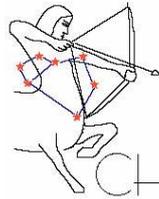




SIXTH FRAMEWORK PROGRAMME



COMMUNICATING CULTURAL HERITAGE IN THE 21ST CENTURY

The Chiron Project and its Research Opportunities

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In Collaboration with Project Partners



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Foreword

Starting a research career in an interdisciplinary domain denotes a courage that only young people may have. Not only interdisciplinary topics usually receive less support than those central to a discipline, but also careers may be adversely affected, and researchers often suffer from the “please try elsewhere” syndrome. The applications of Information Technology to Cultural Heritage are no exception. Although there exist notable initiatives supporting interdisciplinarity in this domain, as the continuous support to young researchers by CAA, the association organizing the yearly Conference, or, at an institutional level, provisions within a few very innovative programmes as the Methods Network in the UK, it is rather difficult to find support for the initial stages of an interdisciplinary research career. The above considerations show the importance of CHIRON, the Marie-Curie Early Stage Researchers Training project which supported many of the contributors to this volume, and complements the training activity of EPOCH, the EU-funded Network of Excellence on the applications of ICT to Cultural Heritage. In the latter case, training activity spans over a number of different levels, from introductory IT training for museum professionals to short technical seminars and to focused courses on highly specialized topics. It is not by chance that the two projects share some – but not all – the partners.

At the end of CHIRON’s year one, it was therefore decided to organize a joint workshop between the two projects. It aimed at offering CHIRON fellows a meeting occasion and a floor to present the results of their research activity, and an opportunity for EPOCH to gather precious information concerning the needs of early stage researchers and the effect of supporting their activity. The seminar was attended by the EPOCH team in charge of training, who discussed with the CHIRON fellows their experience and how it can be used as a model for future interdisciplinary, trans-national collaboration. They also formed the audience for the presentations by the CHIRON fellows of the outcomes of year one activity. These lectures also opened a discussion which has been taken into account in the written texts, which were reviewed by senior EPOCH scholars.

The present volume collects the scientific contributions by the CHIRON fellows and shows the excellent results obtained in one year. It is expected to organize periodically a similar meeting to provide a report and assessment of the activity of both projects.

CHIRON – Cultural Heritage Informatics Research Oriented Network

A Marie – Curie EST project

Introduction

CHIRON is a four years research program, started in 2005, aiming to provide training opportunities to graduates wishing to start a research career in the field of Information Technology (IT) applications to the research, conservation, and presentation of tangible Cultural Heritage, funded by the Marie Curie East Stage Training programme.

Inter-disciplinarity is an essential aspect of the project. Young researchers need to be exposed to a variety of specialized techniques as well as to on-site experience. Moreover, specialization in a single discipline has placed the focus on individual steps of the production process (the pipeline) that leads from data acquisition, management and processing to exploitation and communication. Fragmentation is thus an issue to be addressed promptly and needs a holistic approach that at present no training institution can provide. Partners proposing CHIRON cover complementary parts of the potential training field. Their collaboration in a joint project provide an integrated coverage of the different specializations adding a common perspective and coherent approach. This is being developed through a joint training activity, to which all the young researchers participate, and specific research projects carried out by individual partners in a co-ordinated way. CHIRON partners offer researchers a spectrum covering different archaeological periods and different locations – from Northern/Central Europe to the Mediterranean Area and the Near East. A wide range of technologies is covered as well, from database to multimedia and state-of-art 3D modelling and visualization applications to Cultural Heritage. Economic and social implications are also taken into account.

Description of main project's activities

Research

The CHIRON research training project includes the following activities:

- Supervised involvement in a research project led by the hosting institution. This provides “learning-by-doing”, experience in teamwork and practical experience of research activity. This is the main activity of the fellow. The duration of research projects may vary from one to three years.
- Crash course(s) to fill interdisciplinary gaps for students with a prevailing disciplinary training. For example, engineering graduates will follow a short course on the fundamentals of archaeological investigation, landscape survey, monument preservation, cultural resource management and cultural communication, aimed at giving substance and theoretical foundations to the applications they already have studied. On the other side, humanities graduates will follow a short advanced course on technology, including databases and text encoding, multimedia, 3D modelling and digital data acquisition. Such courses aim at bridging between disciplines and providing a sound basis in the “other” field to achieve a good overall knowledge of heritage / technology theory and practice. This basis provides a holistic view, on which further training will provide specialization. These courses are common consortium activity; they will produce a common syllabus. Such courses are in principle open to other (paying) participants, not supported by the CHIRON project.
- Highly specialized courses on individual subjects jointly managed by the network and provided by individual partners, according to their main research experience. These courses will involve mainly the researchers hosted by the organizing institutions, but may also accept other participants hosted by other institutions or from outside the CHIRON scheme.

- Short secondments (< 3 months) at local institutions for specialized training or applications. For instance, these may provide training on special, scarce equipment (e. g. an expensive 3D scanner), practical experience on specific activity (e. g. geophysics application to archaeology or use of a particular visitor evaluation method in a museum) or involvement in an ongoing project of theirs, to test or improve on it the research developed by the fellow (e. g. participate in an archaeological excavation to test a new archaeological documentation methodology). It is envisaged that most of these short secondments take place in the same country of the host, that will act as coordinator of a cluster of such collaborating institutions, which are not directly involved in CHIRON to keep the partnership size manageable but can provide specific, highly specialized contributions to training.
- A basic language course in the national language of the host institution, to facilitate human relations and collaboration with other team members (the working language will anyway be English), attendance at local training opportunities (lectures, workshops, etc.) and a better awareness of the local culture, which is fundamental for understanding cultural heritage, its needs and hence the effects of IT applications.

Content of the training activity

The general field of training is IT applications to tangible Cultural Heritage. This includes, among others, the following topics:

- **Automatic data acquisition:** techniques for 3D data acquisition (3D scanners, structured light, photogrammetry). GPS. Total station. Digital photo and video. Digitisation of cultural heritage information. Text digitization and automatic recognition (e.g for written sources, ancient languages, etc.). Ubiquitous computing.
- **Data organization:** Archaeological documentation & standards. Museum documentation. Technology for cultural data management: databases, XML encoding. Ontologies. Methodological problems related to documentation. Different scales of applications (objects, sites, museums, monuments, landscapes) and related issues. Use of secondary sources: previous and old reports, ancient and historic texts, maps, images and drawings.
- **Data management and processing:** Database-based and native XML-based archival systems. GIS and their use. 3D modelling. Multimedia production. Storage-related problems: technological and social issues.
- **Interfaces:** Design and evaluation of interfaces. Direct or web access to cultural archives. User profiling and multi-layered access. Personalisation. Multi-modal interfaces. Wearable and portable appliances. Integration issues (groups, outdoor and monument environments, ...)
- **Communication and interpretation:** Digital museology. VR applications. Storytelling methodology and technology.
- **Dissemination and publication:** Electronic publication; digital preservation; interoperability; common information environments. IPR management. Integration with tourism and local development.
- **Methodological issues:** Credibility and validation. User evaluation of use and effect of IT applications (quantitative and qualitative analysis).
- **Social and economic issues:** Sustainability. Socio-economic models for CH. Business models. Impact of cross-cultural issues on Cultural Informatics.

As far as on-site activity is concerned, the research projects will aim at objects, monuments, museums and sites. The geographical distribution of application sites and case-studies will cover Europe, the Mediterranean area and possibly other areas in the world. Historic periods go from Prehistory to modern times (industrial archaeology and World War II, for instance).

Contribution of each participant to the training program

For each partner the list below points out the most significant topics on which they offer training:

1. PIN srl Servizi Didattici e Scientifici per l'Università degli Studi di Firenze: managing the document

- Archaeological documentation and standards
- Archaeological databases, including diverse sources and content (structured data from excavation and/or collections, texts, images and so on)
- User interfaces design, testing and evaluation
- Web services and content management
- Multimodal interfaces and wearable equipment (through collaborating institutions)
- On-site experience and tool testing concerning data acquisition and management, multimedia creation and cultural communication, on a series of archaeological sites and museums of different sizes and periods (via collaborating institutions: antiquities authorities, archaeological departments, other research centers) in a Mediterranean environment
- Archaeological use of IT for standing structures and monuments (data capture, documentation, communication, compatibility of contemporary actual use with preservation/museum use)

2. U. of the Aegean, Dept. of Cultural Technology and Communication: creating the museum

- Theoretical background and practical training on museological issues
- Design of cultural information systems
- Communication of ICT information to different types of users
- Design of VR applications
- Evaluation of effect of ICT on end users in the cultural heritage sector
- Study of use of ICT for contemporary cultural practice

3. Ben-Gurion U., Beer-Sheva – Dept. of Archaeology: on the field

- Field experience in a Mediterranean/Near East environment, in particular in the desert
- Use of IT in field archaeology: GIS, automatic field data acquisition, remote sensing and satellite imagery.
- Collection management (in collaboration with the regional antiquity authorities) and re-use of pre-existing archaeological archives

4. U. of Brighton: the technological and economic challenge

- 3D modelling and real-time visualization
- Interactive digital TV and multimedia production
- Usability studies and Human Computer Interfaces
- Cultural tourism and sustainability
- Socio-economic impact of Cultural Heritage through monuments sites and museums
- Business Innovation in Cultural Heritage

5. Ename Center: managing communication and the public

- Structuring and managing data for use in public presentations
- Design and development of on-site presentation applications for monuments and sites
- Site technology management and evaluation
- Participation in the formulation of public policy and standards for site interpretation
- Adapting traditional interpretation forms (text panels, live guides, reconstructions) to a digital environment
- Computer aided cultural routes
- Integration of tourism and local development in cultural heritage projects
- Integration of high-tech cultural heritage presentation techniques in non-technical teams

6. U. of York, Dept. of Archaeology: digital preservation and access

- Electronic publication and digital preservation
- Resource discovery; Internet technologies, metadata standards, interoperability
- Database design and implementation; data structure, documentation and standards
- CAD, GIS and VR modelling; web delivery of 3-D visualisation; terrain modelling; web- GIS

7. ETH Zurich, Computer Vision Laboratory: visualizing the past

- Computer vision – complex texture analysis and synthesis
- Virtual and augmented reality
- Remote sensing and satellite imagery
- Virtual archaeological reconstructions and worlds - procedural scene creation
- 3D Data acquisition
- Image-based content retrieval

The table below summarizes partners' specialization, showing that all relevant topics are covered. As detailed in the previous description, partners may focus on different issues within each topic, may have different perspectives or have competencies not evidenced in the table, aimed at displaying their main research interests.

	PIN	UoA	BGU	Brighton	Ename	UYORK	ETHZ
<i>Automatic data acquisition</i>			X				X
<i>Data organization</i>	X				X	X	
<i>Data management and processing</i>	X		X				X
<i>Interfaces</i>	X	X		X	X		X
<i>Communication / interpretation</i>		X		X	X		X
<i>Dissemination and publication</i>		X			X	X	
<i>Methodological issues</i>	X	X	X		X	X	
<i>Social and economic issues</i>		X		X	X		

The following table reports the number of researcher/months assigned to each partner.

	PIN	UoA	BGU	Brighton	Ename	UYORK	ETHZ	Total
<i>Researcher/months</i>	72	72	48	60	72	72	60	456

Recruitment

The call for applications is periodically posted on the project's website (www.chiron-training.org) and on each partner's website. The target population consists of eligible graduates in the relevant disciplines, having developed an application of IT to cultural heritage in their dissertation or in their subsequent research. Candidates for all positions are selected by a special commission appointed by

the board. Selection criteria include the ranking obtained by candidates in their diploma, the quality of their dissertation/publications (to be submitted in any of the European official languages if known to the selecting commission or in an extended English abstract, certified by an accepted academic authority) and the quality of their research proposal in the framework of the project goals.

Training implementation

Every fellow has an individual tutor, chosen among researchers or trainers of the host institution, and a supervisor (in general, a senior researcher). Contacts between the fellow and his/her tutor and supervisor vary according to projects, but must be frequent and not less than bi-weekly, and duly documented in the project reports by an activity diary. Researchers must report at joint network meetings and participate in seminars. It is then expected that every year fellows successfully submit at least a poster or a short paper at a peer-reviewed international conference or journal. Finally, every fellow must provide an interim report (approved by his/her supervisor) on her/his activity every two months, and a formal report every semester, to be accompanied by his/her supervisor's report, all to be consolidated into the network semi-annual activity report. Fellows' interim reports will be available to the Board members.

Every fellow will be provided with access to facilities of the hosting institutions for individual office work (personal desk, computer, access to publications and Internet, etc.) and of the equipment necessary to carry on the research plan (special software and/or equipment). Special arrangements will be made to allow researchers' access/use to particular items (e.g. expensive 3D scanners, high-speed computers, rare and ancient publications, archaeological finds) necessary for his/her work, either with short secondments at collaborating institutions or through the provision of the necessary authorizations.

According to the network implementation plans, there will be 7/12 fellows every year working on individual and independent, though coordinated, research plans. While this is still a manageable size and fits with the programme budget, it may be expected that the trained researchers not yet involved in PhD courses will be absorbed by national/international research programs or national PhD programs.

Chiron's first year of activity

Following a first recruitment period of a couple of months, fifty eligible candidatures were received for evaluation. Almost half of them arrived from Mediterranean countries, in particular Greece and Italy (8 candidates each). A fifth of applications arrived from Central and Eastern European countries, while only 14% from Northern Europe and Scandinavian countries. This distribution may be related to the demands/needs of the discipline in these countries, and the education opportunities offered in these countries. Some hints of these trends may be also found in the Epoch's first year report of activities discussing the formation and education courses in Europe (http://epoch-net.org/index.php?option=com_content&task=view&id=167&Itemid=258). Important to note is the presence of a high amount of applications from the Far East (eight) and the American continent (four); even though Marie Curie programme is principally a European oriented project, and the recruitment strategy was accordingly aimed at the European public, four of the eleven successful candidates of Chiron's first year of activity originate from these area (Australia, Japan and two from USA). This may be an indicator of the willingness of non – European researchers to join European research teams and the high preparation level and professionalism of these candidates.

Being an inter-disciplinary project, it was interesting to note the candidates' field of study. Almost two thirds of them are graduates in humanities/social sciences, in particular archaeology or history, while a third of them have already a specialization in informatics applied to humanities. The rest of disciplines is almost equally divided between computer sciences and architecture. A few applicants studies communication or design. Thus, it is quite obvious that there is a bias towards graduates in humanities, when compared to those of the ICT field. This phenomenon may be related to the job

demands in the humanities, much lower than the ICT one, a graduate in humanities having much less job opportunities than his fellow in the ICT field. On the other hand, the humanities field is not very attractive for ICT graduates, since there are relatively few investments related to technological applications to Cultural Heritage, when compared to any other fields.

In this context the reference to the Epoch project is again relevant. Being funded by the IST, Epoch aims at defining best strategies and tools for an efficient research and communication of Cultural Heritage, using state-of-the-art technologies and developing new ones, when existing tools fail to satisfy the requirements of the field (www.epoch-net.org). The shared research and training programme between Chiron and Epoch is best testified by the joint formation and short courses organised by Epoch, at which Chiron fellows participated – the Epoch course “Standards in Recording and Documenting of Archaeological Excavation Data”, organised by PIN srl (Chiron coordinator) viewed the participation of most of Chiron 1st year fellows. Moreover, short secondments and visits of Chiron fellows at Epoch partners and the active involvement of most of Chiron fellows in Epoch’s research activity are other successful stories of collaboration between Epoch and Chiron, and the complementary aspect of the two projects.

1st Year project advancement

A particular attention was devoted to the creation of a homogeneous research team among the 1st year Chiron fellows, with common goals and research activity, which will continue after fellows will end their stage. In this context, Chiron serves as a platform for the establishment of future generation discipline (informatics applied to humanities), as well as the creation of a new methodology of sharing information and cooperative work. Next and following years new Chiron fellows will be asked to join this research team, and contribute their knowledge and skills to the shared research agenda.

At a personal level, each fellow achieved several results, some of which are presented in the following chapters: Daniel Löwenborg (fellow at PIN) and George Pierce (fellow at BGU) are working to solve the problem of integrating different format databases, in order to facilitate their investigation, a major obstacle when research is based on a synthesis work of material originating from various sources. Evangelia Argyropoulou and Stella Malliaraki (fellows at Ename center) are working on the definition of an innovative way of communicating Cultural Heritage, by means of Heritage Interpretation Centers, which will include among others educational programmes and community activities, with a strong exploitation of IST, while Claudia Liuzza is analysing the anthropological dynamics that develop in an archaeological field work. A complementary research is conducted by Mia Thornton (fellow at U. Brighton), who explores the way people interpret virtual heritage content in museum environments, which will have a deep impact on the way ICT is involved in the dissemination of Cultural Heritage. Caner Guney (fellow at U. York) investigates the potential of applying business and enterprise architecture concepts to the growth, maintenance and success of CH projects. Laia Pujol (fellow at UoA) is working on the definition of a semantic and syntax of 3D applications for museum exhibitions; Tijn Vereenooghe (fellow at ETHZ) is working on a novel approach to 3D model building, of mainly large urban areas, using a strategy that involves the definition of a grammar for the establishment of the social dynamics in an urban environment, a research area with few practical results so far, while Holly Wright (fellow at U. York) tries to simplify the process of web representation of 3D models. Thus, it is clear that all researches are complementary, integrating the research along the pipeline of using ICT for the research and dissemination of CH.

Listed below is a summary of 1st year research activity of Chiron fellows, by host institution:

PIN: The research focused on standardization, data organization, management and processing, and also methodological and theoretical aspects of these. The main objective was to implement the Swedish FMIS-data into a GIS database and develop methods for analysing these data. Side aspects included evaluation, data validation and user interfaces. The research project endeavoured to

manage different sources such as historical documents, ancient maps, images and drawings, modern excavation databases and field notes, relevant to the afore mentioned subject. Daniel Löwenborg's article below details first results of this activity.

UoA: The 4-year project 'Creating the Museum' investigates the use of various ICT applications, including virtual reality, in archaeological presentations and interpretations of the past focusing on their effect on visitors. These investigations will be placed in a museological and cultural communication theoretical framework, which is by definition multidisciplinary and combines among others, archaeology, sociology, psychology, pedagogy, instructional technology, information science and media studies. Laia Pujol's article summarizes her research as a fellow at UoA, which is also based on her PhD thesis.

BGU: the research focuses on GIS and remote sensing applications to field archaeology. The research project concerns using satellite high definition imagery to spatially organize a number of archaeological datasets and improve their inter-relation, and/or to re-use existing archaeological documentation (dating from the '50s to the '80s) under different formats and structures, to be managed within a GIS/database environment. The archaeological value is highly relevant, because concerned sites are used to define "cultures" or are typical of specific conditions (e.g. nomad sites of the 5th millennium BC). The research focuses on the human settlement development in the 6th – 4th millennia BC in the Southern Levant, and its relationship with the natural environment. The research integrates excavation data, remote sensing data, satellite images and other resources into a wide GIS based database.

Brighton: the first 12-months fellowship (Mia Thornton) program focused on technological applications to multimedia communication of cultural heritage. The research examines the capacity for intercultural interpretations of virtual heritage within museums/monuments/sites. This is proposed through reconceptualising virtual heritage technologies as cultural forms, not as pieces of technology impacting on culture but rather themselves as cultural constructs. In this way, virtual heritage is not merely a physical object but also considered in terms of its cultural heritage content.

Ename Center: two 12-month bursaries concerning the design of on site presentation systems for archaeological sites and monuments, cultural routes and innovative museum designs. The project will focus on the domain of dissemination and evaluation of ICT applications in the field of public heritage interpretation. In particular, it will examine the case of heritage interpretation centres, a new form of public communication institutions, which highlight the significance of local heritage, through displays, educational programs, and community activities. Evangelia Argyropoulou and Stella Malliaraki present below their conclusions of their research related to this subject.

UYORK Two 12-month fellowships starting as planned in month 11 of year 1 to synchronize with the academic calendar. The purpose of the first research is to describe an open enterprise architecture framework, called "GeoHistory", for GIS-based cultural heritage documentation and management. This research examines how Enterprise Architecture can be configured to embrace historical cultural projects. Caner Guney describes in great detail results of this research, which is part of his PhD research subject.

The second research regards visual communication, in particular ways in which the discipline can best present visual (archaeological) information on the Web. The emergence of web-based technologies presents a significant opportunity and challenge for archaeologists attempting to collect, process, present and ultimately preserve graphical information for continued use. As part of the development of 'Web Standards' by the World Wide Web Consortium (W3C), the emergence of the eXtensible Markup Language (XML) has brought new functionality to The Web, and this has created further opportunities for archaeologists in many areas, including those interested in visualisation. The tools of XML visualisation are Scalable Vector Graphics (SVG) for two-dimensional data and eXtensible 3D Graphics (X3D) will likely be the recommendation for data

expressed in three dimensions. Holly Wright (second Chiron fellow at U.York) published below her first conclusions and will continue to work on this subject during her PhD studies.

ETHZ: The main goal of the research concerns 3-D reconstructions of archaeological sites, particularly with the aim of reconstructing the non-monumental quarters at archaeological sites, as these generally fall outside the scope of most 3-D modeling projects. To reach the goals, new grammar-based methods for the abstraction of architecture should be found, which leads to a connection between formal and polygonal representations of buildings. The design grammars will simulate building styles of a particular era and site. Obviously, here expertise about these styles needs to be offered by archaeologists. Applying directives of a high architectural level in the development of 3-D modeling techniques will automatically lead to a reliable and visually realistic transformation of the site maps into virtual reconstructions. Their construction will follow rules about the architectural styles from the period, and will be constrained by any additional, auxiliary information that the archaeologists can provide. Tjil Vereenooghe, 1st year Chiron fellow at ETHZ took part in this research activity.

Summary

Chiron is an Early Stage Training and Research project, under the Marie Curie programme. Its twofold goals are to define the different components of the framework of communicating Cultural Heritage by means of New Technologies and how to enhance the effectiveness of bridging between technology and Cultural Heritage. Its common research agenda focuses on the definition of a clear organisational and disciplinary framework for increasing the effectiveness of work at the interface between technology and the cultural heritage of human experience represented in monuments, sites and museums. This framework encompasses all the various work processes and flows of information from archaeological discovery to education and dissemination in the various environments and for the different target public. The articles presented below summarize the first year of Chiron's research activity.



Figure 1 . 1st year Chiron fellows at a meeting in Prato (Italy)

Bibliographic note:

Sorin Hermon received in 2003 his PhD in Archaeology from Ben-Gurion University of the Negev, Beer-Sheva, Israel, where he taught courses related to human evolution, introduction to prehistory, theory and methodology of archaeological research and computer applications to archaeology. He participated and conducted several excavations in Israel and research projects focusing on the role of lithic industries for the reconstruction of socio-economical organisation of proto-historic societies. His main fields of interest are theoretical and methodological issues related to visualization and 3D modelling applications to archaeology, fuzzy logic concepts applied to archaeology, socio-economic processes in the prehistory of the Southern Levant and lithic studies.

Sorin Hermon published several articles related to the above mentioned fields and is the co-author (with Isaac Gilead) of “The lithic assemblages of Abu Matar and Safadi – two Chalcolithic sites in the Negev, Israel”, and is co-editor (with Franco Niccolucci) of “Multimedia Communication for Cultural Heritage”, proceedings of the PRISMA conference, held at Prato, Italy, in 2001 and “Beyond the Artefact – Proceedings of the CAA Conference 2004”.

Since 1999 he is working as a researcher at VAST-Lab, PIN, University of Florence, a laboratory specializing in ICT applied research to Cultural Heritage.

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FLEXIBILITY INSTEAD OF STANDARDS?

How to make digital databases on cultural heritage useable to large audiences – a researchers perspective

Abstract

With archaeological and cultural heritage information being increasingly available in digital format, it is tempting to make these databases available to do complex searches of large areas, like for all of Europe. Such an enterprise will naturally have to face many problems along the way, and in this article the author wishes to highlight some issues that have become apparent from working on a limited area with the Swedish database on cultural heritage information. It is suggested that it might be worthwhile to avoid very strict standards and instead go for flexibility in the database and ensure interoperability to as many formats and applications as possible. The use of the application FME Workbench is put forward as a suggestion as how to overcome some of these problems.

Introduction

The digital revolution is now starting to hit the sector of cultural heritage (CH) with full force. Even the group of people working in archaeology, that sometimes seem a bit reluctant to pick up on new innovations, has realised the benefits that the modern technology has to offer. There is an increasing number of examples of how technology can be used to heighten the experience of ancient cultures through sophisticated computer graphics and virtual reality. There is also a general awareness of the possibilities for research that comes with the enhanced availability of information that the internet provides, and the means of processing vast and complex spatial data that GIS application offers. Together, these factors have a clear potential of redefining how we do archaeology, the kind of questions we ask, the level of information we can process, and the scale we are working at, etc. However, as always with the use of new technologies, there are several problems in the beginning, as how to handle the technology and the new theoretical problems that comes with the technology and just generally how to do thing in the most efficient way. When the enormous possibilities of the new technology becomes apparent to more and more people working with CH, there is an (understandable) tendency to dive head-first and start exploring what can be done. The result is often chaos to some degree, but in the meanwhile, we learn more and more on the best practises. With time, however, it will be necessary to take a step back and try to think about more long term perspectives on how to make sure that what we are doing is relevant and useful even after the initial euphoric excitement of playing with the computers and exploring the possibilities have settled.

Databases of cultural heritage information

At the present time, there is an increasing availability of databases where information on different aspects of cultural heritage is being collected and stored, the intention is often to make the information available over the internet (Clark 2001). With modern computer applications, it should thus be possible to combine vast amounts of data and analyse this in relation to each other and in combination with other sources of information (Schlader 2002). However, there are today no standards for heritage data, and there are often problems of incompatibility of formats when records are being digitised. This makes it difficult or impossible to analyse databases of different origin, even if the content are similar and it would be beneficial to compare them together. There can also be problems when there is well established applications and methods for a certain task, if the databases holding the information needed is in a format that is not supported by the existing technology. Another problem might arise due to the fact that the needs of those who use the database might differ substantially, and not always be in line with the original intentions of why the database was designed in the first place. The data contained therefore needs to be detailed enough to meet the demands of the most advanced users, but also in a format that is well adapted to different users and simple to query (Sugimoto 2002).

Databases have long been used within archaeology, as an effective way to store and handle data collected at excavations and surveys. These databases have, however, often been specific for each

and every investigation, in terms of how the data has been organised and labelled. With the increasing use of technology for cultural heritage, the diversity of the data can thus cause considerable problems. Where technology should be an aid for whatever task is at hand, the increasing dependency on technology can be a problem, with much time being consumed in order to make it possible to start working on the data. Advanced computer applications have only been used for a short amount of time in the CH sector, and there is a hope that in the future it will be possible to overcome these initial problems and that research and management will be able to utilise the technology to facilitate the work greatly (Madsen 2001).

Making data usable to everyone?

To meet the aim of making it possible to integrate diverse datasets, different paths are available. One is the use of standards, where all data should be entered in a common form and format, and thus fully usable to all who comply with the same standard. Examples of such attempts are the CIDOC CRM project (<http://cidoc.ics.forth.gr/>), which aims to create a common standard for data to be used within the museum environment, and the Dublin Core Metadata Initiative standard (<http://dublincore.org/>), what deal with standardised form of data, without considering the media. For the software side of the problem of standards, XML has been put forward as a possible way to tackle some of these problems (Niccolucci 2002). By shaping data in a way that will ensure that it is widely accessible, much will have been gained. However, it will never be possible to come up with one common standard that will work for everything. There will always be different needs that require different solutions, and the use of different specialised software, that in their turn are developed and in a worst case scenario may not always support the same formats of earlier versions (although we should at least demand backward compatibility). It would be difficult to come up with one solution of standards to solve all imaginable problems.

Another alternative to creating standards is to ensure interoperability in-between the different applications. If data is stored in a way that makes it possible to use, either direct or indirect, with the application of choice, there is less need to make everything absolutely in accordance to the same standard and format. The idea is to ensure that it is possible to transform the format to data that is useable for everyone within a certain sector, if the application cannot use the format the data is being stored in from the start. For this purpose, XML and different versions of XML can indeed prove very valuable. A problem with XML is however that the format can be difficult to work on within the specific application the user wants to work with. However, as long as all different databases are compatible with XML, it should be fairly straight forward to convert on-the-fly when importing data in XML before working on a dataset, and then convert back to XML for storing and sharing purposes. XML does in this case function as the media of data between different applications, even if none of them are actually processing the information in the XML form.

Although XML is a powerful format for database management, it too carries limitations, and can not deal with every kind of data. This does however not prove the idea of interoperability false, but it may be necessary to look for different solutions sometimes. One such method for facilitating interoperability is to use a specific application that performs the conversion from one format to another. This would result in a separate step between the applications, and thus more work in the process of ensuring interoperability. On the other hand, more complex and diverse data could be handled in this way, and there is less need for streamlining the different applications and formats. This method is especially useful when handling geographical data, such as GIS, that has a spatial information attached to it, which can be difficult to facilitate otherwise. In the process of conversion of the data, it could also be transformed to comply with the specific needs with much control.

In the present debate on how to put the digital technology to best use in the sector of CH there are often voices raised that there should be a common standard for all the European area, in order to make wide range analyses of the archaeology/CH of the whole continent. Although this is a praiseworthy idea, for highlighting the need of large scale international approaches in research,

there are overwhelming practical problems of creating a standard that everybody in Europe working on CH would be happy with.

Working with diverse formats – interoperability instead of standards

For my own research I have been working with the Swedish National Monuments Record (NMR), which has recently been digitised for all of Sweden (FMIS - <http://www.fmis.raa.se/fmis/>). This makes detailed survey data available in a digital format, initially to professional archaeologist, but in time it will be open to the general public over the internet. Although the digitised NMR is a great material for any archaeological study of Sweden, the data is not entirely straight forward to analyse with GIS due to the fact that it was designed for on-line access over the internet. To be able to analyse the data contained in this database, it was necessary for me to redesign some aspects of how the data was organised, a task that proved to be quite difficult. This work raised some questions and ideas to on how it might be appropriate to handle databases of this kind, on both the national and international level. Since so much work now is being done in the way of strengthening collaboration on information technology in CH, I think it could be a good idea to share some of my experiences on working on a existing database of this kind. Thus providing a view on problems and benefits of this kind of material from one of many end users; the academic researcher.

The FMIS web application has a function to extract data, and export that in GIS files for either ESRI ArcGIS systems or MapINFO, with the attribute data in either XML or dbf format. It is thus possible to work on the data in the standard GIS packages directly after downloading the data. However, the data is structured in a way as to be easily viewed in the web application, and not in an ideal way for working and analysing the data contained. Therefore, it was for instance necessary to redesign the table containing the information of all individual monuments that belong to one single archaeological site, typically graves of different character within the different burial grounds. By doing this, it would be possible to analyse all the burial grounds in terms of what kind of graves they contain, and start looking for chronological or regional differences.

In the original form of the attribute table for the graves, the different characteristics of the grave, like type of grave, shape, construction, and other attributes, were separated into different columns, with the number of the graves the attributes were relevant for (in the case when there were several graves that had been characterised in the exact same way, at one and the same site) in a separate column again (Fig. 1). With the characterisations of the graves thus split up and divided, it would be difficult and impractical to analyse in the ways I needed. Therefore a new table was created (Fig. 2), with separate columns for all the possible combination of attributes, representing all the unique grave designs that the classification of the record allowed. With this completed, it is possible to look at differences between burial grounds based on the individual graves they contain.

ID	Comb Id	Raa-number	Type	Shape	Construction	Attribute	Number
1	3476	Alby 56:1	Stone setting	Round	Stone filled		4
2	3476	Alby 56:1	Mound	Round			3
3	3476	Alby 56:1	Stone setting	Round	Unfilled		12
4	153	Alsike 76	Erected stone			Monolith	2
5	153	Alsike 76	Stone setting	Oval	Earth filled		3
6	7284	Tierp 32:2	Stone setting	Round	Stone filled		2
7	7284	Tierp 32:2	Stone setting	Round	Earth filled		5

Figure 2. A schematic image of the table before the redesign. Fictive numbers

Comb ID	StS_r_sf	StS_r_uf	Sts_o_ef	M_r	ES_m
3476	4	12		3	
153			3		2
7284	2		5		

Figure 3. The same table after the redesign

Extract Transform Load

The task of redesigning the table was performed with the Extract Transform Load tool, FME (Feature Manipulation Engine) Workbench by Safe Software (<http://www.safe.com/>). This application has also proved valuable for several other tasks, through its ability to combine different kinds of data (according to the web page 150 formats are supported) or extract specific data from complex databases. In the case of the redesign of the table, a scheme was created that extracted the information in the different categories and sorted them into the new table (see Fig. 3).

The Workbench, which is the engine used in ESRI's Data Interoperability extension and thus thoroughly reliable for ArcGIS data, functions through a graphical interface. A database or table is imported, and an format for the output is selected. This gives a graphical view of the content of the data, with the different columns of the table divided into segments, to be treated individually if necessary. Then "transformers" – the different tools that performs the operation at hand – are dragged into the view, connected to the desired input and output and set up. In the case of redesigning the table containing the information about the grave fields, the transformer *Attribute Filter* was used, which made it possible to extract the information on different types of graves separately. Then the different subdivisions, such as form and construction details for each category of graves was filtered up to two times more, to include all unique possibilities. These were then linked to the output table, where a field had been created for all combinations of type, form and construction. The FME Workbench then sorted the values for each field to its correct location in the new table. To ensure that all the individual types of graves that were within the same burial ground were in the same row of the table, another transformer was used, the *Attribute Accumulator*, that combined the different grave types based on their combined id key (Comb ID), that are common for all the graves within a single grave field.

This results in a table that have all the grave fields as entries, with columns for all possible designs of graves containing the value of each type as an integer. The table was then converted to Excel, as the simplest way to sum the fields to have an entry with the total number of graves for each grave field. Finally, the table was combined with the Shape file containing the geometries of the grave fields, creating the kind of rich GIS data about the graves that was needed for further analysis. In the process of redesigning the table, a "waste-file" is also created with all entries that were not filtered to the output table to make sure that no entries were disregarded by mistake.

