.ed.ac.uk/home
2 : Landward

Archaeologists have been using agent based modelling (ABM) programs almost as long as the software has been in existence. In that time archaeologists have used ABM to model a wide range of problems from networks to settlement patterns. Of course, the range of possible subjects to model is endless and it has not been possible to tackle every topic. One area that has yet to be fully explored by archaeologists is giving senses to agents. This paper examines efforts to give human-like senses such as sight, smell and sound to agents in ABM programs. The paper will explore potential and limitations of such work in complex systems. It will also examine the pitfalls encounter and methodology used in hopes of stimulating further work in this area.

To Simulate or not to Simulate? Getting the most out of using Agent Based Modelling.

Evans Andrew, Spikins Penny, Heppenstall Alison
University of Leeds
Leeds West Yorkshire

Agent-based modelling (ABM) is now firmly established in the spatial and social sciences as part of the simulation tool kit. It's potential to create hetereogeneous individuals that can interact with other individuals and their environment is an enticing prospect. Within the spatial sciences, this has given rise to opportunities to not only test out established theories, but also to create new knowledge and understanding about systems under research. One of the strengths of ABM is that they can potentially explain how micro-scale patterns give rise to macro-scale phenomena. Applications can be found ranging from simulating the movement of millions of individuals (Parry and Evans, 2008) to simulating the behaviour of a few (Malleson et al., 2012). Spatially, applications are equally diverse with agents being embedded within environments that are geographically explicit (Wise and Crooks, 2013) to those using abstract space (Heppenstall et al., 2013). For archaeologists, the agent framework provides a unique opportunity for the construction of, and exploration of past societies and environments.
In this talk we will focus on the complications in modelling spatially explicit agent-based system. In particular, we will focus on issues of scale, representation and behaviour, and some of the pitfalls involved in modelling both real and abstract geography. We will look at model development, verification and validation. We will draw these strands together through the presentation of an ABM that allows exploration of the potential effect of threshold changes in human cognition on human dispersal patterns.

Session 26

Digital Archaeology

(Wednesday 23th 10h30-18h Pantheon Amphi 2B)

Chairs : François Djindjian, François Giligny, Laurent Costa
1 : Université de Paris Pantéhon Sorbonne &UMR 7041 ArScAn
1 : Université de Paris Pantéhon Sorbonne & UMR 8215 Trajectoire
3 : CNRS UMR 7041 ArScAn

Unrolling 134 columns: Karnak Great Hypostyle Hall Column Decoration

Laroze Emmanuel [1*], Egels Yves [,2*]
1 : Centre de Recherches Égyptologiques de la Sorbonne (CRES)
CNRS : UMR8167
2 : École Nationale des Sciences Géographiques (ENSG)
IGN
http://www.ensg.eu/
* : Corresponding author

The Great hypostyle hall of Karnak has been the subject for several years to a complete survey of its parietal decorations. After having studied the walls which are surrounding the space, the Karnak Great Hypostyle Hall Project team has been involved in the analysis of 134 columns who supported an half-hectare ceiling. In spite of his interest this project has been delayed for a long time due not only to the magnitude of the task but also to technical reasons as those of the survey and the representation of the columns' cylindrical surfaces. The development of new survey tools such as the 3D scan and more particularly of the digital photogrammetry made a decisive contribution and brought solution fitted to our fieldwork contexts. Thanks to these enhancements and according to the epigraphists? needs, it was decided to produce photographic unrolling of the decoration for each column and provide a new architectural documentation (plans, sections and axonometric views). The complete set of topographic and photogrammetric data were collected during two field seasons. The first campaign entrusted to a private team specialized in the lasergrammetry (Atm3D) was dedicated to the complete plotting of the hall. The second one conducted by a team of the ENSG (IGN) was devoted to the photographic survey. The architectural context was especially constraining : masks, illumination, height of columns and tourist attendance imposed a multiplication of the recording stations. Finally, 300 positions of scan, 1000 photogrammetric shots , 4000 pictures, a topographic polygon of about 600 targets were requested. The processing of a such mass of information imposed a rigorous logistic and the implementation of an industrial procedure. The pictures unrolling which totalize 1,5 hectare of decorated surface, are nowadays done. This original documentation already serve as a resource for the epigraphic survey.
The purpose of this talk is to give an outline of the project: fieldwork, process and technical developments. The last results of analysis will be presented. The reflections and the technical solutions which have been investigated during this project also will be laid out.

Integration of laser scanning, photogrammetry and building surveying within the virtual reconstruction of Winchester cathedral and its precinct buildings

Miles James
Archaeological Computing Research Group, University of Southampton (ACRG)
acrg.soton.ac.uk

Winchester cathedral and its precincts have undergone a series of changes since their first construction, in part due to the changing culture of monastic influences and in part due to the geology of the local area. Winchester Cathedral first built in 1079 is currently in a state of restoration following a series of structural faults with the building having its foundations built on layer of peat. The structural damage has since been fixed since the discovery of the damage in the late 19th Century but there is a need to focus on the precinct buildings which are under similar influences. As a result, through a wider research focus a series of different recording methods have been used at Winchester cathedral and its precinct buildings to identify the structural integrity of the buildings that are currently there and have been in the past. The paper will outline the methodology used within the production of virtual models based on laser scanning, photogrammetry and building surveying. It will outline the improvements made to processing the data within relevant software and provide an insight into the extraction of raw data for integration within CAD. Furthermore the paper will outline the potential that these technologies have within producing more realistic virtual reconstructions of past buildings based on structural analysis tests. Additionally the paper will discuss the integration of these technologies within the new virtual display units currently being built at the Cathedral for public interaction and will also discuss the potential that RTI has within the explanation of graffiti marks and the identification of inscriptions on ledgerstones that have been worn down over time for public and academic purposes.

The use of laser scanning, photogrammetry and gigapan imaging at Portus

Miles James*, Earl Graeme, Wheeler Peter, Keay Simon
Archaeological Computing Research Group, University of Southampton (ACRG)
acrg.soton.ac.uk
* : Corresponding author

The Portus Project is a multi-disciplinary archaeological research project that is investigating the maritime port of Imperial Rome, so named Portus. The site itself was the commercial hub that connected the Metropolis to the Mediterranean. It is large complex site covering 3.5km2 and which encompassed c. 230.5 Ha of harbour basins and quays. Over the last fifteen years a number of different techniques have been used on site ranging from field archaeology to computing, the physical anthropology and biological profiling of human skeletons, geo- archaeology and environmental analysis. Recently laser scanning has been integrated in this research as means to accurately record the standing architecture, the landscape and the excavation process. A series of scans were completed in subsequent field seasons to produced virtual models which would be used for investigation within the construction of the building work. From this data areas of importance could then be analysed off site and used to produce accurate measurements for use within virtual reconstructions. The paper will thus focus on the acquisition of this data across the site and subsequent data extraction for use within our investigation. Furthermore the paper will also discuss the photogrammetry data collected on site of both architectural features and of artefacts from the excavation and their subsequent integration online. Additionally the paper will discuss the use of gigapan imaging used on site to create a virtual tour of the area for public access. Moreover the paper will discuss the integration of the recording methods used to produce an overall representation of the standing building work to compare against previous surveys and lastly the paper will discuss the use of the various methods within the production of realistic virtual reconstructions.

Measuring and Describing 3D Texture. Case studies.

Moitinho De Almeida Vera*, Barceló Juan A*
Universitat Autònoma de Barcelona (UAB)
UAB Campus 08193 Bellaterra (BARCELONA) SPAIN
http://www.uab.es/english/
* : Corresponding author

In this paper we define an archaeological texture in terms of a formalized visualization of complex patterns within a surface composed of spatially organized subpatterns, which have a characteristic, somewhat uniform appearance. Unfortunately, there is no universal method of searching for informative visual marks. They can be extracted from any object almost ad infinitum, but one usually fails to formalize the significant criterion for what is intrinsically « textural». The insufficiency and lack of a clear consensus on the traditional methods of visual description ? mostly based on spoken language, descriptive and qualitative ? have invariably led to rhetoric, ambiguous and subjective interpretations of its functions. In this paper we suggest some systematic, formal and standardized ways of describing texture, implementing objective, mathematical, quantitative, and whenever possible automated techniques.
Our approach is based on the use of non-contact close-range 3D scanners, which can capture surface data points with less than 50 microns between adjacent points. In this way, instead of using grey-level values measured at pixel resolution, we have proper measurements of depth and height at well localized points within the surface. The real value of 3D digital data comes from the ability to be able to extract meaningful information from it. In this vein, we should extract a number of different texture descriptors from the generated 3D model. That means integrating some parameters related with the 3D geometry of the objects' interfacial boundaries in a set of relational

coefficients. Many of these parameters are currently regulated by international standards, which describe terms, materials and methods, and how they can be used to consistently measure and analyze surfaces. The ISO 25178 series (2012) define more than 40 areal parameters for measuring 3D surface texture; the spatial periodicity of the data, specifically its direction; the spatial form of the data (amplitude and spatial information; the surface bearing area ratio curve (Abbott-Firestone curve); and a segmentation of the surface into valleys and peaks (watersheds algorithm and Wolf pruning). The advantage of applying 3D areal surface metrology methods and parameters is that these are calculated on the entire or sampled surface and not upon averaging estimation calculations derived from 2D profilometric methods and parameters.
This way of describing and measuring texture variation is applied to the study of the engraving block of El Mirón Cave (Ramales de La Victoria, Cantabria, Spain), where the ultimate goal of this ongoing work is to provide new information and a better knowledge about the Paleolithic engravings in such archaeological context to understand to what extent distinct technical choices determine the detection, characterization, and interpretation of the carvings. A second case study is focused on the Neolithic stelae with horns from the Serra de Mas Bonet (Vilafant, Catalonia, Spain), and in a set of lithic tools that have been associated with them. This investigation is directed toward a better comprehension of the manufacturing procedures used mainly in the production of one of these stelae.

Laser Scanning and Automated Photogrammetry for the knowledge and the representation of the architecture cave in Cappadocia : Sahinefendi and the Open Air Museum in Goreme

Inglese Carlo [1], Carpiceci Marco ,[2*]
1 : Dipartimento Storia, Disegno e Restauro dell’Architettura - Università “Sapienza” di Roma (DSDRA)
Piazza Borghese n. 9 - 00186 Roma
www.uniroma1.it
2 : Dipartimento Storia, Disegno e Restauro dell’Architettura - Università “Sapienza” Roma (DSDRA)
Piazza Borghese n. 9 - 00186 Roma
www.uniroma1.it
* : Corresponding author

The survey campaign conducted on the “Church of the Forty Martyrs “ in Sahinefendi and churches located within the GoremeOpenAirMuseum is part of a research project oriented to the testing of systems for surveying and representation applied to both two-dimensional and three- dimensional phenomenon of the architecture excavated rock .
The OpenAirMuseum in Goreme, is a complex of unique anthropological as well as historical and artistic value , a UNESCO World Heritage site in 1985 , of which there is currently a working staff of the architectural survey . The data acquisition using old and new technologies and processing in post- production involves a necessary critical action that affects not only each specific monument , but the same methodology of acquisition and processing . In particular, we tackled the problem of systematization of procedures for the architectural survey in the field of rock art in the light of the technologies ‘ emerging ‘ Laser scanning , photogrammetry automated multi- stereo -matching and execution of immersive picture . Next to the architectural survey , a more extensive operation and contemporary consisted of the acquisition and processing of data useful for the formation of photographs to be included in immersive virtual tour. The type of surgery is in fact dictated from time to time by the intrinsic characteristics of the subjects chosen , by way of guidance , the pictorial richness led to the creation of immersive photographs and architectural richness to the necessity of detection for scanning laser .
At a later stage of the experiment have been dealt with in the specific field of architectural representation . The rock architecture , unlike the one built , has the need to represent its particular morphological feature : the irregularity that comes from its being an artifact excavated. It ‘ was therefore necessary to conduct a trial of representation techniques unusual for architecture, most commonly used in the field of cartographic representation as contour lines and planar development of complex surfaces .
In this field, surveys are conducted for two different sites of exceptional importance, in Sahinefendi has revealed the “ Forty Martyrs Church “ , with its recently restored painting equipment , contextualising the structure with the whole of the characteristic “ cones “ neighboring up to go to the

Monastery rock made in the upper part , on the slopes of Mount “ Orta Tepe .”
A Goreme were surveyed , however, a series of rock-hewn churches included in the Open Air Museum, including St. Catherine ‘s Chapel, the Apple Church, the Sandal Church, the Pantocrator Church .

The modelling of the early Neolithic site of Portonovo as a case study for testing a 3D documentation pipeline for archaeological excavation

Malinverni Eva Savina [1,2], Tassetti Anna Nora [2,1], Conati Barbaro Cecilia [3]
1 : Università Politecnica delle Marche
http://www.univpm.it/English/
2 : Università Politecnica delle Marche (UNIVPM)
P.zza Roma 22, 60121, Ancona
http://www.univpm.it
3 : Sapienza Università di Roma (UNIROMA1) Piazzale Aldo Moro 5, 00185, Roma http://www.uniroma1.it/

Stratigraphic archaeological excavations demand high-resolution documentation techniques for 3D single-surface documentation because only within a destructive process each single deposit can be uncovered, identified, documented and interpreted. This 3D recording is typically accomplished using total stations but other techniques are nowadays standing out because of their performance and affordable deliverables and should be taken into consideration because overcoming the previous constraints (processing time and cost) and establishing a straightforward, fast and often low-cost workflow for excavation recording.
The paper outlines how different state-of-the-art survey workflows can be applied to map the Early Neolithic site of Portonovo-Fosso Fontanaccia (Ancona, Italy), located on a south-facing slope, along the right bank of the river Fontanaccia. The excavations revealed 18 domed ovens (six of which were intact), aligned at different heights along the hill slope and dated at the half of the VI millennium BC cal 2?. It is the only evidence of this kind in Italy and in the Mediterranean area. Different survey experiences are carried out to map the five ovens excavated during the 2013 field campaign, ranging from digital photogrammetric to terrestrial laser scanner data acquisition and from open source to commercial processing. With the same aim different deliverables are produced and investigated: photorealist 3D surface models, orthophotos, 3D sections and webshare data solutions.
The option of quick, well-tested and often low cost/open source survey pipelines makes the research experience a case-study highlighting new approaches that can be integrated in the general excavation methodology and additional interesting features such as model/data reusability. The produced photorealistic 3D models together with all the other digital data can be integrated inside a GIS environment satisfying the need to manage on situ the documentation of on going excavations. Moreover, the photorealistic 3D models can be refined and drive other cultural heritage experiences such as multimedia enjoyment and virtual museums. This communication feature becomes especially important when the archaeological site (as happens to our case-study) must be covered/closed in default of other protecting /museum solution.

3D point clouds representation and enrichment: The case of S.Imbenia (Italy)

Lorenzini Matteo, Sanna Luca,*, Rendeli Marco,*, Garau Elisabetta,*
Università degli Studi di Sassari (ArsLab)
Viale Umberto
* : Corresponding author

The application of 3D technologies to archaeological research has been the subject of intense experimentation carried out by different scientific groups. Activity has focused in particular on the use of tools for the acquisition and reconstruction of 3D archaeological features or sites. So far researchers’ interest has been aimed mainly at the exploitation of the potential of 3D technologies for virtual reality and the visualization of archaeological features and artifacts, for which many good models exist, but we often lack the opportunity to fully understand the data which characterizes virtual objects. In that sense, this paper describes pipe line adopted by ArsLab project in order to provide both development of 3D digital objects both metadata definition as content provider

of 3D-Icons. ArsLab, contextually to the project, will deliver 3D contents and metadata belonging to different heritage sites, monuments and objects located all over Sardinia: medieval castles located in the province of Sassari, archaeological artifacts located in different archaeological sites, nuragical settlement etc. In this case we will present the common methodology adopted by our laboratory from the acquisition of 3D archaeological feature to development of OAI-PMH metadata repository on nuragical context of S.Imbenia located in north west coast of Sardinia in Alghero district. Our approach consist of three essential points: Data Acquisition done by laser scan system and photogrammetry, Data processing done following a well-known pipeline for the geometric and appearance modeling of the surveyed objects or sites. Generally unstructured point clouds are converted into structured polygonal models to digitally recreate the geometric shapes of the surveyed objects and allow better photo-realistic visualizations, Development of our OAI-PMH repository and, finally, data parsing and enrichment done by metadata definition following Europeana Data Model schema. In particular, for metadata enrichment we have provide to development of data mapping tool that allow metadata alignment to our OAI-PMH structure to EDM profile. ArsLab repository will be also available as SPARQL end point thanks to the integration of APACHE SOLR framework with our OAI-PMH repository. The method adopted in S.Imbenia case represent a very powerful and innovative solution for the management of archaeological 3D features that allowing the integration of 3D digiral and semantical information based in a interoperable and user friendly way.

Spatial 3D Representation and Medieval Archaeology: Searching a new common language.