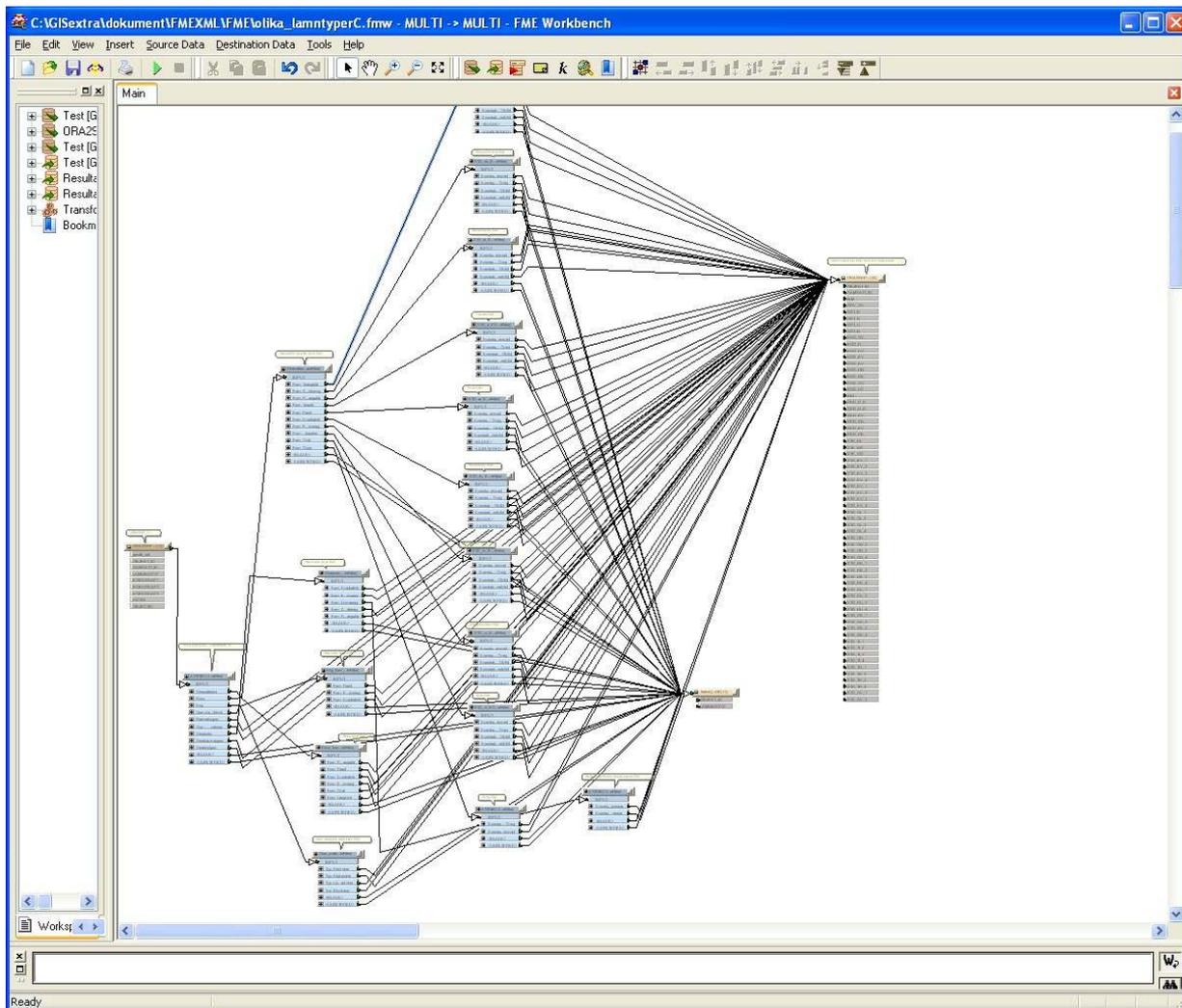


Figure 4. Extraction of information scheme

Conclusions

This paper has focused on interoperability through standalone applications - for overcoming the problem of working with data in different formats, with a case study of how this has been done within a cultural heritage project working on data from Sweden. This could be seen as an alternative way to strict standards of format and media, for ensuring that collected databases can be used by everybody who needs to work on the material. Although XML has been shown to be very useful within CH in order to create complex and flexible databases (Sugimoto 2002), and will probably be a valuable medium for sharing data between different organisations, there will also be a need to ensure that the information is structured in a way that is appropriate for the task at hand.

The idea of making it possible to share and combine data internationally is an important task for the future, but making standards that everyone can comply with might be something of an utopia, with too many problems such as linguistic and cultural barriers (Kvamme 1995). The strategy chosen to maintain interoperability, will have to be evaluated for each single project, depending on what kind of needs the database will meet, and what information it will contain. For a well defined material of a limited area, like for Mediterranean archaeology, it could well be worth building a consolidated database of one single standard (Constantinidis, in press). But when the material is too diverse, and the conceptual differences of the material is too great, forcing the information of such a complex material as archaeology, where each and every object is unique and object for interpretation, into an artificial conformity, would probably do more harm than good.

The purpose of this article has been twofold; to point at a possible problem with standards in archaeology, and to suggest part of a solution. From the point of a researcher, working on an early example of a “standardised” database on cultural heritage, it has been apparent that it is not enough to ensure that standards are interoperable in terms of format, content and concepts. When the database is to be put to use, it is also important that the data is organised in a way as to make it possible to analyse in the best way to answer the questions at hand. When I have been in contact with representatives from the Riksantikvarieämbetet, they have commented that they indeed considered building the table of the grave fields in the way I would like it, but instead went for the present form, since that suited their needs for flexibility of the database and web access better.

For me, many problems relating to database formats and structure have been solved by using the FME Workbench application, developed by Safe Software. This is indeed the same application that Riksantikvarieämbetet uses to make extractions from their database, in order make them in the format the user chooses in the online application. By using such a standalone translator of data as step in between storage and analysis, it is not only possible to work with different format together, but also to ensure that the data will be structured in the optimal way for each and every end user. Hopefully a lot of work and effort could also be saved if the databases from different countries do not have to be forced into a more strict standard then to ensure that they are possible to convert with such an translator.

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TOWARDS CONCEPTUAL DESIGN OF “GeoHistory”

Abstract

This paper examines how Enterprise Architecture (EA) can be configured to embrace historical cultural projects. The EA approach is one of the most challenging concepts in information and communication technology (ICT) today. A strong business model and a strong technical architecture are imperative for the growth, maintenance and success of any e-business. “GeoHistory” can be used as a fine-tuning EA framework for Geospatial Information System(GIS)-based cultural heritage documentation projects. It presents an innovative, adaptive and unified framework design for EA that breaks the overall architecture into its major component areas. Then for each component area, a sub-architecture framework is defined. Together, all architecture frameworks define a vision for successfully implementing EA in cultural heritage projects by improving e-business through semantic, interoperable, and enterprise integration. To achieve this, “GeoHistory” makes use of state-of-the-art open-source technology, including the Web, network, database, programming and visualization, and extends their functionality with common technologies and standards like UML, Linux, Java and XML to create a highly scalable ICT infrastructure. Finally, the paper highlights an enterprise approach, such that all data and services associated with cultural heritage can be accessed and manipulated through the Internet in an open, seamless GIS-based platform to insure accurate and effective decision making on cultural resource management.

Introduction

Information and Communication Technology (ICT) plays an increasingly critical role in almost everything these days as well as in the work of the heritage sector, which acts to understand, promote, present, preserve, and improve access to humanity's cultural and natural heritage. Many of today's cultural heritage (CH) organizations rely on digital information and communication technology to gather, organize, interpret, and disseminate data relating to their various projects. In many cases, this involves applications and services that were created at different times and designed for different computing platforms. The challenge now faced by these organizations is to provide efficient and effective methods by which these disparate technologies can work together to achieve academic and/or commercial objectives that are constantly evolving. “GeoHistory”, a spatially-enabled open enterprise architecture framework for the cultural heritage domain, has been developing in response to this challenge.

Enterprise Architecture (EA) is a concept from the business world which involves identifying the main components of an organization or project and clearly articulating how these components function together to achieve defined objectives. To achieve that, enterprise architecture requires a framework for focused business-ICT alignment, change management, technology selection and excellence in execution. “GeoHistory”, as an enterprise architecture framework, applies this approach to the cultural heritage domain through the use of particularly spatial informatics and cultural informatics.

“GeoHistory” faces the challenge of designing, building, deploying, implementing, validating, monitoring, evaluating, and maintaining an enterprise architecture for the cultural heritage domain. In the context of this study, the focus will be mainly on the design process which describes its design rationale in attempting to achieve maximum flexibility, interoperability, interactivity, maintainability and scalability for cultural heritage projects.

The whole approach is exemplified using a real-world case: the documentation project of two 17th century Ottoman Fortresses, “Seddulbahir” and “Kumkale”, and its goal is to realize the project's motto: sharing “the life history of two Ottoman fortresses on the Dardanelles” with a broad range of enterprise constituents and public users.

Defining enterprise and enterprise architecture

This section provides a conceptual overview of the field of Enterprise Architecture. Enterprise Architecture is still relatively immature from both a research and practice perspective and there is not a widespread consensus on the terminology. The terms "Enterprise Architecture" and "Enterprise" are interpreted and defined in many different ways and there is no single universally accepted definition yet.

In the course of developing this study, the definition of the term Enterprise is derived from the book "*How to survive in the jungle of Enterprise Architecture Frameworks*". An Enterprise is any collection of organizations that has a common set of goals/principles and/or single bottom line. In that sense, an enterprise can be a whole corporation, a division of a corporation, a government organization, a single department, or a network of geographically distant organizations linked together by common objectives. [1]

In this context, "KaleTakimi" -a small scale enterprise- is comprised of systems that interact with each other and which also has external constituencies. The internal and external business processes often share common characteristics when managing the enterprise's functional areas. Those systems developed by different groups in different times are operating as one system with a wide vision: This is what is defined as enterprise. Figure1 shows a schematic view of "KaleTakimi" as an enterprise. It includes the full breadth of the organization, as well as the full depth of domains. Different teams in different domains bring their own special set of demands to the business. More demands require secure and fast interactions which are electronic, common standards for information and communication technology. This innovative but at the same time can be disciplined entity-driven architecture and role-based process of "KaleTakimi" ensures consistent, reliable and adaptive business operations. An enterprise generally takes a set of drivers and produces a well thought-out and co-ordinated set of outcomes.

From the viewpoint of this study, definition of the enterprise is an open networked organization for which **knowledge** is the primary resource, **information** is the main asset, **data and data sharing** is the main business concern, and ICT is the underlying tool.

It is worthwhile noting that Enterprise Architecture is an evolving discipline and, in its relatively short life, has already changed considerably in its scope. In the beginning, enterprise architecture was purely a function of IT. Its work was focused on issues such as enterprise application integration and formulating and implementing technology standards across the enterprise. Over the last decade or so, enterprises around the world have become more focused on improving their processes and flexibility on all levels through activities such as Business Process Reengineering. Against this background, enterprise architecture has broadened to become a critical connection between high level business vision and its effective expression through strategy, human process and automation. As a discipline, it sits, almost as an umbrella, over business, technology, application and information architecture. [2]

Enterprise Architecture refers to the architecture of an Enterprise, identifies the main components of an organization and how components in the organization's nervous system function together to achieve defined business objectives. Components in this context are all the components that enclose the areas of People, Processes, Business and Technology, for instance, goals, strategies, financial information, governance, domains, stakeholders, services, information, communications, applications, technological infrastructure, databases, networks etc. [1, 3, 4]

An EA is, in some sense, a statement of philosophy. Like all philosophies, it must begin with assumptions about the present state and the desired future state. [5] After documenting the present state architecture and designing the future state architecture, a transformation strategy is developed by identifying the gaps between the as-is state and the to-be state, which enables an enterprise to evolve from the legacy systems of disparate stovepipe applications towards the to-be set of modernized, agile, and integrated business processes.

When creating an architecture it is useful to have a framework to identify and categorize the parts of the architecture [4]. Since there is no single universally correct or widely agreed-upon standard framework, organizations can either create their own framework or use an existing one of which there are several well-known frameworks available like Zachman Enterprise Architecture [4, 5]. Many organizations borrow/select one or more of existing proven EA frameworks and adapt/customize them to their needs rather than starting from scratch. On the other hand, with such a broad array of goals, it can be very difficult to determine which framework is right for an organization.

After several different schemes for defining enterprise architecture structure has been reviewed, “GeoHistory”, multi-tiered conceptual framework, was begun to develop from scratch with its own interpretation of CH domain with a detailed meta-model in the form of an entity-relationship model rather than adhering one of the high-level industry-accepted frameworks.

Object Management Group (OMG)'s Model Driven Architecture (MDA) and Unified Modelling Language (UML) modelling techniques are being used for designing “GeoHistory” and making it an executable model for the CH domain.

Semantic Web technologies (in particular, Resource Description Framework (RDF) and Web Ontology Language (OWL)) are being used to represent a conceptual reference model of “GeoHistory” by benefiting from some reference models, like CIDOC-CRM by the International Committee for Documentation of the International Council of Museums, OAI by the International Organization for Standardization, ORM by Open Geospatial Consortium, etc.

As intended in its design, semantic interoperability capability of “GeoHistory” allows it to be extended as different uses for another CH projects or organizations within CH domain.

Business architecture of “GeoHistory”

Business architecture of “GeoHistory” is a functional representation of a CH activity which is meaningful to the various levels of users and encapsulated in the business concepts that constitutes well-defined structure to operate the activity properly. The goal of business architecture is to specify the behavior of a “system of systems” in the context of the business for which it is implemented in terms of collaborating and coordinating chunks of business functionality represented as business components.

Although, at first, the term “business” seems to define a profit-generating activity, in the context of this study, the term “business” is intended to define a concept of organization which is directed towards maintaining collective productivity and realizing creative goals regardless of involving commercial aspects, like profit or trade. Rather the term “business” as it is used here, relies on sharing know-how through the exchange of expertise and information to generate new ideas. The reason to use the term “business” in this context is to transcend the limitations imposed by the post modern definition of the term “business”. By expanding the definition of this term the promotion of a common approach to the tasks of e-documentation, preservation, management and communication of CH resources can be better realized.

Scope

As an robust EA framework, “GeoHistory” typically includes the user requirements, the high-level vision, the missions, the business goals, objectives, strategies, solutions, and the design/governance processes under its business architecture. The scope includes every phase of CH information technology: initial data capture/digitization, information/data processing, reconstruction, visualization and documentation as well as dissemination of results to the scientific and cultural heritage communities and to the general public.

User Requirements

Business architecture view focuses on functional aspects of the enterprise from the perspective of the users of the systems - that is, what the enterprise is intended to do. This can be built up from an analysis of the existing environment and of the requirements and constraints affecting the enterprise. In cultural heritage research, having an idea, acquiring data, and processing it isn't enough. With regard to ICT, there are many scientific and technological challenges facing those working in the CH domain. Meanwhile, these challenges below address the problems that will be solved in the course of the study. The initial challenge for CH organizations is to better understand the past, achieve sustainable and successful management of cultural heritage resources and facilitate effective decision-making on CH by reducing project costs and time.

Recent developments in computing –the growth of Web applications, advances in data management and visualization technology, object-oriented programming, mobile computing, and wide GIS adoption- have led to an evolving vision and role for CH domain. CH organizations have demand on using best-of-breed ICTs in their projects in order to promote their research and teaching practice and enable some significant scientific researches of cultural heritages which would not be possible without them. On the other hand, most of those organizations claim that using these dizzying cutting-edge technologies is difficult due to the high cost of software and/or data processing, and complexity, and the required training. In other words, researchers would prefer to focus on the science of CH instead of computer science. Furthermore, these state-of-the-art technologies make it possible to access data in cultural heritage objects, like intact artefacts, while preserving them untouched for future research.

The CH community needs more versatile communication among all relevant disciplines, stakeholders and users of a cultural heritage project, primarily, between CH data/information/content/application providers, who are aware of that their expertise has strategic potential for CH projects, such as surveyors, photogrammetrists, mathematicians, statisticians, computer scientists, data management specialists, graphic designers, and CH specialists, who are sensitive to the importance of cultural heritage resources, such as archaeologists, historians, art historian, architects, conservation experts, museologists, curators.

CH field is now a very data and information abundant sector as well as others because of the exponential growth of data volume, complexity and quality driven by the exponential surveying (involving laser scanner, GPS, geophysics, satellite imagery data, chemical analysis) and computing technology. The challenge for many organizations is to unlock existing data held in research team's own silos and to make it available across the CH organization to perform strategic and operational decisions.

There is also a need within the CH community to deliver more innovative, accurate and better content/data/information/applications/services. Better service delivery enables the exchange and sharing of spatial and non-spatial CH resources.

As indicated at the beginning of this section, in cultural heritage research, having an idea, acquiring data, and processing it is not enough. CH research requires exploration of terabytes of data and the transformation of qualitative observations into quantitative results by placing management, process,

computation, presentation and dissemination of vast volumes of data at the heart of modern cultural heritage research.

Vision & Mission Statements

The high-level vision of "GeoHistory" is to engineer an enterprise architecture framework which proposes innovative, interoperable, scalable, and flexible enterprise solutions in a holistic way in order to fulfill the cultural heritage domain's specific user requirements that are indicated above.

"GeoHistory" highlights an enterprise architecture approach, such that all data and services associated with cultural heritage resources can be accessed and manipulated through the Internet in an open, seamless framework to ensure accurate and effective decision making on sustainable and successful cultural heritage management by maximizing the use of (geo)data, (geo)semantics and (geo)visualization.

To achieve this, the key issue is 'technology choice and fusion' based on an open architecture. "GeoHistory" uses the integration of technology that brings together different open source state-of-the-art technologies and open standards, including UML, XML, SOAP and Java, and extends their functionality with Internet, object-oriented concepts, business logic and GIS features to create a highly scalable ICT infrastructure by initiating a dialog between technologies and CH professionals. This strategy makes it possible for "GeoHistory" to have a broad interoperability across heterogeneous data silos and application environments. It closely follows emerging standards and technologies and also validates new technological approaches to develop the best of breed cultural heritage applications and services.

Business Goals

The business goals of "GeoHistory" were extrapolated at a conceptual level below based on the future state functional and technical requirements of CH domain:

1. Gather the knowledge and experience of how best to bring technology, processes and people together and address the impact they can have on each other in order to describe a specific way in which to model CH research, projects, organizations as an enterprise, and explore spatial, temporal, social, cultural, and economic interactions. Make all the business processes Web-based as part of the e-business that is e-heritage solutions for cultural heritage domain by ensuring adequate security & authentication.
2. Propose a service-oriented component modelling and design approach organized around the concepts of services and components in the Service-Oriented Architecture. Perform adaptable design of "GeoHistory" in order to position the enterprise to respond rapidly to changing needs, emerging opportunities and threats of CH domain in terms of business strategies, governance, and technologies by aligning business and ICT strategies.
3. Document the entire architecture from requirements to implementation and define the shortcomings in business and technological considerations need to be addressed.
4. Transcend the traditional/hierarchical boundaries among different domains within an inherently interdisciplinary framework that has a broad range of constituents and interfaces. Provide better understanding, productivity, decision making and science by supplying interdisciplinary collaboration and exchange of knowledge and expertise.
5. Share consistently deliverables internally and externally. Join up data, meta-data, information, knowledge, contents, (web) applications, services, resources, and systems in one united environment, which is web interface, in order to enable every member of a research team and/or other users to interact with the deliverables no matter where they are

- located. Build rich virtual research environment and a web based resource for edutainment and e-tourism.
6. Reduce data silos with higher levels of integrity and accuracy. User works against one integrated system of systems that provides dynamic and changeable views of same information and eliminates duplication of data or data silos.
 7. Set up technology enabled platform fundamentally based on a rapidly developing technology. Provide CH professionals with an understanding of some of the complex technical and specific technical management issues that must be addressed when carrying out CH projects.
 8. Deploy high-level technologies. Provide seamless integration of information, communication and geospatial technologies and their functionalities to improve the acquisition, distribution and use of data and information. Facilitate interpretation, exploration and analysis of large volume of data by providing 'data exploration and discovery tools', 'state-of-the-art visualization', 'interaction and computing technology', 'analytical tool kit'.
 9. Extrapolate at a conceptual level the future state functional requirements and technical requirements and compare current technologies to those future state needs to identify gaps.
 10. Formulate affordable and interoperable solutions. Assemble “GeoHistory” based on open architecture involving open computing standards, such as UML, XML, SOAP and Java to formulate and implement technology standards across the enterprise and to ensure interoperability with third-party tools.
 11. Examine geospatial information technologies, like (Geo)Spatial Information System (GIS or SIS), within both enterprise architecture and cultural heritage domain. Integrate various information systems (CH Site Management System, Architectural or Archaeological Information System, Monument Information System, Tourist Information System, (Geo)Spatial Information System, etc.) in one coherent architecture in order to facilitate integration of enterprise data and/or etc. and promote information sharing, increase usability and reduce IT maintenance costs.

Business Strategy

“GeoHistory” life cycle was divided into six parts:

1. Design and Assess
2. Build
3. Deploy and Implement
4. Validate
5. Monitor and Evaluate
6. Maintain

Design Strategy

Component-based modelling and design approach in this study, which is basically model-driven but also incorporates several agile development principles, is being used as a basis for modelling a Service-Oriented Architecture (SOA). This service-oriented component modelling and design approach provides a paradigm shift from components as objects to components as services that makes component concepts capable for modelling the architecture of collaborating and coordinating loose-coupled business-valued services. The approach is flexible and agile, providing the way of balancing business and IT concerns, and adopting changes from both sides. Using the analogy

between the concept of service and a business process, SOA provides that loosely coupled services are orchestrated into business processes that support organization's business goals.

"GeoHistory" presents an innovative, adaptive and holistic unified framework design for EA that breaks the overall architecture into its major component areas. Afterwards for each component area, a sub-architecture framework is defined. Together, all architecture frameworks define a vision for successfully implementing EA in cultural heritage projects.

The design of "GeoHistory" was defined a three-phase development process consisting of overall EA framework and its sub-frameworks design, the components design within the frameworks and seamless integration of the components steps.

The overall framework will be multi-tiered to maximize flexibility, adaptability and stability. In a multi-tiered model, "GeoHistory" consists of several distinct but highly interrelated frameworks, each of which can be conceptualized as having its own distinct architecture.

"GeoHistory" is an integrating framework which incorporates the following architectures:

1. Business Architecture: The enterprise architecture describes the business but is also a part of the business. Therefore the architecture can be described within the architecture in terms of it's models, data, processes, etc.
2. Technical Architecture: The technical architecture within EA is the design required in order to "build a responsive IT infrastructure", "develop and manage distributed systems", "plan and manage communication networks", and "define how your business will operate in the next generation of enterprise technology".
3. Data Architecture: A major design objective of the data architecture within EA is to enable "effective use of the data resource".
4. Information Architecture: Information Architecture is defined in this study as "a high-level map of the information requirements of an organization". It shows how major classes of information are related to major functions of the organization.
5. Application Architecture: The form and structure of the application architecture within EA is specifically designed to "improve the effectiveness of application development".

In this study, the focus will be mainly on technical, rather than business, data, information, or application aspects. Figure2 outlines this design philosophy.

Enterprise Architecture is about understanding all of the different components that go to make up the enterprise and how those components interrelate. Components in this context are all the components that enclose the areas of People, Processes, Business and Technology. In that sense, examples of components are: strategies, business drivers, governance principles, stakeholders, units, locations, budgets, domains, functions, processes, services, information, communications, applications, systems, infrastructure, databases, networks etc.

A component does not exist in isolation; it fulfills a particular role in a given context and actively communicates with it. A component participates in a composition with other components to form a higher-level component. At the same time every component can be represented as a composition of lower-level components. A component must collaborate and coordinate its activities with other components in a composition to achieve a higher-level goal. Well-defined behavioral dependencies and the coordination in time between components are of great importance in achieving the goal.

A component is a module designed for a specific function and a component may also be replaced with a more appropriate component in the course of a enterprise's growth and as technology

changes without affecting the rest of the architecture. Changes can be confined to particular components or areas.

The component-based design approach works very well in many ways, in particular, how all parts of an enterprise work together to provide the capability of an enterprise to achieve its vision. Seamless EA integration step shows how the components fit together through relationships among the components in the component network. "Unified Modelling Language (UML)" was selected as the primary enterprise modelling and design tool for advanced modelling using a top-to-bottom approach of "GeoHistory".

Development Strategy

"GeoHistory" becomes the blueprint of the "KaleTakimi"'s business goals and processes and underlying IT infrastructure. The concepts and principles presented in this study can be also applied in other cultural heritage projects.

A meaningful mission of this study is first to put "GeoHistory" to work via the documentation project of "Seddulbahir" and "Kumkale" Ottoman Fortresses and then, provide an EA pattern including semantic approaches. Open and ready-to-manipulate capabilities of the pattern allow the other CH organizations to tailor their solutions freely and easily.

Technical architecture of "GeoHistory"

"GeoHistory" has a comprehensive and sophisticated ICT strategy to fulfill enterprise's technical challenges in order to create the most productive enterprise computing architecture for Cultural Heritage domain and Cultural Heritage Informatics by deploying high-level technologies. Major challenges are seamless integration of multiple disparate technologies to distribute the standards-based, interoperable and interactive services through an open, secure, scalable, distributed and loosely-coupled technical architecture and infrastructure that meets the demands of the enterprise's growth.

In the course of designing technical architecture, to suit CH Domain needs, a comprehensive overview of ICT and their integration problem was realized. There are not only a dizzying number of both open source and proprietary technologies available in the tremendous ICT market, but there are also rapidly evolving new technologies. To survive within that market, the enterprise needs strong technical architecture, which is possible only when the architecture is flexible enough to accommodate the integration of existing legacy applications, scalable enough to accommodate the new innovative technologies and adaptable enough to technology changes. In the market today, cultural heritage communities should be naturally cautious when they choose the right technology which supports their technical architecture of their studies or projects, especially in terms of cost, time and labor efficiency. In the ICT design strategy, there is a need to understand the technical aspects of the project in order to pick and chose the right technology within the technology chaos.

Today 'being online' means 'being global', since the Internet is geographically independent virtual world. People browse and data moves between geographically separate databases through the Web which is new geographic space. In this design, the Web is being used as a development platform and also user interface (Web browser-based GUI) to distribute data and application effectively.

Mapping technical architecture of "GeoHistory" covers nine main areas:

1. Open Architecture
2. Semantics Architecture
 1. Semantic Web
 2. Web Technology (the Web, Web 2.0, Web 3.0)

3. Service-Oriented Component Architecture
 1. Component-Based Development (CBD) Modelling and Design with Model Driven Architecture & UML/RDF/OWL
 2. Distributed Technologies (From Peer-to-Peer (P2P) System to Web Services and Grid Computing)
 3. Web-based Distributed Multi-Tier Client/Server Computing Architecture
 4. Service Oriented Architecture (SOA)
 5. Web Services Architecture
 6. Web Content Development/Management/Distribution Framework Architecture
4. Data Storage and Management Architecture
5. Visualization Architecture based on Computer Graphics Technology
6. Spatial Informatics Technology Architecture
7. Communication Architecture
 1. Network Architecture
 2. Mobile Computing Architecture
8. Infrastructure
 1. Computing Infrastructure (Enterprise Software)
 2. Physical Infrastructure (Enterprise Hardware)
9. Security Architecture

Technical Architecture Design Pressures are as follows:

- integrity → [semantics]
- standards-based interoperability → [open standards (XML, GML), data exchange standards (XML, GML), semantics]
- interactivity → [visualization]
- global distribution & connectivity → [SOA, Web Services]
- cost-efficiency
- easy accessibility & usability
- security
- flexibility

Open Architecture

To extend and integrate with new technologies later in the process, the architecture is based on open strategy which involves open standards like XML, HTML, GML, and technologies/softwarewares like JAVA, Linux. Although the use of open source software has become increasingly prevalent in many areas of ICT, open source solutions might not always be better or more advantageous than proprietary softwarewares for an enterprise. This decision is based upon the business objectives and timeframes, the quality of open source product and so on. An Open Source Strategy can help to define these for an enterprise. In this study, an open architecture based on open standards is being developed that aims to investigate what the business benefits and pitfalls of open source for CH community. "GeoHistory"s open source strategy is not just about source code. It covers the following strategic considerations together:

- Adopting and using appropriate open standards
- Obtaining more favorable open source licenses
- Selecting right open source softwarewares
- Getting support from multiple communities and/or vendors

It is a tough challenge to choose the right open source solution because there is now too much fragmentation in market. For instance, there are over 100,000 open source Linux projects, or more than 50 open source Web application development frameworks. Not all of them will be successful or get noticed in the realm of the Enterprise. "GeoHistory"s open architecture identified each of the technology domains needed in the enterprise and matched open source products to them.

Technology Domain	Open Source Product
Designing and Modelling	OMG's UML
Development	Eclipse
Productivity	OpenOffice.org
Web Server	Apache + Tomcat
Application Server	JBoss
Database Server	MySQL
Programming	Java
Security	OpenSSH
Operating System	Linux
Modelling Tool	ArgoUML & PoseidonCE
Web Content Management	Typo3

Semantics Architecture

Semantics Architecture of "GeoHistory" provides semantic representation for the enterprise, the data, the information, and the knowledge to improve e-business through semantic interoperability, and enterprise integration using semantic technologies, collaborative technologies, semantic integration and ontology driven semantic interoperability.

UML

It is a fact that architecture framework modelling takes longer than the development of it. It is also a fact that development time can be drastically reduced by proper architecture framework modelling and documenting. UML was devised to satisfy the need to model object-oriented (OO) systems and to enable Component-Based Development (CBD). In an OO system, generally several components are tied together using what are called "interfaces". To understand how those different components interact, it is quite useful to build a model. [6]. UML provides a common language to bring together all the actors of the extended enterprise so that they can understand the e-business, its requirements, and how the architecture framework will be created in a collaborative modelling environment.

"GeoHistory" is being designed with UML that features an underlying meta-model. The UML meta-model expresses the proper semantics and structure for "GeoHistory". In this way,

“GeoHistory” would be flexible and adaptable enough to be customized to the specific needs of any other CH project.

A number of modelling tools are available on the market, ranging in price from free to tens of thousands of dollars per seat license. Choosing the right modelling tool to design the architecture framework of an enterprise depends on the needs, the preferences and the budget of the enterprise. Both modelling tools “ArgoUML release 0.20”, which is open source and free of charge UML modelling tool under the BSD Open Source License, and “Poseidon for UML community edition 4.1.2”, which has its roots in the ArgoUML open source project, were selected to design “GeoHistory” in this study.

Distributed Computing Architecture

To make scalable, flexible, distributed, the architecture is designed in multi-tiered manner. Multi-tier architecture provides the simplicity of developing the system in one development machine and the flexibility to move the components to several distributed machines in production.

There is a significant trend towards multi-tiered applications delivery with separation of data, process, and presentation functions. In this section of the study, an extensive survey and several categorizations of technologies related to Web applications are presented. Evolutionary Steps from earlier computing architectures are categorized as following:

First Generation: Database and Client-Server Applications (Document-centric)

(Early Client-Server Model) (Fat Client) [Two Tier] [B2B] (distributed computing)

Second Generation: Web Applications (Application-centric)

(Web Browser) [Three, Four or n-Tier] [B2B & B2C] (web-based distributed computing)

- Internet
- CGI Applications
- Scalable CGI Applications
- Web Server Extension Interfaces
- Browser Extension Interfaces
 - Applets
 - Client-Side Scripting
 - Rich Internet Applications (RIA)
 - Expanded Use of Dynamic HTML
- Interpreted Template –Based Scripting
 - Server-Side Includes
 - Cold Fusion
 - Server-Side Java Script
 - Active Server Pages (ASP)
 - PHP
- (Evolutionary Step) Middle-tier&Middleware/Java Platform: Java2 Enterprise Edition (J2EE)
 - Servlets, JSP
 - Enterprise Java Bean (EJB)
- Web Application Frameworks
- Persisting
- Enterprise integration – Enterprise Application Integration (EAI)
- Enterprise Portals - CMSes
- Service Oriented Architecture (SOA) [Tierless]

Third Generation: Web Services

(Service-centric)

[C2C + B2B + computer-to-human]

- Web Services SOA
- Model Oriented Architecture
- Role-based Modelling and Deployment
- Internet2/Internet 3?

The Distributed N-tier architecture of "GeoHistory" for enterprise Web applications in its simplest form consists of three tiers: (see Fig. 3).

1. User Tier (presentations, the Web browser)
2. Web Application Tier (middle-tier, middleware, middle services)
 1. Web Server (presentation tier)
 2. Application Server (business logic tier)
 3. Data Persistence (data access tier)
3. Back-End Tier (underlying tier)

The infrastructure required to support this architecture consists of servers to host the web components and the data tier. Network devices (routers and switches) connect servers within the enterprise.

Web Content Development/Management/Distribution Framework Architecture

As the Internet has grown, so have the challenges associated with delivering static, streaming, and dynamic content to end-users. Today's web sites serve as an extremely effective vehicle for data and information exchange and transactions with users, project members and stakeholders, but the details behind these operations can be very difficult to manage. The ability to easily update Web content is a key benefit of a dynamic Web site. But, the scope of "Web content management" is much broader than having the ability to edit a block of text on the Web site.

Enterprise Web Content Management Framework (EWCMF) of "GeoHistory" refers to the creation, management and distribution of enterprise content in a collaborative environment through a Web (geo)portal. EWCMF manages the lifecycle of content in the enterprise. The architecture provides the same content to be rendered through various user devices in a number of different formats, such as PDA or WML.

EWCMF has following Web content types:

- HTML, XML, any text
- Images, photo galleries
- Documents, PDF files
- Proprietary doc formats
- Audio, video, streaming video
- Flash Movies, SVG files
- Multimedia
- Hyperlinks / Web resources
- Any other bits (or etc.)

Web content management is usually a collaborative effort that involves various roles and players. The idea is to allow both technical and non-technical personnel to easily work together in order to simplify and streamline the process of creating high-quality, accessible web portals. "GeoHistory" requires a software tool for editing and constructing enterprise Web contents. The market for content management systems remains fragmented, with many open-source and proprietary solutions available. Choosing the right Web Content Management System requires a good understanding of the capabilities needed to meet the enterprise's current and future requirements. Open Source and Proprietary CMSes on the market were evaluated to provide better business solutions and finally Typo3-version 4.0 as an enterprise-class Web-based open source Content Management System and Development Framework picked, deployed and customized to address the content-centric needs of business of "GeoHistory" building dynamic-content-driven Web sites and portals.

Data Architecture

An evolutionary path has been witnessed in the database industry in the development of the following functionalities: data collection and database creation, data management (including data storage and retrieval, and database transaction processing), and data analysis and understanding (involving data warehousing and data mining). In this manner, "GeoHistory" provides robust data life-cycle management to control and manage CH data throughout its entire life-cycle – from collection, acquisition, modelling, storage, access, process, visualization, dissemination, usage, integration, protection and corruption to eventual deletion. In addition to data management, it promotes a new focus for information and knowledge management for the CH domain through data, information, knowledge, and wisdom chain. Figure 4 shows the data flow in the data architecture of "GeoHistory". "GeoHistory" utilizes a data mining approach to turn huge amounts of data into useful information and knowledge using pattern recognition technologies as well as statistical and mathematical techniques. MySQL 5.x is an open source, multi-threaded, relational database management system that is selected to develop sophisticated database-backed Web sites and applications.

Visualization Architecture

Two goals of visualization are communication and discovery. The growing number and variety of complex information makes visual approaches for communication a necessity. Data visualization is an important technique that helps in the understanding and analysis of complex data. "GeoHistory" provides a uniform framework for scientific visualization, effective integration, and web-based presentation of complex heterogeneous CH spatial-temporal data sets. This framework facilitates interpretation, exploration and analysis of a large volume of CH data with significant geo-spatial, temporal, and semantic characteristics. Advantages of this approach include improved visualization of geo-spatial and temporal raw data; better navigation and selection of data; and intuitive user interface.

Visualization techniques can be classified by whether data display is 2D or 3D based. Most of current CH organizations widely use two-dimensional visualization techniques. On the other hand, there is an increasing interest in 3D representations of geographic data, especially for the universal web access of such data. Both 2D and 3D visualization have their own strengths and weaknesses. When a large amount of data has to be presented in a limited space, visualizing in 2D will introduce a cognitive overload and thus heavily reduce usability. Instead, 3D visualization uses an extra spatial dimension to create a virtual world where information is presented. However, delivering 3D content over Internet is more technically challenging. The difficulty of the distribution and navigation of 3D content over the Internet are the major obstacles that prevent the popularity of 3D web sites. The generation of detailed 3D model is always time consuming and even requires a lot of manual work. Moreover, user interaction in 3D is not always intuitive and may be difficult to learn.

The objective of this visualization framework is to provide a good foundation to integrate various data sources, generate 2D and 3D worlds in an automatic way and provide highly interactive and intuitive graphical user interface (GUI) for users. Thus, "GeoHistory" utilizes the combination of two and three-dimensional visualization to improve usability of the user interface to the largest extent. It provides maps in 2D (SVG graphics) and 3D (X3D graphics). The 2D map gives the user a big picture and overview of the whole world, while the 3D virtual world presents geographical objects in more detail and in a more realistic way. Both 2D and 3D environments can be presented with different levels of details or at different scales, giving the user a choice about the granularity of presented data. Current Web technologies: Scalable Vector Graphics (SVG), Virtual Reality Modelling Language (VRML), and eXtensible 3D (X3D), defined by the World Wide Web Consortium (W3C) provide a necessary foundation for such an architecture.

Data visualization is an important area of data analysis, where the data collected is summarized and presented in visual form to aid in decision-making and in grasping the minute details and relationships of data sets. Another objective of the visualization framework is to analyze very large data sets with data warehousing and data mining techniques. The framework for data visualization architecture is illustrated in Figure 5. It consists of three parts: general visualization component, exploratory visualization component and, VRML development architecture component.

"GeoHistory" needs a global and consistent format for encoding data sets that are from different sources have different formats in order to integrate and present multiple data sources and types in a comprehensible fashion. In this manner, the user can focus on extracting meaning from data without being required to explicitly manage the heterogeneous data. Extensible Markup Language (XML) provides a common medium of data description and display for diverse systems to understand each other. Geography Markup Language (GML) has been defined as an XML encoding for geographic information. GML has been designed to be used as a mechanism for information discovery, retrieval and exchange. This encoding helps in the storage, exchange and modelling of geographic information containing both spatial and thematic data. Geo-spatial and attribute data is retrieved from the data storage tier and is to be further analyzed based on requirement using data mining techniques. The analysis results are presented in various visual forms. The data described and stored in GML can be extracted and styled to suitable graphical representation. XSLT could be applied to the geographical content (GML) to generate 2D (SVG) and 3D (VRML/X3D) geographical presentation.

Mobile Computing Architecture

All devices exist in the physical infrastructure of "GeoHistory", such as servers, workstations, laptops, tablet PCs, pocket PCs (or PDAs), mobile phones, and smart kiosks, are in a networked environment in order to support problem solving and decision-making at any time and any place. Mobile phones and other digital devices are rapidly gaining location awareness and Web connectivity, promising new spatial technology applications that will yield vast amounts of spatial information. Examples of such applications include in-the-field data entry and access, and field mapping applications. All data traffic "over-the-air" from a mobile device to the Wi-Fi network is encrypted for secure wireless communication infrastructure. The basic integration of three technology components for field application:

- Lightweight, low cost, hand-held mobile devices like Pocket PC with phone or smart phones or multimedia phones
- Location positioning (GPS) (GPS-enabled mobile devices like Pocket PC with GPS or field-based Tablet PCs with integrated/add-on GPS)
- Wireless communication (CH site wide wireless connections with enhanced security)

Spatial Informatics Technology Architecture

Everything happens somewhere, from the cradle to the grave and in all aspects of life. Positive events like births, schooling, work, marriage, as well as negative ones such as crime, disasters and death, all occur at a location. As a result, 80% of information has some geographic connection. Increasingly, because technology makes it possible, the linking of that location to people or incidents has become a powerful tool in understanding, analyzing and managing the world humanity live in. Not just to help predict future events and manage them but also to help evaluate a past situation and reconstruct it again as effectively as possible.

(Geo)Spatial Informatics Architecture of "GeoHistory" provides the ability to gather (geo)spatial data, information and associated attributes about the location and characteristics of man-made and natural features and events above, on and beneath the surface of the earth by encompassing a broad range of disciplines including geodesy, surveying, remote sensing, photogrammetry, etc. It then is capable of utilizing (geo)spatial data and information to model, analyze and interpret spatial relationships by encompassing cartography, mapping, generalization, SIS technology, etc. Subsequently, it provides the ability to present and distribute results to enable better decision-making by encompassing SIS technology, Internet, cartography etc. Eventually, it provides the ability to track man-made and natural features as they change over time and space by encompassing SIS technology, etc.

The SIS architecture of "GeoHistory" is currently emerging based on some new technologies that allow all SIS functions to run in a centralized server environment and be accessed from any device on a network, from browser-based user to mobile computing devices on the site. The business objective is to apply SIS to the widest possible range of users in the enterprise by embedding spatial data and technologies, and SIS functionality in enterprise applications.

Another objective is to develop an open SIS architecture including open source SIS softwares and open standards in SIS. Both open source GIS databases PostGIS by PostgreSQL and MyGIS by MySQL are selected to store spatial data. MapServer 4.8.3 developed by University of Minnesota is being used as a SIS map server in the architecture. Since more than 65 spatial data formats are available in SIS market, to retain the interoperability, the architecture is based on open standards, in particular, Open Geospatial Consortium (OGC) standards, such as GML, WMS, WCS, WFS, JPEG2000, GMLJP2.

Conclusions

As stated in the introduction, the purpose of this study was to explore the enormous potential inherent in an intimate relationship between the enterprise architecture concept and cultural heritage challenges. The theoretical concepts underlying the approaches to be advocated here concern the technology-driven cultural heritage studies through consideration of factors such as spatial informatics and cultural informatics.

This study began with a brief description of the interaction of technology with business, thereafter, business concepts were mapped to information technology concepts. Throughout this study a motivation aimed to understand this interaction on a conceptual level.

This study was concerned with the meaning, practice and theory of cultural heritage conservation and management. The intention in this study was to establish connections between post-modern thinking and the fields of business and technology in the CH domain. When CH organizations and the related research in this field can expand the more narrow and traditional definitions of business the conceptual framework will be greatly enriched and the sharing of CH resources and information will be greatly facilitated.

The on-going study design of “GeoHistory” utilizes open interoperable technologies to bring the power of cutting edge ICT technology to the study of cultural heritage resources and to create the most optimum cultural heritage research platform to support the entire life cycle of cultural heritage information.

In conclusion, the study was intended to be a pioneering study for the cultural heritage domain, which assists the researchers to develop new approaches to the CH major, exploration and communication of the past.

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Figure 1

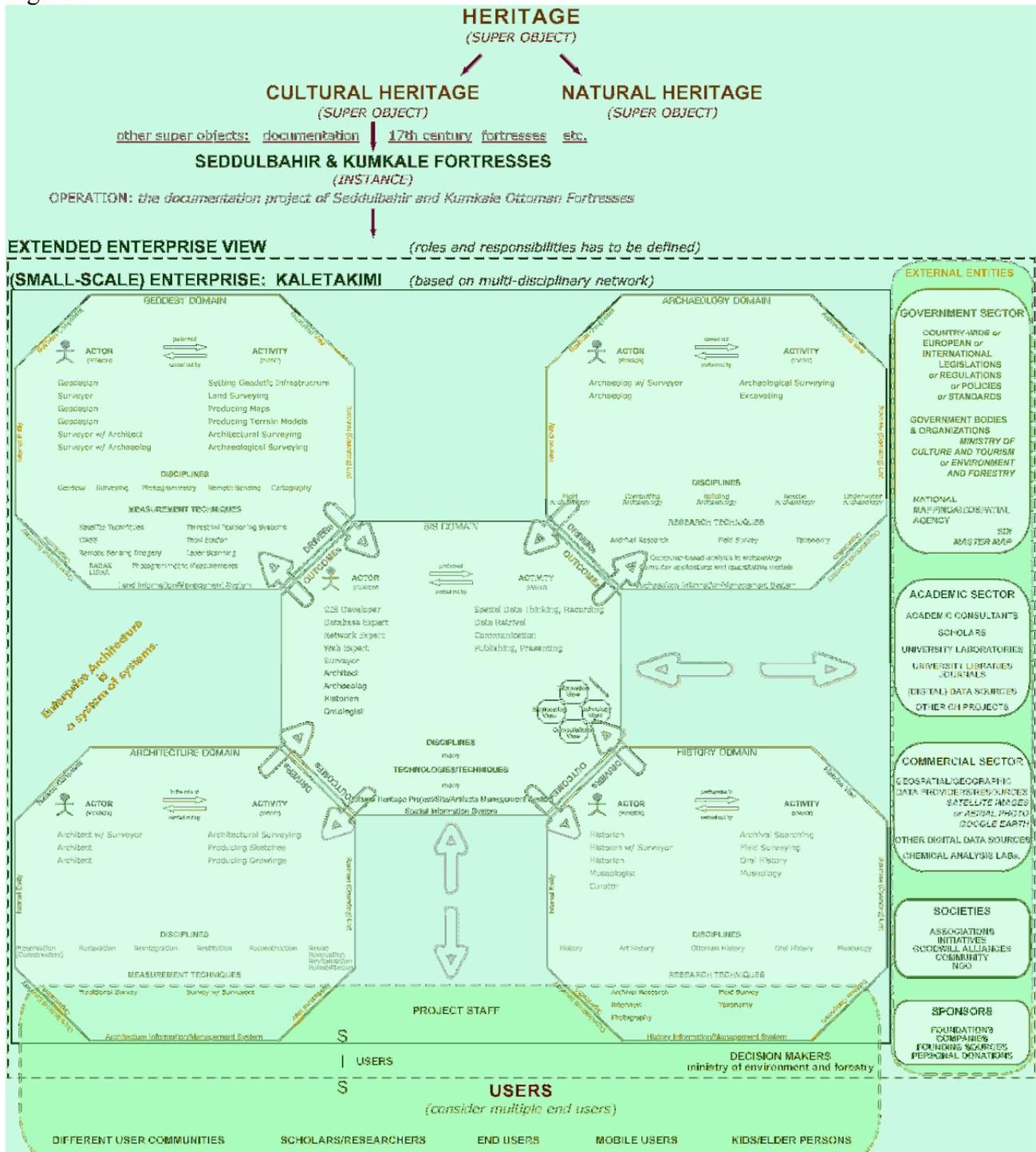


Figure2

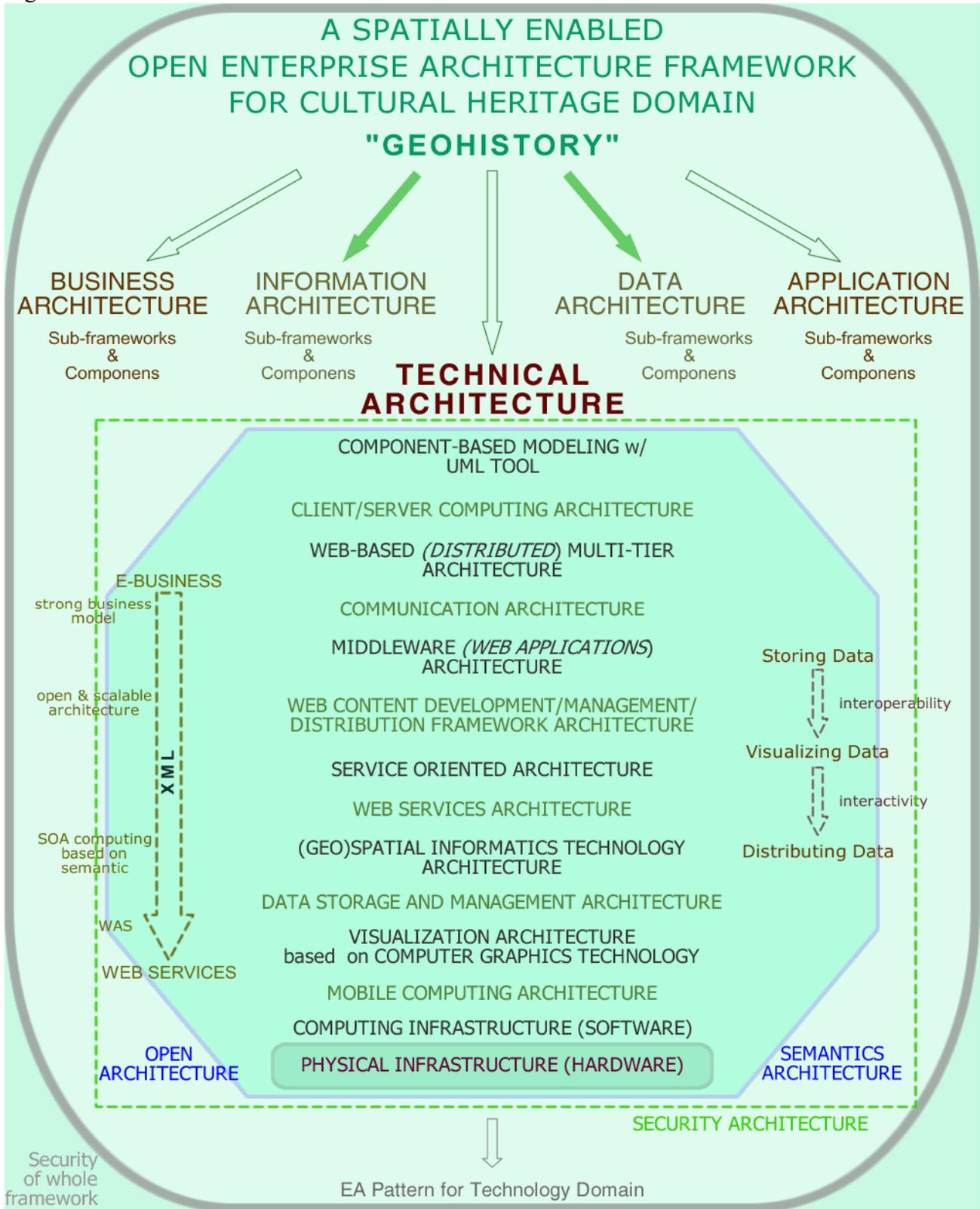


Figure3

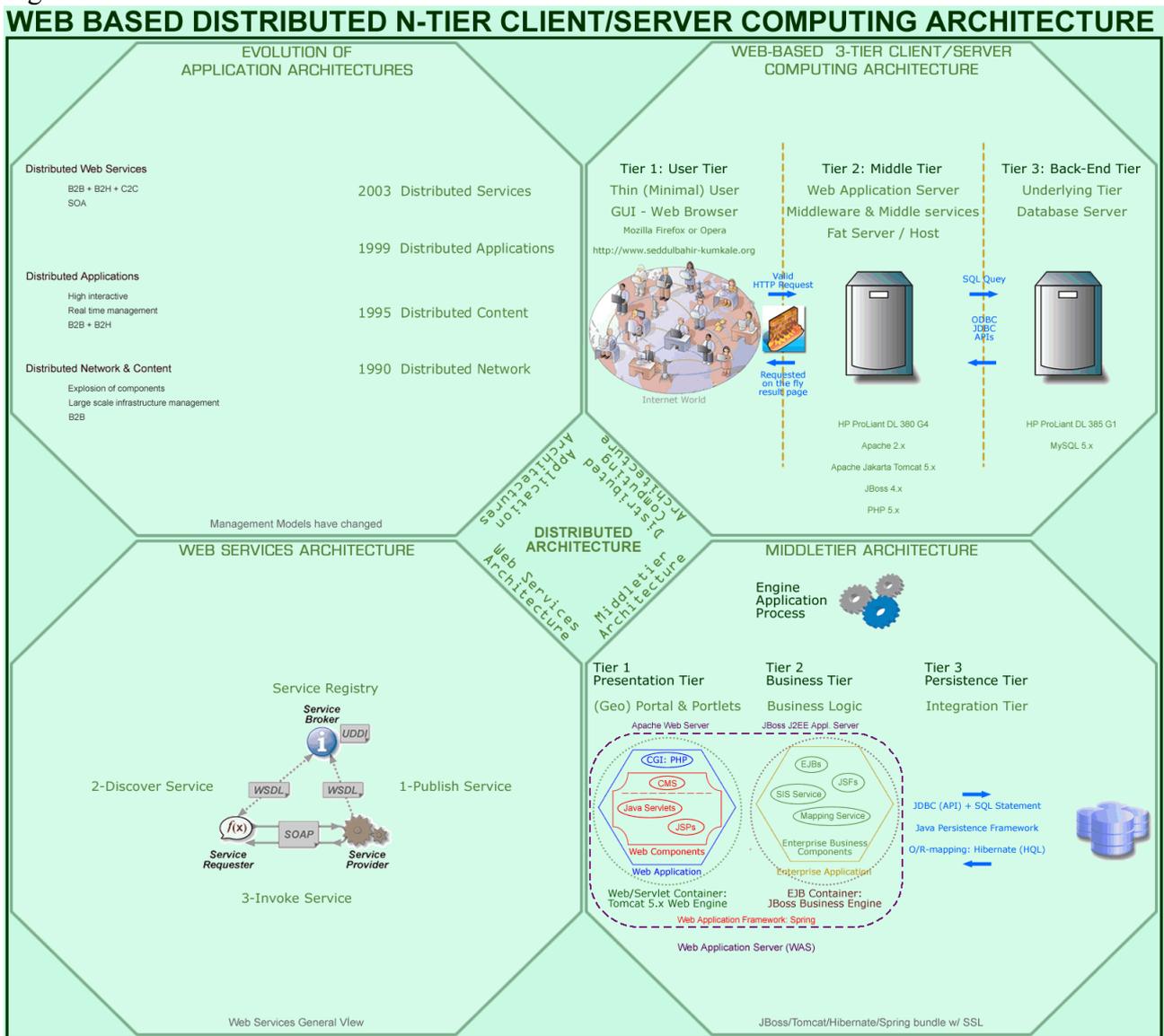


Figure4

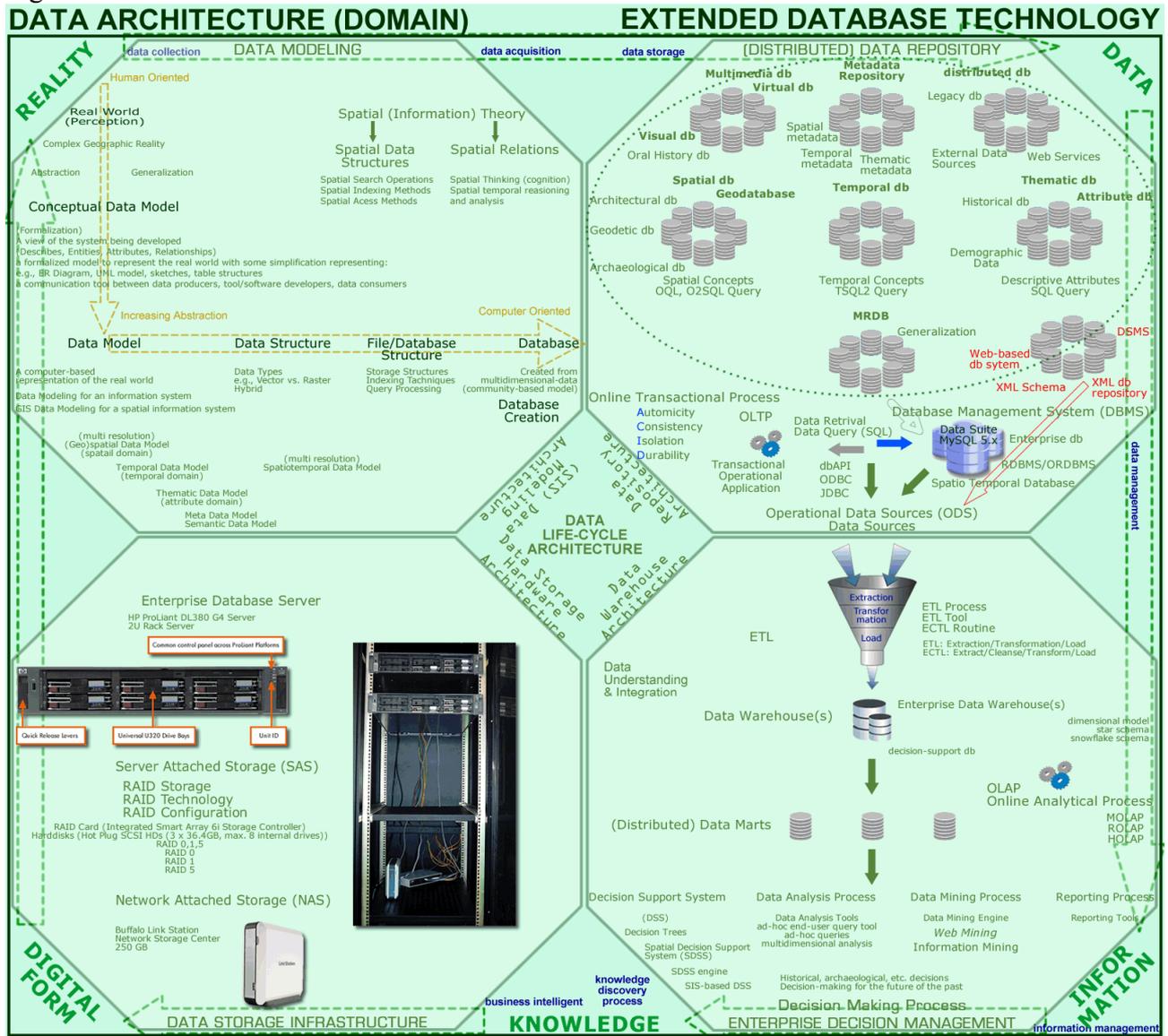
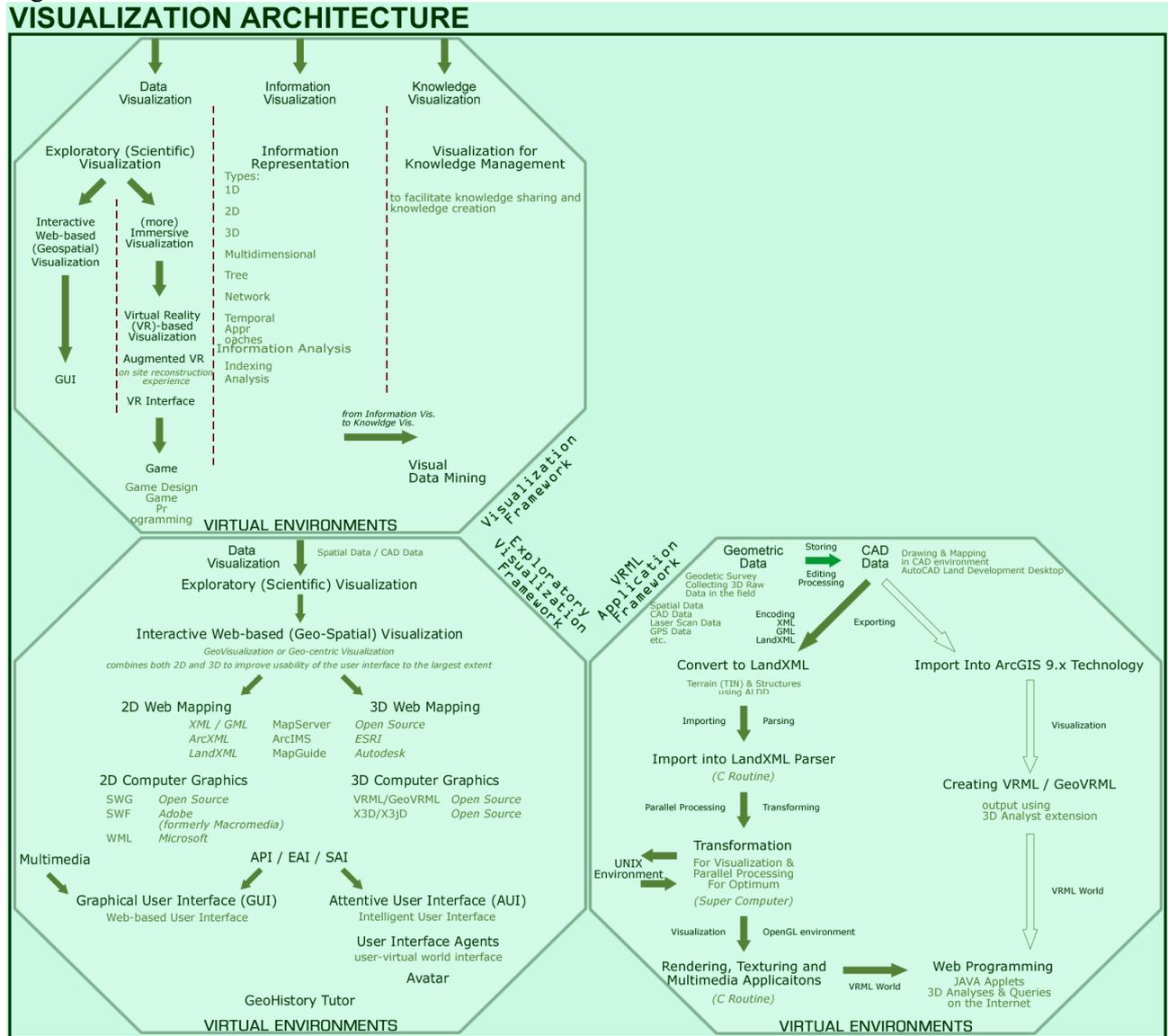


Figure5



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EXPLORATIONS IN ARCHAEOLOGICAL VISUALISATION

Using XML technologies for Visualising Anglo-Saxon settlement in Northern England

Abstract

This paper outlines the objectives of a research project exploring the changing use of visualisation in archaeology. In particular, it discusses the challenges and opportunities surrounding the use of vector images on the web, and their relationship to archaeology. The project includes a case study using data from the Anglo-Saxon site of Burdale in the county of East Yorkshire in Northern England. The data from this site will also be used to explore issues of interoperability with data from Cottam and Cowlam, two nearby Anglo-Saxon sites with similar research objectives.

Introduction

The web has connected people and information in a way that is unprecedented, and the predictions for its future growth show that receiving information via the web is now an expectation in many cases, not a novelty. It is therefore important for disciplines like archaeology to understand the impact of these expectations, and be able to respond. Archaeologists have been experimenting with the web all through its development, and in some cases, making substantive and comprehensive information available that would have been impossible only a few years before. Sixteen years on, however, the web is a mature technology, and it is time for archaeologists to assess its usefulness, rather than its potential.

This maturity has produced both new technologies and new ways of thinking about how that technology might be applied. At the same time, the initial obstacles associated with uptake of the web, low bandwidth and lack of access, have greatly improved. The combination of these two developments means that the web is a very exciting and challenging place at this particular moment in time. For archaeologists interested in visual communication, this is particularly true. Visual information on the web has been implemented quite unevenly in comparison with textual information. In particular, vector images that are tied to actual data, or generated by data, have not been well represented, and the spatial nature of archaeology makes this a particular concern. Despite the advantages of smaller file sizes and functionality associated with this type of image, the development of ways to present vector technology on the web has lagged behind other areas. Whilst this is the current situation, there are fundamental changes underway that may address the problem.

One of the major technological developments of the mature web is the creation of the eXtensible Markup Language (XML). The advent of XML has the potential to revolutionise, not just the web, but also the way in which digital information is organised and shared generally. Related to the properties of this new technology, is the idea of organising and processing information using the concept of ontologies. Ontologies comprise a particular method for creating a common understanding of a defined type of information. By organising information in this standardised way, it may then be communicated between people and application systems (Davies *et al.* 2003, 17). In a web where the amount of information available has become so vast, such that its sheer volume is an obstacle to finding the actual information being sought, the most crucial development to its ongoing usefulness is the concept of knowledge management. Essentially, XML was designed to structure 'managed knowledge' which can then be organised into ontologies. Whilst the need to manage information on the web has driven the development of XML as a tool for data exchange, and ontologies are considered to be a very important part of this development, these concepts, technologies and standards are also being adopted outside the web environment.

Creating a shared and common understanding of the actual information to be managed is another key goal towards which archaeologists and others in the field of cultural heritage are currently working. The recent creation of the Le Comité international pour la documentation du Conseil international des musées-Conceptual Reference Model (CIDOC-CRM) as a formal ontology for cultural heritage information shows this commitment (anon. 2006a). If taken up by archaeologists and other cultural heritage practitioners, it has the potential to influence how all cultural data is managed and shared, and should be taken into account when thinking about how archaeological information will be presented in the 'next generation' web. This would certainly include archaeological visualisation.

The development and practical implementations of ontologies like the CIDOC-CRM, and the creation of XML to structure those ontologies, are the key components in the concept known as The Semantic Web. Tim Berners-Lee, who created the web in 1990 and still oversees its development through the World Wide Web Consortium (W3C), has coined this phrase for his vision of the next generation web development (Berners-Lee 2000, 169). Whether his ideas for the future will be taken up in a way that he would recognise remains to be seen, but it is important to look at this change in information management on the web within the context of his overarching concept.

The intension behind The Semantic Web is to create a web where information is organised within a common framework, which does not rely on any particular application, operating system or enterprise. This is particularly important for the preservation of archaeological data, as it makes the data available for use whether the proprietary program used to create it is still available or not. The Semantic Web is a web driven by the information itself, rather than being its lowest common denominator. In order to create an ontology, the information users must first be in agreement about the meaning of the data to be included. XML can then be used to exchange, use or reuse the data in whatever way and with whatever technology is current and useful at the time. The Semantic Web is the vision for the future of the mature, more useful web.

Archaeological Visualisation: Vector Graphics

Archaeologists have been using vector-based digital tools for many years (Eiteljorg II 1989), and today they are used routinely in many areas of archaeological work. This method of organising visual information using points, lines and polygons is a unique system that can inform the archaeological process. Unlike raster images, which are made up of an array of disparate pixels (Jones 1997), vector images exist within a defined set of coordinates (Eisenberg 2002, 2). The ability of a vector image to 'know where it is' is significant for a spatial discipline like archaeology. They are resolution independent, and display the same clarity at any level of magnification (Laaker 2002, 7). Vector graphics can also be used to organise drawings into layers (Watt 2002, xvii), and the pan and zoom features make different forms of analysis possible as well (Eiteljorg II 1989). Raster and vector graphics are not competing forms of visualisation, rather they are different formats for different purposes, and are sometimes most powerful when used in combination.

Archaeologists use vector graphics in a variety of ways. Whilst visual tools like raster-based Geographical Information Systems (GIS) and digital photography are very important to archaeology, there are many other forms of visualisation that are often best handled using the vector format. Some of the primary uses include the electronic illustration of artefacts, and computer aided drawing (CAD) of excavation plans, sections and site maps (Fig. 1). Excavation plans, sections, and site maps are particularly important. Without this fundamental spatial information it would be almost impossible to make sense of any archaeological fieldwork. The transition of this information to a digital format began in the late 1980s with archaeological survey teams using CAD programs (Eiteljorg II 1989; Middleton 1998, 6). CAD drawings can subsequently be incorporated into a variety of other formats that use vector-based information like GIS programs. Today, most GIS

programs have the ability to create visualisations that are both raster and vector based, and to use them in combination (Wheatley and Gillings 2002, 16). In many cases CAD drawings are also the basis for three-dimensional Virtual Reality (VR) modelling, which also combines raster and vector technology to create a unique form of visualisation (Terras 1999).

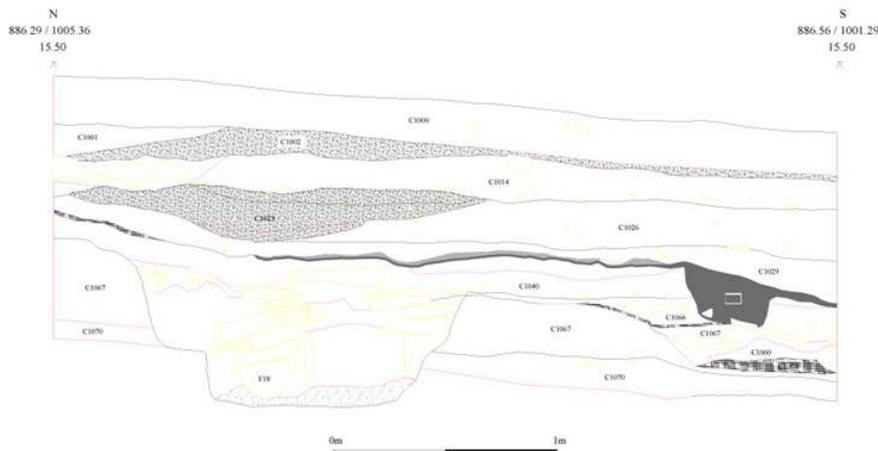


Figure 1: Example of a section drawing created in AutoDesk's AutoCAD. Section drawings can be quite large and complex, and it is difficult to strike a balance between images that are large enough to convey information, but are still readable. This section drawing is from the excavations in advance of an oil tank (Sector 2, Intervention 6) from the Tarbat Discovery Programme (Carver 1998).

CAD is a powerful tool for creating digital plan, section and site drawings, as well as an essential building block for much of the spatially derived digital visualisation currently used in archaeology. CAD's ability to plot images from information linked to a database in actual scale made it appealing to archaeologists early on (Eiteljorg II 1988; Holloway and Lukesh 1994) and there are a variety of ways to convert drawings into digital format for manipulation. Like digital archaeological illustration, use of CAD speeds up repetitive tasks and creates very accurate drawings. Drawings can be expanded and updated after each field season to reflect new work or corrected information, unlike paper drawings that have to be redrafted each year. CAD can also be used to combine drawings created in a variety of scales into a document with a common scale (Beex 1995, 101) and data gathered using disparate technologies, like traditional survey and photogrammetry, into a single drawing (Batchelor 1995, 231).

Because the vector information in CAD is tied to a database, data can be imported, exported and queried. In addition, CAD can organise information into thematic layers, which can be turned on or off to highlight different combinations of information (Fig. 2). The layers in a single drawing can show structural details, the hypothetical location of structural details, and how different types of artefacts or structures are distributed throughout a site. Layers can also show chronological change over time by dividing them into phases (Eiteljorg II 1989). Because CAD can create visualisations in three dimensions, the relationships of different archaeological elements can be explored in both horizontal and vertical space simultaneously. This can be very useful, especially in situations where it is difficult to get a complete view of how a site is structured (Main *et al.* 1995, 136). In some ways, the ability to view a CAD drawing from different directions, in plan, elevation or isometric views is perhaps its most powerful attribute (Eiteljorg II 1989).

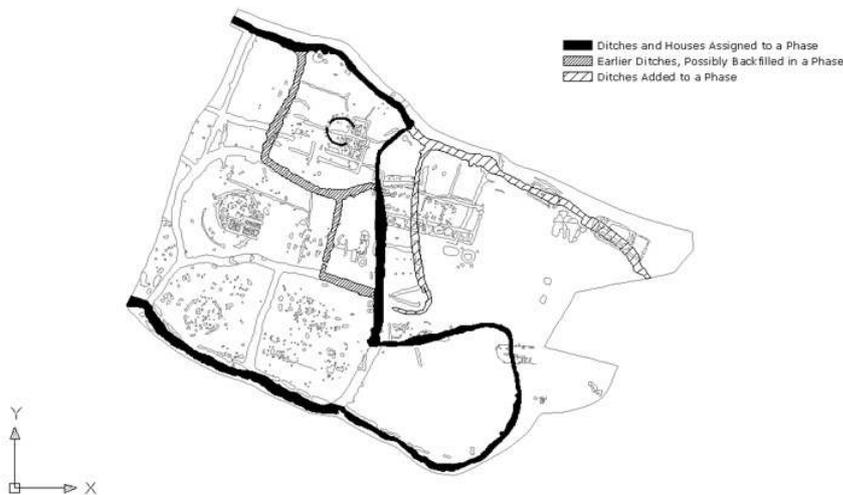


Figure 2: Example of layered plan drawings created in AutoDesk’s AutoCAD. Image shows a single layer (phase 4) turned on. When the user can control layers, different phases can be illustrated over time. Plan is from the Dalton Parlours Iron Age Settlement and Roman Villa in the parish of Collingham, West Yorkshire. Drawings show Iron Age settlement phases, as interpreted by post excavation analysis by the West Yorkshire Archaeology Service. Digitised by the author from the Dalton Parlours excavation report (Wrathmell and Nicholson 1990).