Pruno Elisa, Nucciotti Michele,*, Drap Pierre,*
Université de Florence (SAGAS) P.zza S.Marco, 4 - 50121 Firenze http://www.unifi.it/mdswitch.html
* : Corresponding author

The paper presents a first reflection concerning an interdisciplinary project between Medieval Archaeologists from Florence University (Italy) and ICT researchers from CNRS L-SIS of Marseille (France), aiming towards a connection between 3D spatial representation and archaeological knowledge. It is well known that Laser Scanner, Photogrammetry and Computer Vision are very attractive tools for archaeologists, although the integration between representation of space and representation of archaeological time has not yet found a methodological standard of reference. We try to develop an integrated system for archaeological 3D survey and all other types of archaeological data and knowledge through integrating observable (material) and non- graphic (interpretive) data. Survey plays a focal role, since in the meantime it is a metric representation of the archaeological site and, to a wider extent, also an interpretation of it (being also a common ground for communication between the 2 teams). More specifically 3D survey is crucial, allowing archaeologists to connect actual spatial assets to the stratigraphic formation processes (i.e. to the archaeological time) and to translate spatial observations into historical interpretation of the site. In this work, stratigraphic analyses (both of excavated deposits and of upstanding structures) are closely linked to E. C. Harris's theory of stratigraphic unit (US from now). Every US is connected to the others by geometric, topological and, eventually, temporal links, and are recorded by 3D photogrammetric survey; a technology which proved able to create links with all other archaeological data. So, in order to provide an integrated 3D survey system we first tried to identify a basic conceptual Object (the US) for the surveys, according both to Archaeology and to Information Science. In this paper we would present our conceptual framework, using as a case study stratigraphic analyses of upstanding buildings (examples will be mainly taken from the Shawbak Project Jordan, Florence University) in order to show how positive and negative US have been represented (both as material objects and time instances). To do this we had to address and solve a number of theoretical issues. We developed a set of tools for medieval archaeological analysis ranging from the production of traditional graphical documentation to the use of 3D/2D GIS, through the creation of centralized and exhaustive object storage tool both for archaeological and photogrammetric data. Using these tools archaeologists will be able to produce, store, visualize and manage both archaeological and 3D data, according to their needs. At the end we show how this approach may enable automatic 3D thematic representation and new archaeological analyses through bidirectional-links between 3D representation and archaeological data.

3D modeling by digital photogrammetry applied to the palaeolithic mammoth bone site of Gontsy (Ukraine)

Djindjian François [1], Iakovleva Lioudmila [2,3], Egels Yves [4]
1 : Université Paris 1 Panthéon Sorbonne & UMR 7041 Arscan
Université Paris 1 Panthéon Sorbonne & UMR 7041 Arscan
2 : Institut d'Archéologie de l'Académie des Sciences d'Ukraine
3 : Archéologies et Sciences de l'Antiquité (ArScAn)
Université Paris I - Panthéon-SorbonneCNRS : UMR7041Université Paris X - Paris Ouest Nanterre La DéfenseUniversité Paris 1 Panthéon-Sorbonne
Maison René Ginouvès Boîte 3 21, allée de l'université 92023 NANTERRE CEDEX
http://web.mae.u-paris10.fr/recherche/arscan.htm
4 : Institut Géographique National (IGN)
Institut Géographique National

The digital photogrammetry technique was used to obtain a 3D modeling of a palaeolithic settlement with mammoth bone huts in Gontsy (Ukraine). The processed settlement area contains three mammoth bone huts, pits, working areas and hearths. The difficulties that had to be overcome are the lack of contrast (color of the loess), the small discrimination of artefacts (repeatability of the mammoth bones) and the existence of many blind areas (overlay of the bones).

Reconstruction of a rare ornament from a sealers site on Kangaroo Island, off southern Australia

Walshe Keryn
South Australian Museum (SAM)
North Tce, Adelaide, South Australia, 5000
www.samuseum.sa.gov.au

An ornament fashioned from the pelvis of an echidna (monotreme) was found on an archaeological site on Kangaroo Island, off southern Australia. The site was used by sealers in the early 1800s, to trap and skin wallabies and other small mammals for their fur. Very little is known about the sealers who occupied Kangaroo Island at least 30 years before official colonisation of South Australia. Such an ornament has never been previously reported and is considered extremely rare and unique. In fact very few personal or domestic artefacts have been recovered from sealing activities and sealing sites. The ornament has been reconstructed by use of 3D modeling and photogrammetry in order to identify a possible style or ethic influence in the design. The ornament has also been analysed at a micro level in order to understand the method of modification and to identify the tools used in fashioning this unusual artefact.

Scaling down subjectivity in the identification of micro- wear polishes

Sinha Prakash [1], Khare Ashish [2]
1 : Department of Ancient History, Culture & Archaeology
Department of Ancient History, Culture & Archaeology University of Allahabad, Allahabad-211002
2 : Department of Electronics and Telecommunication
Department of Electronics and Telecommunication, J. K. Institute of Applied Physics & Technology University of Allahabad Allahabad- 211002

Since S. A. Semenov's functional studies on lithic tools, especially after English translation by M. W. Thomson in the year 1964 a number of attempts have been made to understand dynamics of lithic industries following micro-wear or use-wear analysis. A new dimension was added in these exercises by Keeley in the year 1974 claiming that polishes of various worked material like wood, plant, meat, bone, antler, hide, etc. may be identified under high power microscopy. But reliability on identification of worked polish is debatable. All because of no scientific language to describe characteristics of worked polishes. The polishes are not simply a product of contact with a specific material. The texture analysis results also indicate that other variables, such as edge morphology in relation to use motion, have an effect on polish development. A multi-dimensional approach has also been suggested and inferences are drawn considering the morphology of the working edges, utilization damage, the orientation of striations and the location and extent of micro-wear polishes besides characteristics of polishes.

Some scholars are working hard to infer function of stone tools on the basis of extraction and identification of organic materials from the edges of stone tools. Such studies can be helpful in identifying worked material, however with caution.
In this paper an attempt has been made to develop mathematically defined criteria to scale down subjectivity in narrating the characteristic features of worked material polishes. A number of variables have been taken into account like un-retouched, retouched, type of raw material, duration of use, number of strokes, hafting, etc. The identification and classification of characteristic features of different worked material such as wood, antler, meat, bone, hide and various types of plants has been done using Support Vector Machine in Wavelet transform domain. Wavelet domain representation of a problem enjoys the advantage of multi-resolution analysis. In the proposed method, we have computed local wavelet coefficients of different microscopic images and the automatic learning of rules, using the known images, for classification has been generated using Support Vector Machine (SVM). Finally classification of unknown images has been done using Multiclass SVM classifier. The proposed algorithm has been developed in MATLAB ver.2011B environment. We have achieved accuracy of order of 80% in classification process.
Here, we wish to present our researches on cutting bamboos and grasses and their mathematically defined identification and classification. The bamboo and grass polishes may be identified using digitalized microscopic images without using subjective description of the micro-wear analyst. It is found that this method amply reduces the subjectivity in indentifying worked polishes and may be used by other researchers without going exhausted experimentations.

Geometric Tools 3D. Modelling and processing metrical and technological data

García Puchol Oreto [1*], Juan Cabanilles Joaquim [,2], Pardo Salvador [1]
1 : Departament de Prehistòria i Arqueologia, Universitat de València
2 : Museu de Prehistòria de València
* : Corresponding author

Recent advances in 3D technologies provide an excellent routine for modelling and studying archaeological artefacts. In this paper we show the application of 3D laser scanning in a sample of Mesolithic geometric tools (Cocina Cave, Eastern Spain) in order to demonstrate as the use of this technology (a structured light scanner with a resolution of tenths of millimetre) allows obtain very accurate 3D models with numerous possibilities to analyse technological, functional, stylistic and metrical data. Cocina Cave assumed great relevance as the main reference site for the characterization of the last Mesolithic assemblages in the Western Mediterranean (geometric Mesolithic). The cave shows a large stratigraphy with several levels corresponding to the last Mesolithic, Neolithic and Bronze Age. At Cocina, geometric tools represent one of the most distinctive elements of the lithic assemblage. In fact, trapezes and triangles represent the main objective of the knapping bladelet production. This is a common character of the Mesolithic industries that, across the Western Europe, presents similar patterns in the knapping techniques and methods employed. In this presentation we will focus on the technic aspects for scanning this type of tiny objects and the resolution needed to obtain accurate models for answering questions about functional and stylistical aspects.

The use of photogrammetry recording and 3D informations for the study of woodworking and building techniques in the Western Arctic.

Méreuze Rémi [1,2]
1 : Université Paris 1, Panthéon-Sorbonne (UP1)
Pres HesamUniversité Paris I - Panthéon-Sorbonne
12 place du Panthéon - 75231 Paris Cedex 05 http://www.univ-paris1.fr/
2 : Archéologie des Amériques (ArchAm)
CNRS : UMR8096
Maison Archéologie & Ethnologie, René-Ginouvès 21, allée de l'Université, F-92023, Nanterre Cedex http://www.mae.u-paris10.fr/archam/Presentation-generale.html

This work is part of a PhD research where are explored house construction techniques and wood use in northwestern Alaska and the Mackenzie delta (Canada) between the 15th century and the period of contact with Euroamerican whalers (19th century). To understand the regionalization that occurred during the 15th century among the Thule people (the direct ancestors of the Inuit), we choose to look at their technology and especially at their building techniques since houses are changing foreplans and shapes at this time period. A detailed study of the tool marks on the architectural wood but also of the shape and dimensions of the frame elements and ways by which wood elements were reduced and layout is the approach we chose to explore the last 500 years of house building construction and address the question of this regionalization in northwestern Alaska and the Mackenzie Delta. As part of this project, we systematically record and measure tool marks and shapes in the wood remains from ancient house frames.

The frozen sites in the Arctic are ideal for this type of study, all of the organic material is exceptionally well preserved. Therefore, it becomes possibles to study the tool marks on the archaeological wood. But some issues were to be faced. Once they are excavated, the wooden remains start to decay. Also, we can't go back and forth to look at the archaeological remains which is stored at the University of Alaska in Fairbanks. Therefore, we choose to use photogrammetry to record easily the data from the house frames, accurate enough for a technological study. We also wanted to find a way of recording the tool marks in a 3D model in order to compute them as accurately as possible and to preserve the third dimension information, sometimes forgotten in technological studies.

Photogrammetric recording seemed to be the best solution to precisely record to wood use in house buildgin. We used a chain of open-sources softwares to study these informations. Python Photogrammetry Toolbox (http://www.arc-team.homelinux.com/arcteam/ppt.php) was used to create a point cloud from the pictures. Then, the mesh is cleaned and a surface is made with Meshlab (http://meshlab.sourceforge.net/). The study of tool marks involves that we compute different kind of measurements like its surface or its angle with the working plan. What seems to be the simplest idea is to use GRASS (http://grass.osgeo.org) through QGIS (http://www.qgis. org) to handle 3D informations as spatial data. Using it allows to record and compute the data related to the woodworking.

The photogrammetry recording can be used to preserve data that are hardly accessible. With a GIS software, it provides an easy and accurate way to record and handle technological informations on a volume, keeping it in three dimensions.

3D visualisation and multidisciplinary analytical techniques on CH objects from the collection of the Hungarian National Museum

T. Biró Katalin [1], Szabó Lőrinc Márk ,[2]
1 : Hungarian National Museum (HNM)
2 : Semmelweis University Faculty of Physical Sciences and Sport Sciences,

Various objects of cultural heritage from the collection of the HNM were subjected to non- destructive analysis by nuclear and imaging techniques. The main objective was to gather more information on the objects for presentation and characterisation studies. After initial trials on objects ranging from stone artefacts, pottery, metal and composite objects, ranging from Palaeolithic to Early Mediaeval, the focus of analyses concentrated on polished stone tools made of ?greenstones». These items represent in Hungary prestige objects of long-distance trade. It is imperative to preserve the objects' full integrity and at the same time gather all available information for characterisation. Analytical techniques applied comprise magnetic susceptibility (MS), prompt gamma activatrion analysis (PGAA, for bulk chemical composition), electron microprobe analysis (EMPA) and Goebel-mirror X-ray diffraction for mineral phases.3D scanning was also used to calculate volume that helped us to definfe specific density of the pieces. The software background for 3D laser scanning included NextEngine ScanStudio HD and Autodesk 3ds Max, while stereophotographic conversion was realised in Autodesk 123D, and Autodesk AutoCAD. As these objects are also elements of prestige and aesthetically very prominent items we are using digital close-range stereophotogrammetry in rendering the objects available for virtual exhibition purposes.

Laser scanning of a Second World War Finnish air raid shelter

Hakonen Aki [1], Ryynänen Harri ,[2], Okkonen Jari [1]
1 : Archaeology/University of Oulu
2 : Architecture/University of Oulu

The air raid shelters, the design called «Stone Rooster» («Kivikukko» in Finnish), were built in numerous Finnish towns during the Second World War. These beehive-shaped stone structures were meant as backup stations from which railway traffic could be controlled during wartime air raids. The poster focuses on the Stone Rooster of Oulu. In the spring of 2013 the structure was scheduled for dismantlement. Prior to this, it was fully documented by laser scanning in a joint project by the archaeology and architecture departments of the University of Oulu.
The building of Stone Rooster was completed in 1941?42. Oulu suffered heavily from wartime air bombardments. Reportedly over 700 buildings were damaged or destroyed during the Continuation War of 1941?44. Stone Rooster withstood the bombardment due to its structural composition. The outer layer was formed of a semi-spherical dome of rectangular stone boulders, which were lain leaning into each other, creating a highly resistant wall against pressure waves and shrapnel. The second layer was a packing of earthen material, which not only kept the outer stones in their place, but also absorbed incoming shockwaves. Under the earthen layer was a concrete bunker supported by steel framing. The bunker was divided into six rooms, from which railway traffic could be controlled.
The scanning took three days. Two days were spent clearing and scanning the outside surface of the structure. On the third day the interior was scanned with lower resolution, to capture the outlines of the concrete maze. Working within the dark and narrow corridors provided challenges for the team. Ultimately the conversion of the structure into a point cloud was completed with 31 different scans. The structure was dismantled shortly after the scanning. The 3D data will be further processed to provide a presentation of the monument whose corridors remained closed to the general public until its destruction.

Developing a digital Archaeological Information System in the north-central Mexican context: A case study.

Kroefges Peter, Nicolás Caretta Miguel
Universidad Autonoma de San Luis Potosi (UASLP)
San Luis Potosi
http://www.uaslp.mx/

Archaeology in the north-central Mexican context is characterized by its frontier-like nature in terms of the contrastive environmental settings and its socio-cultural processes during prehispanic and colonial contexts. Material remains and historical sources reflect a dynamic rhythm of change in occupation of Mesoamerican agriculturalists, northern hunter-gatherer groups, and later, Spanish intruders that struggled to establish and adapted their strategies to the specific living conditions in what now are the states of Aguascalientes, Querétaro, San Luis Potosí, and Zacatecas.
This administrative and political division of the study area has been among the causes for an uneven archaeological record, due to the different preservation strategies and research objectives of the corresponding Cultural Research Management agencies (CRM) on the one hand, and the academic archaeology departments on the other.
The goal of this paper is to present a proposal of an Archaeological Information System that allows integrating both CRM and academic field results produced in the field and in study cabinets across institutional and political divisions. For the case of the state of Aguascalientes, we will discuss the conceptual and technical challenges to design a computer-aided system that stores and analyzes different types of information: Georeferenced 2D and 3D data from surface survey and excavation projects, laboratory results of artifacts and ecofacts, as well as bibliographic and cartographic source materials. Finally, we demonstrate some of the technical and interpretative potentials for the archaeology of this frontier region in north-central Mexico.
Archaeological Information System, Cultural Research Management, Fieldwork techniques, fron-

tier archaeology, north-central Mexico.

Recording the inaccessible parts of the neolithic passage grave of Gavrinis

Grimaud Valentin [1*], Cassen Serge ,[2*], Lescop Laurent ,[3*]
1 : Laboratoire de recherche archéologique (LARA)
Université de Nantes
2 : Laboratoire de recherche archéologique (LARA)
Universi de Nantes
3 : Ecole nationale supérieure d'architecture de Nantes (GERSA)
Ministère de la Culture et de la Communication
* : Corresponding author

The very well-known passage grave called Gavrinis was recorded with lasers during the spring of 2011. The goal was to achieve the digitization of the architecture and the engravings. Indeed, 25 pillar stones of 30 were concerned by these stone cuttings. Two laser scanners based on different technologies were combined to reach the best accuracy possible. One was devoted to record the architecture, the second to the details. At the end, around 100 millions points were recorded in a coherent data base. It allows us to study these engravings in correlation with the relief of the stone, which produced a better understanding of all this rock art.
Nevertheless, due to different factors, all the engravings were not recorded: some were not yet discovered, some were not seen by the team working on the digitization, some parts were inaccessible to the laser scanners, or were molded and stored in an archaeological deposit.
Thus we had to figure out how to complete these missing parts with more flexible techniques than laser scanners. The easiest parts were already recorded in high definition, it remains only the hardest part to reach. The constraints like the obscurity and the narrowness of the missing parts were really strong. And at the same time, we had to consider an economic factor: it was not possible to use expensive technologies.
Since a few years, different image-based technologies have been developed, amongst them photogrammetry. A wide range of tools were tested in order to find the best one for these conditions, such as Visual SFM (from Changchang Wu), 123DCatch (from Autodesk), Hypr3D (now Cubify Capture), and Photoscan (Agisoft). But at the end remained always the same problem: how to work with non-scaled and non-oriented meshes? How to combine them with the high resolution meshes produced by laser scanners? In many cases, the engravings are too tiny to appear in the mesh.

Beyond spreadsheets: tablet automation of the artefact inventory process for eResearch

Traviglia Arianna [1*], White Stephen [1*], Wilson Andrew ,[2*]
1 : Macquarie University
Dept. Ancient History, W6A 320, 2109 Macquarie University NSW
http://mq.edu.au/
2 : University of Sydney
Menzies Centre for Health Policy, School of Public Health D02 - Coppleson Building The University of Sydney NSW
2006 Australia
* : Corresponding author

This poster will showcase the process of automated artefact inventory, further cataloguing and study applied within the «Beyond the city walls: the landscapes of Aquileia» Project. The project uses low-cost Android O/S consumer tablets to directly uploaded artefact data into an integrated database. Choosing a flexible delivery system that allows applets to capture data in a customised way enables us to adapt to real time changes in the workflow. Extended abstract Registration and cataloguing of artefacts has almost completely moved from paper to computers and with the introduction of powerful mobile devices comes the opportunity to digitally record this process in highly linked and flexible ways. This poster will showcase the process of automated artefact primary inventory, further cataloguing and study applied within «Beyond the city walls: the landscapes of Aquileia», a landscape archaeology project based in Aquileia (NE Italy) and focused of the landscape transformations occurred in the area as result of the Romanisation process. Samples artefact collection is undertaken as a routine during the field walking survey seasons and a large amount of manifold archaeological artefacts have been collected over the past 3 years of the project. To handle the cataloguing and storing of a considerable number of artefacts an efficient process was set up to minimise the time spent in primary inventory procedures and to automate them as much as possible. A fundamental aspect of the system is the decoupling of the data collection workflow from the ultimate data model. As part of the initial development, a conceptual data model was created. The res earch and inventory workflows were then identified and a data collection form created for each workflow. The workflow was then exported with the existing data model integration data onto an Android tablet as an XForm using ODK Collect (an Android ?data entry' Forms Application) to drive the data collection. Data collected in the ODK forms were then uploaded, tracked and ingested into the data model seamlessly. Choosing a flexible delivery system that allows applets to capture data in a customized way enabled us to adapt the system for a variety of data collection needs and to further extend the information gathered to support later eResearch.

Session 27

New trends in virtual reconstructions of cultural heritage

(Wednesday 23h 10h30-16h05 Pantheon S6)

Chairs : Andres Bustillo[1], Pedro Martin-Lerones[2]
1 : University of Burgos (UBU) - Spain
2 : CARTIF Research Centre (CARTIF) - Spain

Virtual reconstructions of Cultural Heritage, whether small artefacts or entire cities, are powerful tools, both for research and educational purposes, as well as for the divulgation of our past. Different techniques have been developed over recent decades to create virtual reconstructions using CAD, photogrammetry, laser scanning and photoscanning, as well as hybrid combinations of these techniques. Special effort has gone into creating low-density 3D Models that allow real time interaction with the final user. Moreover, new ways of presenting these 3D Models have been tested: Internet, 3D caves, mobile devices, etc. The target user who will interact with a 3D Model also determines the best technique for its creation, because a virtual environment aspiring to be a learning process for young students hardly requires the
same approach as a museum exhibition open to the general public. This special session will be used to gather experiences from around the world on the following topics:
Improvements in CAD techniques, photoscanning, laser scanning, and hybrid techniques to create virtual reconstructions, New ways of interacting with virtual reconstructions (Internet, games, etc) Applied experiences of virtual reconstructions of Cultural Heritage for different target populations (students, general public, etc.)

The virtual reconstruction of a small city from the Late Middle Ages: the case of Briviesca (Spain)

Alaguero Mario [1], Bustillo Andres [,2], Guinea Blanca [1], Iglesias Lena [1]
1 : University of Burgos (UBU)
Department of Historic and Geographic Sciences, University of Burgos, Spain
www.ubu.es
2 : University of Burgos (UBU)
Department of Civil Engineering, University of Burgos, Francisco de Vitoria s/n, 09006 Burgos, Spain,
Tel.: +34-947-259358, Fax: +34-901-706775 www.ubu.es

A variety of methods are employed for the virtual reconstruction of many cultural heritage items, from small objects to entire cities. However, the estimated requirements in terms of development time and human resources are often limited in these approaches. This study proposes to develop a virtual reconstruction method applicable to small historic towns that optimizes and rationalizes the use of both requirements. It is based on an estimation of modeling time that is dependent on two variables: final visual quality and the ultimate purpose of the reconstruction. In accordance with those two variables, different 3D meshes and image textures sizes are considered for standard buildings and the results are presented to the final user to obtain feedback prior to the 3D modeling stage that represents the central activity. The continuous support of experts in the architecture and the history of the Middle Ages in Spain was requested to define such details as the urban layout of the city and the structure of everyday housing and singular buildings such as places of worship and stately homes that are still easily recognizable in the city. Two different 3D modeling techniques are proposed depending on the singularity of each building and its structural elements. The problems that relate to the complexity of a large 3D project (final rendering time, etc) are surmounted by estimating final 3D mesh sizes at the start of the modelling stage. Our method also emphasizes the generation of 3D models and image textures that may be re-used in future virtual reconstructions with similar characteristics. It is applied in this study to the specific case of a virtual reconstruction of the villa of Briviesca (Spain) as it was in the XV century, with the final use of off-line rendering for the construction of a TV documentary. Finally, alternative 3D modeling solutions are discussed for different applications of the 3D model, such as on-line immersive environments.

The History All Around Us: Virtual Reconstructions of Cultural Heritage using Augmented Reality

Kee Kevin [1], Poitras Eric [,2], Compeau Tim [,3]
1 : Brock University
500 Glenridge Avenue St. Catharines, ON L2S3A1
www.brocku.ca
2 : McGill University (McGill)
555 Sherbrooke Street West, H3A 1E3 Montreal
http://www.mcgill.ca/
3 : Western University
1151 Richmond St London, ON N6A 3K7
www.uwo.ca

The desire to reveal the history all around us, to see into the past, is as old as civilization. With the development of augmented reality (AR) technology, archaeologists and historians are exploring new ways to research and communicate the past. In «The History All Around Us», the authors focus on the design, development and testing of one location-based iPhone application to examine the ways in which AR and virtual reconstructions can enrich our understanding of cultural heritage. The paper is organized in three parts. In part one, the authors draw conclusions from the design and development of two location-based heritage applications for the iPhone (see www.ihistorytours.com). These iPhone apps introduce visitors to the heritage of the villages of Queenston and Niagara-on-the-Lake, Canada (the latter of which hosts more than 2 million visitors a year). The authors reflect on the effectiveness of the design of these apps, and the development team's decision to offer visitors to these villages the choice between: i. a «Roam Mode», which

follows the user's decisions, and functions like an on-demand history tour guide (using virtual reconstructions and information to inform the user about the historical buildings and objects around him); ii. a «Quest Mode», which makes decisions for the user, drawing the user into exploring the heritage of the villages to solve a mystery. In the second part, the authors provide a preliminary report on the testing of these iPhone apps, and the authors' efforts to embed dynamic assessment mechanisms within the apps to adaptively modify the content given to the user, and improve the user's experience of the app. The authors note that while virtual heritage reconstructions and environments are now commonplace, rigorous testing for user engagement and learning with these applications is less common. The authors suggest that the design and evaluation of virtual reconstructions and environments should be driven by theories of affect, learning and instruction drawn from the discipline of educational psychology. In the third part, the authors offer conclusions about the ways in which the imminent (2014) arrival of augmented reality platforms such as Google Glass (http://www.google.com/glass/start/), and connected Google Glass cultural heritage applications such as «Field Trip» (https://play.google.com/store/ apps/details?id=com.nianticproject.scout&hl=en) will transform the ways in which archaeologists and historians develop and use virtual reconstructions of cultural heritage.

A virtual visit to promote the wide monumental sie of Chan Chan(Trujillo, Peru)

Malinverni Eva Savina [,2 1], Colosi Francesca [,3], Orazi Roberto
1 : Università Politecnica delle Marche
http://www.univpm.it/English/
2 : Università Politecnica delle Marche (UNIVPM)
P.zza Roma 22, 60121, Ancona
http://www.univpm.it
3 : CNR-ITABC
Via Salaria km. 29,30, Monterotondo, Roma

The archaeological complex of Chan Chan, inscribed in the UNESCO World Heritage List, is situated about 550 km. from Lima along the northern coast of Peru. The town was the political, administrative and cultural capital of the Chimu Empire (850-1470 AD) and represents the greatest pre-Columbian settlement built in adobe. The urban structure of Chan Chan, which is actually spread on a surface of 14 Km2, presents a number of buildings which characterize the town from an architectural point of view (ciudadelas, huacas, huachaques).
Since 2002 the Italian Mission of CNR-ITABC has been operating on the site with the main purpose to provide the conservation, documentation and valorisation of the complex opposing the architectural and territorial decay and favouring the economical and social growth supported by the development of tourism.
In order to achieve the expected results in this last decade we are provided many data by means of various types of surveying (remote sensing, GPS, photogrammetry and laser scanner) managing them into a dedicated GIS.
Due to its impressive dimensions, the tour of the whole site is actually impossible for logistic and security reasons, so the tourists cannot understand the extreme complexity and articulation of the ancient city nor perceive its uncommon vastness. Actually only a very small part of the wide archaeological area is available for an accessible and safe visit (only Tschudi Palace was restored) and a small Museum introduces the visitors to the history of the site with traditional supports (panels and a plastic 3D model) which illustrate the findings.
Many multimedia applications nowadays allow to produce a virtual visit to illustrate in « comfortable» way sites don't always reachable or to give the unique way to know closed or disappeared sites.
For these reasons in the year 2012 the Italian mission carried on a photographic survey finalized to the realization of a virtual tour of the site, making many panoramas from significant points of view. All the panoramas were georeferenced and related to the GIS database so to put them in relation with the others information useful to efficiently manage the archaeological site by local authorities. On the other hand, the localization of the panoramas on the GIS maps has allowed to prepare, with the support of the archaeologists, a virtual visit which will can to be installed

by means of efficient tools and devices (tablets or totems) in the Museum's site or to open the access to the site on web publishing on-line the tour. This multimedia solution is not a simple image virtual tour but it is enhanced adding in synthetic form some information notes about the many emergencies visible on the panorama which can illustrate in brief the different aspects of the archaeological site.

With the same procedure another project to acquire and realize the panoramic tour of the Huaca Esmeralda, one of the most representative monuments of Chan Chan, was performed and it will be add to the whole Chan Chan virtual visit project.

Representing Roman Sculptural Polychromy: Creative collaborations between digital Art and Archaeology

Beale Gareth [1], Earl Graeme [,2], Dawson Ian [,3]

1 : Centre for Digital Heritage, University of York (CDH)
Centre for Digital Heritage University of York, Heslington, York, YO10 5DD, U
http://www.york.ac.uk/digital-heritage/

2 : University of Southampton, Archaeological Computing Research Group (ACRG)
Southampton SO17 1BF
http://acrg.soton.ac.uk/

3 : Winchester School of Art (WSA)
Winchester School of Art University of Southampton Park Avenue Winchester Hampshire SO23 8DL
http://www.southampton.ac.uk/wsa

This paper describes an ongoing multi-institutional collaboration including researchers from the Archaeological Computing Research Group at the University of Southampton, The Centre for Digital Heritage at the University of York and Winchester School of Art. The project has made use of computer graphics and 3D printing in order to represent, interpret and critically engage with Roman sculpture and concepts of sculptural polychromy. The project has developed unique methodological approaches based upon interdisciplinary collaboration and the mixing of art and archaeological practice. A series of workshops and exhibitions have been run which emphasise the importance of blending of digital and traditional representational techniques. This paper will describe these methodologies and will demonstrate the role which computer graphics can play in the development of innovative and collaborative ways of working in the arts and humanities. The project was formed around a desire to explore the value of digital technologies as a means of engaging with sculpture discovered during excavations at Portus and Herculanuem in Italy. The aim of the project was to produce representations of Roman sculpture which explored uncertainties relating to the way in which statues might have been seen during the Roman period. Rather than pursuing these questions solely from an archaeological perspective it was decided to form a collaboration with a group of artists working with digital technologies, sculpture and painting. This collaboration allowed the sharing of technical expertise but it also helped to generate work with a greater theoretical complexity.

The research has made use of a variety of digital imaging technologies ranging from the capture of geometric and reflectance data through to the development of innovative representations using 3D printing as well as a variety of 2D print and screen media. This research builds upon Archaeological traditions of image making and specifically discourse relating to the negotiation and representation of uncertainty in the archaeological record. The collaborative character of this research provided unique a contribution to this discussion, incorporating concepts of practice based learning and placing an emphasis upon the use of innovative and compelling representational forms.

This paper describes the methodologies and working practices and outputs which have been pioneered as part of this digital archaeology and art collaboration. It details the challenges and opportunities of interdisciplinary working at a theoretical and practical level and recommends strategies for other researchers wishing to pursue collaborations of this type.

I

nterpreting from 3D - Comparing medieval artifacts using Computer Vision tools

De Padova Doriana
Università di Roma "La Sapienza"
Università degli Studi di Roma "La Sapienza" Piazzale Aldo Moro 5 00185 Roma
http://www.uniroma1.it/

Combining traditional techniques with advanced technological in-field tools, creates opportunities to model historical space and time providing a range of choices and a possibility to interpret an archaeological context in "real time". Combining laser scanner acquisition with computer vision techniques allows visualization and interpretation of ancient contexts and possibilities to evaluate features and spaces required by buildings for their functions. For the present project, computer vision was used to evaluate and analyse in a non-invasive way, medieval artefacts, their features, their function. Features of the stone furnishings under analysis were acquired using computer vision methodologies and processed with MeshLab. Such a tool applies filters to meshes so as to inspect small features, the real artifact shape, and to take actual measurements. This in turn permits to compare them with similar objects found in the same context. This project is aimed at analysing the remains and re-interpret the function of ancient buildings according to their fittings and the results of their analysis, both during the excavation and afterwards. From a research point of view, the possibility of an early visualization of different hypotheses on the excavation field allows a deeper comprehension of the archaeological context. Laser scanner and Computer Vision acquisitions combined with 3D models recreating the original environments help finding out where the artifacts were situated in the building and what their purposes could be. Sharing and visualizing the artifact's features using a 3D model can be easily done also thanks to tablet technologies with the aim of involving also general public in the comprehension process together with short descriptions and different metadata uses.
Keywords - Computer Vision; 3D modeling; Medieval Archaeology; Meshlab; Medieval Artifacts; Virtual Reality; Interpretation, Comparison

Living Heritage ? A collaborative production methodology of digital content for cultural heritage among technologies, languages and creativity.

De Felice Giuliano
Laboratorio di Archeologia Digitale (LAD)
www.archeologiadigitale.it

Living Heritage is a project carried out by our lab in cooperation with several enterprises specialized in digital content industry and Regional Directorate for cultural Heritage.
The project, that is now in a final stage, aims to tool up an authoring tool for the production and use of digital content for archaeology and cultural heritage communciation. This tool is oriented to carry out the realization of communication products, permitting a strong and easy integration between technologies, knowledge base and creative languages. In this way we hope we can fully support the complex cultural message hidden in archaeological knowledge and bring it to a wide audience. While some interim results of this project have been presented last October at Digital Heritage 2013 in Marseille, now we are in the closing phase and we can show the final prototype realized and the general results of the project.
The approach we used for the realization of Living Heritage is inspired to the living labs methodology, a production system based on collaborative design and creation processes. In our specific case (Living heritage is a rare case of application of this methodology to archaeology and cultural heritage) the methodology helped to create a system capable of boosting the links between knowledge and communication in the field of archaeology and cultural heritage. The tool is expressly designed to enhancing the role of the researcher and resolving some issues recurrently in the sector of digital content industry oriented to cultural heritage, where the production is normally a one-way process, which starts from the suppliers of knowledge towards communications experts to finally reach the public. The collaborative approach among all the stakeholders (ICT experts, domain experts and digital artists) permitted to overcome the lack of interaction between

the actors, that is recognizable at several levels in the production of digital content for heritage valorization:
- the technological choices are often made a priori, without assessing their actual ability to adequately convey cultural messages;
- content producers can rarely boast a deep-rooted experience in the domain of knowledge; - domain experts are only passively involved in the production process;
- finally, the public targeted by the projects of communication has no way to take their vision within the process of production but acts as a mostly passive observer.
The fully codesign approach promoted in the living labs methodology turned up to be an interesting solution to improve the overall quality of communication products in heritage sector, helping to integrate different perspectives already in the design phase, and to get a result that should be at the same time scientifically correct, and attractive, avoiding what has been called a disneyfication of cultural heritage but also the ?coldness' of a simple application of technologies.

Science and History at Fort Conger, An Interactive Website

Levy Richard, Dawson Peter*
University of Calgary (UofC)
2500 University Dr. NW Calgary, AB T2N1N4
www.ucalgary.ca
* : Corresponding author

Laser scanning is currently utilized in various areas of the world to document ancient architecture and artifacts. Our area of interest is Ft. Conger, Nunavut, one of the most remote 19th century scientific stations in the Canadian arctic. In the summer of 2010, both Z + F Imager 5006i W- Lan and Minolta Vivid 910 laser scanners were used to create an archival 3D image of the site and its artifacts (Dawson et al 2013). In this paper we will explore how this data serves as the basis for a virtual reconstruction of the 1881-1900 station. Under a grant from the Virtual Museum of Canada, a website with embedded virtual worlds will act to educate the public on the importance of this scientific expedition in North American history. Established in 1882 on Ellesmere Island, a variety of wood framed structures provided researchers and military officers and staff a permanent base from which to conduct scientific research. As one of 14 expeditions conducted during the First International Polar Year, the establishment of Ft Conger was led by First Lieutenant Adolphus Greely. As a virtual world, visitors to the website will be able to explore three themes: the science of the First International Polar Year, the science of indigenous knowledge, and the science of heritage preservation and stewardship of archaeological resources. The virtual world experience allows visitors to be transported virtually back in time to the fall of 1883, immediately after the evacuation of Ft. Conger. As a time traveler, the visitor is required to solve a series of problems to unravel the mysteries of the site. Each task is an introduction to the life and science of the period. For example, when exploring interior of the main house the visitor is required to make measurements in magnetism, calculate latitude with a 19th century sextant and identify plant specimens collected by Dr. Pavy and Lt. Greely during their stay at the station. Successfully solving each problem enables movement from one experience to the next. Upon leaving the relative safety of the living and research quarters, the visitor is required to engage in a number of tasks involving the use of Inuit technology. Upon returning to the present, the final task is to record the site as it exists in 2013, with a virtual laser scanner. Ultimately, the goals of the Fort Conger virtual world are to explore complementary ways of knowing the Arctic world by showing how Western science, Inuit Traditional Knowledge and the science of heritage presentation come together at the archaeological and historic site.