Vector-based information is very significant to archaeologists, as shown by the results of *The Publication of Archaeological Projects: a user needs survey* (PUNS) report, published by the Council for British Archaeology (Fig. 3). It places maps, plans and sections as third in importance, only behind the introduction and conclusion in an archaeological report (Jones *et al.* 2001). Even photographic information is not rated as highly. This is even more significant, as the results of the survey indicates that very few people read a publication in its entirety.

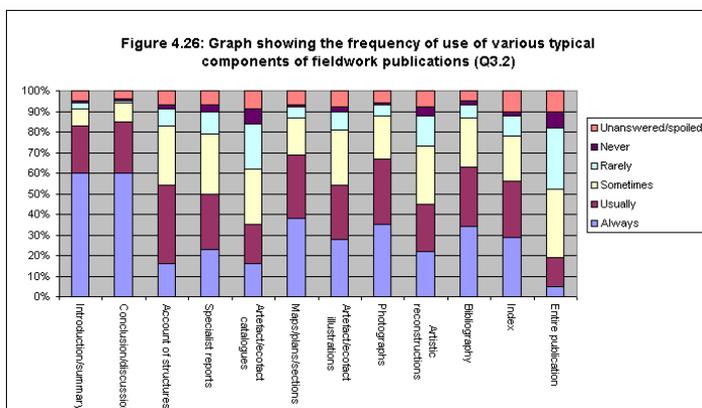


Figure 3: Graph showing the frequency of use of components of archaeological publication, reproduced from *From The Ground Up, The Publication of Archaeological Projects: a user needs survey*. Report and analysis undertaken by the Council for British Archaeology by Siân Jones, Ann MacSween, Stuart Jeffrey, Richard Morris and Mike Heyworth. Published 2001. <http://www.britarch.ac.uk/pubs/puns/>.

The PUNS survey was meant to evaluate the usefulness of archaeological project publications generally, and reflects the way project reporting and analysis has been traditionally communicated. In contrast, the recent Historic Environment Information Resources Network (HEIRNET) User Survey was designed to assess the needs of individuals and organisations, specifically using digital resources for archaeology and the historic environment (Brewer and Kilbride 2006). This survey produced some very interesting contrasts between what archaeologists find useful generally, and what is useful when it is presented in an online format (Fig. 4).

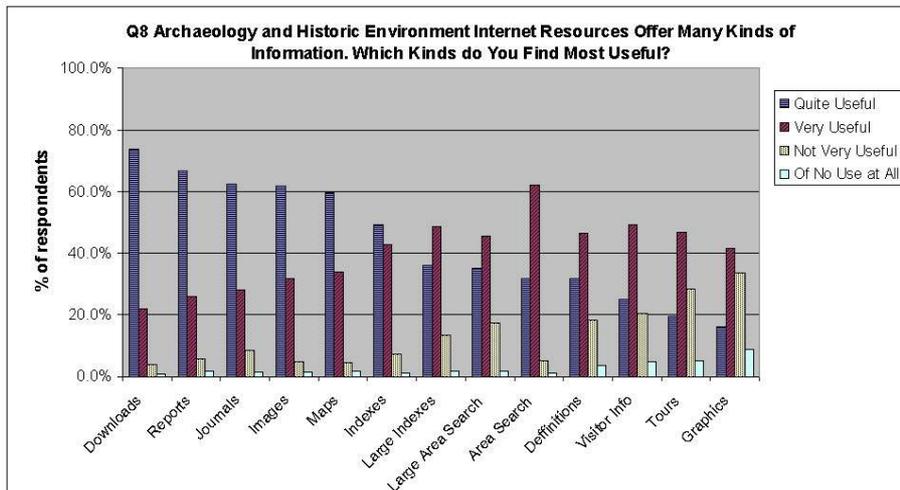


Figure 4: Graph showing the usefulness of different kinds of Internet resources to practitioners working in archaeology and the historic environment, reproduced from the *HEIRNET User Survey 2005*. Report and analysis undertaken by the Archaeology Data Service on behalf of HEIRNET by J. Brewer and W.G. Kilbride. Published 2006. <http://www.britarch.ac.uk/HEIRNET/survey/section1.htm>.

Whilst the results are not exactly comparable, there are some significant differences that are of interest, especially with regards to archaeological visualisation. Maps rated extremely highly, as would be expected based on the PUNS report. In contrast, graphics, which would be expected to include elements like plans, sections and other types of vector-based spatial information, received the lowest rating. In fact, of the 118 individuals who identified themselves specifically as archaeologists, only five indicated online graphics were ‘very useful.’ Based on this information, it is possible to conclude that a significant gap has developed between the type of resources archaeologists rely upon for their research, and the ability of web technology to deliver those resources in a useful way. If this is the case, considerable work needs to be done to improve how vector graphics are presented on the web. The advent of mature web technologies like XML and their related concepts which are now available not only have the potential to address this problem, but create archaeological visualisations that are more accessible, substantive and dynamic than their non-digital counterparts.

Archaeology and Semantic Web Technologies

When Tim Berners-Lee founded the W3C in 1994, its purpose was to help stabilise the implementations of the rapidly expanding HyperText Markup Language (HTML) he used to create the World Wide Web (Berners-Lee 2000, 143; Cagle 2002, 8). Berners-Lee hoped, but could not have known that HTML would become the international phenomenon it is today (Berners-Lee 2000, 37). The fact that he chose to make it open-source and therefore freely available to anyone sparked a creative surge that should be instructive for anyone weighing the value of a new technology. By bringing together developers from disparate and often competing vendors, the W3C guides the intentionally unwieldy Web forward with some sense of cohesion through their system of ‘recommendations,’ which are more commonly known as web standards. The desire to allow development by commercial interests, but not at the expense of non-commercial interests was a large motivation for creating the consortium, but it has taken time to build momentum. A marked example is the ‘browser wars’ of the late 1990s, a proprietary struggle between the two major browser manufacturers, which resulted in frustrated designers trying to create multiple sites that would work with different browsers, and frustrated users who never knew if their browser of choice would work at any given website (Zeldman 2003, 26). Web standards are now largely being accepted as the way forward for long-term growth and efficiency, and browser manufacturers think

more about the advantages of being compliant rather than trying to lure users with proprietary features. The W3C tries to be a voice of reason, and that voice has become increasingly authoritative (Castro 2003, 16).

Through its recommendation system, the W3C has begun to develop XML-based tools specifically designed to address visual information. Specifically, they have created an XML application for defining vector graphics, called Scalable Vector Graphics (SVG). SVG belongs to the growing family of open-source W3C technologies that are actively shaping the way information is presented on the Web, and it is best understood when viewed within that context (Winter and Neumann 2003). SVG was developed to address the lack of an alternative to the raster images that dominate the Web (Watt 2002, xvii). Raster is the native, and therefore most appropriate format for images like photographs, but even with file compression, the most common image file formats, .gif and .jpg, create large files that are slow to load, with limited image quality.

Whilst print designers have used raster and vector technology equally and in combination for years, Web designers have been without a comprehensive vector graphics solution. Forced to work around the particular issues associated with vector images for so long, SVG has remained somewhat below the radar of many, but this will almost certainly change. In addition to possessing the useful qualities found generally in vector technology, SVG opens up a host of additional possibilities. When combined with other forms of technology, like databases and JavaScript, it is capable of interactivity that is both simple and complex. SVG can be used to create high-quality graphical interfaces for input and analysis of archaeological information, and make primary data easier to understand (Fig. 5). As archaeologists seek to preserve their data either for further active use, or in the form of an archive for future interpretation, forward migration of data is an important issue (anon. 2005; Zeldman 2003, 17). Using standards-based W3C technology and archaeological data in ways that can be easily brought to the Web will likely produce data that is better maintained, easily migrated and serves multiple purposes.

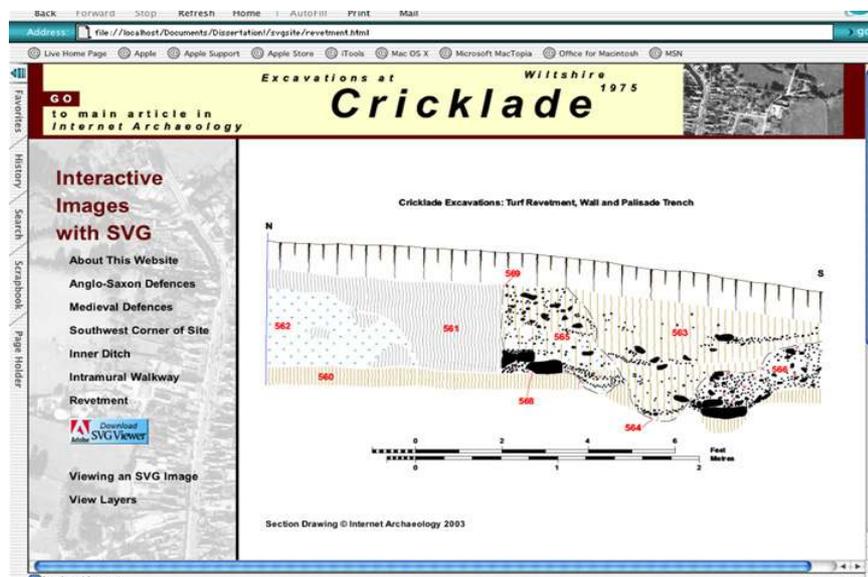


Figure 5: A website showing a section drawing rendered in SVG image. From *Archaeological Vector Graphics and SVG: A case study from Cricklade* by H Wright, 2006. Internet Archaeology, in prep.

The initial reasons for creating SVG may seem quite modest, but its XML heritage has resulted in a tool that is powerful and full of possibility. As such, it is important to remember that some of its most compelling features, like platform independence and interoperability with other XML

technologies, are not exclusive to SVG, they are just part of membership in the XML family. Because SVG is freely available, nobody 'owns' it and no single software company can tailor it to their particular market. Like HTML, SVG is made up of nothing more than text, which can be viewed by developers and users alike, which makes it easy to see and share the way SVG documents are structured. SVG allows selective display of elements in an image. Because vector graphics can be created in layers that can be turned on and off, those layers can be preserved in SVG, and interacted with using a scripting language like JavaScript (or more accurately, ECMAScript) (Watt *et al.* 2003, 17). The text that makes up an SVG graphic is also available to search engines able to read XML, so if a vector graphic contains text; it is still recognisable as such even if it is embedded into an image (Watt 2002, 95).

This ability to recognise the textual parts of an SVG image also allows for internationalisation of its content. If the settings in a browser are set for a particular language, the SVG image will display the same graphical elements, but the textual elements that are appropriate for that language will be chosen and displayed (Watt *et al.* 2003, 19). Browser detection and SVG will also allow for greater flexibility in the future for designing accessible websites. SVG's resolution independence already means users with visual limitations can scale images to a level of magnification that is comfortable. For users that require images with different colour contrasts or text only, SVG should be able to serve a version of the same page to meet their needs. Rather than designing Websites for an accessible lowest common denominator, developers could create one site that can be viewed (or not, in the case of audio browsers) in a variety of ways. This will be somewhat in the future, however, since accessible SVG browsers and plug-ins will have to be created first (Watt *et al.* 2003, 510).

SVG can also create graphics that are data-driven and generated dynamically from a server. This can be done in a variety of ways using existing programming languages like PHP, PERL, ASP or JSP, but the result is a visualisation that can be created 'on the fly' based on user criteria (Watt *et al.* 2003, 695-698). Whilst SVG is a rapidly growing recommendation, all web browsers do not support it natively, but this is changing. The most popular browsers that do support SVG natively are Mozilla's Firefox 1.5 (anon. 2006b), and Opera 8 (anon. 2006c). These are both available for a wide variety of operating systems. Because SVG is non-proprietary there are several companies and organisations with an interest in furthering its development, and they have added SVG support to their products or created plug-ins for other browsers. Adobe's SVG Viewer plug-in is the most widely used, with the broadest distribution and compatibility with all major browsers or platforms.

Archaeology occurs in three dimensions, and many vector-drawing tools used by archaeologists reflect this. Much of the value in CAD and GIS programs lie in their ability to render information in 3D. Unsurprisingly, the power and versatility of XML has gained the attention of the Web3D Consortium. Under its former guise as the Virtual Reality Markup Language (VRML) Consortium, this non-profit organisation has been responsible for the creation and promotion of open-source 3D technologies for nearly a decade. After developing VRML 1.0 and 2.0, they have chosen XML for the next implementation. Working in conjunction with the W3C and over 100 commercial and non-commercial concerns, the consortium has embraced XML and is in the process of creating an XML-based VRML application called X3D.

The Web3D Consortium intends X3D to be compatible with VRML documents and tools, but with the ability to integrate with other XML technologies. X3D is meant to replace VRML, but to also remain compatible. Web3D cites several factors for moving to an XML based standard. XML has become the dominant syntax currently in use, whereas VRML uses its own unique syntax. Moving to a more universal syntax is meant to address the problems of forward migration and, of particular interest to archaeology, archival preservation of data. Web3D also sees XML as a way to simplify the way VRML is created, and to provide a tighter integration of VRML with other XML

technologies. In particular, Web3D sees X3D as part of the XML family, to be used in conjunction with SVG, Synchronised Multimedia (SMIL) and XHTML (anon. 2006d). Another addition to this list for archaeologists could be the Geography Markup Language (GML), an XML application developed by the Open Geospatial Consortium for describing Geographic information (anon. 2006e). As a specific tool for storing and transporting geographic data, GML is not designed for visualisation. It is intended for use with the other XML applications designed for this purpose, like X3D and SVG (Lake nd).

The Case Study: Data From Anglo-Saxon Sites in the East Yorkshire

The Wolds region of East Yorkshire in Northern England has a rich archaeological history, with significant settlement evidence from the Bronze Age, Iron Age, Romano-British, Medieval and Post-Medieval periods. The Wolds Research Project seeks to answer regional questions about the interaction between the city of York and the surrounding landscape since the Iron Age, through the combined work of researchers in the Dept. of Archaeology at the University of York (anon. 2004).

Fieldwork has already been carried out at a number of sites as part of the Wolds Research Project, including three sites from the Early Medieval period, located near the villages of Cottam and Cowlam, and most recently near Burdale House Farm (Fig. 6). To explore the way archaeologists can use Semantic Web trends and technologies in their general research, and specifically for visualisation, a practical application will be carried out using data from the fieldwork at Burdale. The data will be used to create archaeological visualisations, using web-based technologies and concepts associated with knowledge management. This will include data derived from survey, aerial photographs, geophysics, field-walking, excavation and work done with a group of metal detectorists.



Figure 6: Excavation in progress at Burdale, showing some of the complex curvilinear features associated with the Anglo-Saxon settlement. Spatial data from this fieldwork will be used to explore archaeological visualisation, using web-based technologies and concepts associated with knowledge management. Photo by the author.

The spatial data from survey, geophysics, and especially plan and section drawings will be organised according to XML ontology principles, and visualised for the web using XML-based technologies. This exercise will show how the visualisation tools already in use by archaeologists can be incorporated into the mature web, and illustrate the difficulties and new opportunities for enhanced understanding and interpretation this affords. It will also allow further exploration of the ways to link non-visual data spatially, so that visualisation can be used to better connect all forms of

data. It is hoped, that by choosing this holistic approach, new and innovative possibilities and connections will become apparent through the research process.

To further test the potential of the practical application, existing excavation data from fieldwork carried out at Cottam and Cowlam will also be used to explore interoperability issues associated with concepts of knowledge management. All three sites have similarities in their location, occupation history and the techniques used in gathering and organising the resulting data, which makes them ideal for interoperability testing. If mature web technologies and concepts can be applied to the data for all three sites, it should then facilitate easier and more effective comparisons, and allow greater understanding of the regional landscape. Further research at other sites in the area could then be easily shared and incorporated in the future.

Conclusions

Whilst vector-based data is very important to archaeological research, making that information available on the Web has traditionally been more challenging than raster-based images. With the advent of Semantic Web technologies, this is now changing. In particular, XML applications like SVG may allow vector data to be viewed and preserved in non-proprietary formats, that still retain the functionality associated with the programs that created them, and will allow for better preservation of this data in the future. XML applications are also part of larger technological and conceptual Semantic Web ideas, which include organising information using ontologies, and creating technologies that are based on standards. To explore how these applications may be of use to archaeologists, further research needs to be undertaken using data from practical projects like the Burdale site in North Yorkshire. This will illustrate how the technology may be used to better understand, communicate and answer specific archaeological research questions, which is what this project aims to do.

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VIRTUAL HERITAGE: OPEN TO INTERPRETATION

Abstract

This paper discusses the significance of cultural heritage content in virtual heritage, and outlines some of the issues in communicating this content for public interpretation. This discussion is presented in response to a twofold problem identified in the virtual heritage field: firstly; the proliferation of technical research, which tends to represent only tangible cultural heritage, and overlooks the intangible dimensions of sites or artefacts; and secondly, the broader need to contextualise virtual heritage within social, economic and political structures. Instead, a critical framework is proposed through reconceptualising virtual heritage as cultural constructs, and the framework is informed by three broad characteristics: knowledge can be considered multivocal and fragmented; representations can be dynamic and open-ended; and interpretation process is polysemic. The core of the framework emphasises the importance of content (oral histories, dances, music etc.) in guiding the production of virtual heritage, as opposed to technology being the sole motivator. Further still, the framework discusses how content in virtual heritage needs to be transformed from merely representing quantitative data towards cultural information, and this is suggested through representing meaningful relationships between cultural heritage elements. The departure point of this paper is then discussing this framework in relation to interpretation, in particular issues of visual communication, ideology and interactivity. This paper informs a larger research project examining the capacity for intercultural interpretations of virtual heritage in museums.

Introduction

With the accelerated spread of globalisation and multiculturalism, questions surrounding cultural difference are becoming increasingly prominent and complex. The recent events surrounding the Mohammad caricatures show how representations of culturally significant figures can elicit a multiplicity of reactions from people, including anger, violence and intolerance. In the media, different groups responding to these events were described on one side as “not giving up their critical spirit out of fear of being accused of Islamophobia” (BBC, 2006, <http://news.bbc.co.uk/1/hi/world/europe/4763520.stm>) and on another side as “what we are looking for is that you take our sensitivities in your definition [of freedom of expression]” (BBC, 2006, http://news.bbc.co.uk/1/hi/world/south_asia/4736854.stm). These and other similar events reveal the complex issues involved with understanding the relationship between interpretation and cultural difference. Even if in the past few decades there has been decisive moves against perpetuating monocultural or international stereotypes, particularly in the visual communication field, there still remain many issues to be resolved in the domain of cultural difference.

This paper aims to address issues of cultural difference in virtual heritage, as a field engaged with the relationship between culture + interpretation + technology. The critical question of this paper is examining intercultural interpretations of virtual heritage in the museum. Yet before this question can be answered, there are fundamental concerns of virtual heritage that need acknowledgment: firstly, virtual heritage needs to be understood amongst media also dealing with the interpretation of culture, such as the visual arts, historical texts, performances; secondly, virtual heritage needs to connect more explicitly with theoretical issues such as ideology, narrative, place, myth and authenticity; and thirdly, virtual heritage needs to understand that interpretations of the past can be open-ended and dynamic. These three ideas are fundamental in beginning to locate virtual heritage within notions of cultural difference.

The paper will begin by situating the discussion within the interaction design field, a perspective often overlooked in virtual heritage, yet provides another lens for understanding interactivity. The paper will then move onto discussing three different approaches towards interactivity based on work by Witcomb (2003) for museum technologies: *linear* interactivity, where content is often didactic and leaves little room for multiple interpretations; *serial* interactivity, where the content is non-linear and completely unstructured; and *dialogic* interactivity, where the emphasis is on shared

dialogue between the museum and visitor to discuss meanings. Dialogic interactivity is suggested as the most appropriate approach for virtual heritage projects dealing with multiple perspectives of the past. However, dialogic interactivity is not without issues and from this analysis the paper will propose a critical framework by utilising theory from interaction design, as well as suggesting how interculturalism can work towards incorporating a multiplicity of voices. A case study of Ipswich Art Gallery in Queensland, Australia (formerly Global Arts Link) is then discussed as a practical demonstration of the critical framework, as well as feeding back into the examination of cultural difference in virtual heritage. It is hoped this paper will contribute to the growing discussions attempting to move beyond western notions of ‘authenticity’ and ‘realism’ as the only markers for creating meaningful interpretations.

The literature in this paper draws from four predominant disciplines: interculturalism underpins the entire paper; museology theory is drawn on for the context; interaction design provides a perspective in examining interdisciplinary projects; visual communication is used as the analytical tool for examining the dissemination of virtual heritage; and cultural anthropology is used for the interpretation of culture and the past.

Defining interculturalism

Before examining the intersection of interculturalism and virtual heritage, the term interculturalism needs to be clarified. It is relatively easy to define what interculturalism *is not*, although these are paradoxically often cited as predominant understandings of interculturalism: interculturalism is not the same as multiculturalism, where the latter only refers to the inclusion of several cultures; interculturalism is not merely concerned with understanding codes, icons and symbols of different cultures other than your own; and interculturalism is not merely about collaborating with people from different cultures. Stating what interculturalism *is* becomes a little more difficult, not in the least due to the variety of ways often used to express interculturalism, such as intra-culturalism, cross-culturalism, cultural difference and cultural hybridisation. Similarly, although interactions between cultures have occurred throughout humanity, discussions of the term interculturalism are still relatively confined to higher levels of leadership, such as government, the Human Rights Commission or United Nations Educational, Scientific Cultural Organisation (UNESCO).

Part of the process for defining interculturalism comes in mapping out some boundaries of the term culture, which here is understood as being “concerned with the production and exchange of meanings” (Hooper-Greenhill, 2000, p.12). Culture is then embedded with interpretations that are open-ended and dynamic and more importantly, culture occurs through the interaction with others. Bearing this in mind, the characteristic that runs across various terms of interculturalism is the idea of *plurality* or *hybridity* that has “emerged in recent years as a way of reconceptualising cross-cultural interactions and exchange, as well as explaining processes involved in the generation of new or alternative cultural forms” (Kreps, 2003, p.14). Pluralistic frameworks can be seen as arising in response to issues of cultural difference, as plurality emphasises the multivocal, shifting and contextual nature of culture. Consequently, interculturalism can be defined as the interaction between different cultures towards the generation of hybrid cultures. The strategy of intercultural dialogue is increasingly applied to pluralistic frameworks; however, this will be dealt with later on.

Interculturalism then demands a complex understanding of technology, where virtual heritage is not merely a tool but understood as a cultural form in itself. Flew (2002, p.21) summarises this idea in his term *cultural technologies*, where he states “technologies (are) not simply material forms that impact upon culture, but rather themselves as cultural forms”. Further still, Flew identifies three levels in understanding cultural technologies: technology as media or physical objects, tools and artefacts; technology being able to produce and distribute content; and also technology being situated within systems of knowledge and social meaning that accompany their use and

development. This idea is important to virtual heritage as it positions the field as not only having the potential to impact on wider social, economic and political structures but also as a significant cultural expression.

The implications for virtual heritage is moving beyond how objects and artefacts were used in the past or their material composition, and instead about situating them within the present context, or as Champion states (2005, p.3), “this leads me to suggest that Virtual Heritage is the attempt to convey not just the appearance but also the meaning and significance of cultural artefacts and the associated social agency that designed and used them, through the use of interactive and immersive digital media”. Although this is not only a task for virtual heritage, it shifts the fundamental concern of the field toward creating cultural experiences.

Whether the field realises it or not, virtual heritage projects are then often deeply involved with issues of cultural difference and interpretation. It is critical that research methodologies for virtual heritage projects are suitable for dealing with issues of cultural difference. As Blakenship (2005, p.24) states “regardless of whether one is an advocate or a critic, globalization has unleashed or accelerated cultural exchange and transformation. Our efforts to describe the dynamic processes through which elements from one culture pass to another are undermined when we employ interpretive frameworks that are crude and increasingly inadequate”. This view is in opposition to many virtual heritage projects which support more didactic and modernist understandings of the past, including dominant values and codes. The intersection of interculturalism and virtual heritage can instead be a strategy for the multiple understandings of cultures, where there is no single version of the past, but a series of fragments that can provide hints for the future.

What is interactive in museum technologies?

Discussions about cultural difference and interpretation are growing within the museum field. A significant influence over the past decade has been the spread of new museology perspectives. Amongst other things, these perspectives are calling for the re-examination of the social role (Vergo, 1988) of museums, including the movement away from collection, conservation and documentation-based strategies. In this perspective, the deployment of technology can then be aligned with making museums more democratic and accessible to the public (Witcomb, 2003, p.129). Yet, there are still many issues to be addressed, including whether claims of interactivity and technology can meet new museology perspectives.

Complementing new museology arguments is the interaction design trend of emphasising a two-way relationship between the user and technology, such as Rokeby (1998, p.1) who states “interactivity’s promise is that the experience of culture can be something you do rather than something you are given”. There has also been a shift in interaction design, where many companies now talk of ‘producers’ rather than ‘consumers’ of their technology (d-media conference, 2005). And more recently, media studies discussions on design have emphasised the importance of creating “meaningful experiences” through interaction design. These discussions move beyond focusing solely on interaction towards emphasising the immersive potential of technology and the importance of designing experiences, where “in the future, we believe, the best design work will be done with meaningful experience at the center of the process, carefully and fully articulated” (Shedroff and Diller, 2006, p.15). Across these discussions there are common characteristics for generating a two-way relationship: the user being active in the production of their experience; the experiential nature of technology; and the significance of using everyday content. While these discussions are useful in examining the technical implications, there still remains a need to discuss issues of *meaningful content* within the technology + interpretation + culture equation.

Three approaches to interactivity in museums will now be discussed and expand upon approaches Witcomb (2003) has identified: linear or didactic interactivity, spatial or serial interactivity, and dialogic interactivity. These approaches can be aligned with understandings of narrative: linear, postmodern or multiple narratives. Although they can be understood in relation to the entire museum space, this paper will focus on museum technologies.

Despite their increasing spread, new museology perspectives are often neglected in the construction of interactive technologies in museums. Instead many interactive technologies are structured on more modernist understandings of the museum, and consequently constructed through *linear* approaches, such as museum touchscreens. These technologies are premised on one-way communication strategies and can perpetuate monocultural stereotypes or dominant beliefs within a society. While these technologies may include multiple menu options, the past is often presented through linear text and image designs, requiring only passive interaction and leaving little room for multiple interpretations. Similarly, many museum technologies are focused on presenting the more tangible aspects of culture, photographic realism or technical capacities, such as QuickTime VR panoramas and 3D artefact reconstructions. In the poorest instance, these technologies can be seen as manipulating visitors on a purely emotional level. Simply inserting technology into a museum space does not make it immediately interactive; the technology itself also needs to employ two-way communication strategies.

An example of linear interactivity that Witcomb uses can be seen at the Beit Hashoah Museum of Tolerance in Los Angeles, United States of America. The content of this museum deals with issues of intolerance within society through the deployment of digital technologies. The events surrounding the Holocaust are used as the predominant example of intolerance during the past century. The issues of intolerance and how to combat them are incredibly complex, yet the museum has come under much criticism because of its technological strategy. These criticisms identify the technological content as based on linear interactivity, appealing to visitors on an emotional rather than a historical level (Witcomb, 2003, p.137). For example in the Tolerancenter, there are several stations which “point to the way in which language has been used to denigrate people who are different from oneself on the basis of gender, age, ethnicity, colour, even weight” (2003, p.137). The stations repeatedly flash dominant values and codes on the screen, and reveal to the visitor how these beliefs can be embedded and perpetuated through mass communication. Although the stations reveal the processes involved in mass communication, the stations “have been designed within a model of communication which assumes a one way flow of information. They have a ‘message’ which it is our task to grasp” (2003, p.137). Further, this linearity is emphasised in the design of the space through “highly organized system of control. A system which not only controls where the visitor walks, the order in which they can see exhibits and the amount of time they can spend in front of them...” (2003, p.136).

Another approach that contrasts linear interactivity is that of *serial* interactivity. Museum technologies structured on serial interactivity overcome the fundamental concern of linear interactivity: serial interactivity has the potential for sustaining a two-way relationship. Serial interactivity in museums steers away from presenting one point of view towards presenting a plurality of views through non-linear interactivity that is not technologically defined. As these technologies are serially or episodically structured, the past is not presented in any particular order or the order is implicit. The emphasis shifts towards the audience being able to create their own experience and generate their own meanings from interacting with the technology. Serial interactivity then enables a space for visitors to think critically about past cultures, as well as relating it to their own lives. However, the main issue with serial interactivity is that content often demands a high level of prior understanding from the visitor and can adversely exclude many

groups from engaging deeply with content, such as children. Similarly, it loses a “sense that a public, group understanding of historical narratives might no longer be possible” (Witcomb, 2003, p.141). Also, “the difficulty for those museums who wish to be less didactic and more interactive is to achieve a balance between multiple points of view while maintaining an editorial line which is not reductive” (Witcomb, 2003, p.156). Consequently, while serial interactivity supports two-way relationships between the user and technology, it remains an unstructured experience and can distort interpretations of the past.

The Australian National Maritime Museum (ANMM) in Sydney, Australia is used by Witcomb to illustrate the concept of serial interactivity. As its title suggests, the museum is concerned with the Australian maritime experience, however, rather than treating the history chronologically, the museum treats history through themes and sub-themes. These themes cluster together exhibits or vignettes including: Merana Eora Nora - first people; Passengers - the long sea voyage; Commerce - the working sea; Navy - protecting Australia; and Watermarks - adventure, sport & play. The significance of the ANMM is that these themes are used for setting up an interactive relationship with visitors, as can be seen from their statement that “the design of each individual exhibit must evolve from a knowledge of how visitors will move through it. The design should exploit thematic links, contrasts and relationships perceived by “serial viewing” (in Witcomb, 2003, p.144).

The use of serial narratives meant the museum does not convey a predetermined or ordered approach to Australian maritime experience. Further still, there was “no expectation on the part of designers or curators that visitors had to see every exhibit in order to fully understand the ‘message’. There *was* no single message”. A vignette in the Passengers exhibition can be used as an example, where objects such as crockery and cutlery are used to trigger visitor’s memories of being on passenger liners. While the ANMM adopts a more dynamic approach to museum and visitor relations, this is also the reason why the museum has come under scrutiny. In wanting to appeal to visitors creating meaning from exhibitions, the ANMM shies away from presenting an editorial position and consequently, “the problem at the National Maritime Museum was a lack of curatorial line... It does not attempt, for example, to deal with the theme of the sea as an organizing idea. This means the six themes... do not coalesce around any discussion point” (Witcomb, 2003, p.156).

The problems with linear and serial interactivity can be deconstructed through Nathan Shedroff’s (1994, p.4) model for a Unified Field Theory of Design, which he essentially describes as “information makes data meaningful for audiences because it requires the creation of relationships and patterns between data. Transforming data into information is accomplished by organizing it into a meaningful form, presenting it in meaningful and appropriate ways, and communicating the *context* around it”. Although linear and serial interactivity can be argued as different approaches with different aims, the main problem with these strategies is that they neglect to deal with ‘context’ and ‘audience’ appropriately when dealing with cultural difference.

The model argues that content is comprised of four different stages in communicating meaning: data, information, knowledge and wisdom. This supports the distinction between reproductive and productive virtual heritage projects, as identified by Malpas who states “we can distinguish between the reproductive use of new media, where the aim is to record or to re-present heritage artefacts or sites... and a more productive use of new media to create something new or supplemental to the artefact or site” (2006, p.171). Shedroff’s model is useful in deconstructing different levels involved at the intersection of content and technology. However, the relationship between content and technology can be quite complex and Shedroff’s model could be criticised as oversimplifying the development of meaningful content onto a simple trajectory. The important idea of the model is understanding that the creation of meaningful content is based on more than data. The problems with linear and serial interactivity identify the need for another approach that is based on the past as

open-ended and dynamic, yet maintains an editorial perspective. In the next section, the concept of dialogic interactivity is suggested as the way forward.

Dialogic Interactivity

The third approach is what Witcomb details as *dialogic* interactivity, which can be seen as the midway point between linear interactivity and serial interactivity. This is not a new idea and can be found in the idea of multiple narratives in film, as dialogic interactivity supports a sustainable two-way relationship between the visitor and technology “where meanings can be negotiated with an explicit commitment” (Witcomb, 2003, p.130). Past cultures in these museum technologies are then structured around multiple voices and contestation, becoming an ongoing dialogue with “the effect of this treatment is constantly to pose questions, suggestions, rather than finished statements which tend to fix the narrative in the authoritative voice of the museum” (2003, p.159). The content is then fluid, plural and open-ended for visitors to create their own meanings, as well as exchange with others.

This approach is perhaps not suitable for all museums but it is a growing approach amongst museums that are more interested in multiple interpretations of the past. However, there are still some issues that need resolving when applying dialogic interactivity to museum technologies.

The first problem is presenting multiple perspectives of history can be seen as simply easing away from confronting issues or being politically correct. Dialogic interactivity can be then be accused of fence sitting, as it is attempting to “treat all narratives as equally valuable – denying that one may be ‘better history’ than another – implies that we forgo the possibility that anyone should take responsibility for the past” (Moris-Suzuki, 2005, p.15). This could inadvertently have the effect of ‘othering’ or exclusion, particularly for those relating to multiple perspectives of the past. Further, “if all narratives are equally true/untrue, it becomes impossible to determine who should redress the legacies of past wrongs, and therefore impossible to act in ways that address that responsibility” (2005, p.15). This is a problem not just confined to virtual heritage but within contemporary historical discussions, and so while multiple perspectives are based on equality it can also come at a high cost.

The interpretation of multiple perspectives can also demand a high level of knowledge from the viewer, particularly when dealing with cultural difference and the past. This can exclude visitors who only have a general knowledge of the content, and so “while [dialogic interactivity] may be an interesting play on the nature of museum knowledge, it leaves those without the necessary knowledge unable to play the game” (Witcomb, 2003, p.163). The use of open-ended content and critical thinking can require a certain level of knowledge before the cultural heritage content can even be begun to be reflected on. Further still, even if the strategy is to open up dialogue between visitors, the intercultural dialogue is narrowed when not all people able to participate.

Different strategies for approaching interactivity in museums have now been discussed: linear interactivity reflects modernism and provides a single solution in understanding the past; serial interactivity provides a more post-modern approach where multiplicity and fragmentation are key elements; and dialogic interactivity provides a way for museums seeking to engage broader and more diverse audiences. In the following section, a critical framework will be proposed in response to the issues that have just been outlined and illustrated in the last section through a case study.

Critical Framework

This paper proposes a critical framework called the Intercultural Site and based on three broad characteristics: knowledge is considered multivocal and fragmented; cultural heritage content is dynamic and open-ended; and the interpretation process is polysemic. The critical framework

argues for establishing a two-way relationship between the technology and the user, with one impacting on the other. This accentuates understanding the relationship between the technology and user as an ongoing dialogue, with the possibility of creating ongoing *cultural* dialogues about the past. This is based on intercultural dialogue and emphasises the visitor becoming part of the meaning-making process. As UNESCO (2006) states, the nature of dialogue is “based on study and common action” and emphasises visitor interpretations, as well as taking on board their interpretations in the exhibition evolution. Intercultural dialogue has the potential to make the past more relevant, while sustaining ongoing dialogue between people.

The past can only be understood from the perspective of the present context. Cultural dialogues need to be then structured on a framework or interpretive line, as suggested through Moris-Suzuki (2005, p.27) who provides an approach through her idea of historical ‘truthfulness’ which is “an open-ended and evolving relationship with past events and people. In emphasizing the word ‘truthfulness’ rather than the word ‘truth’, I am trying to shift debate away from the sometimes arid arguments about the existence or non-existence of historical facts, and towards a focus on the processes by which people in the present try to make sense of the past”. Therefore, Moris-Suzuki acknowledges the open-ended and multivocal nature of virtual heritage content but also emphasises the need to approach these within an interpretive framework. Further still, Moris-Suzuki (2005, p.27) emphasis the centrality of dialogue in this framework when she states “it may be more useful to try to assess the ‘truthfulness’ of the processes by which people create meaning from the past”. The past, such as artefacts or objects, can then be used as a catalyst for eliciting multiple perspectives.

The Intercultural Site proposes that cultural heritage projects using multiple perspectives can use cultural difference as their interpretive framework. This means a multiplicity of interpretations can be accounted for both in the project and elicited by the user, as well as providing a suggested ‘instrument’ for the user to interpret the content, which becomes the *suggested* way for audiences to interpret the content, yet at the same time being transparent of an agenda.

Ipswich art gallery

An application of the Intercultural Site and dialogic interactivity can be seen at the Ipswich Art Gallery in Queensland, Australia. The museum is built in the city’s Old Town Hall and is centrally located for residents and visitors of Ipswich. The architecture of the building is a fusion of remnants from the Old Town Hall and renovations of the gallery, emphasising the multilayered history of the city. The concept of the museum is then expressed through the architectural design of the space, as revealed in the architects’ vision of the space by Bruce Buchanan, Andrew Gutteridge and Justin O’Neill (2000, p.22): “...an essential function of Global Arts Link is to bring into being a new form of cultural exchange... past and assist the present day development of social, technological and cultural exchange. This mediation of the past and future is also the role of the building. The Old Town Hall holds many of the city’s memories and stories while the new development will lead future expressions of the city’s life...”.

These architectural concepts are integral in emphasising the museum’s overall interpretive framework of exploring the city’s multicultural identity throughout past.

Ipswich Art Gallery works towards celebrating the diversity in its region, which consists of a strong Indigenous community, as well as many from varying cultural backgrounds including Italian, Greek and Turkish. Similarly, Ipswich Art Gallery acts a space for setting up intercultural dialogues to explore the region’s identity and future or as the Gallery has stated, “at the same time [Ipswich Art Gallery] acknowledges that *where people live and what they engage in* – that is, placemaking – is extremely important in reflecting who they are” (GAL, 2000, p.3). In this way, the Gallery’s

approach to the past is not about trying to present a homogenous Australian experience but instead acknowledges multiple understandings within the local community.

The exhibits are similarly premised on maintaining constant dialogues with the local community. In this way, the exhibits both reflect and construct the inherent cultural diversity of the region, as well as exploring their sense of identity. This reflects the strategy of historical truthfulness by utilising community voices rather than an authoritative voice. At its core, Ipswich Art Gallery is a community-based museum “which aims to be audience rather than object driven, the implications in understanding this diverse audience, as well as other visitors, are enormous” (GAL, 2000, p.4). The local Ipswich community is able to contribute their own content, such as stories, film and objects, to the construction of exhibitions in the gallery. This highlights the Gallery’s aim of a bottom-up approach to knowledge and meaning-making in Ipswich Art Gallery or as Roberts states, “we wanted to have a much greater focus on people and how technology was going to be incorporated within it [the gallery]” (Moore, 1999, p.7). Virtual heritage is then used to interpret issues of identity, place and myth on both individual and collective levels for the Ipswich region.

An exhibition that illustrates this is the *Bendigo Hall of Time*, which presents Australian Indigenous and non-indigenous views side by side and constantly updated with local stories. The Time Machine exhibit includes a large custom-made monitor and controls, created with bright colours and moulded plastic. The exhibit provides historical background for the Ipswich region, not through chronological order but rather by moving between events, people and places. The identity of the region is presented as multicultural and diverse in its nature. For example, multiple voices are present within the exhibit, including local perspectives alongside more official voices, such as the media and government. Further still, various social, political and environmental issues within the region are presented in an open manner: art history is placed alongside articles of Pauline Hanson phenomena. This is arguably the strength of the exhibit as it gives the local community a sense of ownership in exploring their regional identity.

Upstairs is the dedicated Children’s Space, which has become a large focus of the Gallery and is the first in Australia. A taskforce of local early childhood educators worked with GAL to develop facilities and programs that link with early childhood development and education curriculum, and as Douglas (GAL, 2000, p.5) describes the “space is dedicated to stimulating young children... the experience of learning through play as well as a sense of enquiry about the arts and family interaction”. The space is highly interactive using a variety of media that are again not technologically premised: artwork on the giant magnetic wall, finger painting on computer screens; children’s virtual exhibition on the museum’s website; a storytelling space; and an exhibition space of art and craft from local children. The space also extends beyond the exhibitions to include regular workshops and temporary exhibitions including: Disco Puppy, an interactive disco floor where children’s dance movements controlled the movements of three dancing puppies on a projected screen; and Flying High, a hand crocheted climbing web by artist Evelyn Roth that was “an interactive art experience based on the sensation of flying” (Ipswich Art Gallery, 2006, http://www.ipswichartgallery.qld.gov.au/site/past_exhibitions.php). The Children’s Gallery is significant as it not only prioritises the voice of children in the space, but a diversity of beliefs and expressions through art and craft.

Ipswich Art Gallery’s emphasis on designing exhibits based on an intercultural framework can be seen as providing visitors with a device for interpreting local identity and history, as well as providing a space for exploring the future.

Towards the future

The Intercultural Site is a preliminary proposal and my fellowship will be extending this, as well as applying it to further case studies. Consequently, it is acknowledged there are still many issues still to be addressed within notions of cultural difference and virtual heritage, for example the voice of local community. Longer term questions relate to how the application of this framework can be sustainable and also, whether the idea of ‘cultural literacy’s’ can improve the framework.

As the virtual heritage field is dealing with the interpretation of cultural heritage (by visitors, producers, collectors), issues of interculturalism are significant to the field. Interculturalism may not be the only way for understanding virtual heritage but it is an increasingly relevant one. Virtual heritage enables unprecedented communication strategies between different cultures towards encouraging respect and understanding of cultural difference. It then becomes critical that the paradigms and methodologies underlying virtual heritage projects are suitable for beginning to deal with issues of cultural difference and the Intercultural Site provides a forward.

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ARCHAEOLOGY, MUSEUMS AND VIRTUAL REALITY

A semiotic approach to the use of VR for the presentation of archaeology in museums

Abstract

This text presents the doctoral research project carried out between the years 2003-2006 at the Universitat Autònoma de Barcelona and at the University of the Aegean. The project examines the use of Virtual Reality (VR) as a presentation tool; it seeks to understand if and how VR is useful for the interpretation of archaeological knowledge in museum settings. Given the facts that VR is based on visual information and the question encompasses several fields, it establishes a semiotic theoretical framework that allows for the use of its analytical methodology and at the same time assembles all the information in a coherent way. The knowledge domains involved are Archaeology (epistemology and social function), Human Perception and Cognition, Communication, Technology, History of Science, Semiotics of images, Museology and Education. Each section has strived to combine theoretical deductions and empirical verifications in order to put forward some preliminary theoretical foundations for the use of VR as a dissemination tool in archaeology. This paper will concentrate on justifying the adoption of a semiotic approach and will present some results along these lines.

Introduction

Faced with the spread of virtual reconstructions in archaeological museums and unverified praise of its advantages, this project had a dual purpose: The first was to find out whether VR is suitable for disseminating archaeological knowledge in exhibitions. Based on this information, the second was to propose a theoretical framework for the use of VR as a communication tool in museums, given the fact that they are currently lacking.

To fulfil the intended aims, the research project was developed as follows. In the beginning, as it was a very broad inquiry, all the fields involved were defined and, taking into account that VR is based on visual information, semiotics was chosen as the theoretical and methodological framework to analyze the different aspects of this communication technology and integrate all the information in a coherent way. Nevertheless, any theoretical framework cannot solely rest on purely intellectual constructions but must be based on a body of empirical information that validates it. Therefore, the next step consisted of identifying relevant points and carrying out research about empirical studies related to the museographic pragmatics of VR, that is, studies that would verify the conclusions reached inductively.

This comprehensive approach has two potential shortcomings. First, it touches on several subjects but does not make an in-depth study of any of them. In spite of that, it must be borne in mind that this was not the aim of the project: the interest lies in generating a global theoretical reflection because at this time, knowledge is fragmented and more or less implicit in the different fields related to VR. The second reason for criticism can be the fact that empirical conclusions have been extrapolated from other applications or environments since until today there have been no examples of the conception that has guided this research project. Nor would it have been appropriate to design a specific one, because before embarking on in-depth studies we need to have a theoretical and methodological basis that has in fact been proven to be lacking by the cross-disciplinary approach adopted here. Thus, a systematic selection of studies analyzing the effectiveness of each factor involved was conducted, and in the end all the pieces of information were put together in the theoretical proposal.

Placement within current international research

When it comes to contextualizing this research project within current international research, I have mainly taken into account the diverse studies about VR published between the years 1999-2005. VR is a very special means of representation and Information and Communication Technology (ICT)

application. It is located at the crossroads of four traditions –museography, the media, mathematics and depiction (both artistic and scientific)– which took a specific shape in the western world and led to the creation of VR, nowadays their heir and latest exponent. For that reason, it is difficult to define and analyze the concept: it raises diverse issues that come at times from quite distant knowledge domains, namely the historic, cognitive, technological and social fields. Nowadays, VR is being studied in each of them, but, naturally, the approach depends on their own concepts, methodologies and objectives. In other words, VR is studied in a disperse and fragmentary way, according to different perspectives that apparently have little relationship between them and, therefore, will lack an integrated approach.

Some of the publications examined have a theoretical perspective –(Barceló 2001, Champion 2003, Forte 2003, Owen 1999)– but it is either not made explicit or limited to transferring theory from another knowledge domain and inferring the consequences for learning without any empirical verification. On the opposite side, we can find experimental studies or evaluations analyzing a very specific aspect which only take into account empirical considerations, without any theoretical basis, except for some authors –M. Roussou (2005), W. Winn (1993), K. Osberg (1997), B. Harper (2000), R. L. Jackson (2000)– who assert their constructivist notion of learning. However, neither of the two possibilities –the theoretical or empirical approach– has the far-reaching and integrative intention that characterizes the research project presented here.

Studies evaluating VR's effectiveness have been carried out, as mentioned above, in different domains. The first is engineering, which possesses a long tradition of experiments about interface usability, and was interested in testing whether, given the positive results in the military, the technology could also be useful for conceptual learning (Winn 1997). This is the case, for example, of the HITL's Learning Centre at the University of Washington. Another line of research belonging to the realm of technology was developed from the "presence" studies, a complex and very active field of computing science which has mainly used quantitative methodologies and fidelity measures. One example of this approach would be Mel Slater's research (Slater 1999).

The second context which has showed an interest in VR is museums. Having adopted ICT more out of social and political pressures than out of a conscious educational strategy (Pastor 2004), some museums, following the evaluative tradition of these institutions, have slowly started to ask about VR's educational effectiveness or about the influence of a virtual visit compared to a real one. Therefore, it is a subject of interest for them, although naturally this kind of evaluation presents a strictly museological perspective and in some cases its dissemination or accessibility is restricted to museum staff. The last sector which has explored –very widely– the educational possibilities of technology is pedagogy, but as expected, its studies have concentrated more on formal learning and other kinds of interfaces –initially PCs, and more recently multimedia– because they are more similar to the traditional means of knowledge transmission –text and images– that characterize the formal educational environment. Despite this initial gap, the accumulation of interactions and transfer of perceptions amongst the three fields has brought their objectives closer together and very recently, we have started finding some hints of a general, official and coordinated interest in evaluating the usefulness of VR in museums. The problem is that it is still too recent and mainly concerned with the perception of technology and the audiences' level of satisfaction.

In addition, in each of the aforementioned fields, there have been doctoral studies specifically aimed at evaluating VR applications, what brings them closer to the particular features of the project being presented in this publication. First are the dissertations from the domain of computation, such as those written by Christine C. Byrne (1996) and Kimberley M. Osberg (1997) under the supervision of William Winn, and characterized by the adoption of a constructivist perspective. The main difference is that the studies concentrated on the formal learning context. There is also a doctoral

research project undertaken from the museum standpoint (Flon 2002), but it was aimed more specifically at VR's impact on visitors as a communicative strategy –it analyzed knowledge transmission through visual means– than at the assertion of a theoretical basis for its use in archaeology. Another research project that can be included in this group is the one conducted by Joy Podgorny (2004), who designed and implemented a VR application and evaluated its efficacy in relation to the level of engagement. Although the aim of this project was to study teamwork, and it was not a true virtual model but rather mainly a three-dimensional projection, it is still relevant because it was done in the museum context, and it tried to discern which factors influence such an important variable as engagement and above all it attempted to set up a methodology of analysis. This is exactly the same value that can be attributed to Kher Hui NG's Master's dissertation (NG 2002) which, although being conducted in the field of computer design, not only proposed an evaluative protocol and concentrated on the informal environment, but also dealt with such an essential question for museums as social interaction.

Finally, we should comment on two research projects (Mosaker 2001, Tzortzaki 2001) very similar to the present one because their authors sought to examine how the past is presented in virtual reconstructions and how these contribute to disseminating this knowledge in museums. In the first case, Delia Tzortzaki deems that the CAVE®-like system used at the Foundation of the Hellenic World in Athens is related to the positivist concept of archaeology because it is a semiotic system which, because very detailed 3D models are presented, conveys the notions of objectivity, authenticity and truth (Tzortzaki 2001). On the other hand, Lidunn Mosaker makes a general reflection about the way the past is (re)presented, leading her to adopt a broad perspective in which she reviews different aspects related to history, cognition, technology, society and also epistemology and ontology. It is a proposition amazingly close to the one presented in this text, but there is a fundamental difference: while Mosaker works with different theoretical frameworks depending on the subject, and this makes it difficult to comprehend the common thread –although this could also be due to the fact that the paper presents a summary of her dissertation–, this project tries to integrate all of them into a single theoretical and methodological framework, semiotics, which brings overall coherence and furnishes analytical tools.

At the present time, instead of designing applications to fulfil some already-established aims, we are still in the trial phase, trying to understand VR features and how they relate to learning efficacy. This generates contradictions between the studies' results and interferes with the integration of all this evidence within an overall framework about VR's educational use. This foundation is necessary to use it appropriately and until now constructivism seems to be taken as such. But it presents problems of suitability because it was not intended for technology (Mantovani 2001). This is the reason why semiotics can constitute an excellent starting point, until VR or ICT in general build up a more effective paradigm in collaboration with the other disciplines involved.

Justification of the semiotic theoretical framework

The initial question was if VR is useful for the presentation of archaeology in the exhibition setting. This is a very broad problem and involves answers at perceptive, cognitive, pedagogical and museological levels. These fields are so diverse that they needed the presence of a theoretical and methodological framework in order to integrate the analysis and results. This basic structure was provided by semiotics, for the five main reasons outlined below.

The first is the general context of this research project, the information society, which appeared as a consequence of a process rooted in the Industrial Revolution and whose latest exponent is the introduction of ICT in all spheres of daily life (Echevarría 2000, Lévy 1995, Maldonado 1994). This is noticeably modifying the gathering, representation and transmission of knowledge.

The second is the fact that the three main branches of this research project –archaeology, museums and VR– can be analyzed from the communicative standpoint because it plays an essential role in all of them. In the first case, archaeology constitutes the bridge between our heritage and society, since it endows the archaeological remains with meaning that provide the basis for constructing identities (Criado 2001). This link is forged through education, either formal or informal. As a matter of fact, the exhibition –the second of the three branches– is one of the main means of disseminating archaeological knowledge and, following the present-day idea of the museum, its principal function is communicative, more specifically, educational, and consequently social. Regarding VR, as will be explained below, the fact of being a means of representation already confers on it an essentially communicative aim; but, moreover, it is generated computationally and computers were originally designed with an essential communicational component: they solved problems through a linear input - output dialog with the user.

The third justification comes from philosophy, and more specifically from the parallelism between the philosophical definition of virtuality and the objectives and components of VR. According to Pierre Lévy (Lévy 1995), virtualization is produced through a process represented by the medieval “*Trivium*”: grammar, which corresponds to syntax; dialectics, which corresponds to semantics; and rhetoric, which corresponds to pragmatics. This parallelism can be established because, as in language, virtuality is made up of units which do not have any meaning when taken alone but that can be put together in different ways in order to create meaning. This is accomplished through actualization, which is conditioned by the pragmatics of the interface and, at a previous level, by the aims. Thus, the functioning of virtuality according to Lévy justifies this project’s epistemological choice from another perspective and at the same time points to the general way of approaching the analysis: the distinction between the three realms of analysis is pertinent because it is common to both semiotics and virtuality.

The fourth justification is the computational essence of VR, which can be approached in two different ways. The first is that, since the first calculating machines, computer interfaces have progressively been transformed to adapt to a communicative purpose that is semiotic in a broad sense, although communication in computers has been studied and typified mainly through mathematical theories. Communication and semiotics are linked because the former implies the transmission of a message that is intended to be meaningful, uses a specific and already-established code and is conditioned by the circumstances and the features of participant elements. In the case of computers, syntax could be found at two levels, the internal binary code and the signals that arrive or leave the peripherals –mouse, screen and keyboard. Semantics would refer to the user’s or computer’s interpretation of these signs, while pragmatics would correspond, as mentioned in the previous paragraph, to the interface and the aims. All this gives rise to the human – computer interaction (HCI) as a specific mode of communication. The second way to approach this fourth justification, closer to philosophy, is to take into account the fact that computers by themselves are already a particular kind of virtualization because present-day computers have become a machine of machines and therefore constitute a virtualization of the virtual (Lévy 1995). Consequently, the philosophical and communicative justification is even more applicable to VR.

The last justification is that VR is a particular sort of image and this kind of representation is made up of signs that communicate information through a more or less conventional relationship with a signifier. VR can behave simultaneously as a sign, as a representation and as a symbol, depending on the nature of its elements: either more abstract or more directly related to reality in an iconic way. This definitively justifies the use of semiotics and confirms that examining VR from this perspective allows the application of the analytical and structural potential of semiotics that,

according to some authors (Maldonado 1994), improves on the methodologies that have been traditionally used to study images, such as philosophy, psychology and art history.

For all these reasons, I decided to approach the use of VR in archaeology from the semiotic point of view and tried to apply to computational simulations the analytical methodologies developed in other knowledge domains. Moreover, as a consequence, all the partial data coming from each field involved were integrated into a coherent structure.

However, applying this framework brought some problems derived from the fact that semiotics has been developed within the discipline of linguistics and, to a lesser extent, the audiovisual world, and it therefore did not fit exactly VR applications. As an interactive simulation of reality, VR is not a natural language, nor is it a still image or a movie. VR simultaneously contains a declarative and an iconic component and, consequently, falls between conversation and movie. VR is also distinguished by the fact that it destabilizes the traditional relationship between signifier and meaning. This is due to two reasons: first, because it seeks to replace the reality perceived by our senses; and second, because it contains an already-established meaning –the one from each sign, although the global message is built up during the interaction. Nevertheless, these differences are no obstacle to applying the semiotic perspective; on the contrary, they help to broaden its theoretical and methodological scope, especially bearing in mind that Jean Piaget already claimed that what we would now call “traditional” semiotics was excessively formalistic: it forgot that the fundamental nature of linguistic signs is communicative and, consequently, was limited as an analytical tool (Maldonado 1994). Therefore, this study proposes not a semiotics of language but a semiotics of communication, which, aside from being able to take into account VR’s particularities –interactivity enables to avoid the formalist in favour of the communicative discourse– it also emphasizes the pragmatic dimension, in the concrete uses of technology.

This is the main advantage when compared to the analysis carried out by G. Bettetini (1991), one of the two semiotic analysis of VR which have been published to date. The comparison with this study led to the conclusion that the present research project goes further for three main reasons. First, it is not limited by the dichotomy between image and language. Second, it does not restrict pragmatics to purely computational interactivity but instead considers in this analytical sphere the aims of the application and, therefore, adopts a broader approach in which interactivity is included as a specific tool, determined by the goals. Third and last, Bettetini does not make any reference to either semantics or syntax, which would have helped to better understand the capacity of the semiotic approach to ICT; had he done so, he might not have reached such discouraging conclusions about the possibilities of this theoretical and analytical framework.

On the other hand, Delia Tzortzaki (2001), author of the other semiotic analysis, adopts a purely pragmatic –but still theoretical– approach that leads her to consider VR from the perspective of the transmission of archaeological discourses in the museum. This is simultaneously both an advantage and a hindrance. It is an advantage because from the start she does not limit herself to describing the system components but takes into account the external, contextual and epistemological factors which determine the application’s features. On the other hand, she does not compare VR solely with a text, rather she considers its dual dimension, both visual and textual, always within the spatiality framework. This leads her to a two-fold analysis: diachronic, about the resources activated by the exhibition as a spectacle; and synchronic, about VR as a specific narrative, which is the form historical discourse takes in the museum. Last but not least, this more pragmatic conception allows her to analyze another fundamental question about VR use as a dissemination tool in the museum: its function as a means within another means, the exhibition, which acts as a contextual framework. It is clear that this approach opens up more perspectives and provides more explicative elements. But, this is also a hindrance because then she does not conduct a complete semiotic study but limits

it to the chosen pragmatic context. This is proven by the fact that, as she concentrates on communicating about archaeology in the museum, her conclusions about VR as an image and as a narrative are not situated within the domain of VR semantics but within archaeological epistemology and museology, and this does not provide information about VR itself, which is what we are seeking here.

After this critical reflection, only one final consideration remains: instead of applying an analytical tool, was I simply “semiotising” my subject of study? At the most general level, it seems that I am only applying the three major domains of semiotics –syntax, semantics and pragmatics. Yet in reality, I am trying to analyze the needs and the consequences of using a specific communicational tool within a particular context and/or with a specific purpose. This analysis intends to be as exhaustive as possible; therefore, it must take into consideration all the elements involved, from the description of the communicative tool itself (VR) to the environment in which it is used (archaeology, museums) and the way it is used (perception, cognition, pedagogy). This is not only to make the relevant questions match with semiotics, rather the three-fold distinction is pre-existent. Moreover, proper semiotic analysis can be applied to certain specific aspects, along with the methodologies borrowed from their own knowledge domains, as in the case of VR as an image. However, an exhaustive application of the most widely known semiotics is impossible because, as mentioned above, it has been developed for linguistics. Instead, the medieval *Trivium* transcended this field and constituted a reflection about the world. It is in this sense that it was understood and adopted for the present research.

Semiotics of VR

After having introduced and justified the theoretical and methodological framework, the central part of the project, which looks for the theoretical foundations of VR use in archaeology through its semiotics, is divided into three chapters devoted to the syntax, semantics and pragmatics of VR, respectively.

VR syntax

In this section and the one on semantics, the analytical potential of semiotics specifically developed in other fields can be applied. Virtual reconstructions contain a verbal language which is situated on two levels: one internal, which regulates the workings of the simulation, is logical and never visible; and the other external, aimed at providing information to users. Despite this, if the goal is truly to make a virtual reconstruction as opposed to multimedia, then the communication takes place mainly through visual and motor interfaces, while language plays a marginal role. Thus, VR presents characteristics that make it more similar to iconic than abstract representations, and this justifies the fact that the semiotic analysis applied comes mainly from the knowledge domains that examine images: art and audiovisual communication.

The most essential building blocks of images can be divided into 3 different types (Villafañe 1998):

- Morphological (formal): dot, line, plane, texture, colour, shape.
- Dynamic (temporal): format, pace, tension.
- Scaled (iconic signifiers): size, format, scale.

They are all articulated to construct meaning in a way that is quite similar to the perception of natural scenes (Alonso and Matilla 1997, Hamm 1986).

Comparing VR with these general characteristics of images enabled us to prove that a reconstruction preserves the basic elements that are also found in, for example, a painting or a photograph, but adapted to the technology. To begin, the dot is the simplest iconic element, and in the case of VR, it is essential because it serves as the basis of everything that appears on the screen:

onscreen, the objects are represented through clusters of coloured dots. Texture is also an especially important element in VR, since it constitutes the perceptive basis of the reconstructed world: the objects are made by a basic geometric structure, and textures are superimposed on the planes delimited by the edges. In terms of the distinction between shape and structure, it should be mentioned that the advantage of VR is that it contains both at the same time: the structure, the visual representation of the concept, is put into place from the moment of the modelling and navigation tools are added later in order to enable the object to be viewed from infinite perspectives and thus more completely. The latter consideration is related to the keys to representing depth: VR contains all the pictorial clues characteristic of any iconic representation, but it can additionally simulate certain psychological clues as well (Kalawsky 1993).

In VR, the scaled structure of the image is one of the most flexible due to its quantitative component. For example, the size of the objects can be changed by using the zoom tool, with the goal of viewing it better or spotlighting a specific detail. Format, however, has lost its determining nature when representing temporality, because it has been replaced by dynamism. On the other hand, it is still important from the general standpoint of content, although we no longer talk about the ratio (of the picture) but about the type of interface. Depending on whether it is an HMD, a CAVE® or a Desktop screen, the representation is better suited to one environment or the other. Scale, and less commonly, proportions, are other parameters that VR navigation tools allow us to modify for scientific purposes. In the specific case of scale, we find, along with the dynamic and interactive behaviours, one of the main elements of VR's isomorphism.

From the dynamic standpoint, VR presents several very important differences compared to the other types of images. First of all, it works through a potential chaining –that is, it is not deployed in the physical space of the medium. Thus, it is located halfway between the still or isolated image and the sequential image. This leads the temporality to be either suggested, such as in paintings, or real, such as in films. If we wish to reconstruct an action, a causal sequence or the like, we must use dynamic images because their nature is fundamentally narrative. If, on the other hand, we wish to re-create an action taking place in an enclosed space or a certain atmosphere generated by stable elements, the best route are isolated images because of their descriptive nature (Villafañe 1998). This is precisely what the most common or traditional applications of Virtual Heritage do: they solely present architectural elements that are highly static, and this is why they convey a sensation of artificial stillness. As we have converted a tool that is designed to be interactive into an isolated image, in this case we cannot speak about VR *per se* but of digital images.

The second difference is that VR introduces interactivity as a narrative means. In this sense, it goes beyond films because it allows one to intervene in the development of the sequence. Thus, not only is the time sequence discretised, rather we can regard it as more “realistic” because it allows us to manipulate the elements represented, just as we would do in reality. Bearing in mind that one of the main goals of virtual reconstructions are or should be scientific visualization and experimentation, then we shall also be involving inferential reasoning, thus leading the relational nexus to cease being purely iconic to become abstract or verbal as well. Analysing it from the communicative perspective, we could conclude that it is closer to interpersonal communication because the code includes both verbal and visual elements, but especially because feedback is established between the two participating elements such that both alternate in the role as emitter and receiver.

The discovery of these novel features led to an examination of the syntax, also from the standpoint of linguistics, in order to gain a better grasp on the transformations brought about by simulation technology. The conclusion was that in either of the two cases, the key element changing the frame of reference is interactivity, which affects both the visual significance and the semantic component.

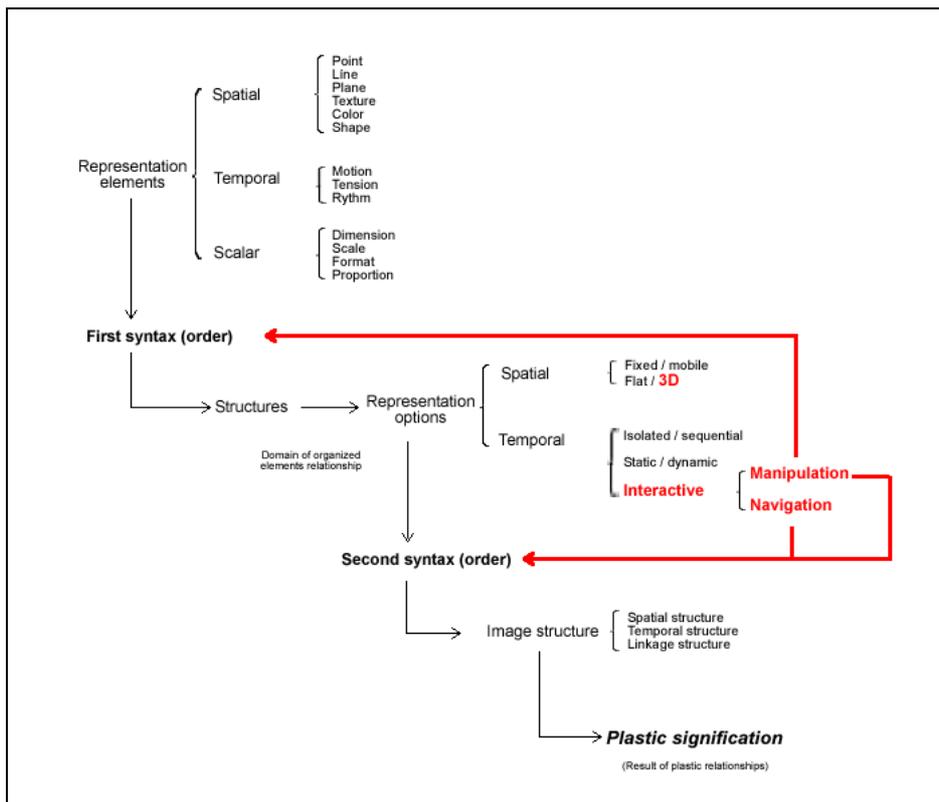


Figure 1: Semiotic functioning of VR: Its interactivity modifies the scheme proposed for images (Villafañe 1998). The normal text and lines show the traditional structure of meaning, while the bold text and thick lines show what has been added by VR and how the basic meaning construction relationships have changed.

In the former, as can be seen in figure 1, we can distinguish between two different situations: interactivity is either limited to navigation or modifies the characteristics of the simulated world. Navigation only influences the placement of the objects and thus affects the second level of syntax. In contrast, modifying the quantitative and qualitative parameters of the reconstruction influences the basic morphological elements and thus also affects the most basic level of syntax. In the second case, that of semantics, the traditional schema is also affected by interactivity because there is not only the denotative and connotative element of every still image but also the meaning that emerges from their connection, from the possibility of changing the discourse with an epistemological purpose. This adds an external symbolic component that is not considered in the study of images but is, precisely, in the realm of linguistics, and which corresponds to the pragmatics of discourse.

In conclusion, the most basic syntax of VR can be compared to that of images, but interactivity modifies certain elements and leads us to abandon dynamic images and move closer to dialogue. However, it cannot be compared to human conversation because it lacks the richness of creativity. Yet on the other hand, this is compensated for through multisensoriality –inherent in the relationship with the environment- and exhaustiveness – inherent in computers. Thus, VR is similar to an exchange with the environment with the difference that while this commonplace experience tends to be denotative and connotative on a cultural level, in VR it mainly possesses epistemological connotations which bring us into the realm of pragmatics.

Semantics of VR

Semantics is another aspect of VR in which can be to some extent applied the semiotic analytical tools developed in the closest domains. The basic information about the images dealt with three factors: the way the visual reading of an image is produced, the relationship between denotation and

connotation, and the way the relationship between an object and its representation is established (Rodríguez Diéguez 1978, Tijus 1995, Villafaña 1998). The latter took place through a comparison between ontological and physical resemblances, which leads first to define the concept of iconicity and secondly to distinguish between three different types of relationships, homology, isomorphism and analogy, given the fact that VR is a model of reality.

Applying this information to VR also leads to very interesting conclusions about its relationship with the real world and the way interactive technology fulfils or modifies conventional semantic links. To begin with, on an internal level, as VR is generated through computation, the relationship between signifier and meaning disintegrates and is transformed into abstract logic in order to be able to manipulate the information. It is later recovered on the screen –in some ways in the style of the Hegelian synthesis defined by Walter Ong (1958)– because it translates the new information into iconic, referential language. And this is possible thanks to geometry, which constitutes the point of contact between the world of shapes and that of numbers.

On an external level, as illustrated in Fig. 2, interactivity influences both visual and conceptual meaning and establishes a new link between them because we are not watching a still depiction but images that change responding to our actions. Therefore, meaning is also created symbolically, through the interaction with the virtual reconstruction. Furthermore, this also breaks the traditional relationship between signifier and meaning because, together with qualitative realism, it tends to blur the normally clear distinction between reality and representation. According to Philippe Coiffet’s model (1995), VR contains two kinds of realism: qualitative, which refers to the quality of graphics, and quantitative, which refers to the system response or interactivity.

This is a direct consequence of the goal of VR, which aims to bring the proximal object and the referred object as close as possible (Tijus 1995). In other words, it never manages to break the semantic triangle set forth by Ogden – Richards (Rodríguez Diéguez 1978), but it strives to bring the symbol and referent as close as possible; or, from the strictly linguistic standpoint, it simplifies the relationship between signifier, meaning and symbol because it lessens the latter’s degree of abstraction.

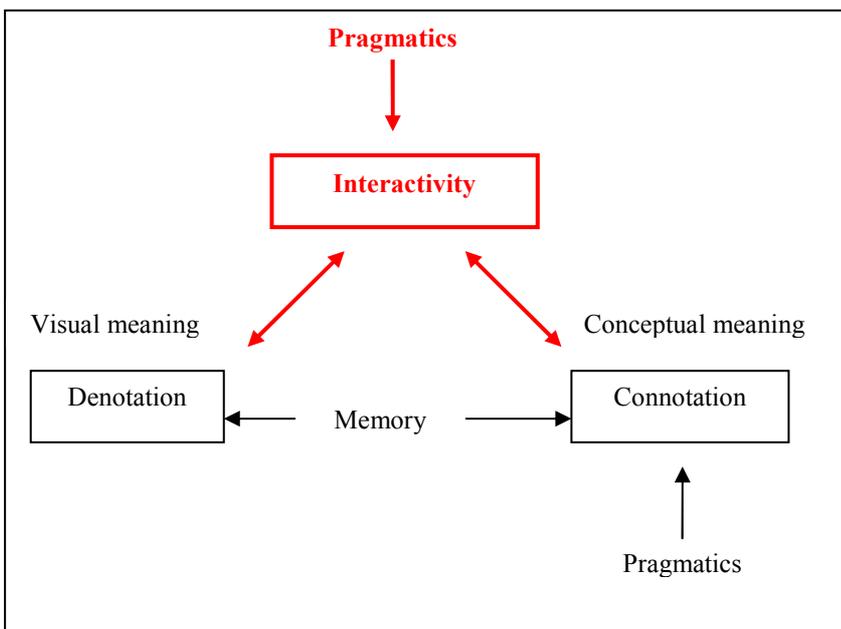


Figure 2: How usual understanding of images (Alonso and Matilla 1997) (normal text and lines) is modified after adding interactivity (bold text and thick lines).

By establishing a gradation of their respective proximity according to the degree of iconicity and functional homology, we shall now examine the relationship between VR and reality. If we bear in mind the shape and structural resemblance, along with the function, then VR –and especially Immersive Virtual Reality (IVR)- could be regarded as isomorphic from the formal standpoint and analogical from the behavioural standpoint. According to Wittgenstein, Leibniz and Pierce, these characteristics are what confer on it its power or verifying value, and consequently are what make it interesting for science, since VR becomes a tool for understanding reality.