Session 28

Digitization, visualisation and interpretation of ancient sculpture

(Thursday 24th 8h30-13h Pantheon S11)

Chairs : Bernard Frischer 1, András Patay-Horváth 2, Roberto Scopigno 3
1 : Indiana University, School of Informatics- United States
2 : University Eötvös Loránd Budapest (ELTE BTK) - Hungary
3 : Visual Computing Laboratory Istituto di Scienza e Tecnologie dell'Informazione (ISTI CNR) Pisa - Italy

There are many possibilities offered by the latest technological innovations, which are variously used in different projects to document, to visualize, to reconstruct and to analyze ancient sculpture in 3D. Despite the spreading of knowledge among specialists, there are only isolated efforts in this field and there was certainly no conference or session devoted to this topic during the past decades.

The session would like to bridge the gap between classical studies / classical archaeology / history of art on the one hand and information and communications technology applied to archaeology and cultural heritage on the other: specialists from both fields are therefore invited to present their ongoing projects, problems, preliminary or final results (theoretical considerations as well as case studies) concerning innovative technologies, which are somehow related to the visualization, reconstruction and interpretation of ancient Greek, Etruscan and Roman pieces of sculpture. Case studies might include papers dealing with single statues or entire sculptural groups of any material (stone, metal, terracotta) and size (from jewellery to monumental sculpture) coming from the whole Mediterraneum. The presentation of papers concerning plastic arts of prehistoric or later (medieval, renaissance,
etc.) periods is also welcome, if they contribute to general methodological issues (e.g. analysis
of tool-marks, identification of individual master-hands or workshops). On the other hand, we would like to avoid presenting a collection of papers, which merely describe new digitization projects of some statues with standard technologies. Instead, we are mainly looking for contributions offering technological improvements (concerning e.g. the accuracy, the costs, the workflow or the pipeline) and novel computer-aided approaches to the study of the artworks, e.g. new insights concerning or the computation of shape characteristics.

The session will thus focus on different approaches and methodologies to record, to process, to store, to organize and to make use of the information (often recorded by different projects using various kinds of equipment and standards) and would like to create a platform where experiences with different hardware and software solutions, expectations and possibilities concerning the accuracy, reliability, etc. of the different tools can be exchanged.

Special emphasis will be given to the discussion about virtual reconstructions and virtual repatriation of cultural heritage objects, which now are in various museums around the world and belong to a particular site/country. The creation and usage of digital libraries and virtual museums may be discussed as well.

A Machine Learning Methodology for Interpreting and Visualizing Stylistic Clusters of Levantine Ivory Carvings of Women and their Relationships to Orientalizing Greek Ivories

Gansell Amy [1*], Zairis Sakellarios, Van De Meent Jan-Willem, Wiggins Chris
1 : St. John's University
8000 Utopia Parkway, Queens, NY 11439
* : Corresponding author

Thousands of first-millennium BCE ivory carvings have been excavated from Mesopotamian sites in Iraq and Syria, hundreds of miles from their Levantine production contexts of the Mediterranean coast and interior river valleys. At present, their specific originating workshop localities are unknown, as are the stylistic ideals that defined regional styles and workshop sub- styles. The task of inferring stylistic archetypes is complicated by the small number of well preserved objects that survive. Relying on subjective, visual methods, scholars have grappled with the sculptures' classification and regional attribution for over a century. This study combines visual approaches with machine learning techniques to offer data-driven interpretations on the classification and attribution of this Iron Age sculptures and to explore their relationship to Levantine ivories found in Greece and Greek Orientalizing ivories.
Our initial study sample consisted of 162 Levantine sculptures of female figures that have been conventionally attributed to three main regional carving traditions: «Phoenician,» «North Syrian,» «South Syrian». We developed a generative model that clusters the ivories based on a combination of descriptive and anthropometric data collected by hand-held calipers. The resulting clusters show good agreement with conventional art historical classifications, while revealing new perspectives, especially with regard to the «South Syrian» tradition. Specifically, we have determined that objects of the South Syrian tradition might be more closely related to Phoenician carvings than to North Syrian sculptures. We also identify the features that drive our cluster assignments and thus might be diagnostic of regional styles and workshop sub-styles. The clusters in our model are full probability distributions, and we take the means of these distributions to represent the stylistic centers of the objects they contain. Such probabilistic information could be used, in theory, to create visualizations of stylistic prototypes of the period, or to assist in reconstructing more complete pictures of poorly preserved sculptures. We are also developing a web application for interactively exploring the results of our model.
Illuminating regional Levantine social and mercantile networks to the east and west, the next step of this investigation will compare carving styles among Levantine ivories excavated from Mesopotamian sites and the handful of Levantine ivories found in Greek contexts. We will also attempt to distinguish design commonalities and distinctions between Levantine ivories, excavated from both Mediterranean and Mesopotamian sites, and the array of Greek Orientalizing ivories depicting female figures. Ultimately, our model could be extended to test the hypothesis that some stylistically ambiguous ivories currently classified as Levantine imports to Greece might actually have been Greek copies of Levantine originals or prototypes. In this sense, they would present a new category of «Orientalizing» sculpture.

Kopienkritik of Classical Sculpture via 3D Digital Form Comparisons: The Case of Polykleitos

Sengoku-Haga Kyoko [1*], Zhang Yujin [,2], Masuda Takeshi [,3], Ono Shintaro [,2], Oishi Takeshi [,2], Ikeuchi Katsushi [,2]
1 : Faculty of Arts and Letters, Tohoku University
27-1 Kawauchi, Aoba-ku, Sendai, 980-8576
2 : Institute of Industrial Science, The University of Tokyo
3 : National Institute of Advanced Industrial Science and Technology, Tsukuba Central 2 (AIST)
* : Corresponding author

Given that there are no extant examples of renowned Classical Greek bronze statues, their study has developed via the Kopienkritik method that examines and compares Roman copies to elu-

cidate lost originals. And yet, unaided visual comparisons are an insufficient means of understanding subtle differences between three-dimensional forms.
This paper proposes the use of modern technology to revise this traditional approach, namely, the use of 3D digital models to examine Roman copies. A 3D laser scanner, specifically a Konica-Minolta Vivid 9i scanner with an accuracy of ±50?m, was used to scan ancient Roman copies. By superimposing two of the resulting digital forms, the distance between matching points on the two forms is plotted, and then visualized in a color code. While a technically rather simple procedure, it has great meaning for archaeologists given its ability to distinguish millimeter differences and, as a result, reveal new information about ancient sculptures.
Our study focused on the renowned Doryphoros (Spear-bearer) of Polykleitos. This image stood as a «canon» of classical male imagery and was enthusiastically studied and copied by ancient sculptors, thus resulting in the survival of numerous Roman copies. We scanned four extant Roman copies in Naples and Munich: the bronze head from Villa dei Papiri, the marble herm in Naples, the marble statue from Pompei, and the marble statue in Minneapolis. In this last case we scanned a modern plaster copy instead of the ancient marble statue. The comparisons revealed that some elements of those copies are incredibly precise ? with differences of only a few millimeters between some pairs.

The iconography of the Emperor Nero: damnatio memoriae and 3D digital reconstruction

Manferdini Anna Maria
Dept. of Architecture, University of Bologna Viale del Risorgimento 2, 40136 Bologna http://www.da.unibo.it/it

The present paper presents the digital 3D reconstruction of the image of the Emperor Nero starting from the acquisition of a marble bust of the I century A.D. that was built by Bolognese inhabitants (Itay) to thank the Emperor Nero for having financed the reconstruction of their town after the fire on 53 A.D. The bust was found in Bologna in 1513 in the site of a roman theatre and lacks of limbs and head. This latter was probably intentionally removed after the death of Nero following the damnation memoriae practice reserved to who was judged as enemy of the country. Besides its cultural relevance, this bust is particularly important for its artistic value which is evident in the extremely detailed ornaments of its armor and for the likelihood of its wide drapery that is characterized by evident widespread occlusions.
These characteristics, together with the translucent surface of marble, represented a challenge in the digitization step performed using a triangulation laser scanner that was therefore selected for its ability in surveying accurate and detailed geometries, as well as for its ability in reducing noise due to the surface characteristics of marble.
This paper describes the main steps of the whole process from its careful digitization to its interpretation and reality-based reconstruction from similar iconography using a SfM approach, to the hand sculpture of missing parts by matching together fragments derived from portraiture built in different times, belonging to different finds that are collected in different museums, showing Nero's image at different ages, with different somatic and hairstyle.
The reconstruction pipeline also considers the adding of color information derived from traces of pigments that are still present on the bust and from analysis and hypothesis based on similar iconographic repertoire.
The paper highlights the main critical aspects through the whole 3D modeling pipeline, driving the attention on persistent bottlenecks in the survey phase, in the post processing one, in the management of huge amount of information. The paper shows how the use of sculptural techniques mainly developed for computer vision applications were fundamental to turn interpretations and reconstruction hypothesis into geometry.
Through the whole pipeline particular attention was paid to interoperability and to handling different geometries and file formats created using different 3D modeling tools, as well as to the possibilities to easily visualize the huge amount of restored 3D data.
While it has been understood that many faithful Roman copies were produced from classical Greek originals through the mechanical use of point-measuring instruments, this 3D digital Kopi-

enkritik method can evaluate the degree of precision in the best examples, rank the reliability of each copy, and identify characteristic torsions or imprecisions in the Roman copies that must be taken into consideration in our 3D Kopienkritik.
The paper concludes with examples of the wealth of precious information about classical sculpture to be gained through 3D comparison. The century-long and ongoing discussion about the three Amazon statues, each created by Polykleitos, Pheidias or Kresilas but never securely attributed, can finally be solved by this method. We found that the foot form of the Sciarra type Amazon closely matches that of the Diadoumenos (youth tying a fillet around his head) by Polykleitos. Conversely, the foot forms of Diadoumenos and Doryphoros did not match. While they both represent beardless youths, they differ in that the former depicts quite a young adolescent, while the latter is a well-muscled adult. This suggests that Polykleitos used the same foot models for both his female images and his images of younger males. He likely composed his female statues on the basis of his adolescent boy statues, imagery that he conceived as clearly distinguished from the «canon» of mature males.

Template Driven 3D Reconstruction of Chinese Ming and Qing Guardian Lions

Du Guoguang, Wu Zhongke*, Zhou Mingquan, Xu Pengfei, Wang Kang, Xu Chongbin, Zhou Pengbo
College of Information Science and Technology, Beijing Normal University
* : Corresponding author

Chinese Guardian lion is a kind of Chinese traditional architecture decoration that prevails in Ming and Qing Dynasty, which spreads all over China's palaces, temples, pagodas, bridges, mansion and gardens. More often, there is a pair of stone lions that placed on the left and right side of the door and are called guardian lions. Their shapes, unlike a real lion, are varied. Their unique structure was basically finalized in Qing Dynasty, and can be divided into head, face, body, legs, teeth, hips, embroidered belt, bells, spin thread, chisel bead and chisel cubs.
There are many methods for its digitalization such as the traditional laser-scanner based method and the multi-view stereo reconstruction method. The laser-scanner based method can achieve high quality but the laser-scanner is usually expensive, complicated to operate and there exists some areas that lasers can't reach. The steps of using the multi-view stereo reconstruction method are relatively convenient and what we only need to do is to take a few pictures and get the model. However, the model's resolution is limited and there exist many areas that can't be covered.
In this paper, we come up with a template driven 3D reconstruction approach. Firstly, a library of 3D lions' models is built, and semantic segmentation is implemented on it in order to get the components. Secondly, the multi-view stereo reconstruction algorithm is used to achieve the lion's 3D model whose resolution is low. Thirdly, the rough 3D model is segmented, and by comparing the components segmented with the components in the library, the best approximate components are achieved. Finally, the component in the library is edited to comply with the size of the rough model and the rough model's components will be replaced by the component models in the library. Eventually, we get a model with higher resolution. Experiments show that this method is easy to conduct and achieves models with high resolution and integrity.

Artistic personality behind the sculptures of the temple of Zeus at Olympia: new perspectives for an old question

Bencze ágnes
Péter Pázmány Catholic University, Budapest (PPKE)
Szentkirályi utca 28. 1088 Budapest
www.ppke.hu

Since their discovery in the 1880s the pediments and metopes of temple of Zeus at Olympia have been subject of continuous analysis, interpretation and discussion. In this paper I wish to present one of the most debated questions related to these documents and some new ways of analysis made possible by the technology of high-precision 3D scanning. Our focus is the definition of the artistic personality or personalities responsible for the overall project and for the execution of this sculptural decoration. During the last hundred years a countless number of contributions was made, alternately pointing out major differences of style within the ensemble and the unity of general spirit and composition of the whole. One or more, the personal style of the Olympia master (or Olympia sculptors) was also subject of conjectural connections with «regional schools » of late archaic and early classical Greek sculpture, with all the methodological risks implied by this concept. Following a brief historiographical summary of this vast debate, I wish to outline some possibilities offered by a future 3D picture documentation that can bring new light to the question, first of all concerning the unity or heterogeneity of the overall design and its general concept.

Beyond 3D Scanning: Developing a Computer Program for Matching, Retrieval and Analysis of 3D Archaeological Models

Jimenez-Badillo Diego [1*], Ruíz-Correa Salvador [,2]

1 : Instituto Nacional de Antropologia e Historia, Mexico (INAH) Seminario 8, Colonia Centro, Deleg. Cuauhtemoc, Mexico, DF CP 06060 www.inah.gob.mx

2 : Centro de Investigacion en Matematicas (CIMAT)
Jalisco s/n, Mineral de Valenciana, Guanajuato, Gto. CP 36800, Mexico
www.cimat.mx

* : Corresponding author

Thanks to recent advances in scanning technologies there has been an increase in the number of methods developed for digitizing archaeological artefacts. Many of the resulting 3D models are used for visualization or archiving purposes. Unfortunately, once a collection of 3D models is stored in a computer repository it is difficult to gain access to such data due to the lack of appropriate retrieval mechanisms. The conventional way to search for 3D models consists in composing queries based on text descriptions. However, textual annotations are necessarily constrained by the application domain of the database, as well as by language and other factors. We believe it is time to go beyond data acquisition and start developing tools to retrieve and analyze digital 3D models focusing on the specific requirements of archaeological applications. In this paper we present some results of an ongoing project focused on developing an automatic recognition system for 3D archaeological models. The computer program takes a 3D surface mesh as input (i.e. the query model). Then, the search engine compares it to hundreds or even thousands of 3D scanned objects stored in a repository identifying those that approximate the shape of the query model. The matching models are finally retrieved, ranked by degree of similarity and presented to the final user.

During the presentation we discuss the specific requirements that the recognition system must satisfy for archaeological applications.

Then we describe three main techniques implemented for shape recognition: (a) analysis of shape distributions of distance functions (Osada et al 2002); (b) reflective symmetry functions (Kazhdan. Funkhouser and Rusinkiewicz 2004); and harmonic 3D shape matching (Kazhdan, Funkhouser and Rusinkiewicz 2003).

Finally, we show the first prototype of the system and discuss its advantages as well as current limitations.

Extracting and Recognizing Words and Patterns from Wadang of Han Dynasty

Meng Yue [1*], Zhou Mingqiuan [1*], Wu Zhongke [1*], Shui Wuyang [,2*], Ren Pu [,3*], Wang Kang [,2*]

1 : Beijing Nomal University? (BNU)
No.19 XinJieKouWai Street HaiDian District,Beijing City
www.bnu.edu.cn

2 : Beijing Nomal University (BNU)
College of Information Science and Technology, Beijing Normal University, No.19, XinJieKouWai St., HaiDian District, Beijing, P.R.China.100875 http://www.bnu.edu.cn

3 : Beijing Nomal University (BNU)
College of Information Science and Technology, Beijing Normal University, No.19, XinJieKouWai St., HaiDian District, Beijing, P.R.China.100875 www.bnu.edu.cn

* : Corresponding author

Wadang is a piece of tile which plays a role of protecting wooden eaves and beautifying the roof contour in front of the ancient building roof. In Chinese history, Wadang of Han Dynasty is famous as its words (the font of Zhuan) and patterns carved on. But as time goes by, the physical characteristics of the carved words and patterns on Wadang gradually wear and tear. Therefore, digital protection for Wadang is of great urgency.

In the paper, an approach of extracting and recognizing words and patterns from Wadang is proposed. The results can help people understand the content of cultural relics quickly and popularize the significance of the ancient Chinese words and patterns. It also can help archaeologists to build a complete word corresponding system, to facilitate future research. The method includes three steps. (1) Extracting elements (includes word and pattern) from two- dimensional image. Due to 2D images often are influenced by environmental factors, the work of extraction need a series of pretreatment, using convolution operation to eliminate light, reduce noise and increase the image contrast. By calculating the image automatic threshold to binary the image to segment the Wadang element. Then extract the skeleton line of segmented result through the skeleton line extraction algorithm; (2) Recording attributes of 2D image data is not complete, and it may lose some properties, so the element extracted from 3D model is more accurate. By calculating the curvature of the 3D model, remove the points of which curvature outside a certain range and then extract the three-dimensional Wadang elements. This article will compare different curvature calculation results. Because the results that are extracted from 3D model can be mapped to two dimensional plane, it can provide image data source for the extraction of two-dimensional; (3) Carrying out word recognition. By using the extracted word skeleton line to match the refining results of standard word stock of font of Zhuan, these words on Wadang are recognized. The matching method is feature vector mathching. We divide the pixel of image in different parts and compute the number of points hit in these parts to compare with the number from other image.

This method of extraction can acquire relatively ideal results. The results basically accord with the requirement of follow-up research. The rate of recognition is satisfactory. We are the first to extract the word from Wadang and match the standard words.

Session 29

Virtual Reconstruction in Archaeology

(Thursday 24th 8h30-19h Pantheon Amphi 2A)

Chairs : Philippe Fleury[1], Robert Vergnieux[2], Sophie Madeleine[1], Bernard Frischer[3]
1 : Universite de Caen, Centre Interdisciplinaire de Réalité Virtuelle (UCBN / CIREVE)
2 : CNRS ARchéovision Bordeaux- France
3 : University of Virginia – United States

Today digital techniques offer new possibilities for reconstructing the past. For several years, the number of virtual reconstructions of archeological sites increased, especially on Internet. Nevertheless, all this pictures haven't the same level of authenticity. We would like to highlight some questions of methodology: why are we doing these reconstructions and for who? How distinguishing scientific productions from imaginary ones? When the work preliminary to the reconstruction itself is performed by a research team (we mean the analysis of ancient source materials), how giving validity to this analysis from the academic point of view? Is it possible to connect a database with the virtual environment to provide the visitor with the possibility to have a good idea of the degree of reliability of the model?

Then, this session will focus on the future of the scientific reconstructions: how the virtual model are used? It cannot exclude scientific commentary: the researcher must be in input and in output of the model. The model needs a scientific mediator but in the same time, it's interesting to provide access to the recent research to the public at large. How both aspects can run together? When we speak about the future, an important issue is the archiving of the virtual environment. There are a lot of software to reconstruct archaeological sites in virtual reality and so many digital formats. The challenge is the preservation of the digital formats. How the virtual reconstructions of archaeological sites will be accessible in the next few years?

Finally, virtual reconstruction can be enhanced by virtual reality. The advent of what we usually call virtual reality took place in the 1980s at the same time as the development of computer graphics. Two fundamental notions are associated with it: immersion and interactivity. Immersion is the operation which consists in going to the other side of the "mirror," seemingly entering into the image. The immersion is physical when an interface is used, but it can also be simply mental. Interactivity is the operation which consists in the real- time manipulation or transformation of the image. What are the interests of these technologies for virtual reconstruction in Archeology? Is it just attractive for the public at large or is there a scientific interest?

The papers of this session will have to answer to these quest ions in showing their methods, applied to their virtual reconstruction of archeological sites.

Modeling Permeable Boundaries: Reconstructing Doors and Partitions in the Casa del Menandro at Pompeii

Lauritsen Taylor [1]
1 : University of Edinburgh
Room 1M.30 School of History, Classics and Archaeology University of Edinburgh Doorway 4, Teviot Place Edinburgh, UK EH8 9AG
http://www.ed.ac.uk/schools-departments/history-classics-archaeology/classics

Since its excavation in the 1920s, the Casa del Menandro has been one of the most thoroughly studied dwellings at Pompeii. In 1933, the house was the subject of an extensive monograph by its excavator, A. Maiuri, and throughout the rest of the 20th century it regularly appeared in works dedicated to the subject of Roman domestic architecture (most recently in R. Ling's four-volume study, The Insula of the Menander at Pompeii). In many of these texts, the Casa del Menandro has been presented as the archetype of a «visually transparent» Pompeian dwelling, often referenced in an effort to highlight the centrality of sightlines and visual planes within the Roman domus. This interpretation, however, has developed almost exclusively without consideration for the presence of the permeable boundaries (doors, partitions, and other closure systems composed of perishable materials) that once appeared throughout the residence.
In 2010, the Casa del Menandro was studied as part of the Doors of Pompeii and Herculaneum Project, an architectural survey of doorways in 31 Campanian dwellings. 21 of the 28 doorways examined in this house produced diagnostic evidence for the presence of a boundary in antiquity. P. Allison's study of domestic artefacts (2007) confirmed the presence of three additional boundaries and provided further insight into the types of closure systems that appeared within each doorway. These data were utilised in conjunction with the architectural survey conducted by R. Ling (1997) to build a SketchUp model of the primary reception areas (i.e. the atrium and the peristyle). The doors and partitions that populated these spaces were included, marking the first time that permeable boundaries were incorporated in a virtual reconstruction of a Pompeian house.
In the Vesuvian cities, 3D technologies have typically been employed to record standing remains as they currently appear (using laser scanning, photogrammetry, etc.) or to create visualisations of the urban environment on a grand scale. When houses have been the subject of study, virtual models have tended to follow the well-trodden path established by the scholarly literature, representing the domus as an empty, boundless structure. As such, these reconstructions offer little assistance in analysing the ancient domestic environment. By considering the ways in which the Casa del Menandro model forces us to re-evaluate some of these long-held scholarly beliefs, this paper will argue for the inclusion of non-extant materials (doors and curtains, furniture, and other perishable and non-perishable artefacts) in the creation of future visualisations of the ancient house.

A Chamber grave of the early Migration Period reconstructed by GIS and 3D-software

Goebel Karin [1], Nowotny Jörg [2*]
1 : Foundation Schleswig-Holsteinische Landesmuseen, Schloss Gottorf, Centre for Baltic and Scandinavian Archaeology (ZBSA)
24837 Schleswig, Schlossinsel
www.zbsa.eu
2 : Foundation Schleswig-Holsteinische Landesmuseen, Schloss-Gottorf, Centre for Baltic and Scandinavian Archaeology (ZBSA)
24837 Schleswig, Schlossinsel
* : Corresponding author

In the year 2005 a backhoe operator uncovered a layer of sturdy wooden beams during construction work in Poprad-Matejove/ Slovakia. Fortunately he thought that this was a shelter of the Second World War with explosives in it and therefore he informed the authorities. It turned out that he had unearthed a well preserved chamber grave from the early Migration Period. Now the archaeologists had to cope with the task of excavating this grave with little money as fast as possible and to find a solution for the wood preservation. Luckily the department of wood preserva-

tion at the Stiftung Schleswig-Holsteinische Landesmusseen in Schleswig/ Northern Germany had idle capacity and the decision was made to transport all the wood across half of Europe. In June 2006 the excavation of the grave started and shortly before the onset of winter in November 2006 all the wooden parts together with 40 unexcavated blocks were packed on a big transporter for their long trip to Schleswig.
The grave consists of an outer chamber in block construction style (3m to 4m) and an inner chamber in a complex frame construction (2,5m to 3,6m). It was robbed and nearly all valuables were removed. However it turned out to be of big advantage for posterity that the robbers had no interest in the furniture. They tore it apart, stripped the silver fittings and left the pieces scattered all over the chamber and the entrance area together with leather strips and ornaments and remains of textiles. Afterwards they left the scene of the crime without taking their digging equipment with them.
The whole excavation documentation was converted in a Geographic Information-System and a detailed construction plan was created to ensure that every part of the grave and the furniture could finally be put together. This was a special challenge because of the damage done by the backhoe in 2005 and the previous destruction by the grave robbers more than a thousand years before. After 3D-scanning of the wooden parts of the chamber and the furniture it was possible to reconstruct them by the usage of 3ds Max.
A table with shaped foot and tabletop and a deathbed with shaped legs and fittings of yew wood belong to the amazing equipment of this chamber. Other wooden parts might belong to something like a stretcher, which was used to transport the dead to his grave. At the moment there are still some smaller blocks of the grave waiting to be excavated in a lab and then integrated into the GIS. Without the preparatory work in the GIS, the 3D reconstruction of the grave and furniture would have been much more difficult or even not possible within 3dsMax.

Visualizing, Modeling and Animating Ancient Cities and Their Environmental Surroundings By Using Real-Time Render Engines: A Case Study For The Antakya(Antioch) City

Kaplan Kayhan[1,2]
1 : Gedik University
2 : Istanbul Gedik University
Istanbul

This study aims at revitalizing the history, culture and social life of ancient cities with their environmental factors through computer-aided 3 dimensional (3-D) images. This study will be a tool to visualize ancient cities whose historical remaining did not remain intact and existence is known by books, maps, pictures, and inscriptions.
In this study, as a result of historical investigations, and comparative analyses of similar examples; objects or structures subjected to changes over eras, partly damaged or lost were visualized by producing models reflecting their historical condition from their initial design process. Images obtained were converted to animations with the addition of motion, sound, light, and related effects. In addition to animations, a different technique was implemented in this study concerning Antakya: the space having being modeled was installed in a Play engine to obtain simultaneous images.
Though eventually impossible to bring together the pieces with these images, these kinds of computer-aided visualizations and reassembling studies helped to better explain original design of an artwork, review its historical development and understand its remaining.
In this study, additional architectural studies were conducted in light of scientific and technological datasets, as well: modeled cities were presented with their historical settings, costumes and fitting elements, narrative animation, and emotional visual effects.
Findings obtained from the research were the ones with rich visual contents. Images will be mainly used in the three domains of presentation, research and education.

Contending with diversity in the Eighteenth-Century: Reconstructing an authentic experience through the application and presentation of varying levels of data within a virtual environment.

Inker Peter*
The Colonial Williamsburg Foundation P.O.Box 1776, Williamsburg, Virginia 23187 http://research.history.org/Digital_History_Center.cfm
* : Corresponding author

Archaeology collects many diverse sets of data, often at differing resolutions. These datasets are not always immediately compatible, or easily accessible to the public in cultural heritage settings. There seems to be an inherent dichotomy between our ability to contend with incomplete and diverse sets of data, while at the same time reproducing an authentic reconstruction of the past. It is now common to find virtual reconstruction embedded in cultural heritage settings, and this allows us a new way to examine and present this diversity of data.

A significant quantity of archaeological excavation, along with historical and architectural research, has taken place in Williamsburg during the past 80 years. The results of this investigation have provided us with a wide-range of diverse datasets. These data are also at varying resolutions, from the micro scale (artifact fragments) to the macro scale (environmental and topographical evidence). As part of the Virtual Williamsburg project, these diverse sets of data have been collated into a broad structure, allowing an understanding of past environments through contextualized reconstruction. The results have been modeled virtually, capturing the varying levels of resolution from the wide-scale topographic level, down to the level of the individual artifact. The result is Virtual Williamsburg, a digital reconstruction that captures the series of rich and extensive archaeological datasets in a series of dynamic pedagogical models. Not only does this provide the general public with an accessible way of understanding the data, it ultimately also presents the current state of archaeological research in Williamsburg through a virtual interface.

The paper focuses on the immersive environment Virtual Williamsburg, illustrating the methodology used in handling diverse data, creating authenticity, and openness in reconstruction. It presents the audience with the potential for the presentation of varying levels of archaeological data through authentic digital reconstructions in an accessible and queryable environment.

Potentialities of 3D reconstruction in Maritime Archaeology

Costa Elisa, Beltrame Carlo
Ca'Foscari University of Venice

3D reconstruction allows to highlight, better respect a bidimensional drawing, the position of shipwreck cargo or wooden hull; at the same time, it offers a good picture with great appeal for community, that, with this kind of perspective, can better appreciate the archaeological evidences. Despite the fact that this peculiarity is undeniable, we don't have to consider 3D drawing only as a documentation designed for general public, but we have to evaluate the innovative potentiality of this methodology for technical archaeology and survey.

During excavation and documentation of a site many causes affect the choice of a kind of technical documentation or another, since they influence the timetable of investigation: features of the evidences, seabed property and the depth of the shipwreck.

In this paper we describe three different research projects lead by the Dipartimento di Studi Umanistici of Ca' Foscari University of Venice; those allow us to meditate on different technologies utilizable on heterogeneous finds for misure and tipology, in order to obtain informations to realize tridimensional drawings.

In those case studies, 3D reconstruction is the final step of three different documentations: tridimensional photogrammetry, map and section drawings and DSM, Direct Survey Method, a tridimensional trilateration that convert direct measurements in points with x, y, z coordinates. First example is a render 3D as a result of tridimensional photogrammetry and it is conducted on an amphoras cargo from a Byzantine ship sank at Capo Stoba, along the coast of the island of Mljet, in Croatia, during X-XI century A.D.

Second reconstruction, instead, came from bidimensional map and section drawings. 3D model represents, from various perspectives, a portion of wooden hull of a Venetian ship, sank at San

Paolo, Mljet island, at the end of XVI century A.D.
Last kind of technical documentation used for the realization of 3D model is based on DSM, Direct Survey Method, applied on a marble cargo of Punta Scifo D wreck, dated to III century A.D., discovered along the coast of Isola di Capo Rizzuto, in Calabria, in the South of Italy. This research is important and useful also for engineering study on nautical property and for investigate on size and shape of the boat.
Considering set of problems about the excavation of these different kind of shipwreck, as the depth, the necessity of protecting the wood covering by sand to recreate anaerobic conditions and evaluating that archaeology is intended as a destructive operation, we finally achieved that tridimensional reconstruction is the most complete documentation that can be realized, because it allows to optimize time and work during the excavation, to obtain more complete data than bidimensional documentation, and, furthermore, it offers new prospects for research and study in the final stage of the post-excavation work.

Virtually reassembling Angkor-style Khmer temples

Schaefer Anja, Leitte Heike, Bock Hans Georg
Interdisciplinary Center for Scienti?c Computing (IWR) IWR, Im Neuenheimer Feld 368, 69120 Heidelberg http://www.iwr.uni-heidelberg.de/

Most Cambodian temples, especially those in remote places, are nowadays suffering from severe damages like collapsing structures. Manual reassembly of fallen temple structures is very tedious: An archaeologist is usually confronted with a cluttered heap of stones, whose original position is mostly unkown. Currently, this kind of large-scale puzzle is solved by a team of experts who analyze each stone, based on their experience and knowledge about Khmer culture. Possible solutions are cross-checked by hand and, if considered to be correct, cranes are used to put the stones in place. This method has major drawbacks though: First, it accelerates the decay of stones even further. Second, the workers are at risk due to the huge weight of each stone. This motivated the development of a virtual approach to support the reassembly, as computer algorithms find a potential solution in less time, thereby minimizing the amount of manual work for carrying the stones. Furthermore our approach has the potential of decreasing costs of in-situ analysis.
Our contribution is a virtual puzzle algorithm for faster reassembly work. Its basis are high- resolution 3D models of more than hundred separate stones, gained by our close-range structured- light 3D-scanner during field work in Banteay Chhmar, Cambodia. Although the stones are partially deteriorated or feature broken arts, they can be viewed as polytopes with a roughly cuboid form, often with additional notches. Exploiting this geometric feature and using prior knowledge about the orientation of each stone leads to a fast matching test, which enables the exclusion of impossible stone configurations. The general idea is to i) simplify the high-resolution models to wireframe models, described only by their corners, edges and side-surfaces, ii) apply mathematical and statistical tests to evaluate the matching quality of each pair of stones and iii) find best fitting stone configurations and evaluate these suggestions. Altogether we use different existing techniques and modify them to be used in the field of cultural heritage.
The simplification step is necessary in order to be able to quickly match potential side-surfaces. In addition the reduced wireframe model is used to segment the high-resolution data according to each side-surface.
The second step consists of a similarity analysis, where we combine several techniques, namely the iterative closest point algorithm, the Hausdorff distance, and statistical analysis, in order to determine wether a potential match is correct. Most of the stones feature a bas-relief, which is also taken into account for the similarity analysis and improves the quality of potential matches. In case a stone does not have a bas-relief, we rely on a combination of geometrical and statistical analysis of the side-surface matches.
In the last step we use graph theory and combinatorial analysis in order to combine the similarity values into a correct solution of this large-scale 3D puzzle. To ensure algorithmic correctness in all steps of the reassembly pipeline we collaborate closely with expert users.
In this work we will focus on the second part and present our similarity analysis using examples from the Banteay Chhmar data set.

Cultural Heritage documentation in cave environnement using low-cost means for archaeologists. Case study of the Larchant cave in the Fontainebleau forest in France

Lureau Aurelia [1], Belarbi Mehdi [,2*], Raymond Pascal [,2*], Touquet Régis [,2*]
1 : Université Paris1 Panthéon-Sorbonne
Université Paris I - Panthéon-Sorbonne
2 : Institut National de Recherches Archéologiques Préventives (INRAP)
INRAP
http://www.inrap.fr
* : Corresponding author

The “painting cave” of Larchant is located on the ovest edge of the stoneware plateau of the Fontainebleau forest which gives to the forest its peculiar aspect. The cave was discovered in 1959, partially excavated, then excavated in the ‘80s and various numerous artifacts were discovered. The datation is from Mesolithic to the Middle-age, with a permanent dwelling since 8.000B.C.

But what makes this cave unique compared to the other prehistoric caves of this part of the Fontainebleau forest is that there is a prehistoric painting and also numerous engravings dated from the beginning of the human presence to the modern era.

The project was proposed to us with two objectives : to catalog the engravings in 3D, and, if possible, to have 3D models precise enough to be able to use them in scientific ways. The long-term goal of the project is to realise a GIS of the prehistoric caves of the Fontainebleau forest for a public use via mobile app and a website. But our goal was to try and have precise enough 3dD models for the scientific interpretation of the archaeologists. We only had reflex and bridge cameras and a theodolite, but we attempted the whole 3D model of the cave to create a map for the engravings and the painting, and then tried to georeferenciate all the models and do measurments on the engravings.