Iconicity or abstraction scale

Degree	Reality level	Criteria	Dimensions	Example
0	Object	Restores all the object properties	3 (material)	Objects in the exhibition; archaeological site
1	Scaled three-dimensional model	Restores all the object properties. There is identification but not identity	3 (material and represented)	Reproduction of an object; reconstructions like Archéodrome of Bourgogne
2	Reduced or augmented model	Geometrical properties are maintained	3 (material and represented)	Models
3	Stereoscopic images	Restores shape, measures and position of objects which are present and emit light radiations	3 (non material but represented)	Holograms
3.5	Virtual Reality	Restores shape and position of radiation-emitting objects projected onto a screen following a rigorous perspective	2 material 2.5 represented + 1 temporal	Virtual reconstructions
4	Orthophotography	Projection, rigorous perspective	2 material 3 represented	Photography of a layer or an object without distortions (photogrammetry)
5	Colour photography	Criteria of outline continuity and shape closure	2 material 3 represented	Photographs
6	Black and white photography	Criteria of outline continuity and shape closure	2 material 3 represented	Photographs
7	Perspective drawing, outlines drawn	Criteria of outline continuity and shape closure	2 material 3 represented	Drawings
8	Anatomical construction sketch or	Topography is kept but with arbitrariness of values, quantification of elements and simplification	2 material 3 represented	Anatomical section, geographical map, ground plans and cross-sections, drawing of pottery

9	Cross-section, front elevation; figurative representation without perspective; pictograms	There is identification but spatial relationships are altered. All the sensitive features except shape are abstracted. Layout following topological proximity	2 material 2 represented	Anatomical section, geographical map, ground plans and cross-sections, drawing of pottery without metrics; electrical circuit; silhouettes, children's drawings
10	Organigram or block diagram	Substitution of the elements by normalized symbols; ranging from topography to topology; geometrisation	2 material 2 represented	Organigram of a company or a computer program
11	Formulation scheme	Elements are functional black boxes linked by logical connections	2 material 2 represented	Chemical formulae, developed sociograms
12	Complex space scheme	Logical and topological relationship between abstract elements in a non geometric space. Unions are symbolic.	2 material 1 represented	Strengths, static schemes
13	Purely abstract scheme and vector scheme	Combination in the same space of representations of schematic elements (arrow, line, plane, object) belonging to different systems, without any logic criterion	2 material 0 represented	Vector graphics, sonorous objects, vowel triangle
14	Description with words or algebraic formulae	Graphic representation inside an abstract metric space of relationships between vector magnitudes	2 material 0 represented	Equations and formulae. Texts
15	Signs	Purely abstract signs, without any imaginable connection with meaning	2 material 0 represented	Signs made at random, automatically

Table 1: Placement of VR in the iconicity scale created by M. Alonso and L. Matilla (Alonso and Matilla 1997) after the original scale designed by A. Moles (Moles 1975).

As shown in Table 1, that I have simplified and adapted to archaeology from (Alonso and Matilla 1997), VR is halfway between holography and orthophotography, since the representation is not physical and this enables it to (dynamically) represent three-dimensionality, but at the same time it is limited by the screen containing it. In reality, it is like a flat three-dimensionality in which the metric distances are always Euclidean –such as in orthocorrected photographs- with the addition that the point of view can be shifted and panoramic perspectives can be generated. However, the major advantage of VR is that it has the ability to move around this scale or to contain any of the categories beneath the point where it is located. This is possible thanks to the abstract logic underlying all computers, which enable them to fulfil the same functions as the classical iconic models and combine them with mathematical and diagrammatic models. The elements that determine the position of VR are the interface and the contents, which in turn depend on the pragmatic function of the model. From the standpoint of the interface, IVR is located higher up, while Desktop would be lower down, always bearing in mind that we are talking about ergonomic capacity as opposed to the figurativism of the content. That is, we have added another classification criterion: the ability to simulate our perception of the world. From the standpoint of content, the ideal Virtual Heritage would be located between levels four and seven because the angle of

observation can be shifted during the navigation, although it is necessarily simplified because not all the data are available.

Nevertheless, when comparing it to images, we realise that VR modifies the scale of iconicity because it contains other determining elements, in addition to the figurativism of the content: the interface, the level of symbolism of the reconstruction and the multidimensional interactivity. This obliges us to speak not of the “iconicity scale” but instead of its “ontological proximity to reality”, because we are simulating the behaviour of the world not in three but in four dimensions. The first three are indeed iconic –because they are spatial- but time must be regarded as abstract because it is not directly observable and its existence comes from intellectual inference. All this is shown in table 2, specifically designed for VR.

VR’s scale of proximity to reality

Reality level 1	Criterion 1	Degree	Reality level 2	Criterion 2	Dimensions	Examples
Hybrid Reality	Augments the reality through its own objects	1+	Reproductions of reality or reality itself, contains and displays integrated information	Informational artefacts, they act like reality	4 (reality’s)	<i>Tangible media.</i> Replica of archaeological objects (e. g. at Ename)
			Image of reality with superimposed information			
Augmented Reality	Augments reality through its capture and display on screen	3+	Image of reality with superimposed information	Dynamic, interactive and shows the environment in real time	2.5 (navigability in 2D/3D flat) + 1 (real time)	PDA at exhibition or site
			Model			
Immersive VR	Simulates the multisensorial perception of the world and the feeling of presence inside an environment that can preserve all geometrical properties	3.125	Model	Is dynamic, interactive and simulates temporality	3.99 (temporal, navigability and multisensoriality)	Star Trek Holodeck. VisTA-walk system
			VH	Is dynamic	2.5 (navigability and flat 3D)	Nu.Me Project, Troya VR
Desktop VR	like a window on a manipulable world. Projection following rigorous perspective	3.375	Digital images	Is static	2 (like a photo)	Dunhuang CAVE
			Model	Is dynamic, interactive and simulates temporality	3.99 (temporal, navigability and multisensoriality)	Vista System, Nu.Me Project
			Virtual Heritage	Is dynamic	2.5 (navigability and flat 3D)	Most present-day virtual reconstructions
		3.875	Digital images	Is static	2 (like a photo)	Most old virtual reconstructions

Table 2: Scale of proximity to reality for different kinds of VR after introducing its 4D interactive capacity.

In the case of VR, time is manifested through dynamism/interactivity, and it serves as the basis for its epistemological function: the transformation of virtual objects establishes not only iconic links but also links of logical causality, with the advantage that the time elapsed can be changed at will, something that is impossible in reality. This ability places VR at a more abstract level than pure interactive simulation of the environment, and it justifies the use of VR as a scientific and disseminative model: if we wish to make a narrative, there are already books or films available; to express highly abstract concepts, the verbal or algebraic languages are irreplaceable; the potential of VR lies in interactivity and its ability to systematise and explain the inferential chains related to the direct manipulation of the world and, in the case of archaeology, with the manipulation – impossible in reality – of the temporal dimension.

This capacity has also at least theoretical advantages in terms of information dissemination and learning. Of all the representative conventions, the perspectivist iconic representation of reality is regarded as the closest to our sensorial perception. As VR integrates this kind of depiction and interactivity, it becomes the best simulation of interaction with the environment (Cadoz 1995, Maldonado 1994), not so much because it really reproduces our natural relationship with it –as Science-Fiction pretended–, but because our behaviours are equivalent, analogical, to those that would be produced in the presence of the real object. This is the capability that gives it its verifying and also educational potential. In the case of the historical disciplines, given the fact that are regarded as especially complex because they deal with multifaceted phenomena based on different theoretical and methodological premises, the use of a virtual reconstruction would serve to facilitate learning because it presents causal connections and other types of reasoning or abstract methodologies through a flexible, iconic representation. On the other hand, the addition of time enables us to gain in specificity, if we define abstraction as the number of dimensions that are presented or withheld. Thus, the attention of non-experts can be focused on the content, on the manipulation of spatiotemporal variables, instead of becoming stuck on grasping the most basic aspects.

All of this is possible, paradoxically, because as mentioned above, the binary logic of the computer breaks down the relationship between signifier and meaning. This leads me to view VR, from the semantic perspective, as an interface, a two-way translator between our understanding of the world and symbolic logical language that allows us to manipulate the units of meaning or knowledge. Yet now, instead of being codified according to our verbal language, it is done so using the iconic language because we are working with spatial data.

Pragmatics of VR

The pragmatic analysis of VR –to use the term from the semiotics which refer to the practical aspects–, is conducted by examining its contextual side, this is, how the uses, aims, etc. of the representation determine its features. From a general standpoint, VR is (more than) an image and therefore can accomplish the same functions as images: descriptive, informative, creative, aesthetic, suggestive... but, in the final analysis, they are all communicative, because they are representations of reality. On a second level, VR is determined by its application in a specific context or knowledge domain. In this respect, we had previously seen that VR's syntactic and semantic features moved us away from pure ontology and drove us repeatedly towards the epistemological function because virtual reconstructions are determined by their computational basis. This justifies the use of VR in the sciences, including physics, astronomy, ecology and also archaeology, as several researchers have questioned the latter's traditional link with the art historical approach. VR can be used in two phases: research, in which it becomes a scientific model aimed at obtaining knowledge; and dissemination, in which it becomes a communicative tool aimed at reconstructing this same knowledge.

The research stage raised the fundamental question of VR pragmatics: is there any theoretical justification for these two uses? In other words, can we claim that VR is more suitable than other means of representation, taking into account the epistemological and social needs of archaeology? The main theoretical connection between VR and archaeology lies in the representation language of the domain's basic knowledge units: both archaeology and VR manipulate spatiotemporal entities, and this assertion is upheld in spite of the underlying concept about archaeology, because all theoretical trends are based on the archaeological record as a primary source of knowledge. However, each one entails different basic assumptions which determine the aims, contents and situation of VR within the research project, as I detail in the following table.

Approximation	Use	Archaeological approach
Presentation and description of archaeological data	Visualization of objects	Retriever of archaeological material, traditional in the descriptive sense
Presentation of spectacular findings	Emotional impact	Sensationalist, treasure quest, traditional in a romantic sense
Methodology of research	Understand science through its methodology	Science that provides knowledge
Social, political, ethnic dimension	Community cohesion, identity construction, economic invigoration	Social discipline, integrated into our present

Table 3: Relationship between the basic archaeological paradigm and uses of VR.

Continuing with the pragmatics of VR, the other question to be analyzed was the transmission of archaeological knowledge to non-expert audiences. The study concentrated exclusively on the museum because it constitutes one of the main points of contact between academic archaeology and lay people, and it also is one of the prime consumers of virtual reconstructions as a dissemination tool. However, the scanty bibliography available showed that this use is not supported by a solid theoretical basis based on empirical evaluations of real uses and effects. Thus, this part of the research was aimed at establishing a preliminary debate about the subject, joining all the involved aspects into a coherent discourse: general framework, museology, museography and learning. The main purpose of all these chapters was to verify if VR is suitable for communicating archaeological knowledge in the museum from each of the perspectives that constitute the visit experience.

In this case, the methodology did not come from semiotics but instead from experimental psychopedagogical studies and museum evaluations and visitor studies. The results are so plentiful and diverse that they go beyond the scope of this paper. Nevertheless, some of them have been published (Economou and Pujol 2006, Pujol 2005, Pujol in press) while others will be the subject of future publications.

Conclusions

The foremost contribution of this research project is the proposal of a global theoretical and methodological framework for integrating VR into archaeology and for analysing these uses. As a result of the initial question, the historical context in which it is posed, the conception of archaeology and museums that guided the project, and the definition of VR itself, the chosen field is communication and consequently the semiotic approach derived therefrom. A semiotic approach allows three things:

- To integrate into a coherent discourse the conclusions about the advantages and disadvantages of VR regarding the different aspects involved: perception, cognitive psychology, epistemology, museography, pedagogy, etc.
- To be able to apply and adapt the analytical methodology developed in other fields, because VR is a very specific means of representation, falling between natural language and images, and, within the latter, between external and internal images.
- To obtain an evaluative tool to verify these theoretical foundations in the future.

The next important contribution of this project can be considered to be the practical application of the theoretical framework. Indeed, it provides us with a rational and explicit basis for the scientific and disseminative use of VR in archaeology that did not exist before or, at most, was fragmented in the different fields related to the applications of this technology. The aim of this project was, after having verified if it was viable, to propose a theoretical foundation to support the use of VR for the presentation of archaeology in museums. This would not have been possible without the panoramic and exhaustive perspective provided by the semiotic structure. My doctoral dissertation suggests how this use should be, given particular premises about VR, archaeology and museums, but it also offers some guidelines for any situation based on empirical data obtained from the indications dispersed in different fields and real examples.

The adoption of a cross-disciplinary perspective like the one allowed by the semiotic structure does not allow to explore each involved field until its ultimate implications, but in contrast it quite exhaustively shows the diverse paths of analysis to explore. Therefore, we should continue researching each one of them independently through a more in-depth bibliographic search, but especially by evaluating real VR applications specifically designed with the dual objective of verifying the hypothesis about its usefulness and generating an evaluative methodology particularly aimed at VR, because until now it has been proven that traditional tools are not suitable because they were intended for other paradigms.

It is also important to continue examining further the analytical possibilities of semiotics, because in addition to the syntactic or semantic realm they can also be applied to the pragmatics through evaluation studies. Bearing in mind that the way signs are used not only reflects different epistemological positions but also influences comprehension and learning because it activates different perceptive and cognitive processes, semiotics can be truly useful for evaluating the educational effectiveness of the virtual reconstructions used in exhibitions: the distinction between the different kinds of signs created and/or used and the way they are manipulated and related to real objects of knowledge can constitute an alternative analysis to gain profound insight into how people learn through virtual reconstructions

Nevertheless, all these possibilities go beyond the scope of a single person. In fact, this is a general problem of current research in VR: specialists from different fields agree on the need to undertake joint projects that pose the basic questions about VR and combine the different perspectives and knowledge gained independently to solve them. In any event, the long-term goal should be to construct a theoretical and methodological framework for using and evaluating VR in archaeology.

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INTERPRETATION AND THE ROLE OF TECHNOLOGY

Abstract

This paper will focus on the domain of dissemination and evaluation of ICT applications in the field of public heritage interpretation. In particular, it will examine the case of heritage interpretation centres, a new form of public communication institutions, which highlight the significance of local heritage, through displays, educational programs, and community activities. In contrast to traditional museums, heritage interpretation centers do not contain collections of objects but rather present information and structure activities through the use of ICT applications and other interpretive tools. The various stages of design and implementation of a planned Heritage Interpretation Center in Heraklion, will be presented with a particular emphasis on the potential benefits for both visitors and cultural heritage technologists. This paper will further show the potential value of the Heraklion Interpretation Center Project as an opportunity to experiment with and assess the effectiveness of selected cultural heritage technologies.

Introduction

Interpretation in the world of cultural heritage is a relatively new term. For the past thirty years not only heritage professionals but also tourist operators and educators, for different reasons perhaps, have been trying to show that cultural heritage is something more than an elitist and static citation of dates and facts. (More information about the history and definition of interpretation see Hall and McArthur, 1996, 1998; HICIRA Handbook, 2005). According to the third draft of the ICOMOS Ename Charter for the Interpretation of Cultural Heritage Sites, 'interpretation is considered to be the public explanation or discussion of a cultural heritage site, encompassing its full significance, multiple meanings and

http://www.enamecharter.org/downloads/ICOMOS_Ename_Charter_ENG_05-07-05.pdf).

The benefits gained from good interpretation of cultural heritage are beyond question. Meaningful heritage, enriched visitor experience, informed audience, protected archaeological sites and effective management tool are the most often encountered in the current bibliography. (De la Torre and Mac Lean, 1997; Hall and McArthur, 1996, 1998; Pearson, 1999; HICIRA Handbook, 2005).

However, good interpretation is a demanding and challenging task. The complex character of contemporary multicultural societies as well as the constantly changing economic and political realities make the work of heritage professionals difficult. Several attempts have been made to put an order to this chaos through the publication of principles and guidelines. Their content may vary from the visitor's experience and the quality of the visit to the information sources, the involvement of the different stakeholders and the use of technological media. (http://www.enamecharter.org/downloads/ICOMOS_Ename_Charter_ENG_05-07-05.pdf; HICIRA Handbook, 2005; Beck and Cable, 1998; Hall and McArthur, 1998).

Despite these efforts, current interpretation does not often meet these challenges. There are no few cases, characterised by 'homogeneity in content, audience and technique' as Hall and Mc Arthur (1998) very successfully comment. An answer to the problems of current site interpretation and presentation was sought in technology. For the past few years the domain of new technological applications in the cultural heritage field has been continuously developed. In cultural heritage literature the role of new technologies is widely recognised, (Richards, 1996; Keene, 1998; Bennett, 2004) while on a practical level the results are impressive. Every year a significant number of innovative technologies is presented in specialized conferences like VAST (concerning Virtual Reality, Archaeology and Intelligent Cultural Heritage) or CAA (Computer Applications in Archaeology). At the same time, there are a number of cultural heritage professionals that does not share the same enthusiasm, while another fact commonly accepted is that cultural heritage and ICT professionals often work separately on the same field. (Owen, Buhalis & Pletinckx, 2005).

Technology and its applications have an important role to play in all stages of the cultural heritage process, from the phases of discovery and documentation to the dissemination of information. In this article we will have a quick overview of the interpretation part of cultural heritage following in particular the guiding principles, as these are recognized and discussed in the ICOMOS Ename Charter (EPOCH Report, 2005).

Access and understanding

One of the main roles of cultural heritage sites is to present their 'story' to as wide a part of the general public as possible. The World Wide Web is one of the most powerful and commonly used tools for this purpose. Today museum or heritage site web pages can provide access to the catalogues or/and databases of the institutions or invite the visitor to experience a virtual tour to a museum/site or to simply find practical information in several different languages. All this kind of information becomes accessible without time limitations to potential visitors, people from abroad or even persons with special needs making the 'story' of a heritage site known.

Despite the potentials of the Internet, the issue of the access to the technology itself should be mentioned here. Museums and heritage sites should always keep in mind that there is a larger or smaller percentage of the population in every country that has no access to technology at all. Consequently, they should use in parallel alternative ways of approaching their audience. (Bennett, 2004; Economou, 2003)

A second issue is that of presenting the 'story' of the site in a comprehensible and enhanced way. ICTs can offer heritage professionals the chance of presenting their material by using an appropriate tool according to the type of information, for example audio guides for the presentation of oral histories. Technology also allows the layering of information, which means that the same or different kinds of data can be presented to different types of visitors in a way that corresponds to their age, interests and educational backgrounds. These methods when properly designed and used increase the level of understanding and engagement of the audience and make the experience of the visit entertaining and educative at the same time.

Information sources

The new ICT applications, despite the resistance of many cultural heritage professionals, give the researchers the opportunity to gather a larger amount of information about an archaeological site or an individual object in comparison to the traditional methods of data recording. Thus, for example the use of digital cameras and portable electronic devices in the field may offer more accurate data in a shorter period of time. These data can subsequently be used for the creation of 3D models of objects or even monuments. (Owen, Buhalis & Pletinckx, 2004) In this and in other forms the information reaches the visitors of a cultural heritage site. In other words, cultural heritage professionals have the opportunity of presenting the public with a greater amount and type of information that would be impossible to be presented in actual space and in conventional methods.

However, in virtual or manual reconstructions there is always the danger of 'creating' data in cases where the scientific evidence is not clear or even inexistent. Unfortunately, there are several examples of reconstructed objects or monuments, which are based not on scientific criteria but on the personal opinion of the researcher.

Authenticity

This is another very important issue that is often raised in different cases. For instance, digital images can be copied and then modified without making this change traceable, alternating in this way its original form. At the same time, one encounters more and more often interfaces in exhibitions based only on virtual reality with the absence of real objects. What is very interesting in

these cases is that according to visitors' evaluations the absence of the actual artefacts is heavily criticized. This demonstrates that the contact with the authentic material of a heritage site is still of crucial significance for the public. (Bennett, 2004; Owen, Buhalis & Pletinckx, 2005; Alzua-Sorzabal et al, 2005)

Sustainability

In the domain of cultural heritage interpretation the idea of sustainability has double meaning. On the one hand we are talking about the sustainability of the resource itself. Cultural heritage is very fragile, thus its conservation should always be a priority. Virtual reality presentations give the opportunity to the visitors to examine an exhibit without its physical presence limiting consequently their effect of tear and wear on the resource.

On the other hand, sustainability concerns also the technological application. A large number of museums and archaeological sites invest in ICTs. Although in the long term technology may generate cost savings, there are many cases of museums and sites that after a few years find their installations unusable either because of technology obsolescence, lack of reliability or lack of further funding and support. (Hall and McArthur, 1996)

Inclusiveness

In every heritage site (from monuments to cultural landscapes) there are more than one interest groups connected to it. Each of these stakeholders may have a completely different view about the site. According to cultural heritage management literature all these different voices should be included in the management process and consequently in the interpretation of the site. Technology can give a solution to this issue. The organisation of all the information in layers allows the simultaneous presentation of more than one stories instead of the one that usually expressed the view of scholars. As we have already mentioned, following the same idea of information layers, cultural heritage professionals succeed in including more types of audiences (children, adults, domestic or international visitors etc.)

Research, evaluation and training

The interpretation of a cultural heritage site is an ongoing, evolving process as the scientific research never stops. Some of the ICTs used in the interpretation can be easily updated and keep the visitor continuously informed about the new data.

Evaluation of the interpretation in general as well as of the particular technological media used in it is of major importance for two reasons, as Prentice and Light (1994) argue. The first has to do with the effectiveness of the messages interpretation intends to communicate to the public, while the second concerns the accountability and cost-effectiveness of the technology used. Unfortunately, in the context of exhibitions this procedure of assessment is not always followed, although the results from already undertaken surveys are very interesting. A representative example is that the existence of an ICT tool in an exhibition does not necessarily mean that the visitor will use it. (Bennett, 2004; Owen, Buhalis & Pletinckx, 2005; Alzua-Sorzabal et al, 2005)

Another issue of major importance is related to the gap that often characterises the work of cultural heritage and technology professionals. The lack of training holds a very important role in this situation. The majority of cultural heritage professionals do not have the appropriate educational background to support and understand the issues related to technology applications and are more focused on the content. On the other hand, people of technological background are often criticized for giving more attention to the medium of the interpretation than to its message. The result is evident in the cases of museums that deny the use of technology, maintaining the typical, static and even boring glass-case image or in cases of exhibitions where the multimedia application is more

famous than any other exhibit in the room. However, both communities should be more focused on the needs of the visitors, which brings us back to the need of constant evaluation. (Economou, 2003; Bennett, 2004)

In this part, we tried to give an overview of the relation between technology and the interpretation of cultural heritage. This relationship is not always harmonious and as we have mentioned before one reason for this phenomenon is that the professionals of the two fields often work in isolation. However, one cannot deny the potentials that ICTs offer to the interpretation of heritage sites. A fruitful cooperation and a balance between the message and the medium of the interpretation may result to an effective presentation and an enhanced experience for the visitors.

Heritage interpretation Centers, a new setting for presenting heritage

The complexity characterising the way in which the heritage resources will be presented to the public has its effect also on the context of this presentation. Today, in parallel to traditional museums or in situ presentation, new kinds of settings for the presentation of cultural heritage have appeared. This new category encompasses for example territory-museums and interpretation centers, which will be examined more carefully.

Heritage Interpretation Centers are a new form of public communication institution created to interpret the cultural heritage of a particular place or area. As an important educational, cultural and/or tourist tool, these centers highlight the significance of local heritage, tangible and intangible through displays, educational programs and community activities. Unlike traditional museums heritage interpretation centers do not collect or preserve objects but rather present information and structure activities through the use of panels, multimedia applications, and specially designed tours.

Heritage Interpretation Centers can be of great significance on different levels. For the local community, whose involvement and support are considered vital, an interpretation center can play a central role in the improvement of the existing infrastructures and may also have a positive impact on the inhabitants' identity. On the other hand, visitors have the chance to gain a deeper acquaintance with the place they are visiting and its inhabitants. As for the cultural and technology professionals interpretation centers offer the potential of experimentation as well as evaluation of different and innovative interpretation media. Taking all this into consideration it is not difficult to understand why the number of Heritage Interpretation Centers increases constantly in Europe. (More information on existing interpretation centers on the website of the HICIRA project, www.hicira.org)

Heraklion Interpretation Center: rediscovering memories

A brief history of the city

The city of Heraklion is situated in the north part of the island of Crete, Greece. Its rich historical past dates back to the prehistoric period. Archaeological evidence has shown that Heraklion – though not under the same name as today- served as the port of the largest and most famous Minoan site of Knossos. (Sakellarakis, 2000). Since then the city has been continuously inhabited. The different names by which the city has been known throughout its history are indicative of its agitated past. Numerous conquerors have taken over Crete and consequently Heraklion leaving their mark in the city. During the Greek-roman period the city was already named Herakleion (dedicated to god Hercules). However this name had changed during the first Byzantine period (5th century A.D. – 827) when people referred to the city as Chandax. In 827 A.D. Chandax, together with the rest of the island was conquered by the Arabs and became known as Rabdh-el-Khandak. The loss of Crete was particularly important for the Byzantine Empire, given the island's vital position in the

Mediterranean Sea. Therefore they never ceased the efforts to regain it. This was made possible in 961 A.D. and it is the milestone of the second Byzantine period in Crete. (Tsougarakis, 2000)

In 1211 Crete and Heraklion changed hands and names once again. This time the Venetians took over the island. Heraklion became the famous Candia and a fruitful period started. The Venetian conquest lasted for 400 years, during which Heraklion experienced significant cultural growth and became the capital of the "Regno di Candia". (www.heraklion.gr). The last occupation of Crete was by the Ottomans. The ottoman army took over Heraklion in 1669 after a long siege that lasted 25 years. Crete became autonomous by the late 19th century, but it was not until 1913 that it became part of the Greek state. Today Heraklion is a vibrant city with the traces of its rich multicultural past visible in everyday life, architecture, traditions, local identity.

From concept to implementation

The main objective of the proposed Heraklion Heritage Center will be to display artefacts, photographs, and memorabilia from the city's recent history and to serve as a main welcome centre for information about historic sites in the city and provide the starting point for audio guide walking tours. In addition, the Center will be the focus of a wide range of educational and community activities such as lectures, special events, and meetings.

There are particular steps to be followed during this procedure. Concerning the on-site presentation, innovative technologies will be used in the design of the exhibitions. As mentioned before Heritage Interpretation Centers are not a means to collect objects. Therefore the creation of virtual heritage environments will be helpful in order to interpret the history of the city in a meaningful and interactive way. Moreover the Heraklion Interpretation Center will act as a starting point for innovative tours within the old city through the use of MP3 players and/or PDAs.

A lot of effort will be put into the inclusiveness and active participation of the citizens in the interpretation of their heritage. The Heraklion Interpretation Center will act as a gathering point of memories through the creation of a database for oral histories and photographs of the city and its inhabitants. The idea is to train people on how to use and update the database, so that it will become a living and accessible part of the city's history.

Expected benefits

As similar projects in other communities have shown, this project has great potential in improving the quality of life in the city of Heraklion. The ambition of the Heraklion Interpretation Center would be to become a space of communication and dialogue for all the people and cultural institutions of the city. More specifically the involvement with the city's recent past could help preserve memories of traditional life in Heraklion through the community-wide collection and presentation of interviews and family histories. Consequently such a project could also raise awareness by citizens of all ages about the history and cultural traditions of Heraklion through active participation in the creation of special exhibits, school projects, and special events.

Concerning the visitors of Heraklion, the Interpretation Center will provide alternatives to major tourist sites. The exhibitions will highlight the city's past providing an opportunity to discover the city through audio-guided walking tours. Finally the cultural heritage and technology professionals will have the chance to experiment on a real-life situation and explore the potential of community based interpretation. The Heraklion Interpretation Center can act as a case study to evaluate the effectiveness of selective technologies to be used in the cultural heritage field.

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SOCIAL CONTEXTS OF ARCHAEOLOGICAL RESEARCH AND ASSOCIATED COMMUNITIES

The Case of Gournā, Egypt

Abstract

This paper is intended to be a preliminary overview of two integrated anthropological researches on an archaeological area of the Theban Necropolis: the first concerns a macro-territorial approach to the site of Gournā (inter-site analysis), the second, a micro-territorial study of the archaeological excavation of the Italian mission of the University of Pisa (intra-site analysis). The intention is to integrate, from macro to micro, an anthropological analysis of the perceived values of this very important area both from the point of view of the local community and from the perspective of the archaeologists working there.

Introduction

The Theban necropolis– located in Upper Egypt on the west bank of the Nile – and the temples of Luxor and Karnak, on the opposite side of the river, constitute one of the most important archaeological zones and principal tourist attractions in Egypt. They are one of the areas with highest concentration of recognized monuments anywhere in the world and were inscribed in the UNESCO World Heritage List in 1979 for being “some of the most fascinating realizations of antiquity”(criteria I); “monuments... of unique and unequalled characters” (criteria III); and “constitute the material witness of the aggregate history Egyptian civilization... (and a) ... source of information concerning the people and cultures of other countries” (criteria VI) (http://whc.unesco.org/archive/advisory_body_evaluation/087.pdf).

However, these masterpieces of human civilization are not situated in an unpopulated area: the temple of Luxor is hemmed in by the streets and buildings of the modern city of Luxor and the area of the Theban Necropolis is inhabited by a population that numbers in the thousands. A deeper understanding of the contemporary significance and function of antiquities area therefore requires a closer examination of the social context in which the World Heritage properties are embedded.

The Evolution of a Community

The village of Gournā, extending from the Colossi of Memnon on the south, to Dra Abu el-Naga and el Tarif to the north, situated in the area inscribed by UNESCO, represents an almost unique case of people living inside an archaeological site. The village core is composed of small clusters of houses situated in the area of the Tomb of the Nobles. The houses are made of mud bricks, according to the traditional building techniques, and are composed of several rooms to accommodate the traditionally large families. The rooms are generally arranged around interior courtyards and sometimes have small towers. Their building material makes them cool in the hot climate and tends to retain heat in the mild Egyptian winters. Their exteriors are decorated with bright colours and various traditional motifs.



Photo 1. View of mud brick houses on the West Bank



Photo 2. Traditional decoration painted over the entrance of an ancient tomb

The ancestors of the Gurnawi did not always live in this particular area. The XVIII century travellers report that the original location of the village was farther south, near the temple of Seti I. Later on, due to the danger of flooding at the time of annual Nile inundation, the place was abandoned and its inhabitants moved to the nearby hills at the edge of the desert. Initially they lived inside the ancient tombs and courts, but they quickly began to built walls on the exterior of the tombs and finally houses on top of them. It should be noted that although the number of inhabitants in the area dramatically increased from the XIV century on, the Theban necropolis was never a place devoid of habitations. Archaeological evidence suggests that even when the ancient tombs were built and still used for funerary rituals, there was a lively community of priests from the nearby funerary temples, who carried out the funerary ceremonies required by Egyptian religion and there was a village – Deir el-Medina – inhabited by artisans who built and decorated the tombs. The occupation of the area continued throughout late antiquity as is shown by findings related to the Coptic monasteries and dated to the VI and VII centuries. In the following centuries, despite the small population of Egypt from the VII to the XV century, there are sound arguments in favour of a continuous occupation with the arrival of new communities of Arabs and Bedouins from Sudan (Simpson 2000).

The life of the local community has been influenced from the XVIII century on by the interest of foreigners in Egyptian antiquities. Members of the Coptic Community were among the first to move to the area but in the following century other communities arrived also attracted by the proximity of the site to the concentration of monuments and antiquities (van der Spek: 2003). As a result, the locals were not the only people living in the tomb-houses and houses built on the area. In the XIX several important names in the history of Egyptian collecting also established residence here, including Giovanni d'Athanasia, agent of the English consul Henry Salt, and Giovanni Piccinini who hosted in his house the Franco-Tuscan archaeological expedition directed by J.F. Champollion and by I. Rosellini. The “tomb-house” of Sir Gardner Wilkinson is also well known (Simpson 2000).

The land on which the Gournawi live was expropriated by a royal decree and became “public utility land” administered by the Supreme Council of Antiquities. The decree gave the Gournawi the right to continue using the houses but prohibited any further additions to the existing structures (Fathy 1969:19). Given that they are on archaeological ground, the houses do not have running water and the only way to get fresh water is by donkey or, for very poor people, by carrying a bucket on their backs up the hills.

The idea of “*restituer à la colline entière sa physionomie d’autrefois*”, to an imagined unreal period in which the hills were free of inhabitants, goes back to the time of Maspero (1912: XXXIV).

In the past, the involvement of the Gurnawi in the illicit discovery and trade of antiquities, was one of the motivations used to justify the expulsion and resettlement of the community away from the present site. The Egyptian Government’s best known attempt at relocation was entrusted to the prominent Egyptian architect Hassan Fathy (1969). As a critic of the use of modern construction designs and materials for low-income housing, Fathy sought to utilize traditional mud brick architecture. He first did so in the construction of a building near Cairo, for the Egyptian Red Crescent, which was later demolished because the authorities deemed that “it did not harmonize” with the other structures nearby. However, officials from the Egyptian Antiquities Service saw it and asked for Fathy’s advice in the creation of a new village in the West Bank of Luxor (Fathy 1969:19). Thus the construction of New Gourna, which began in 1946, used an architectural style that, according to Nezar Alsayyad, represented the application of an “imagined [...] indigenous tradition”(Alsayyad 2006:219), in the sense that it drew its inspiration from the architectural forms of the Islamic style, typical of Cairo in the earlier centuries, but with the addition of forms like domes and vaults that were reminiscent of funerary architecture(Alsayyad 2006:219). The establishment of New Gourna was thus both an attempt to depopulate the Theban hills for the sake of protection of archaeological remains, and an architectural experiment in creating new houses for low-income communities that were comfortable, based on traditional models, and economically sustainable. Unfortunately, the construction of New Gourna was never completed – due to problems among the architect, the local authorities and the local inhabitants– and works stopped in 1953.

The new village is now disregarded by authorities and local administration, some of the building have been destroyed by locals worried that the international fame of Fathy would lead to plans for creation of a tourist village (Rashed1994: quoted in van der Spek 2003). Because New Gourna is located far from the hills, it is difficult for the people to reach the ancient village, where the economic activities connected also with archaeology and tourism take place, and even paying the few pounds for a local bus is somehow a big investment for some workers. Yet oddly, even if Fathy’s architectural experiment was not locally appreciated, his *imagined indigenous architecture* has become widespread in Egypt and his reputation is high among Third World architects (Alsayyad 2006:219).

Archaeological Conservation and Community Displacement

As in the case of Gourna, the protection of archaeological sites and construction of adequate infrastructures to receive tourists are often used as official motivation to justify the displacement of the local population and the transformation of the site into an open-air museum. The idea that the presence of the locals does not add, but subtract something to the experience of the visitors, is not certainly limited to the case of the Theban Necropolis. Yet it is based on some highly questionable aesthetic criteria and privilege economic factors, without due consideration to the rights of stakeholders. The houses of the Gournawi have come to constitute an integral part of the cultural and historical landscape of Theban Necropolis and they deserve to be protected. Moreover, their presence should be seen as enhancing, increasing and correctly completing the historical presentation of the Theban Necropolis.

Gourna is, first of all, a *place*, a landscape understandable only if its original context is preserved and transmitted. The multilayered tradition of Gourna entails the local consciousness of the past and all the correlated activities which, are part of the contemporary mind and of the evolution of place-based communities and their collective memory. In this sense Gourna can be interpreted as a

dynamic process, a museum of memory; removing this memory will not help tourists and visitors to better understand the place, but, on the contrary, will cancel an important link between the Present and a “familiarized” and metabolized Past. Their presence in the area offers the possibility that visitors, arriving only to see the ancient monuments, will also have a glimpse of the life of the local community. A new aesthetics of landscape should not be meant simply to “clean” the territory from apparently obsolete infrastructures, but to recontextualize the sense of place with the sense of time; in this way the visitors could have a chance to be part of the territory, and stimulate a meaningful and possible reciprocal curiosity and interrelation with local communities. The presence of the communities living in the hills should be considered an important factor in the contextualization and enrichment of the experience of visitors and tourist, but also of that of scholars working in the West Bank. For this reason the project of creating an open air museum in the Tomb of the Nobles area risks initiating a process of decontextualization and alienation of a territory. Thus, any internationally or locally funded project aimed to relocate them, is wrong in its original conceptualization because it ignores this possibility by failing to respect the sense of place and the anthropological relations with the landscape and the territory.

Antiquities and Community Context: The Case of the Italian Mission

The diverse relationships of the local population with the foreign community, both archaeologists and visiting tourists, represent an important social and economic factor in the life of the local community which, is employed officially and unofficially in a series of different activities. In archaeology in particular, local workmen’s skills are strongly appreciated by foreign missions in the area, and local people are employed as skilled and unskilled work force in field operations. Though it is often overlooked, the participation and contribution of modern Egyptians in all capacities was an enormously important factor in the history and development of Egyptology.

A study of the daily life of an archaeological excavation in this area and the relationships between its members can give a better idea of the significance of this peculiar activity for the locals and a better understanding of the importance of their work and presence. Correctly and exhaustively interpreting heritage means also giving the full story of how archaeological artefacts were discovered and giving the credit to the people who made the discovery possible. Explaining heritage to them, understanding how they perceive it and how they value their work and contribution to the mission can only widen our knowledge and improve the respect of antiquities between the locals and avoid the creation of a restricted vision which, values the remains of ancient past and their associated activities, only as a consequence of foreign interest and possible economic advantages.

In recent years daily life in archaeological expeditions in the area of Luxor (mainly from the excavator’s point of view) has been recorded by archaeologist in on line journals (among others: <http://www.harwa.it/ita/diario>; <http://www.excavacionegipto.com/diario/diario05.jsp>). Several studies have concentrated on the impact of tourism (Gamblim 2005; Mitchell 1995) but the anthropology of archaeology there has rarely been attempted. Unlike anthropologists, archaeologists have rarely investigated the effects that their research has on the local communities, as well as the power relations between the researchers and those living in the place where they conduct the research. It is true that the preoccupations are different: the anthropologists’ main object of research and the local community are mostly coincidental, while archaeologists study a community which no longer exists and whose connections with the contemporary inhabitants are indirect. However, the effect their presence has on the local population needs to be considered. The potential of this approach has been discussed by D. Shankland (1996) in the different geographical and cultural context of the Çatalhöyük archaeological mission in Turkey.

Although it is necessary to understand how the life of locals in Gournā has been, and still continues to be, changed by the arrival of the Foreign Archaeological Missions, it is very difficult to evaluate

the overall impact on the local population, given the wide number of archaeological missions working seasonally and permanently residing in the West Bank. Since the beginning of my work in 2004 in the excavation of the Italian Archaeological Mission of the University of Pisa, I have been intrigued by the complex relations between the foreign members of the mission and the local workers and, more generally, between foreign archaeologists and local community. The character and role of these interrelations has not been studied systematically and, as mentioned above, only scarce reference was made in the past to the contribution of locals to Egyptian archaeology. For that reason, I decided to take the Archaeological Mission of the University of Pisa as a case study and to analyze the daily life and the relations between the members of an archaeological mission and the local workers. I will report the result of a preliminary study which took place during the fieldwork season in November 2005.

The Italian Archaeological Mission of the University of Pisa, directed by Professor Marilina Betrò, was granted permission by the Supreme Council of Antiquities to study and excavate Theban Tomb 14 (TT14). The tomb was made for the “wab priest of Amenophis, image of Amon” Huy, and it is dated to the Ramesside period (1292-1069 A.C.) A preliminary survey was carried out in 2000 and a complete photographic and architectural documentation in 2003. In December 2003 the first excavation mission started and in November 2004 a new tomb, (MIDAN05) connected and accessible only through TT14, was discovered. The excavation continued in the following years and the last archaeological season took place in November 2005 (<http://www.egittologia.unipi.it/pisaegypt/TT14.htm>).

Analysing Relations of Power and Authority

The archaeological season and its development can be investigated as a cyclical process, and the mission can be considered a micro-community where primary and secondary actors can be distinguished. However, it should be noted that this micro-community is further divided between foreigners and locals. The mission is normally composed of a limited number of foreign members – on the average between 6 and 10 – and roughly 20 local members plus one inspector from the Supreme Council of Antiquities. The tomb is sealed at the end of the each season and unsealed the first day of the next, symbolically starting the beginning of the new season of fieldwork.



Photo 3. Unsealing the tomb in presence of the local guard (*gafir*) and two inspectors from the Supreme Council of Antiquities

A key actor in the process of excavation and negotiation of relationships between the foreign and local members of the expedition is the official inspector from the Supreme Council of Antiquities, who is required to monitor and regulate the work in accordance with Egyptian antiquities laws. The inspector assigned to the mission during the November 2005 season was a woman. There are very

few women working for the Supreme Council of Antiquities as inspectors and, in general, they are less educated than their male counterparts, and less fluent in English. I firstly hoped that, being a woman myself, I could have a better relation with her than with the previous inspectors who, were all males. In reality, our inspector was not very interested in maintaining a close working relationship with the foreign members of the mission and left the foreign members free to work, without excessively controlling them, unless she felt that her authority was disregarded. Due to family reasons she had to leave the work during the excavation season and was replaced a young and highly motivated male inspector. The new inspector was a very motivated and interested young man. He was interested in helping the foreign members in their work and also liked to learn from us: he wanted to participate in a foreign mission as a member. Being a single man and not a resident of Luxor he was living in the so-called Carter's house, the house once inhabited by the archaeologist who discovered the Tomb of Tutankamun. He invited the mission for tea and gave the foreign members of the mission a glimpse into the way of life of this young employee of the Egyptian Service of Antiquities. Thus within the same position there can be very different attitudes to relationship with the foreign members.

The first day of work of every season is also when the selection of local workers takes place. The system behind the selection includes local social considerations and so the choice of workers to be hired is, not surprisingly, a strategic decision, meant to accommodate the different aspirations of local actors interconnected with the mission (the inspector, the driver, the guard of the site, the owner of the place where the mission reside, etc.). Indeed local circumstances and personalities can sometimes overshadow more formal arrangements of status and responsibility. One of the local members of the expedition serves officially as driver but also, unofficially, as factotum. His family has a long history of employment in fieldwork and the mission employs two of his brothers, and his brother-in-law, who is also an excellent skilled worker. His authority is recognized by the workers and this is the reason why the mission does not have a local chief of the workers, a *rais*. An attempt was, in reality, made in the previous archaeological season, but the *rais*'s function was complexly overshadowed by that of our factotum and he was fired at the end of the second week.

However, local social status is not the only factor taken into account during the selection of workers: sometimes there are also social factors that must be considered (i.e. underaged, elderly, or infirm villages who come to seek work). In these cases, outright refusal is sometimes impossible and alternative solutions have to be found. While it is necessary that the work of the mission be carried out as efficiently as possible, it is also clearly understood by the leaders of the mission that the excavations are seen as an appealing employment opportunity by many unemployed members of the local community. The mission therefore recognises, if does not explicitly announce its social function: when possible, these people are hired and given less physically difficult work.

Excavation Geography and Separation of Functions

An important element in the preparation of the fieldwork involves the placement of a headquarters tent as a physical mark of the mission's presence. Once that is accomplished, the work can begin and be divided into above- and below-ground components, in a separation between upper and lower worlds of data processing and underground excavation.



Photo 4. Setting up a physical mark on the landscape: workers assembling the tent

These two worlds are linked in a continuous pipeline starting in the area of the tomb under investigation, where two skilled local members manually remove the soil under the supervision of a foreign member. In reality the separation between local and foreign is not always sharp. Given the difficult working conditions, characterized by dust and heat, there is highly collaborative atmosphere in the underground work more than in other aspects of the excavation. As a result, the foreign archaeologists working underground often develop closer and more collaborative relationships with the local members.

The excavated soil and debris is brought on the surface by a human chain of local workers, who move the buckets of soil up in short halts. Eventually, it reaches the sieves where is examined to look for small findings. This part of the work is given to locals but usually under supervision and with the help of a foreign member.

The material is then under the supervision of foreign members charged with classifying, photographing, drawing, restoring and carry out a preliminary study. Local members participate in some secondary tasks such as the cleaning and reassembling of pottery.

The archaeological mission normally consists of four weeks of fieldwork and its end is marked by two steps opposite to the ones that take place at its beginning: dismantling the tent and sealing the tomb until the next season.

Cultural Interactions

The nature of local-foreign collaboration is sometimes determined by the cultural contexts of the local members, rather than by imposed job categories. The local workers are Muslims and, for some of them, touching human skeletal remains, which are copiously found in a tomb, is a taboo. The foreign members of the expedition included a physical anthropologist who stimulated strong curiosity and negative reactions among the locals, despite her status in the foreign team. Our factotum, usually an open and kind man, consciously avoided relating to her and expressed his belief that it would be very difficult for a woman performing her job to get married—in her violation of a basic taboo. However, other local members were intrigued by the fact that she could give information on the age and sex of the dead. In general, they assumed that her work was a kind of inherited profession and associated it to that of an undertaker. These cultural perceptions were gradually subject to some modification. It was quite interesting to observe how, with time, our factotum was able to overcome his prejudice and finally start to interact with the physical anthropologist.

Other cultural differences can have important effects. One morning the workers entered the tomb but then refused to stay because they found the traces of a “*treiscia*”. From scattered information it was understood that the animal was a lethal snake. As a solution one of our skilled worker proposed

to call the local snake charmer and shaman. Eventually, even if not all the local members believed that this was a valuable solution, he was called. After having inspected the tomb, he confirmed that the snake had left and the work could continue. This unexpected event brought the mission back to the local territory, away from the temporarily detached one of the mission: an experience that eluded modern foreign logic was able to stop the work of the mission. The issue was solved rapidly but it is worth considering its potential consequences — if the shaman had confirmed the presence of the *treiscia* — either in the prosecution of the works of the mission or in the relations with the local members. The event was a moment in which, the two separate worlds had to stop, communicate and compromise to find suitable solutions, with respect for local customs and foreign obligations. For the foreign members of the mission this was the chance to be exposed to what is still an important presence in local culture. Many of the local members started telling stories related to shamans, how much some of them still believed in their power, and that they went to them to cure sickness. The decision to face the issue according to local custom was an open acceptance of their values and seems to have improved their respect for the director of the mission and the mission's relationship with the local members.

Economic Relations

Binding both the local members and the foreigners to the mission are economic interests, but they are of different kinds. It is the responsibility of the director of the mission to raise funds for the mission in the context of her permanent employment at the University. The other foreign members are researchers with independent financial support whose expenses during the fieldwork are paid by the mission.

The local members see the fieldwork primarily as a seasonal job. However there are some who express personal pride in accepting the job with a foreign mission as being more prestigious than other types of work. The week of work consists of six days: Friday is holiday and workers are normally paid weekly. Their wages are slightly differentiated according to skills and difficulty of work; a *baksish* (a tip) is normally paid and highly valued since it represents a recognition of appreciation by the director of the mission who hands over the payment. Local guards (*gafirs*) of the site are also paid the weekly amount of daily wage of a worker. In general the work for an archaeological mission is not, contrary to my preconception, perceived as hard. Moreover, given that the working day starts in the early morning and finishes in the early afternoon, many local members are able to continue their other normal activities, usually agricultural work. However, the mission also had among his local worker a university student who was working during holidays, and took the chance to speak English with the foreign members. The mission also pay a daily wage for inspectors which increase the otherwise meagre wages of these graduated in archaeology. There is a huge difference in salary between someone working for archaeologists and people working in the tourist economy: for this reason many inspectors study for, and dream of, becoming a tourist guide.

Conclusions

Given the complex situation in Gurna, and considering that the preservation of archaeological ruins has been indicated as one of the reasons behind relocation, it might be expected resentment by the locals for the archaeological work, but this was not the case. Our presence was felt as positive factor to helping people without permanent jobs. Not much was generally understood of the work we were performing, and one person believed what we were doing was an “hobby”. The locals have good skills in recognizing some types of archaeological material (due to the fact that some of them work in fieldwork almost all the year round). However, they are not able to interpret it. Some missions have also given guided tours to the workers to make them understand their work. This can be a little step to put forward the idea of giving people who contribute to the archaeology

as an activity and a discipline a better understanding of their function and a better recognition of their role.

In Egypt it is very common to notice that archaeological excavations, and activities undertaken onsite by local people and foreign archaeologists behave as parallel worlds, without a real possibility of dialogue or of a mutual interaction. The excavation is often a self-referential place, out of the local cultural context and not exchanging information with the local environment, apart from its primary needs. It is necessary to concentrate on how an archaeological excavation impacts local communities; if local communities feel connected with, and have a consciousness of, their past; consider and compare the different perception of heritage between locals and foreigners. An improvement in the understanding of the social contemporary context of the areas where heritage research takes place can bring only mutual benefits in long term and contribute to its sustainability.

This approach to research may help to correctly continue to study the past is it necessary to abandon the exclusively archaeological taxonomy and to move forward to an integrated archaeological-anthropological approach in order to give an comprehensive territorial contextualization of heritage. The study of the social context of heritage research can help in better understanding its complex structure and how its connections with the present are as strong as those with the past.

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She has worked for Peace Science Center of the University of Pisa where she was involved on the organization of seminars on civil service and international cooperation, in the editing of the book "Senza Armi per la Pace" (P. Consorti, Pisa 2003) and in creation of a net of contacts with NGO and International Organizations.

Her interests are mainly addressed towards multicultural environments and the analysis of different socio-cultural approaches on meaning and perception of heritage.

FACE TO FACE

A Comparative Study on the Use of Digital Data in Archaeology: UK versus Japan

Abstract

As the globalization and the development of ICT in the cultural domain continue, comparative studies on cultural information held in different countries are unavoidable. This paper attempts to comprehend archaeological information and its creation, use, and its future from an international point of view. It will discuss about the comparison between the Strategies for Digital Data survey in the UK and Ireland and the Digital Data Survey for Japanese Archaeology (JAD2) survey in Japan. The comparative analysis not only uncovered the similarities and differences of archaeological information between UK/Ireland and Japan, but also brought a previously unknown perspective for the future use of archaeological information at an international level. It will also be a useful resource for the use of a global standard such as the CIDOC-CRM in archaeological communities.

This paper also introduces the future direction of the surveys. In particular, it explains the spin-off project of the JAD2 Survey. The preliminary purpose of the survey is to obtain the up-to-date statistics of archaeological information in Japan and to understand its current state. However, with regard to the number of participants and the reaction to the survey, it was not very successful. In order to solve such problems, the author has been organising a group called ACT Archaeology. As an initial goal, it attempts to submit a recommendation for the re-run of the survey at much wider level, to some leading organisations including the central government. It also aims at a propaganda campaign in order to raise awareness of archaeological computing, supported by an international petition. The international petition offers the possibility to create a network of international people in the domain of ICT in Cultural Heritage as well. These activities are now widely promoted through website, mailing list, and newspaper, as well as academic conferences and publications.

Face of reality: Globalization, technology and the survey

The information revolution is regarded as the third revolution in human history. There was the agricultural revolution in Neolithic time and the industrial revolution in the 18th century. Today, we witness how big the impact of ICT (Information Communication Technology) has been. Though archaeologists study the past, it is now their jobs to create archaeological data in digital format for the future. It is not too much to say that ICT has revolutionized the work of archaeology; the way of recording in the field, the way of analyzing in the laboratory, the way of information dissemination, and the way of display in museum. It has influenced archaeological data and services from the bottom of the theories and practices.

At the same time, this revolution has changed the shape of the world forever. Internet is the principal tool. Territorial borders have become almost invisible by means of this remotely accessible technology, and the globalization allows archaeologists to interchange archaeological data across the world. Such globalization is typically seen in the museum community. The CIDOC (the International Committee for Documentation) of the ICOM (the International Council for Museums) has promoted information sharing, particularly on the web, within the cultural heritage sector by the use of a domain ontology called CIDOC-Conceptual Reference Model (CRM)(CIDOC-CRM 2006). Developed through international discussion, this model was submitted to the International Standard Organization; hence it receives an ISO standard, which is the first step to global standardization for the cultural information.

In the meanwhile, the author suggested that the “Ontology of Ontology” approach is required in order to create a world standard for the exchange of cultural heritage information (Sugimoto Forthcoming b). It is a philosophical thought of reasoning why a world standard like the CIDOC-CRM is needed. It is said that the CIDOC-CRM will solve the problems of diverse, dispersed, and fragmented cultural information in the world, but the extent of such problematic diversity of cultural information is quite uncertain. What cultural information is available and how much?

Where is it stored and by whom, and how to access it? Although museum professionals may agree with the use of this world standard, these fundamental questions have not been properly investigated in archaeology. To answer them, the author conducted a digital data survey for Japanese archaeology (JAD2 Survey), which examines the current state of archaeological information in Japan. It focuses on digital data, but covers non-digital data and many other issues related to the use of ICT in archaeology (Sugimoto Forthcoming a). As a result, some interesting statistical facts were recognized.

The survey was not the first of this kind. In fact, some previous surveys in various countries were published and heralded by websites. For instance, there are: “Strategies for Digital Data” survey by the ADS (Archaeological Data Service) (Condron et al. 1999) and “The Publication of Archaeological Projects: A User Needs Survey (PUNS)” by the CBA (Council for British Archaeology)(Jones et al. 2001) in England, and two surveys: “Internet use by Canadian heritage professionals” (Wendy 2000) and “Information technology in Canadian museums” (Minister of Public Works and Government Services Canada 2001) by CHIN (Canadian Heritage Information Network) in Canada. In addition, there are: “Multilingual access to the European cultural heritage multilingual websites and thesauri” survey by Minerva in Europe (MINERVA Plus Project. 2006), and finally, “Digital Archive White Paper” by the JDAA (Japan Digital Archive Association) in Japan (Japan Digital Archive Association. 2001, 2003, 2004, 2005). Furthermore, a new report has just been published for the result of a survey by EPOCH (The European Research Network of Excellence in Open Cultural Heritage) (Niccolucci et al. 2006). But, these kinds of surveys have different aims and have not been widely disseminated to the heritage community. It is also noted that comparative studies of such surveys are extremely limited.

As the globalization and the development of ICT in the cultural domain continue, comparative studies on cultural information held in different countries are unavoidable. Therefore, this paper attempts to comprehend archaeological information and its creation, use, and its future from an international point of view. It will discuss about the comparison between the Strategies for Digital Data (SDD, hereafter) survey in the UK and Ireland (Condron et al. 1999), and the Digital Data Survey for Japanese Archaeology (JAD2, hereafter) survey in Japan (Sugimoto 2006). These two surveys were chosen, because their intentions are similar, specializing archaeological information, and are well documented. Some other relevant surveys and statistics will be also displayed in comparison with the targeted surveys. It is hoped that the comparative analysis not only uncovers the similarities and differences of archaeological information between UK/Ireland and Japan, but also brings a previously unknown perspective for the future use of archaeological information at an international level. It will also be a useful resource for the use of a global standard such as the CIDOC-CRM in archaeological communities.

Face of two surveys: Their scopes

Table 1 shows the difference in scopes of the two surveys (Condron et.al. 1999; Sugimoto 2006).

	SDD (Strategy for Digital Data)	JAD2 Survey Part I Web Evaluation ; Part II Questionnaires
Country	UK, Republic of Ireland	Japan
Period	April 1998	Nov-Dec 2006 (Part I); Mar-Apr 2006 (Part II)
Target	Archaeology consultants, Government archaeologists, National body employees, Contract field archaeologists, Other museum professionals, University/college staff, University/college students,	<i>Maizo Bunkazai</i> Centres (Underground Cultural Properties Centre) employees: Mostly part of local governments or independent organizations Main area of service is rescue archaeology, but includes

	Society members, Independent archaeologists, Librarians/archivists School/FE college teachers, Developer employees	educational functions such as museum and library
Area	Digital Data in-house Archaeologists use and needs of IT	Digital Data on-line (Part I) Digital Data and Non-Digital Data in-house (Part II) Archaeologists use and needs of IT (Part II)
Methods	Questionnaire Telephone Interview	Web Evaluation (Part I) Questionnaire (Part II)
Questionnaire Response Rate	Individuals 344/1760 = 19.5% Organizations 263/1053 = 25.0% People/ Organizations Refused 83/2813 = 3.0%	Individuals 31/? Unknown Organisations 11/140 = 7.9% Organisations Refused 6/140 = 4.3%

It is obvious that the two surveys are too different and it does not seem possible to compare them. For example, the following factors at least differentiate their surveys.

1) Temporal factor:

8 years of time-lag is, certainly, big. Technological progress can maximize the difference.

2) Geographical factor:

British and Irish archaeology are different from Japanese archaeology. Thus, archaeological services and the types of data should vary.

3) Methodological factor:

While the JAD2 survey focuses on rescue archaeology, the SDD survey explores as many areas of archaeology as listed in the table. Interpretation of the results may be difficult.

4) Organizational factor:

The SDD survey was supported by national-level organizations such as English Heritage, Historic Scotland, Cadw and National Monuments Records. On the other hand, the JAD2 survey was undertaken by a staff of only two. This difference of organization and the scale of the surveys affect the response rates and the answers of respondents.

However, the JAD2 survey was carried out particularly taking the SDD survey into account. Therefore, the same and similar questions were added to the questionnaires (Sugimoto and Igarashi Forthcoming). In addition, there will be some benefits from the comparison of the two surveys.

1) Universal discussion on standard and information exchange in cultural heritage

As cultural information exchange at an international level will increase, the comparison of archaeological data among several nations will be extremely useful. The comparative study will be able to encourage the integration of information in an optimum way. As stated above, such perspective is vital for the use of an international standard like the CIDOC-CRM.

2) Technological progress and its effect on archaeology

The evaluation of the two surveys will reveal how technology has developed during the last decade and how it has changed the landscape of various archaeological operations. Therefore, the paper will serve as a milestone for the future archaeological management. In particular, this perspective is valuable for a good practice for digital preservation.

3) Archaeological gap in three countries

The style, history, and service of archaeology in these countries are different, but there do not seem to be many literatures which compare different archaeology in different countries by intensive statistics. The comparison will, therefore, illustrate the reality of international gap in archaeological theory and practice. In addition, this is probably one of a few attempts to read the minds of archaeologists from different countries through statistics.

Consequently, although the contexts of the surveys (the aim, goal and result) are different, it seems to be worth comparing the two surveys in order to understand archaeological information from a universal point of view. Globalization is, again, the keyword. It is hoped that this comparative study will be a benchmark for the use of ICT in world archaeology in the future.

Face to face: the comparison

Access to computer

As computers are now everywhere in our world, it might be silly to explore this basic information about them, but the number of existing computers are essential statistics that probably reflect the quantity of data stored, the level of data distribution, archaeologists' computer literacy, and so forth.

The SDD survey calculated the estimated number of computers used by British archaeologists to be roughly about 2,200 to 3,000 in 1998. As Aitchison (1999) reported that there were 4,395 archaeologists in Britain, the survey implied that the number of computers would be equal to the number of archaeologists in 2004 (Figure 1). By categories, field archaeologists had more than 70 % access to computers (Ind. 74.1%, Org. 83.8%)¹, while local government archaeologists were more-or-less the same (Ind. 72.7%, Org. 84.6%)²(Figure 2). In Japan it is revealed that 30 field archaeologists use 40 computers in their workplace (133.3%) (Figure 3). There are 610 computers for a staff of 327 in 11 *Maizo Bunkazai* Centres (MBC, hereafter), ie. 1.8 computers per person (186.5%)(Figure 4). The lowest percentage for the access to computers in an organisation is 22.2%, whilst the highest percentage is 312.5%. Moreover, an estimation was conducted for the total number of computers used by Japanese archaeologists, in comparison with the British statistics of the SDD survey and Aitchison and Edwards (2003)(Table 2):

Number of Japanese archaeologists in 2004 (Tateno 2005)	= 6965
Total number of MBC staff	= 327
Total number with computer access	= 296 (90.5%)
Total with no computer access	= 31 (9.5%)
Estimated number of computers (90.5% of 6965)	= 6303
Estimated number of computers (186.5% (from above) of 6965)	= 12989
Average of the above two (138.5%)	= 9646

These are rough estimations and should not be treated as complete, but only for a general trend.

It is, without doubt, considerably difficult to compare the numbers of computers in the two countries, but there seem to be some interesting figures. The latest statistics show the substantial growth of British archaeologists in 5 years (Aitchison and Edwards 2003), therefore it is anticipated that the estimation of the SDD survey for the number of computers (Figure 1) has to be modified.

¹ To its convenience, the author uses the symbol "Ind" for the questionnaire for individuals, and "Org" for the questionnaire for organizations.

² Although some MBCs include museum facilities, they normally specialise rescue archaeology, and are/were often a part of local governments. Therefore, the categories in the SDD survey of field archaeologists and local government archaeologists seem to be the closer categories to the employers in Japanese MBCs.

The estimated number of computers in 2006 was about 5000, however, when 69.0% is applied for the number of archaeologists in 2002/03, it returned almost the same number. Thus, the former calculation of the SDD (polynomial) seems to be invalid. It seems that the actual trend line lies between the polynomial and exponential lines. Although the contexts of the surveys are different, the figures for Japanese MBCs are also a good reference.

All these results indicate the personalization of computers in the working environment for the last 8 years. Although there are some variations, nowadays it is common to have more than one personal computer. In particular, mobile computing has developed gradually, since laptop computers become more available in the commercial market, and they are used by the majority of Japanese field archaeologists (Figure 3). On the contrary, PDA (Personal Digital Assistance) is not very accessible. There may be unsolved problems with PDAs such as displaying complicated data on a small screen, access to web pages and available useful software. In addition, this phenomenon can be explained by the advent of the intelligent mobile phones and B5 size small laptop computers. The area of small computer markets will probably be more blurred in the future. Whatever happens, mobile phone technologies such as iMode³ could change the use of computer in archaeology.

Though the SDD and JAD2 surveys are biased by archaeologists with computer skills (Condron et al. 1999; Sugimoto and Igarashi Forthcoming), it is interesting to know how much experience of computing they have (Figure 5). This result from the JAD2 Survey seems to be more or less apparent, but mirrors the expansion of the Internet in the late 1990's. Archaeologists are, now, used to using computers on a day-to-day basis.

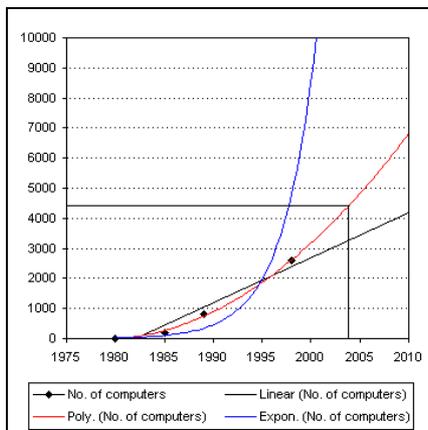
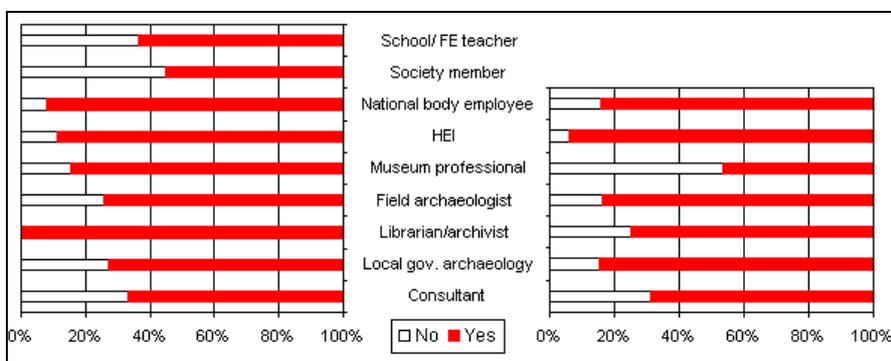


Figure 1. SDD: Estimated growth of computers in Britain (Condron et al. 1999)



³ See, for example, <http://en.wikipedia.org/wiki/I-mode> (Accessed 13 March 2007)

Figure 2. SDD: Access to computers (Ind. left, Org. right)(Condron et al. 1999)

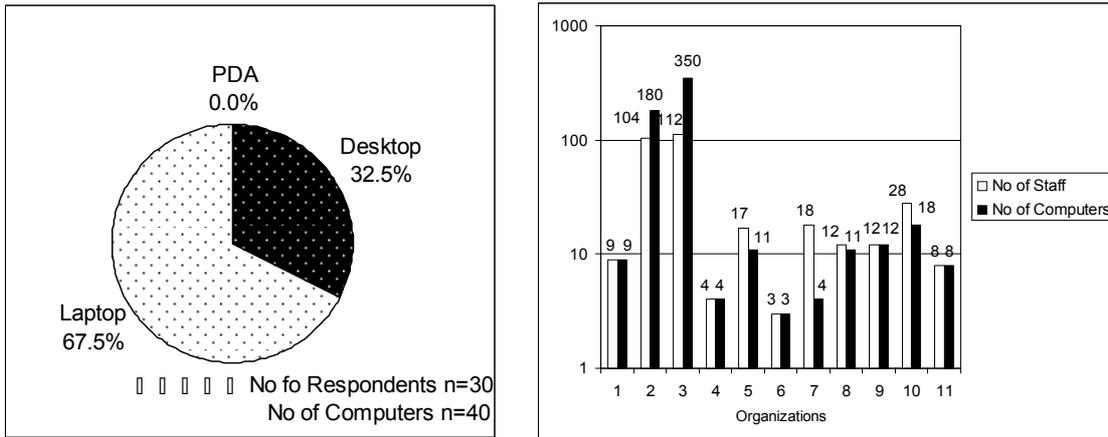


Figure 3. JAD2: Numbers of computers (Ind.)

Figure 4. JAD2: Numbers of staff and computers in 11 organizations (Org.)

Table 2 SDD and JAD2: Number of archaeologists and computers in the UK and Japan (Condron et al (1999) and Aitchison and Edwards (2003))

Year	1997/1998	2002/2003	2004	2006
Japanese Archaeologists	6486	7081	6965	(Est. 6965)
Computers in Japan	-	-	-	Est. 6303 (90.5%) Est. 12989 (186.5%) Est Av. 9646 (138.5%)
British Archaeologists	Est. 4425	Est. 6800	-	-
Computers in UK (Poly)	Est. 3000 (69%)	(Est. 4962 (69%))	Est. c4395	Est. c5000

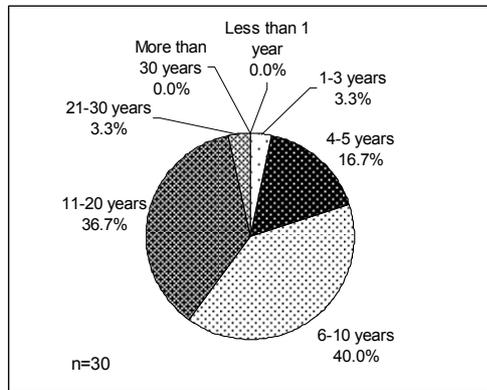


Figure 5 JAD2: The experience of the use of computer

Access to the Internet

In 2006, 86.2% of individuals in MBCs have internet access (Sugimoto and Igarashi Forthcoming). Some of the remaining respondents also mentioned that they have conditional access to the Internet. Dial-up connection seems very unpopular in MBCs in the 21st century. A stunning 66.7% of MBCs have connections to Fiber To The Home (FTTH)(Figure 6). The SDD’s result seems particularly out of date in this sense. For field and local government archaeologist, more than 30% have no

access to the Internet, while less than 50% have permanent access (Figure 8). The JAD2 survey also confirmed the intensive use of the Internet among archaeologists today. Taking into account of those who have no access to the Internet (probably explained by 10.3 % that have no access at all), 62.1% of respondents use the Internet everyday, while 3.4% use it only once a month (Figure 7). The growth of the use of the Internet is certainly observed. It is clear that technical progress is enormous and ICT infrastructure has been well established, at least, in Japan. In fact, the use of the Internet in Japan has grown from 13.4% in 1998, the year of the SDD survey, to 62.3 % in 2004 (Ministry of Internal Affairs and Communications, Japan 2005). In addition, the use of broadband at home has increased dramatically, while telephone line (dial-up) has declined (Figure 9).

It is also noted that the reliability of Internet resources has gradually risen in the last decade. Although there were strong approvals of the Internet from archaeologists in the year of the SDD survey, reliability was one of the most challenging issues about the Internet. At that time, it was not known how trustworthy websites and electronic publications were. However, electronic publications are, nowadays, even the most reliable materials, since they may consist of up-to-date information of full texts and images and movies, possibly with access to an unlimited amount of original data source. Hermon and Niccolucci (2000) argued, in the context of archaeological research, that reliability is influenced by the possibility of the user to access the source data and to manipulate them. In this sense, people have worked hard to trust and use the Internet during the last few years. On-going developments of the reliability of academic resources on the web can be improved by development such as Vascoda⁴, ELSEVIER⁵, PLOS⁶ and Google Scholar⁷ (Futaki 2005).

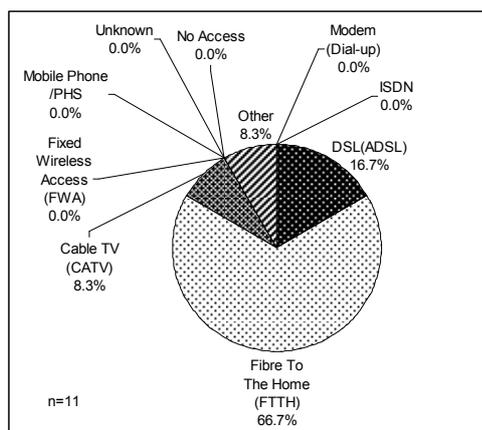


Figure 6. JAD2: The types of Internet Access (Org.)

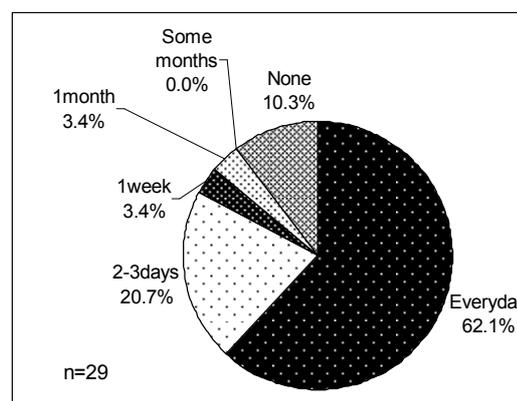


Figure 7. JAD2: frequency of Internet use (1 time per) (Org.)