Underwater Multi-Image Photogrammetry and Reconstruction

Mccarthy John [1], Benjamin Jonathan [,2*]
1 : Wessex Archaeology (WA)
7/9 North St David Street, Edinburgh EH2 1AW
wessexarch.co.uk
2 : Flinders University
GPO Box 2100, Adelaide, SA 5001
flinders.edu.au
* : Corresponding author

We present results of multi-image photogrammetry for archaeological survey, analysis and dissemination in underwater environments. Survey case studies include a submerged Ertebølle Mesolithic site in Denmark and a newly discovered 17th century wreck off the northwest coast of Scotland. The high resolution of the survey data is then used as the basis for analytical techniques and data-driven 3D reconstructions. These techniques have an enormous potential to disseminate underwater heritage to the wider community in ways which were previously impossible. The marine environment makes accurate recording using traditional archaeological techniques very difficult. The potential value of photogrammetry for this particular problem has been recognised since the 1960s. However the technique has proved difficult and expensive and until recently has produced only a relatively small number of selected measurements. Recent advances, particularly within the last five years, have made photogrammetry a much easier and cheaper way to produce high resolution 3D models of entire submerged archaeological features and sites. These developments have principally been in digital photography, computer processing power and the development of software capable of automating many of the most time-consuming and technically challenging aspects of traditional stereo photogrammetry. The application of the technology has had a major impact on terrestrial and aerial survey but nowhere is its influence more important than in the underwater environment. This is because many comparable techniques such as EDM survey, laser scanning and LiDAR are of very limited use to underwater archaeologists. Survey time in underwater environments is also very limited and the speed with

which photogrammetric data can be captured makes this a very powerful tool. Photogrammetric survey in an underwater environment brings its own challenges, relating to low light, moving elements and poor visibility. We will demonstrate how these have been overcome, allowing survey of a similar standard to that achievable in a terrestrial context in each of the case studies presented. We also argue that the technique results in a more accurate and objective record of the underwater cultural heritage at a small scale than is currently possible using other techniques, including sonar survey.
Capture of continuous high resolution surfaces rather than selected points can open up new avenues of analysis and dissemination and result in faster, cheaper and more accurate and objective surveys of underwater archaeological sites. We showcase the use of data-driven reconstructions of underwater archaeological features and highlight how accurate capture of surfaces can be an important aid to analysis. These reconstructions can also be disseminated through various video and interactive formats to allow those who cannot experience the underwater heritage directly to have a better understanding of the site. Examples of dissemintion to local communities living alongside the wreck sites are highlighted. Importantly we will also discuss how these dense site models can added to permanent digital archives.

Reviving a Roman Villa in the Bay of Stari Trogir, Central Dalmatia

Lužnik Nika
University of Ljubljana (SLOVENIA), Faculty of Arts, Department of Archaeology Univerza v Ljubljani Filozofska fakulteta Oddelek za arheologijo A?ker?eva 2 P.P. 580 SI-1000 Ljubljana Slovenija http://arheologija.ff.uni-lj.si/si_index.html

This particular project focuses on a computer visualisation of a maritime villa in the bay of Stari Trogir in the Central Dalmatia. The relatively well preserved standing remains of the villa itself are constantly under process of destruction since they're exposed to construction works of local residents trying to improve the functionality of the coast. The remains were documented in the year 2004 by the Department of Archaeology , Faculty of Arts, University of Ljubljana, Slovenia. The intruiging part in the process of the computer 3d visualisation is that documenting was primarily not intended for computer visualisation and therefore presents a fair test how more or less traditional ways of documenting can be used for this purpouse. Of special interest are also the remains itself as they include a peculiar semi-circular structure, which function is not especially understood and presenting it in a virtually rebuilt environment can serve as an efficient way of testing out different theories of its former appereance. Combined with the conclusions of older reports of the site and analogies first interpretations of the remains were made. In this context presenting the visualisation to a wider audience, a larger pool of knowledge, for example on the CAA conference, might give rise to new ideas about its use as a part of the feedback. Equally important is also the feedback on the whole visualisation construction and presentation. Further following basic priciples of charters like Ename Charter, London Charter and Principles of Seville and as the local people are nontheless interested in the historical remains in their vicinity the plan is to properly present the made interpretations, preferably more than one, in the near future in order to tell a story about their place of living. This should encourage an emotional connection between the residents and the remains and induce respect and love towards the history of place and the desire to preserve and protect our cultural heritage.
The work on this project is a result of the work on the European project CONPRA, which focuses on the challenges in the development driven archaeology and on my own PhD work, which is focusing on information and communication potential of computer aided visualisations of archaeological structures and is also partially financed by the European Union (Inovativna shema za spodbujanje sodelovanja z gospodarstvom in re?evanja aktualnih dru?benih izzivov).

Correspondence based repair method of Terracotta Warriors and Horses

Kang Wang*, Wu Zhongke,*, Xu Pengfei, Jia Taoriu, Du Guoguang
College of Information Science and Technology, Beijing Normal University
* : Corresponding author

Qin Shihuang Terracotta Warriors and Horses is World Heritage. Each of Terracotta Warriors and Horses has different shapes and different postures. However, due to historical reasons a large number of the unearthed warriors are broken, and the manual repair method may cause damage to these original cultural relics. Therefore, computer virtual technology is used for virtually matching the excavated fragments in order to restore the original shape of the entire terracotta. In this paper, a novel correspondence based approach is proposed to restore Warriors and Horses from fragments. Firstly, a preprocess procedure is employed to Terracotta Warriors and Horses fragments achieved by 3d laser scanner by using Laplacian smoothing method to remove the noise. Then, a template based matching method is put forward to match fragments with a complete Terracotta Warriors using three-dimensional shape-based correspondence method. To reduce the time complexity of the correspondence method, we consider only the feature points on the model surface. Here we define the surface descriptors on the template and the fragments by local information at the feature points, and achieve the coarse correspondence from the comparison of the similarity of descriptors. In order to obtain reliable matching results, we apply the global optimization to the result of the coarse correspondence so that each fragment can be precisely matched to each other. The precise correspondence process is based on the multi-scale descriptor comparison to get the best rigid transformations avoid intersected parts. Thirdly, to further eliminate the missing part caused by the erosion and other reasons, we also propose a mending method to the optimized results by the reference of template. This is the first time to apply correspondence methods to the Terracotta Warriors and Horses restoration. And through the experiments on real broken data of warriors, we verify the entire method and the results show that our method achieves good robustness and effectiveness.

An Integrated Approach to Procedural Modeling for Archaeology

Saldana Marie
UCLA Dept of Architecture and Urban Design
www.aud.ucla.edu

This paper presents a suite of procedural rules for creating 3D models of Roman and Hellenistic architecture and urban environments. The use of procedural modeling is intended to address a number of concerns related to 3D archaeological reconstructions. An important advantage of procedural methodology is that it allows for the rapid prototyping and interactive updating of 3D content. The use of attributes and parameters enables scholars to visualize change over time and gauge the impact of various factors on the built environment. Furthermore, these attributes and parameters can be tracked and harnessed as valuable geospatial data through the use of GIS software and of interactive visual displays. Of particular interest for archaeologists is the ability to test hypothetical reconstructions of ancient architecture in a fully realized urban context. The procedural rules[1] link each iteration of a model to its source material, allowing the degree of certainty present in each model to be accurately defined through the documentation of each step in the process of interpreting a given data set. Procedural modeling thus enhances the scholarly value of architectural reconstructions by providing a platform for the comparison and refutation of 3D visualizations. Contrary to traditional 3D modeling methods[2], which merely simulate the form of a building, procedural modeling forces the investigator to approach visual and 3D content through a rigorously syntactic and process-oriented framework. This framework preserves the hierarchy of decisions that result in a given visual interpretation of archaeological evidence. Models thus produced are extremely information-rich and the ways in which they can be used to aid research are just beginning to be explored.
Using the procedural software ESRI CityEngine, I created a suite of procedural rules for the main typologies of classical architecture. My work on a master rule for classical temples exemplifies this project. The temple rule was designed to produce a schematic model of any kind of classical

temple with a minimal number of parameters. The rules were based on sources such as actual archaeological remains in Italy and Asia Minor as well as Vitruvian templates. The rules are designed to be fully modular, that is, the rule for a specific typology collates several sub- rules, which can be re-used and combined as necessary. Urban models are then generated from geodatabases imported from GIS software ArcMap. These geodatabases contain the footprint of the building, along with specific attributes necessary to create the model (such as column diameter, order, and building type), and the bibliographic citations that reference the source material from which the attribute data was derived. All of this textual material may be queried in the final visualization of the model. To date, the suite of procedural rules includes a core set of typologies including temples, altars, basilicas, houses, shops, streets, triumphal arches, arcades, colonnaded streets, stoas, theaters, and stadiums.
[1] ?Rules' in procedural modeling refer to the code that generates a given model. [2] For example, softwares such as Sketchup and 3D Studio Max

The role of digital modelling in the reconstruction of old wall decorations: a critical review

Carlevaris Laura
Sapienza, Università di Roma (DiSDRA) piazza Borghese, 9, 00186 Rome http://www.dsdra.it/drupaluni/

This proposal focuses on the methods used to study and communicate the scope of wall decorations, above all architectural perspective images in Roman wall paintings and the techniques used to create them.
The paper concentrates on the three-dimensional model and how effective it is in a scientific approach to these decorations; the intent is to verify whether the graphic and expressive properties of digital modelling help convey the spatial qualities of these works.
After the Renaissance and the theorisation of linear perspective, the use of pictorial illusion to dilate real space played a unique role in transmitting social and political ideas, successfully conveyed by perspective technique. We are aware of this development thanks to an increasing number of studies and publications on works produced from the fifteenth century onwards. Based on this information, we can ask ourselves: can the same be said for ancient wall decorations or were they produced for some other reason?
These observations include the study methods applied to so-called illusionistic “sfondato” ante litteram. In fact, 3D digital reconstructions were used to investigate large illusionistic wall paintings (quadratura) and successfully emphasise the link between real space and the space created through illusion; this was achieved by recreating the painted architecture and the real architecture by using similar representation methods. The question is whether this procedure is scientifically correct, and whether it can be successfully applied to ancient art; in fact, up to now no-one has successfully proved the illusory intent of ancient art.
Was unity between real and imaginary space the intent of the artists and their clients, or did illusion become part of art only much later when people became aware that art could recreate space by using perspective?
Renaissance and Baroque quadratura is based on a classified and sedimented perspective theory, while the debate still rages about whether or not the ancients were familiar with perspective models based on well-known, common rules or procedures. The possibility to spatially place the pictorial elements beyond the wall is closely related to the accuracy of the perspective construction; this accuracy in ancient art has not been cited either in contemporary literature or by hands-on study of any works. Can we forget «inaccuracies» or «incongruences» of the perspective model used to reconstruct imaginary space, or are we being unjustifiably aggressive towards the creators of these illusions? Above all, can the digital tool to model places which do not exist actually provide new interpretative ideas, or do they ?focus-freeze' our knowledge on stereotypes based on theories yet to be defined?
This paper proposes a critical review of the role played by digital tools in the reconstruction of ancient wall decorations. Performed to provide further interpretations of ancient space, these tools often eclipse the meaning of the role of pictorial decorations in archaeological contexts. Several examples of reconstructed illusory space, as well as the «querelle» regarding whether

or not ancient perspective constructions actually existed, will be used as the basis for this radical revision of the approach to the issue.

Forum romanum: a 3D model for educational purposes in self-service

Fleury Philippe*, Madeleine Sophie,*
Universite de Caen, Centre Interdisciplinaire de Réalité Virtuelle (UCBN / CIREVE)
Université de Caen Basse-Normandie
Université de Caen Basse-Normandie Centre Interdisciplinaire de Réalité Virtuelle (CIREVE) MRSH - Bur. SH 209
Esplanade de la Paix CS 14032 14032 Caen cedex 5 http://www.unicaen.fr/rome
* : Corresponding author

The CIREVE (Centre Interdisciplinaire de Réalité Virtuelle) of the University of Caen Basse- Normandie (France) has developed an experimental self-service model for educational purposes. It is an interactive 3D model of the forum romanum (extracted from the reconstruction of the entire city of ancient Rome), intended for museums, schools, and universities..., with an educational documentation about each building. This paper will explain the context of the experimentation: the reconstruction of the entire city of Rome as it was in the 4th century A.D with scientific and educational purposes. This reconstruction is performed in a research team with scientific methods. Behind the virtual model, there is a permanent possible access to a database with ancient texts, didactic videos, 2D pictures and a bibliography. The used software are 3DSMax for modelling and CryEngine for the interactivity. The aim of the experimentation: it is to provide to educational actors an interactive tool to discover different aspects of classical Antiquity. The interactive model must be used in self-service, i.e. without a scientific mediator. A scientific mediator can be essential for the knowledge transmission, but, in some cases, he cannot attended. The interactive model must then transmit knowledge itself. Constraints of an interactive model in self-service. An interactive model, at the service of the public at large, is different from an interactive model used by a researcher for scientific purposes or from a model used by a scientific mediator. Firstly, it must be fitted with an easily accessible documentation (which replaces the speaking of the scientific mediator). In the experimental model of the CIREVE, there are two types of documentation: an automatic documentation which appears when the user is approaching a building and a documentation «on the request» (similar to the use of a guidebook). Secondly, it must be conceived so that the user can not be lost in streets, in public buildings, in dwellings... Virtual gates must be placed in the virtual model as the barrier in a real site. In 3DStudio, that is «collisions». Third, the software must be protected by the law to not be twisted and in order to respect intellectual property.

25 Years of Experience in Virtual Reconstructions - Research Projects, Status Quo of Current Research and Visions for the Future

Pfarr-Harfst Mieke
Department Information and Communication Technologie in Architecture, Technical University of Darmstadt (FG IKA, TUD)
El-Lissitzky-Str. 1 64287 Darmstadt http://www.ika.architektur.tu-darmstadt.de/ika/start_ika/ informations_und_kommunikationstechnologie_in_der_architektur.de.jsp

More than 20 years of research in the area of virtual reconstruction at the Department of Information and Communication Technology in Architecture at the TU Darmstadt have produced virtual reconstructions in a wide variety of no longer existent buildings and settlement structures. Among them are the imperial tombs of Xi'an, Dresden Castle, the Crystal Palace, the layout of the monastery at St. Gall, Ephesos and currently the cathedral in Florence.

In all research projects the emphasis is on the scholarly validity of the ultimate results. This precondition influences the operational methodology as well as the insightful dealing with available source materials. A constant discourse with leading scholars plays a major role in the reconstruction process. Thus virtual reconstructions are always designed as international and interdisciplinary research projects; their sustainability is guaranteed through publication at various platforms. Additionally, 15 years of such research projects have been incorporated into university level research in order to introduce students to historical architectural research using digital media and also to scholarly work within an international and interdisciplinary framework.

This presentation is a retrospective of previous projects, their conceptual content, methodology and results as well as a critical examination of future challenges in this area. The status quo of virtual reconstructions for imparting knowledge and research as such will be delineated. Selected international research projects will be presented and the challenges as well as the resulting solutions will be delineated. In doing so, uncertainties in model, changes during the reproduction process and the given background will be taken into consideration. The influence on the final result of current scholarly discourse during the reconstruction project will be illuminated. The generation of new knowledge gained by means of the digital model will also be examined. 25 years of experience in virtual reconstructions will maintain its position in the current context of scholarly discussion. On the basis of the potentials of virtual three-dimensional models, these virtual scientific models will be carefully examined as a research tool in the area of cultural heritage, as well as in the generation of new knowledge by means of digital models.
These models offer opportunities combined with great challenges for the research community. These include fusion, generation, preservation and transmission of knowledge, each of which will be individually discussed.
Based on the findings and experience of the past twenty years, combined with questions arising from current discussion, it is the intention of this talk to give a generalised theoretical view of virtual reconstructions in the past and future and thus contribute to the development of a sustainable concept for the future.

3D Documentation and 3D Reconstruction of tombs from Valle del Sarno necropolis (SA, Italy)

Gianolio Simone [1], Genovese Guglielmo [2*], Mermati Francesca [3]
1 : ArcheoDigital Srls
http://www.archeodigital.it
2 : "La Sapienza" University of Rome
3 : University of Naples "Federico II"
* : Corresponding author

Starting at the last quarter of 2013, the ARESlab of «La Sapienza» University of Rome launch the Sarno Archeological project, concerning the documentation, study and reconstruction of local necropolis. This paper aim to describe the pipeline to use the digital technologies to help the Archaeology to understand ancient contexts, with use of 3D documentation and virtual reconstruction of ancient ritual. The goal of project is to create a platform over these data are loaded to share with scholar for scientific purposes and with people for valorizing the Cultural Heritage. From 3D documentation to 3D visualization the work followed several steps: 3D acquisition of vessel and other archaeological finds through dense photogrammetry pipeline (Agisoft Photoscan; Arc3D; Meshlab; PhotoCloud; other 3D-Coform tools); analysis of 3D model; 3D reconstruction and modelling of the fragmented vessel; 3D reconstruction and modelling of the tombs; webgl rendering for 3D visualization (X3D); photographic acquisition for 360° object; datasheets for advanced authoring of X3D. All the information are stored and linked in a WebGIS developed for this project drawn for scientific purposes. The lab focuses its interest in open source software if available for its achievement: for WebGIS we use the GeoServer as web mapping software and other open source tool as geospatial libraries and metadata catalogs from OSGEO community. Inside this, an interface show the basic information of archaeological find, with a link to external main resource, stored on appropriate website with responsive template, that contain the complete datasheet of every find (with historical information, photographs, sketch, etc.), the link to X3D model, the link to tomb reconstructed in Unity 3D format. At this stage, the job state provides a geolocalization of some contexts of tombs, a series of selected pieces digitized in 3D and photographed, with its archaeological datasheet, the project's website. At the end of the project, the model will share in the Europeana library for virtual exhibitions in 3D-PDF format. In addition, an interactive virtual exhibition is programmed with these models.

econstructing Koroneia: a procedural modelling approach applied to an ancient Greek city

Piccoli Chiara
Leiden University
http://leidenuniv.nl/

Virtual reconstructions have been largely used at the end of the archaeological research as a catchy means of presentation when the study and interpretation of the data are already completed. In this way, however, virtual reconstructions are excluded from the cycle of knowledge generation and struggle to be seen by the academic community as tools that could assist in the research process. The focus of this paper is the ongoing creation of a GIS-based 3D reconstruction of the Classical-Hellenistic phase of the ancient city of Koroneia (Greece), which is currently under investigation using non destructive methods. The creation of this 3D visualization aims to organize the heterogeneous and interdisciplinary data and to support the decision making during fieldwork, by providing a platform where several reconstruction hypotheses on the city's layout can be tested. This project will serve as example of how 3D visualization can be used not just as a visual presentation means, but also as a tool for considering the archaeological evidence in a holistic way, for triggering new research questions and testing alternative hypotheses.

For the creation of Koroneia's 3D reconstruction a procedural modelling approach based on Esri CityEngine is used. This software, borrowed from urban planning and geo-design, has been adapted to the needs of an archaeological urban survey. The procedural modelling approach allows the creation of the 3D environment by importing GIS-based data and by writing rule files that describe the 3D geometry in a parametric way. The advantage of adopting this GIS-based procedural modelling approach is that it results in an efficient workflow, both for storing GIS- based data and for quickly updating the 3D visualization, such that it best represents the data from the ongoing survey. This methodology allows therefore a constant 'discourse' between data and 3D reconstruction. The latter is in fact used to visualize and test different reconstruction hypotheses to be checked against the survey's result. Also, from a more technical point of view, this approach makes it possible to parametrically define different levels of detail, thus allowing to export 3D visualizations suited for both detailed renderings and online interaction.

In addition to presenting the methodology for Koroneia's 3D visualization, this paper will offer a more conceptual discussion on the role of virtual reconstructions in archaeology based on the ongoing experience with the Koroneia's case study. Attention is given to the intellectual transparency of such reconstructions, which is a crucial topic when dealing with a fragmentary archaeological evidence. Intellectual transparency can be increased by adopting the methodology here presented, e.g. the rule file records each step of the creation of the 3D models, thus allowing future inspection of the modelling process. In addition, it is possible to include variations in the rule file to generate multiple 3D models, thus visualizing the level of uncertainty of the reconstruction. These elements are essential both to allow the assessment of its scholarly value by the research community, and for a deeper understanding and a more conscious fruition by the public.

R1 What do you want from Digital Archaeology

(Friday 25th 14h-16h45 Pantheon S2)

Chairs : Jeremy Huggett[1], Gary Lock[2] , Paul Reilly[3],

1 : University of Glasgow

2 : University of Oxford

3 : University of Southampton

In a time of financial crisis and disciplinary anxiety, when impact and value are demanded, subjects – and humanities subjects in particular – are searching for relevance. In a keynote at CAA 2012, Huggett argued that archaeological computing needed to seek grand challenges if it was to continue to transform the practice of archaeology and contribute to the development of theories and methods. The immediate challenge is for archaeological computing to confront the task of constructing and pursuing grand challenges in the first place, and this round table discussion is intended to be a first step in this direction.

What are these grand challenges? A range of different criteria can be defined but they have in common some general characteristics. They should focus on the needs and values of archaeology, but at the same time be of interest and relevance to other disciplines, organisations, and the general public. They should have transformative potential, creating something that is novel and innovative, pushing boundaries and going beyond what is currently possible. They should be international and interdisciplinary in scope, involving the whole community rather than just the academic sector. Although challenges should be capable of being implemented, at least insofar as they can be broken down into intermediate benefits and goals, success is not measured solely in terms of the final outcome but in relation to what is learned as a consequence of making the journey. And, at the risk of stating the obvious, they should be difficult to achieve and represent a considerable degree of effort.

Such criteria set grand challenges apart from what might be characterised as a ‘typical’ research project. What may be adequate and sufficient for a research project will not necessarily constitute a grand challenge. For instance, archaeologists will frequently use concepts, techniques and technologies borrowed from another discipline, but such an approach would not be enough for a grand challenge unless it is significantly offset by meeting other criteria. A grand challenge may not need to meet all the defining criteria: the extent to which it does or does not remains a matter for debate. It does mean, however, that grand challenges cannot simply be ‘more of the same’ – they need to go beyond relatively straightforward applications of existing software, beyond areas such as resource discovery and finding aids, beyond applying what may be relatively commonplace in other disciplines, etc. and generate genuinely novel approaches and methodologies that may also find application beyond archaeology. Most challengingly, they should represent a radical paradigm shift and hence unlikely to be met from evolutionary professional/commercial development.

In an environment increasingly characterised in terms of ‘big data’, cloud processing, crowd sourcing, social media, intelligent computing, etc., this roundtable seeks to begin the debate about the future contributions of archaeological computing to the discipline and, in doing so, to identify the next big research challenges for the subject. How can the expertise represented at CAA be best harnessed in pursuit of these objectives?

R2 Linked Data Approaches to Numismatic Catalogues

(Wednesday 23th 14h-18h Pantheon S16)

Chairs : David Wigg-Wolf[1], Andrew Meadows[2], Karsten Tolle[3],

1 : Römisch-Germanische Kommission (RGK) Frankfurt - Germany

2 : American Numismatic Society (ANS) New York - United States

3 : Databases and Information Systems (DBIS) Goethe University - Frankfurt - Germany

Coins survive in vast numbers from many historical periods and cultures, providing important evidence for a wide variety of social, political and economic aspects of those cultures. But currently these data are only potentially available, as differing national traditions have yet to integrate their substantial datasets on the basis of shared vocabularies, syntax and structure.
Building on the experience with Linked Data of projects such as nomisma.org (http://nomisma.org/), the European Coin Find Network (ECFN - http://ecfn.fundmuenzen.eu/) and Online Coins of the Roman Empire (OCRE - http://numismatics.org/ocre/), the roundtable will provide a forum for the presentation and discussion of (meta)data standards and ontologies for data repositories containing information on coins, with a view to advancing the possibilities of data exchange and facilitating access to data across a range of repositories.
The roundtable follows on from the two joint meetings of nomisma.org and ECFN, which concentrated on ancient, primarily Roman coins, held in Frankfurt, Germany in May 2012; and Carnuntum, Austria in April 2013, which was attended by 28 participants from 10 European countries and the USA (http://ecfn.fundmuenzen.eu/News.html). The roundtable is intended to encourage discussion among a wider community, beyond that of ancient numismatics, drawing together lessons from a broader range of projects, and embedding the results in the more general landscape of cultural heritage data management. Too often in the past numismatists have allowed themselves to operate in isolation from other related disciplines, including archaeology, a deficit that this roundtable also aims to address.

Although the core data required to identify and describe coins of almost all periods are relatively simple (e.g. issuer, mint, date, denomination, material, weight, size, description of obverse and reverse, etc.), and this can result in a significant degree of correlation between the structure of different repositories, linking disparate numismatics repositories presents a number of problems. Nevertheless, coins provide an ideal test bed for the implementation of concepts such as Linked Data and the creation of standardised thesauri, the lessons of which can be profitably applied to other, more complex fields.

Base Facies monétaire antique

Gruel Katherine [1], Tricoche Agnes [2*], Charnotet Philippe [1]

1 : Archéologie et Philologie d'Orient et d'Occident (AOROC)

CNRS : UMR8546École normale supérieure [ENS] - ParisÉcole Pratique des Hautes Études [EPHE]

CNRS : UMR8546 - Ecole Normale Supérieure de Paris - ENS Paris - 45 Rue d'Ulm 75230 PARIS CEDEX 05 http://www.archeo.ens.fr/

2 : Pays germaniques , histoire - culture - philosophie (PG,HCP)

CNRS : UMR8547Université Paris VIII - Vincennes Saint-DenisÉcole normale supérieure [ENS] - Paris

Pavillon Pasteur 45 Rue d'Ulm 75230 PARIS CEDEX 05 http://www.ens.fr/umr8547/

* : Corresponding author

The object of this data base is to show the links between the coins and the settlement. The entry of data can be done by the individual coins or by the archaeological context. In that case, you can introduce only the number of coins in each typological serie. The central object of this base is the Celtic period, but all the coins from Roman and Greek worlds can also be registered. Coins are classified by groups, series and classes.
The «Facies monétaires» data base is divided in 6 Tables, including 3 Levels of Cataloguing with
2 layers each :
- The Coins inventory : 1. Individual 2. Facies
- The Geographical index : 1. Sites 2. Contexts
- The Typological index: 1. Series 2. Classes
Then, you find 4 additional Tables : Séries_facies, recorded Coins Photography, Type drawing
and Coordinated Participants Addresses.

Several models and count tables permit statistical exploitations and exports into excel tables to realize mapping and to create numismatic catalogues.

The use of standard data in the KENOM-project

Schlapke Mario [1]
1 : Thüringisches Landesamt für Denkmalpflege und Archäologie (TLDA)
Humboldtraße 11 99423 Weimar
www.thueringen.de/denkmalpflege

KENOM (Kooperative Erschließung und Nutzung der Objektdaten von Museen - Ein Online- System zur nachhaltigen Digitalisierung von Münzen, Medaillen und Papiergeld) is a DFG- founded project (11/2012 -11/2014) to create a Virtual Coin Collection of different numismatic coin cabinets in Germany. The different partners can use a common web-frontend to collect the data of their numismatic material (coins, medals, paper money and others of all numismatic periods) in one database. We also integrated images of the objects in a high resolution. Later these datasets should be integrated in national and international cultural portals and also in special numismatic portals.
The KENOM-partners have to define different work flows to create comparable descriptions of the objects (we call it «Schreibanweisungen») and we can use linking to other objects e.g. coins of the same type in the project. So we hope to reduce the time of recording the data of same coins. A focus of the project is the using of standard data e.g. names of persons, institutions and geo names. Also we have to define a joint numismatic vocabulary (thesauri) of the project, including the use of existing numismatic and other vocabularies. Now we have integrated the Gemeinsame Normdatei of the Deutsche Nationalbibliothek to link to persons and institutions and the library catalogue of the Gemeinsame Bibliotheksverbund to link to relevant literature. A next step is the using of standard geo names to record the mint, finding places and other geographic information of the object description.
I want to present the current state of the development of the project and some goals we want to achieve.

How DIANA Approach can Improve the Diachrony? Integrating Heterogeneous Pieces of Data

Caccamo Caltabiano Maria [1], Puglisi Mariangela [1*], Celesti Antonio [1]
1 : University of Messina
* : Corresponding author

Nowadays, in the field of science of antiquity, there are a lot of digital archives and web applications that allow to display ancient entities and artifacts on digital maps. Entities may include, e.g., gods, abstract personification, historical personages, etc. Artifacts may include coins, weapons, architecture, etc. In particular, ancient coins represents also out-and-out documents that need to be properly studied and analyzed. From the point of view of numismatics, there are not so many web applications enabling researchers to perform an in-depth analysis of the coin iconography.
The Digital Iconographic Atlas of Numismatics in Antiquity (DIANA) aims to fulfill such a gap. It is a web application that allows to analyze the «coin iconography» according to time and space through digital maps. The DIANA's digital archive is based on a relational Data Base Management System (DBMS). The web application is developed combining both server-side and client-side programming languages. The server-side is developed using the PHP language, whereas the client-side is developed using Javascript. In order to provide users a good degree of reactiveness, DIANA has been developed adopting the Asynchronous JavaScript and XML (AJAX) programming technique. In order to build digital maps, the system uses the Google Maps Platform as a Service (PaaS). A mint can be searched on DIANA considering a target coin iconography through a web form. By means of AJAX requests, data are retrieved on the DIANA's digital archive and they are sent in XML format to the user's web browser. After that, the web browser processes the received data and it forwards a second AJAX request to Google Map PaaS that returns a digital map displaying the mint and ancient coins.
With DIANA it is possible to study the «diachrony» with a new innovative approach starting from ancient coins. The project has been designed with an eye toward the possibility of a future integration with other digital archives. The basic idea is to enable DIANA to analyze, besides ancient mints and coin iconographies, even other related data. Currently DIANA sites are located according to ancient mints. In other digital archives places can be located according to ancient artefacts, as well as in Pleiades (http://pleiades.stoa.org). An objective of DIANA is to link and integrate its datasets with other datasets coming from different digital archives in order to improve a particular study aggregating different pieces of information. For example, an artefact (vase, statue, vexilla etc.) depicted on a coin coming from DIANA, can

be related to finds coming from other digital archives. Such a data linking may enable researchers to better understand the diachrony and the cultural context. Linking data of different digital archives it is possible exploiting different data integration techniques, e.g., importing datasets in CSV, KML and RDF format, or by means of web service (e.g., REST, SOAP, etc) interactions.

DIANA is part of the LIN project, aimed at compiling the Lexicon Iconographicum Numismaticae Classicae et Mediae Aetatis, a dictionary whose entries record all the principal and secondary images found on ancient and medieval coins.

Linked Open Data at the American Numismatic Society

Gruber Ethan [1]

1 : American Numismatic Society (ANS)

75 Varick Street, floor 11 New York, NY 10013

http://numismatics.org/

The author has been employing linked open data methodologies at the American Numismatic Society for three years and will participate in the discussion regarding his experiences developing RDF ontologies and XML schemas for encoding information about coins, coin types, and coin hoards, in addition to software development for the dissemination of these sorts of data.

R3 Virtual Archaeology - the first 25 years

(Wednesday 23th 16h05-18h Pantheon S6)

Chairs : Hookk Daria[1] , Sorin Hermon[2], Franco Niccolucci[3], Susan Hazan[4]

1 : The State Hermitage Museum

2 : The Cyprus Institute (CyI)

3 : University of Florence (UNIFI)

4 : Israel Museum (IMJ) -

Virtual reality in archaeology, or virtual archaeology, was “officially” introduced to the archaeological scientific community more than two decades ago, by the work of P. Reilly (1990). Since then, additional terms were added (e.g. virtual environments, cyber- archaeology) and application areas extended from reconstructions of buildings, simulation of construction / destruction of monuments and sites or virtual reconstruction of ancient landscapes. We find today “virtual archaeology” in many museum installations, online web pages and recently in the “apps” world. As an apparently natural course of development, virtual archaeology followed trends in technological developments, the archaeological scientific community seeing applications using haptic devices, cave systems and recently augmented reality environments. Measuring devices improved as well, nowadays including total stations, GPS, 3D scanners or image-based 3D documentation systems. As pointed out in many scientific papers, virtual archaeology is a term that has the potential to cover the entire archaeological research pipeline – from field data acquisition, archiving, analyzing and interpreting the results, to the final publication and dissemination. A digital model produced during an archaeological research becomes object of study and education that means digital heritage by itself. What is then the relation between the original and the digital surrogate? Virtual archaeology and its digital outcomes can be powerful tools for the archaeological investigation, but also as excellent communicators of the embedded (and sometimes not so visible) information cultural heritage assets posses, and, as such, are widely implemented in museum environments. However, even after almost 25 years of “virtual archaeology”, the term is still under scrutiny of definition within the archaeological scientific community (as recently expressed in the he First International Conference on Virtual Archaeology, organized by the Department of Eastern Europe and Siberian Archaeology of the State Hermitage Museum)

as well as the museology (and virtual museums) community (see discussions in the Automation directions in Museums and Information Technologies – ADIT conferences in the Russian Federation, NODEM, Museums and the Web conferences, etc.).
The aim of the session is to create a meeting point between scholars of Eastern and Western scientific traditions, experts in virtual archaeology and related fields, with experiences which sometimes developed in parallel paths but eventually converge, since sharing similar goals. Moreover, the session aims at bringing together scholars that expertise in all or specific steps of the scientific pipeline: data acquisition (recording), archiving, interpreting and publication, the ultimate scope being the definition of the term "virtual archaeology", its research methodology, techniques and technologies to be adopted. We are inviting therefore scientist to present papers that will contribute to the goals described above, in particular (but not exclusively) topics such as data provenance, data reliability and transparency, virtual paradigms in archaeology or ontologies of virtual archaeology.

R5 CAA Publication issues

(Wednesday 23th 16h05-18h Pantheon S11)

W01 Hands-on structured light scanning workshop with discussion

(Tuesday 22th 9h-12h55 EHESS Amphi)

Chair : Dirk Rieke-Zapp
Breuckmann GmbH Meersburg - Germany

Structured light scanning has a long tradition in digitization of artefacts from arts and cultural heritage domain. Recent advancers in 3D printing and inexpensive sensors based on computer vision technology have increased the awareness and availability of 3D digitization tools even for non-experts in 3D metrology. In this workshop we will highlight 3D scanning technology with special emphasis on Breuckmann structured light scanning systems.
The workshop will be divided in three parts
- Overview of current digitization technology with theoretical background
- Hands-on practise using structured light scanners
- Discussion on pressing challenges in the digitization of cultural heritage artefacts
The workshop is directed to novice users of structured light scanning technology as well as experts in this field. Hand-on experience will be important to grasp the process of data acquisition and to understand current research questions.
Members of the EU funded COST action on Colour and Space in Cultural Heritage (COSCH) are especially invited to join this workshop for hands-on experience.
Breuckmann Company has a long standing record in structured light scanning technology as well as its application to arts and cultural heritage. This workshop will offer an opportunity to all people interested in this field to exchange ideas, get a hands-on experience of the hardware and software far beyond the typical presentations available in the exhibition area of the conference.

W02 Digital Documentation of Cultural Heritage Structures and Objects with Terrestrial Close Range and Medium Range Laserscanning

(Tuesday 22th 14h-19h EHESS Amphi)

Chair : Philipp Kresser, Christoph Held, Daniel Blersch
Zoller + Fröhlich GmbH (Z+F) Wangen im Allgäu - Germany

The focus of the workshop will be the documentation of Cultural Heritage Sites with terrestrial laser scanners. This includes the data acquisition and data processing.
Laser Scanning of cultural heritage differs greatly from scanning in the industry. For example, while in industry often it is necessary to cover an object only with a few points to be able to model it with geometric primitives, in cultural heritage, every single point can be of significance. Thus, many more setups are necessary. As cultural heritage sites are also much more fragile, the use of targets for the alignment of scans is not always possible. Hence, different solutions for data processing are necessary. The workshop will focus on these issues and provide the attendees with solutions for their needs.
Inside Z+F, there is a lot of experience with organizing events, such as workshops and seminars, but also with documenting cultural heritage sites. Daniel Blersch, for example, has gained experience during his time at the DIAPReM institute at the faculty of Architecture, University

of Ferrara in Italy where he spent a lot of time with recording and processing data of various Italian sites. He was also in the team for the documentation of the Nativity Church, Bethlehem. Christoph Held was a long-term member of the Zamani Project, South Africa, which is documenting cultural heritage sites all over Africa. Christoph Held, was also part of the documentation project in Petra, Jordan.
The proposed workshop is conceptualized as a joint session between the two technology developers and manufacturers Breuckmann and Z+F. While Breuckmann is focusing on close-range instruments, Z+F will address the topic with medium range laserscanners. Both technologies do have their pros and cons and their field of application and attendees of the workshop will benefit of the combined knowledge.
For the entire workshop we estimate 1.5 days. It will cover the theory of laserscanning with each technology, reports of and advice for scanning in the field, as well as practical hands-on sessions for the attendees to familiarize themselves with the technology.
The organizers of the CAA should receive a separate proposal from Breuckmann GmbH, which will be part of this workshop. The workshop will be held in English.

W03 Hands-On Archaeological Conceptual Modelling 2

(Tuesday 22th 9h-12h55 Michelet S106)

Chair : Cesar Gonzalez-Perez[1], Charlotte Hug[2]
1 : Institute of Heritage Sciences, Spanish National Research Council (Incipit, CSIC) - Spain Website
2 : Centre de Recherche en Informatique, Université Paris 1 Panthéon-Sorbonne (CRI), Paris

Research and practice in archaeology often generates, and needs to manage, a large amount of information, which exhibits complex relationships and categorisation phenomena. The quality of the conceptual models that we use when gathering, organising, processing and reporting this information determines, to a large extent, the quality of our work. Creating explicit, high-quality conceptual models is a crucial task in any information-intensive endeavour, and especially in those where the complexity of the information means that intuition alone is not sufficient.
This workshop will be divided in two parts. During the first half, the workshop will intro duce the discipline of conceptual modelling, often seen as pertaining to the engineering world, to archaeologists and related professionals. This introduction will be achieved by hands-on work, i.e. doing and experimenting with ConML (www.conml.org) rather than through theoretical explanations. ConML is a simple, high-level, affordable, powerful modelling language specifically designed with the humanities and social sciences in mind. In addition to supporting most of the object-oriented structural modelling constructs, ConML extends them with concerns that are rarely seen in industry-standard approaches but which are extremely important in archaeology, such as the ability to express temporality and subjectivity in conceptual models.
During the second half, the workshop will introduce CHARM (Cultural Heritage Abstract Reference Model, www.charminfo.org), an abstract and wide representation of the basic concepts that we can use to compose models of the archaeological record and related information. CHARM will be used to create particular models that are useful to attendees' needs, using their own terminology and conceptualizations, but without losing the ability to interoperate and share information with one another. Special attention will be paid to issues such as how to model material and performative entities as well as agents, valorizations and representations.
The workshop will assume no previous knowledge of conceptual modelling, although it will assume familiarity with archaeological concepts and practice. It will begin by teaching the basic tenets of object-oriented modelling, followed by a comprehensive presentation of CHARM and its applications. Participants will be asked to undertake an extensive array of exercises and practical cases in the archaeological domain, either individually or in small groups, throughout the workshop. The maximum number of participants is estimated at 20.
Similar experiences have been carried out internally at Incipit, in the form of postgraduate courses at CSIC, and as workshops at various editions of the CAA conference, with excellent results in all cases; archaeologists, historians and architects with no previous exposure to con-

ceptual modelling were capable of creating good-quality models after a few hours of practice. The organizers have extensive experience in using conceptual modelling in archaeological domains for over 15 years.

W04 Vocabularies as Linked Data - Workshop

(Tuesday 22th 14h-16h05 Panthéon S Info 1)

Chair : Keith May[1], Ceri Binding , Doug Tudhope
1 : English Heritage (& University of South Wales) (EH) - United Kingdom

The purpose of this workshop is to discuss the possibilities, explain the technologies and demonstrate new tools for non-specialist users to map and extract their own vocabularies - Wordlists, Glossaries, Terminologies, Thesauri, etc - from databases into RDF/XML **SKOS** W3C standard format**.** The RDF/XML output can be produced in a form that allows subsequent expression as **Linked Open Data (LOD).**
We encourage participants to contribute with their own tools and discuss their experience in this area. We are interested in tools for generating vocabulary Linked Data, aligning (mapping) between thesauri, visualising thesauri and indexing or search tools. We will also demonstrate outcomes from the recent projects the organisers have been working on.
Thus the workshop will be an opportunity to update participants on the latest work carried out by the AHRC funded SENESCHAL project to develop LOD versions of national thesauri maintained by English Heritage, RCAHMS & RCAHMW expressed in **SKOS** (Simple Knowledge Organisation System) W3C standard format, which allows controlled data items and vocabularies to be connected using Linked Data technologies. In order to produce LOD, tools and templates were employed from the earlier STELLAR project, which employed semantic and knowledge-based technologies to link excavation databases, vocabularies and associated grey literature..
We will discuss conversion and extraction issues and there will be opportunities to try the tools, using examples of vocabularies e.g. site types and monuments. We would also welcome feedback and experiences from participants who have either used the STELLAR tools or who are carrying out similar work to SENESCHAL with related vocabularies (e.g. Archive and Museum collections).
http://hypermedia.research.glam.ac.uk/kos/SENESCHAL
http://hypermedia.research.glam.ac.uk/kos/STELLAR/
http://hypermedia.research.glam.ac.uk/resources/STELLAR-applications/

W05 Online Resources for Archaeological Research

(Tuesday 22th 10h35-12h55 Michelet S101)

Chair : Holly Wright
Archaeology Data Service (ADS) University of York - United Kingdom

This workshop will introduce archaeological researchers to a variety of online data resources, including those held by the three partners providing online access to their data as part of the new EC Infrastructures funded Advanced Research Infrastructure for Archaeological Dataset Networking (ARIADNE) project. The partners are the Archaeology Data Service (ADS), ARACHNE at the German Archaeological Institute (DAI), and Fasti Online at the International Association of Classical Archaeology (AIAC). Each partner has a different focus. The ADS is based in the UK and supports research, learning and teaching with freely available, high quality and dependable digital resources in English, derived from UK archaeology, or UK-based (or funded) archaeology abroad. ARACHNE is based in Germany and provides archaeologists and Classicists with a free internet research tool for quickly
searching hundreds of thousands of records on objects and their attributes, in both English and

German. Fasti Online provides a database of excavations carried out in countries throughout the Roman Empire since 2000, providing a record in English and in the local language for each season. The workshop will also feature resources from several other online data providers, representing data held in different languages, and from countries outside of Europe. All of the data providers will showcase the resources they have available and discuss how to use them, also illustrating the benefit to archaeology of making data openly available.

W06 Belling the Cat: Making CIDOC Conceptual Reference Model (CRM) data available as Linked Open Data (LOD): A practical hands-on workshop of a complete solution using freeware

(Tuesday 22th 16h20-19h Panthéon S Info 1)

Chair : Stephen Stead[1, 2] , Michael Charno[3],
1 : University of Southampton (Southampton, UK) (ACRG) - United Kingdom
2 : Paveprime Ltd (PPL) - United Kingdom
3 : Archaeological Data Service, University of York (ADS) - United Kingdom

The mice meet in council to debate the problem of the new cat in the district. One suggests that a bell should be attached to the cat to give a warning. This is greeted with universal approval until someone asks “How?” Cultural Heritage Informatics specialists are often heard to say “just publish your CRM data as linked open data so that others can use it”, but how do we actually do that? This workshop aims to lead attendees through the process of taking an export of delimited text (ie. comma separated values) from their database, converting it to CRM compatible RDF triples and then making them available via a triple store for consumption by humans or machines as linked open data. The course will provide an introduction to linked open data and then will lead users through a cookbook of simple to follow techniques for creating and publishing it. All software used in the workshop will be freeware and runs on the free and open source operating system Linux. The software and operating system are uniquely capable of running on underpowered hardware, making deploying it simple even with limited support from an IT department or support services. The full set of software and guidelines will be available to attendees (if you bring a USB stick).

W07 Manage stratigraphic data with Le Stratifiant

(Tuesday 22th 9h-12h55 Panthéon S Info 2)

Chair : Bruno Desachy,
CNRS UMR 7041 équipe archéologies environnementales Nanterre - France

«Le Stratifiant” is a software of stratigraphical and chronological data processing, developed since a few years (Desachy 2008, 2010). It allows the automated realization of Harris matrix-like graphic representation of stratigraphic relationships, including elements of quantified dating (TPQ-TAQ). It has for peculiarity to authorize processing of not sure data (uncertain stratigraphical relations or estimated dates). It is designed in a purpose of simplicity, ease of use, and integration to the existing recording systems. It exists at present in the form of a (free) additive to the software Excel. It is usually used by several archaeological teams in France in INRAP, university and CNRS, and local archéological units.
Demonstrations will present the features and use of “Le Stratifiant” :
- stratigraphical data processing and stratigraphical graph realization ;
- logical errors detection and processing ;

- uncertain data processing ;
- stratigraphical groupings processing;
- elements of quantified dating processing and stratigraphical sequence inscription in the absolute chronology;
- communication with archaeological recording databases and information systems.

W08 Exploring network structural properties with the GeoGraphLab GIS solution

(Tuesday 22th 9h-12h55 EHESS S Info)

Chair : Mermet Eric, Robert Sandrine,
École des hautes études en sciences sociales (EHESS) PARIS - France

This workshop proposition is linked with the “transportation network analysis” session (S. Robert and E. Mermet dir.). GIS solutions are growing with the emergence of open source software. These tools offer analysis methods in various domains involving geolocalised data. On a network, data are nodes and edges. These data structures can be studied simply, some might say too simply, by graph theory (Berge 1973) developed in the late 1950’s.
It is interesting to notice that first studies using graph theory and very beginning of GIS were focused on an historical view of the medieval river trade network of Russia (Pitts 1965; 1979). In such a study, it is highlighted, with various network measures like (accessibility, centrality, proximity) that the special position of the city of Moscow in the river system led to affirm its economic dominance and became capital.
Other methods of analysis of networks add a relational dimension to the simple graph theory (Freeman 1978, Sheffi 1985, Bollobás 1998). If this dimension adds a combinatorial complexity, the most interest is that it becomes possible to understand phenomena underpinned by the only network effect (Gleyze 2005) without the need to integrate thematic data. While at present it is becoming easier to acquire, to access and to integrate data in GIS tools (travel surveys, GPS mapping and tracking, etc.), obtaining reliable historical data can take many years of research.
In this workshop, we propose to introduce a tool for analyzing relational phenomena on networks. GeoGraphLab (Mermet et Ruas 2010) is a GIS solution that allows to analyse and to map networks without thematic data based only on its structural properties. Indeed, a network due to its intrinsic properties reacts in its own and unique way to different stimuli. These reactions are dictated by the arrangement of the network components and how these components are activated by relationship: that’s what we call the potential relational network (Mermet 2011). This approach is based on the geometric aspect of components nodes (positions) and edges (geometries), topological aspect (edges connect nodes), metrics aspect (length, time, costs, etc.) and finally relational aspect (all the relations on the network have to be considered). Then relations are reflected by paths (shortest paths, random paths, etc.) for which it is possible to measure properties to obtain indicators on the network (like betweenness or proximity centrality, average distance, distal or proximal radius, etc.). These indicators, once mapped, offer a particular view of the network status in the study.
Different pretreatments are integrated to correct topology, induce a metric, check the connection. It is also possible to filter relations, to take an interest in specific phenomena involving a set of relations of interest. Finally, an integrated tool for crossing created maps will be presented as a complete graphical language in order to speed up studies and network analysis.

W09 Data analysis for human and social sciences : a multidisciplinary interface

(Tuesday 22th 14h-19h Panthéon S Info 2)

Chair : François Giligny[1], Stéphane Lamassé[2]
1 : Université Paris 1, Panthéon-Sorbonne - UMR Trajectoires (TRAJECTOIRES) - Paris - France
2 : Université Paris 1, Panthéon-Sorbonne (UP1 UFR09 LAMOP) Paris - France

Data analysis is a part of standard tools of data processing in numerous disciplines of human and social sciences. The nature of the handled data and the used procedures allow to define recurring needs and processing chains by means of tools such as the factorial analyses, the automatic classifications etc.
These recurring needs are performed by diverse software, free or not, or can be scheduled in languages as R.
An interdisciplinary reflection on the used methods and the formalization of the procedures in various human and social sciences, history, archaeology, sociology, was undertaken between various laboratories of the university Paris 1 to define needs, formalize the procedures used in the various disciplines and to produce an appropriate software.
This software (http://analyse.univ-paris1.fr) was designed free under R and put on-line, so that researchers and students have a tool adapted to the educational needs and research.
This workshop will allow to discuss about usual procedure, from the needs for the users, to criticize them and to illustrate them with case studies.

W10 Hands-on Workshop- Using Free and Open Source GIS tools: QGIS and GRASS for Archaeology and Cultural Resource Applications

(Tuesday 22th 9h-19h Michelet S Info)

Chair : Scott Madry[1],
1 : University of North Carolina at Chapel Hill (UNC-CH) - United States

This full-day, hands-on workshop (or half day, if you prefer) will present a general overview of the archaeological and cultural resources applications of Free and Open Source (FOSS) GIS Software tools, specifically the QGIS and GRASS GIS packages. Open Source tools have advanced significantly in recent years, and now provide a viable, no-cost alternative to expensive and proprietary GIS systems. Several of these tools make up the ‘OSGEO stack’, providing a full range of GIS, GPS, remote sensing, database, visualization, networking, and spatial analysis capabilities. This workshop will provide a full day’s hands-on exposure to the QGIS and GRASS GIS systems. Participants will be encouraged to bring their own laptops so that they can leave the workshop with a full set of open source GIS tools for future use.

W11 Introduction to network analysis for archaeologists

(Tuesday 22th 9h-12h55 Panthéon S Info 1)

Chair : Tom Brughmans[1] , Ursula Brosseder[2], Bryan Miller[2],
1 : Archaeological Computing Research Group, University of Southampton
2 : Vor- und Frühgeschichtliche Archäologie, Rheinische Friedrich-Wilhelms-Universität

Recently, an increasing number of archaeologists are turning to network analysis in their attempts to understand past phenomena. But what is this network perspective exactly, and what are its advantages? Most importantly, how can archaeologists critically select and perform a network analysis in their own research?
This workshop will introduce the basic principles of network science as well as some of the most commonly used analytical techniques and visualization methods. It will draw on archaeological examples throughout to illustrate these topics. It will include a discussion of some of the most crucial benefits and issues with network science in archaeology. This practical workshop will guide you through completing a network visualizat ion and analysis of an archaeological and geographical dataset using the user-friendly network analysis software platform Cytoscape. It will be followed by a brief discussion of the advantages and disadvantages of other free-to-use network analysis software. Finally, the workshop will close with a creative exploration of another archaeological dataset from Late Iron Age Eurasia. The aim is to discuss connectivity along the Silk Roads from a network perspective, and how this might lead to new hypotheses.

W12 One hour, one model: Agent-based Modelling on-the-fly

(Tuesday 22th 14h-19h EHESS S Info)

Chair : Iza Romanowska[1], Benjamin Davies[2] , Enrico Crema[3], Tom Brughmans[1],
1 : University of Southampton - United Kingdom
2 : University of Auckland - Australia
3 : University College London (UCL) - United Kingdom

The number of archaeological applications of complex systems simulation using equation-based, statistical, network and especially agent-based modelling has increased significantly in recent years. The modelling techniques are becoming easier to use and faster to build (Kohler and van der Leeuw 2007; Robertson 2005). Large, detailed datasets are becoming effortless to obtain and work with (Gruber 1993; Snijders et al. 2012; Watts 2011). Sharing data and models between colleagues across the globe has become quick and seamless. However, computational modelling is often conceived of as a painstaking process limited to focused research programs. Partially because it still lacks the standardized simulation tools, good- practice guidelines and libraries of coded examples that are commonly used in other disciplines. This can make coding models a time consuming process, limiting the use of simulation modelling as an on the fly experimental process. Processes such as social interaction, diffusion, population growth or communication are common to many ABM applications, in a wide range of disciplines. The aim of this workshop is to compare and contrast different approaches to such recurring research themes in archaeological simulation used by modelling and to challenge the notion that simulation building is a pa instaking process involving high levels of expertise. We hope to bring the simulation method into the realm of “tools to think with” (Epstein 2008; Fencott et al. 2012; O’Sullivan and Perry 2013) and promote the use of ABMs as experimental laboratories in archaeological practice.
This workshop is aimed at modellers of all stripes: from qualitative/conceptual modelling to networks and agent-based models and on through to statisticians. The workshop participants will be divided into 3 to 4 groups and will be given programming tasks which have to be solved in

approximately 1 hour each.. We'll begin with a discussion of the concept, then a problem will be introduced, and we'll break into groups to begin model building. Groups will go from model conception to construction and on through to analysis multiple times during the day. A comparison and discussion of the different coded solutions to the same research topic will follow each module. As an immediate result of the workshop we hope to produce a library of documented code snippets that can be used in a wide variety of (archaeological) models.
We suggest that participants familiarise themselves with NetLogo before joining the workshop (a short NetLogo tutorial is available here: http://ccl.northwestern.edu/netlogo/docs/).

CAA 2014 PARIS

21ST CENTURY ARCHAEOLOGY

PARTNERS, SPONSORS AND EXHIBITORS

Programme Archéologies du Bassin Parisien

WIFI ACCESS

During the Conference (Panthéon and Michelet) : Universite-paris1

Login : CAA2014

Password : znoe0641

Full program