⁴ <http://www.vascoda.de/> (Accessed 13 March 2007)

⁵ <http://www.elsevier.com> (Accessed 13 March 2007)

⁶ <http://www.plos.org/> (Accessed 13 March 2007)

⁷ <http://scholar.google.com/> (Accessed 13 March 2007)

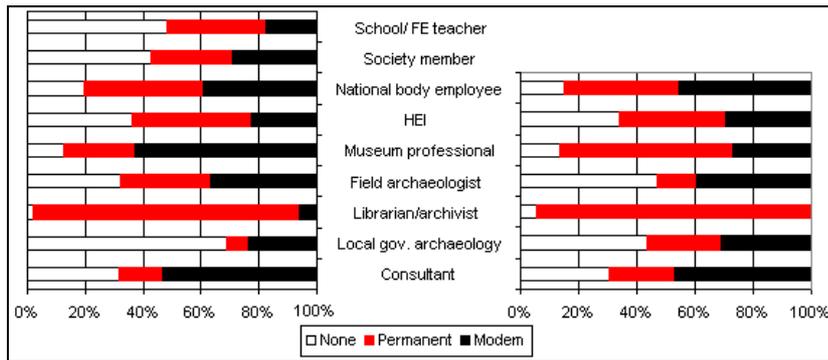


Figure 8. SDD: Internet Access (Ind. left, Org. right)(Condron et al. 1999)

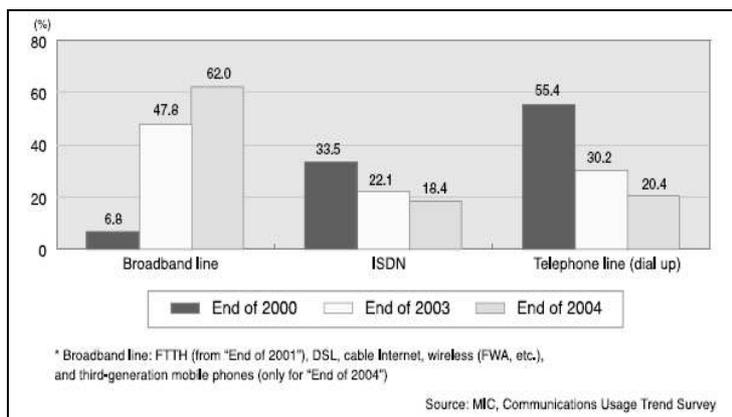


Figure 9. Internet access methods at home (Ministry of Internal Affairs and Communications, Japan 2005)

Data quantity and preservation strategies

Not only the result of the number of computers, but also the quantity of digital data has incredibly changed over time. In 1998, 42 % responses fell within 1 GB, while 29 % hold over 1 GB (Figure 10-1). 8 years later, only 18 % of organisations store less than 1 GB of archaeological data in Japan (Figure 10-2). The largest quantity of data rises up to 10 TB. The question only asked the amount of data held in MBCs, taking into consideration the scale of digital databases and archives. It is easy to presume that MBC's employees store their data in personal computers, thus much more data should be accumulated as a whole. It is also probable that the quantity of on-line resources on the web have rocketed during the past several years. For instance, Hermon and Niccolucci (2000) counted 459,915 web pages for "archaeology" in Altavista⁸. The same attempt in 2006 returned 24,900,000 results for Altavista and 25,300,000 for Google⁹.

In the two surveys, extraordinary large capacity of datasets were not analysed, rather they focused on the general trend of archaeological data. On the other hand, the ADS (2006) carried out a survey for such "big data" created by technologies such as 3D scanning, geophysics, GIS, and video movies. They discovered that three quarter of UK projects produce up to 100 GB of data with 50% below 50GB. 19% of projects also create over 200GB of data. Therefore, the quantity of digital datasets depends totally on the type of projects and services in different organizations. Those

⁸ <http://www.altavista.com/> (Accessed 13 March 2007)

⁹ <http://www.google.com/> (Accessed 13 March 2007)

projects are creating sheer amount of data that cannot be clearly seen in the results of the SDD and JAD2 surveys.

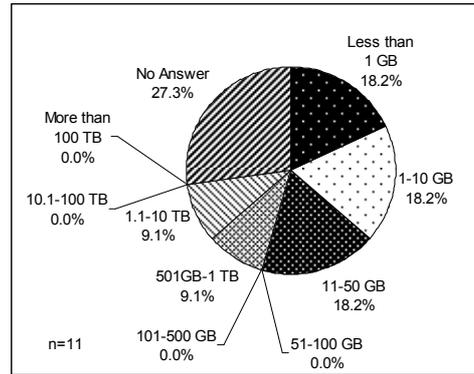
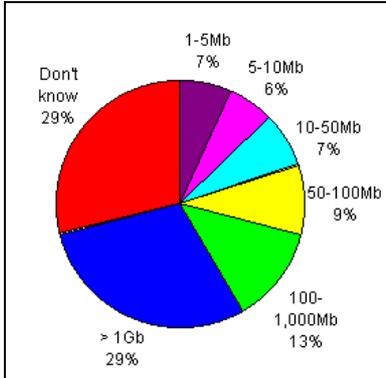


Figure 10-1. SDD: Quantity of digital data (Org.) Figure 10-2. JAD2: Quantity of digital data (Org.) (Condron et al. 1999)

Related to the issues of archaeological digital archives, surprising results were found for the types of storage devices and the back-up strategy. It was expected that the 8-year gap should have changed the percentages of pie charts, however the tendencies are, coincidentally, extremely similar. The use of hard disk and network remains the same sort of popularity, while floppy disk and tape devices were substituted by CDs and DVDs (Figure 11-1, 11-2). Therefore, optical disks seem to have expanded in the computing market in these 8 years.

The back-up strategies have not changed much either. About half of the organizations used only one medium for storage, and the tendency of 2 options and more than 3 options remained almost unchanged (Figure 12-1, 12-2). In Japan the vulnerability of archaeological digital archives is found in Figure 13-1 and 13-2. Despite the small number of samples, only 27 % of the organizations back-up their data weekly, while an incredible 18 % do not back-up at all. It is assumed that there are very few standardized policies and methodologies for data preservation and that the results depend on psychological and social factors as well as personal experience. Although recent digital devices have much more reliability than before, preservation strategies must be discussed immediately. It is possible for some MBCs to lose indispensable archaeological data forever. The back-up frequency was not studied in the SDD survey, however a similar trend could be found. Probably good guidelines for data preservation exist in different countries, yet such information is not disseminated to the bottom of archaeological services. The awareness of this issue seems to be still low.

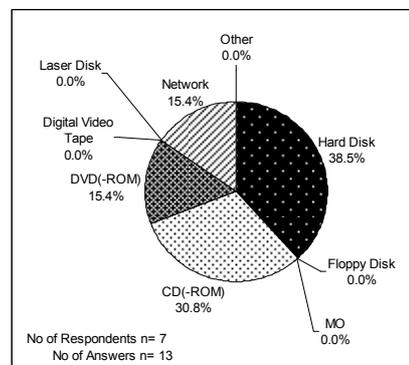
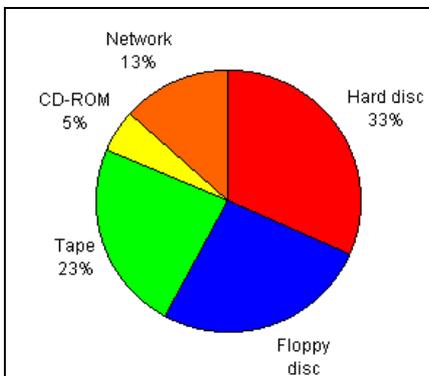


Figure 11-1 SDD: Storage device (Condron et al. 1999) Figure 11-2 JAD2: Storage device (Org.)

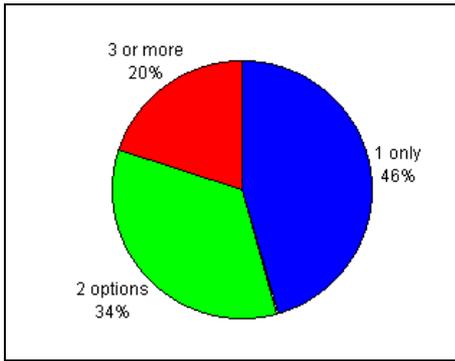


Figure 12-1 SDD: Back-up strategy (Condron et al. 1999)

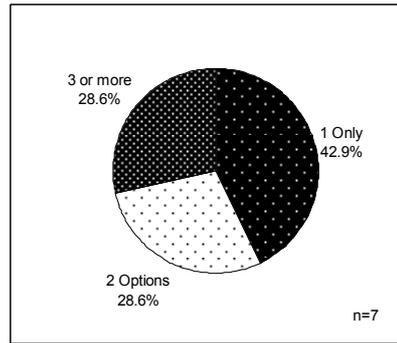


Figure 12-2 JAD2: Back-up strategy (Org.)

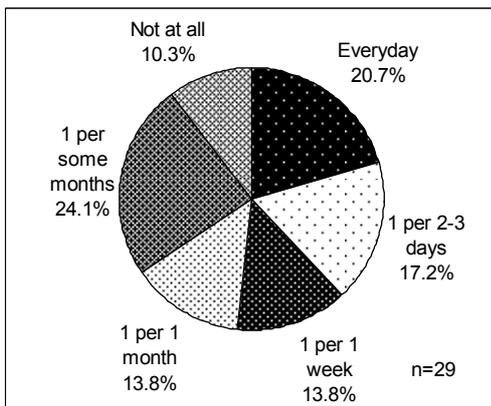


Figure 13-1 JAD2: The back-up frequency (Ind.)

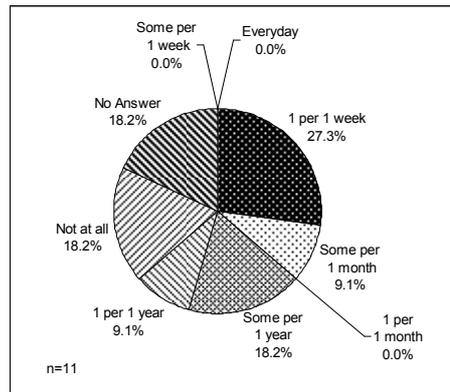


Figure 13-2 JAD2: The back-up frequency (Org.)

The creation of digital data

It is important to have an overall understanding of how archaeologists create data either electronically or non-electronically. However it is not easy to compare the two survey results, since the methodologies and presentations of the questionnaires are vastly different. The SDD survey presents the general situation of the creation of digital and non-digital archaeological data by different categories (Figure 14-1, 14-2, 14-3, 14-4). It is separated into individual and organizations. In contrast, the JAD2 survey offers more detailed statistics about the creation of digital data for field archaeology. It deals with more various types of archaeological data than the SDD survey, and the bar chart displays the total amount of respondents (data) and the portion of digital data, created by individuals (Figure 15).

In general, the SDD survey shows the creation of reasonable amounts of digital datasets, but it is slightly confusing for the analysis of the state of digitization due to the questionnaire methodology.

Thanks to the development of the digital camera and scanner, photographs are more and more digitized recently. Digital photography is cost effective in the sense that archaeologists can take more photographs, depending on the capacity, but also they can see the result immediately on the screen. It also helps to make electronic publication easy. Archaeologists in any country tend to be poorly funded, thus it is a practical option. With regard to archaeological photography, an interesting survey was conducted by Chuter and Devlin (2006) to examine the current practice of photography in British field archaeology. Although film camera is still preferred, it is evident that British archaeologists also enjoy the advantages of digital camera.

For illustrations, British archaeologists seemed to create more data in digital format than Japanese even 8 years ago. This might be a result of the tradition of the different archaeologies. For instance, it is said that Japanese archaeologists usually draw illustrations, on the contrary there are specialists for archaeological illustrations in British archaeology. In the latter case, the illustrations are becoming more and more computerized for the production of electronic-based publications due to the progress of Desk Top Designing and Publishing.

There are no equivalent organizations of Sites and Monuments Record (SMR) and National Monuments Record (NMR) in Japan. MBCs are responsible for the documentation and the archives of archaeological sites and artifacts, but, in most cases, such documentation is not well organized or established properly (Mizuyama 2001). This situation influences the creation of datasets such as sites/artifacts distribution map, (non-)designated sites and artifacts data, and indices of excavation.

Reports were one of the most popular materials for digitization in Britain, since text information is relatively easy to create by word processing software. Yet, the digital version of academic theses and excavation reports are quite limited in the JAD2 survey, probably because electronic files for these purposes, particularly in the PDF format, are underused (Sugimoto and Igarashi Forthcoming). The reason for this is that PDF format, nowadays, has become a synonym of e-publication and other digital text formats are not recognized as proper digital publications.

Increasing interest in “public archaeology” in Japan can be justified by the popularity of event information including lectures, on-site tours, and hands-on events. JAD2 survey Part I showed the same result (Sugimoto Forthcoming a). In these years, some of MBCs have passionately worked on public involvement in archaeology. Gunma Archaeological Research Foundation (GARF) is such an institution¹⁰, offering a variety of educational services, ranging from traveling exhibits, to open lectures and open days. Having said so, the lack of museum data reflects the MBC’s activity. MBC is not a museum but an organization for rescue archaeology which may extend the function to museum activities. Respondents may regard museum data as data deposited and managed in proper museums. In Britain museum data is fairly digitized, except exhibition catalogues.

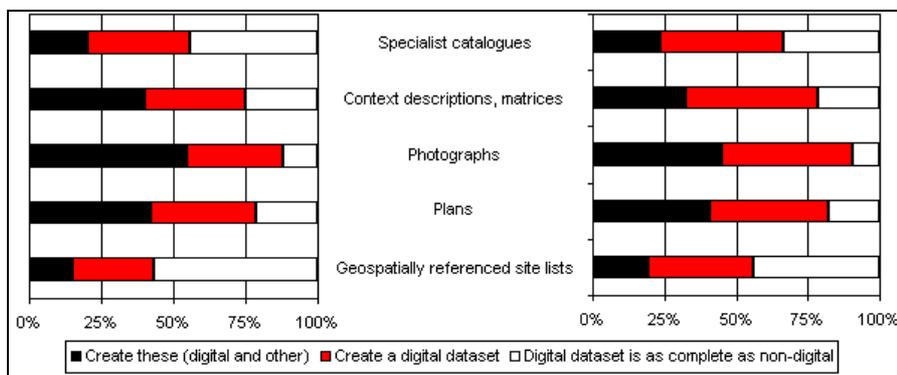


Figure 14-1. SDD: the creation of digital data (Ind. left, Org. right) (Condrón et al. 1999)

¹⁰ http://www.gunmaibun.org/index_e.htm (Accessed 13 March 2007)

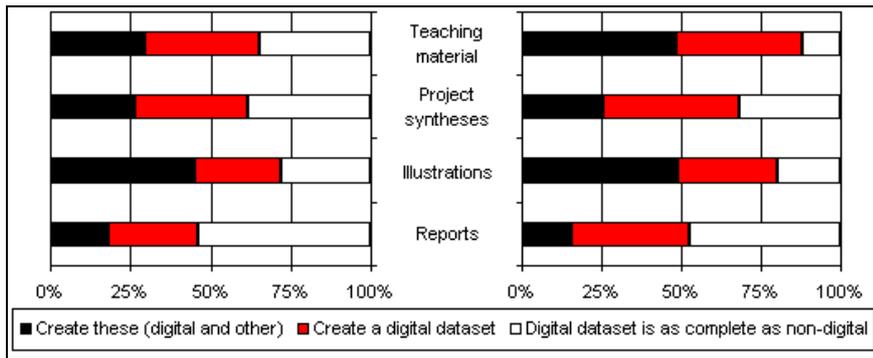


Figure 14-2. SDD: the creation of digital data (Ind. left, Org. right) (Condrón et al. 1999)

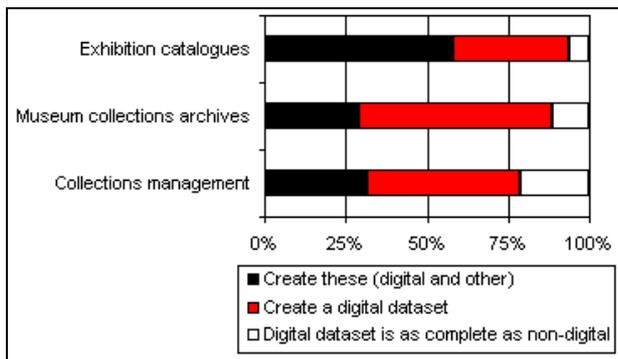


Figure 14-3. SDD: the creation of digital data (Condrón et al. 1999)

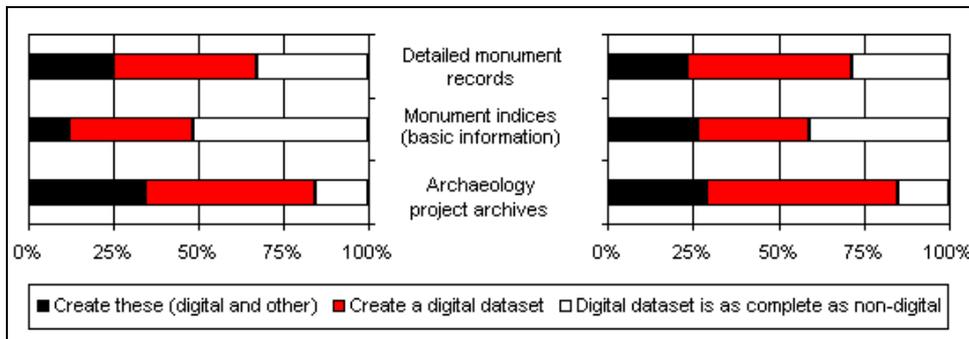


Figure 14-4. SDD: the creation of digital data (Ind. left, Org. right) (Condrón et al. 1999)

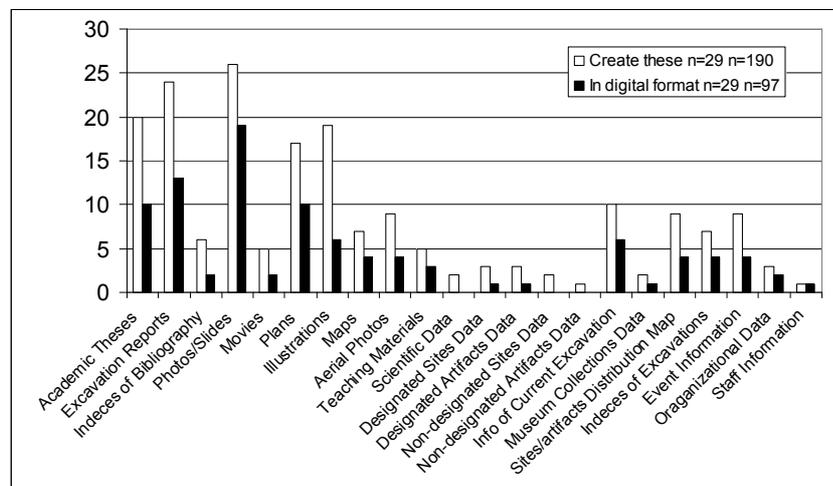


Figure 15. JAD2: the creation of digital data

Level of access to data

Different types of archaeological data are created both digitally and non-digitally. It is, again, difficult to interpret the result of the level of access to data, partly because the policy of data access should be different in each country, but it seems that Japanese organizations in 2006 are more open than British organizations in 1996 (Figure 16 and 17). It is also noted that the 9 % of no access in the JAD2 survey is caused by an organization which is preparing for access in the near future. Having said so, it does not mean that there are more public enquiries in Japan for the access to archaeological data than in the UK. Unfortunately such statistics are not explored in the survey, but the examination of the use of archaeological data by professionals and the general public will be an interesting topic of research. For example, the Herefordshire Sites and Monuments Record (SMR) received quite limited amount of consultancies from the limited groups of the public. Roseff reported that 100 enquiries were made in 1999 (Roseff 1999; Sugimoto 2002a). Such statistics could show the intensity of professional use of archaeological resources and the public interests. They are, indeed, useful for the evaluation of promotional activities by archaeological organizations.

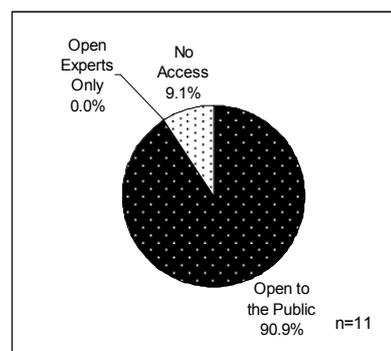
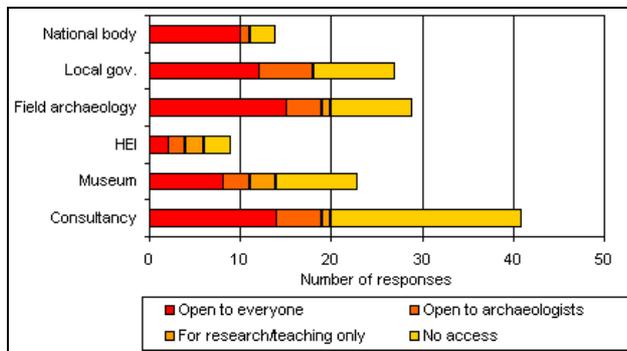


Figure 16. SDD: Level of access to data (Condron et al. 1999) **Figure 17. JAD2: Level of access to data**

Perception of different media

Figure 18-1 and 18-2 illustrate the perception of different media to record archaeological data. In the two graphs, the similarities for digital and paper formats are visible. It is also noted that British archaeologists already realized the potential of digital media in the late 1990's, and this trend is still valid in Japan in 2006. At the same time, the durability of digital data is still uncertain after 8 years, since traditional paper media does not lose its importance. In fact, 62 % of individual respondents are negative about the reliability of digital data, comparing to digital data (Sugimoto and Igarashi Forthcoming). In contrast, microfiche shows an obvious gap. This can be interpreted by the statement of Jones et al. (2001). English archaeology experienced the rise of microfiche in the late 1970's and its fall in the following decade. It is apparent that Japanese archaeologists are not familiar with microfiche, because there were no extreme opinions and the majority answered as ambivalent. It seems to be necessary to study how much microfiche has been converted to digital format in Britain. It will reveal the needs of backlog works and the accessibility to each medium.

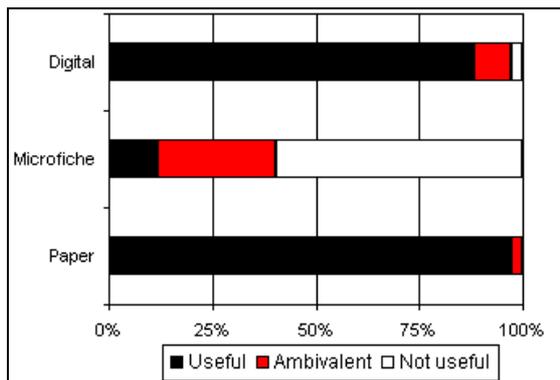


Figure 18-1. SDD: Usability of different media (Condrón et al. 1999)

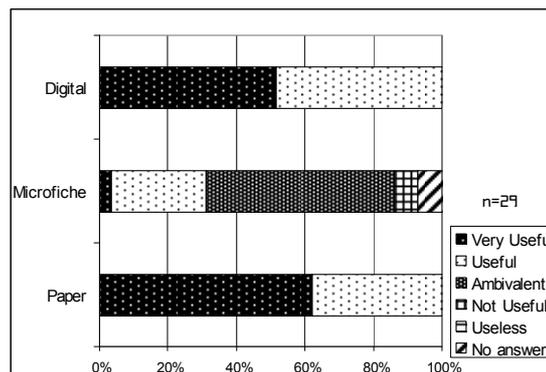


Figure 18-2. JAD2: (Ind.) Usability of different media

The negative perception of digital data

One of the most interesting divisions between two surveys can be found in the result of a question “What prevents you from using digital data?” (Figure 19-1, 19-2, 20-1, 20-2). The similarities are: lack of software/hardware and cost. These factors are based on finance. Answers such as “Didn’t know they (digital data) were available” and “Too difficult to convert (to digital data)” have similar patterns too. On the other hand, it is possible to point out four major differences. First of all, the conception of copyright seems different. It may be true that the British are more aware of copyright issues than the Japanese. There is no direct comparison between two countries, but other Japanese statistics reported that about half of Japanese and Korean are not aware of copyright issues, while the figure drops to about one third in the United States (Figure 21). Secondly, it is observed that there is lack of IT skills in Japanese archaeology. In contrast to the UK, archaeological computing is not yet an established academic subject in Japan. For example, the CAA conference¹¹ first started in the UK in 1973. The equivalent conference in Japan would be JSAI (Japan Society of Archaeological Information)¹² which celebrated the 10th anniversary in 2006. Moreover, there are some British universities specializing in archaeological computing such as the University of York and Southampton. The tradition and history in the two countries may lead to this result. Thirdly, the lack of need and no online connection may symbolize the development of ICT in the 8 years. Finally, “The data I want are not available” may mean the improvement of information delivery on the Internet. These results are underpinned by the statements of DigiCult report that “Being digital for many European archives, libraries and museums (ALMs) is no longer an option but a reality”(European Commission 2002).

¹¹ CAA (Computer Applications and Quantitative Methods in Archaeology) conference. <http://www.caaconference.org> (Accessed 13 March 2007)

¹² <http://www.cis.doshisha.ac.jp/htsumura/JSAI/> (Accessed 13 March 2007)

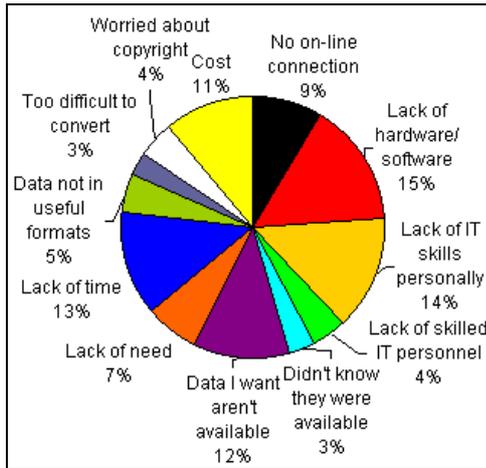


Figure 19-1. SDD: Negative perception of digital data (Ind.) (Condrón et al. 1999)

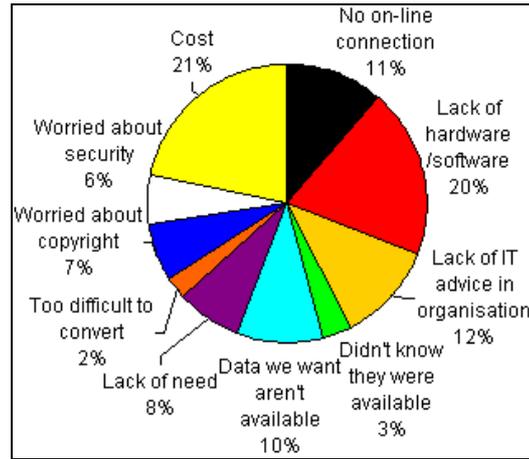


Figure 19-2. SDD: Negative perception of digital data (Org.) (Condrón et al. 1999)

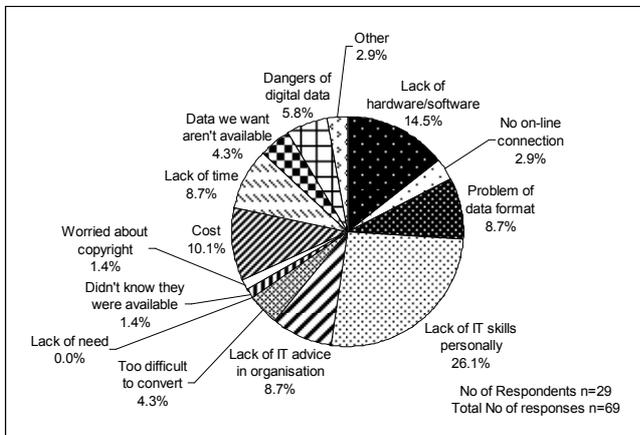


Figure 20-1. JAD2: Negative perception of digital data (Ind.)

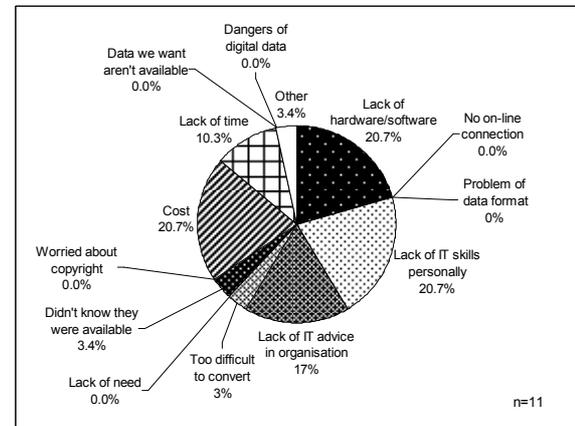


Figure 20-2. JAD2: Negative perception of digital data (Org.)

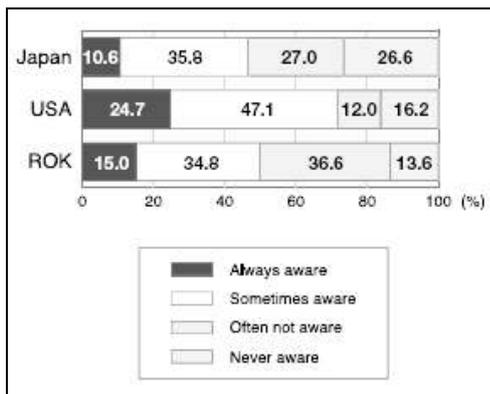


Figure 21. Copyright awareness upon using contents in these countries (Ministry of Internal Affairs and Communications, Japan 2005)

The knowledge of ICT in archaeology

In the JAD2 survey, an interesting attempt was made to examine the archaeologists' knowledge of ICT. Archaeologists in MBCs were asked to answer if they knew some technical terms related to

archaeological computing (Figure 22). There are no compatible statistics for the SDD survey. More than half of them know terms such as “digital archives”, “JSAP”(See another footnote), “GIS (Geographical Information System)”, and “GPS (Global Positioning System)”. Surprisingly, “ubiquitous” is also relatively known. On the contrary, database-related terms including “metadata”, “XML (eXtensible Markup Language)”, and “Cultural Heritage Online¹³” are not familiar to them. None of the respondents knew “thesaurus” and “the CIDOC-CRM”.

Thanks to the efforts of some pioneers of archaeological GIS in Japan (See Kaneda et al. 2001), GIS-related terms have become popular in Japan. On the other hand, XML still does not have a strong status among Japanese archaeologists, though it became a W3C recommendation in 1998. Some XML applications were seen in the *Journal of Computer Archaeology* (See Sugimoto 2003). As far as the CIDOC-CRM is concerned, the unpopularity of this ISO standard indicates emerging needs for its promotion in Japan. The Japanese museum community seems more aware of the use of the international standard, but field archaeologists are quite ignorant. It is also interesting to know how popular these terms are among British archaeologists. A job for the new academic subjects such as “archaeological computing and informatics” is to fulfill the “No” part in this graph.

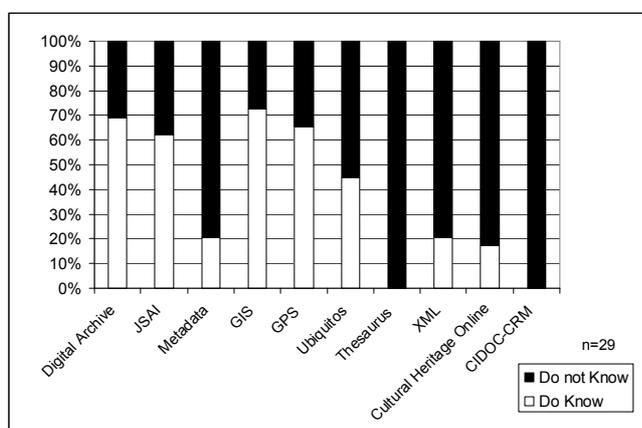


Figure 22. JAD2: The knowledge of ICT and Archaeology

IT training and skills required for archaeologists

Not limited to archaeology, training is an important part of the job to provide high-quality standard service. In a survey report of archaeological profession in the UK, Aitchison and Edwards (2003) stated that 45% of organizations spend time and money on training on an ad-hoc basis, as they have no formal training plan. Moreover, one-fifth of the organizations have no training budget, and a third have no control over any training budget they may have. In terms of computer training, Condron et al. (1999) noted that archaeologists need to have access to support and training in order to create, preserve, and re-use digital datasets effectively, therefore the analysis of training needs is an essential part of the survey.

Figure 23-1 and 23-2 show the needs of computer training and the training provided by organization and planned for the future. In comparison with Figure 24-1 and 24-2, they reflect the trend of the era; how different technologies have been developed and used. In the SDD survey, general skills concerning the Internet and file transfer are prominent, while Japanese archaeologists demand more specialized skills such as database, CAD, image processing, and Desk Top Publishing, partly due to

¹³ <http://bunka.nii.ac.jp/Index.do> (Accessed 13 March 2007)

the complexity of the questionnaire. However, this is also a representation of two different scopes of the surveys. The SDD explored all areas of archaeology, whilst the JAD2 focused on field archaeology. Apparently, photograph processing, data manipulation in database, and digital publication of excavation reports are required for the process of field archaeology.

Most British organizations did not provide training at all, yet some basic trainings for word processing, email, and the Internet were most common. Nonetheless, they were keen to offer various kinds of IT trainings in the future. In contrast, 73 % of Japanese MBCs provide some forms of IT trainings inside and outside organizations. Interestingly, 46 % employ information officers (including a officer holding another post), but none of them have a permanent officer (Sugimoto and Igarashi Forthcoming). They seek in particular a person who has skills of database, image processing, and web designing. However, the chart also shows relatively even distribution, because they are not only interested in such skills but also in the knowledge of archaeological information, IT strategies, and archiving. It seems that the skills and knowledge of both archaeology and informatics are required to be employed as an IT specialists for MBCs.

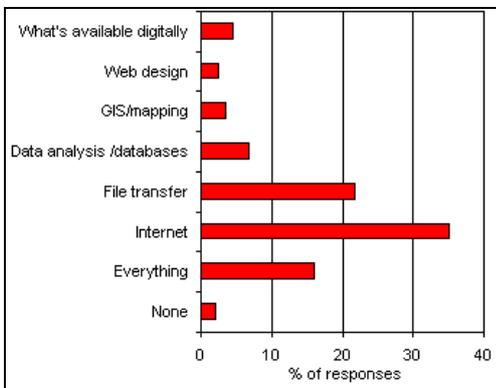


Figure 23-1 SDD: Training needs (Ind.) (Condron et al. 1999)

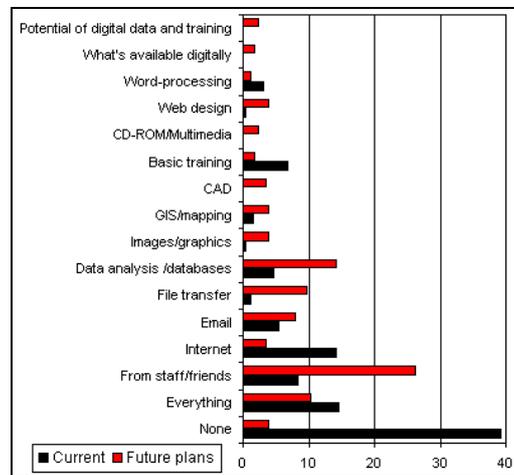


Figure 23-2 SDD: Training provision (Org.) (Condron et al. 1999)

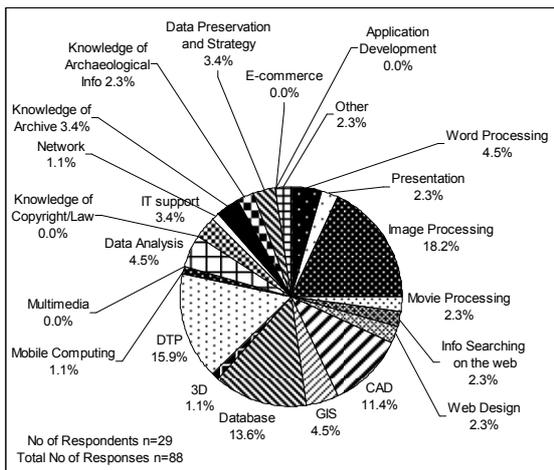


Figure 24-1 JAD2: Needs for skills (Ind.)

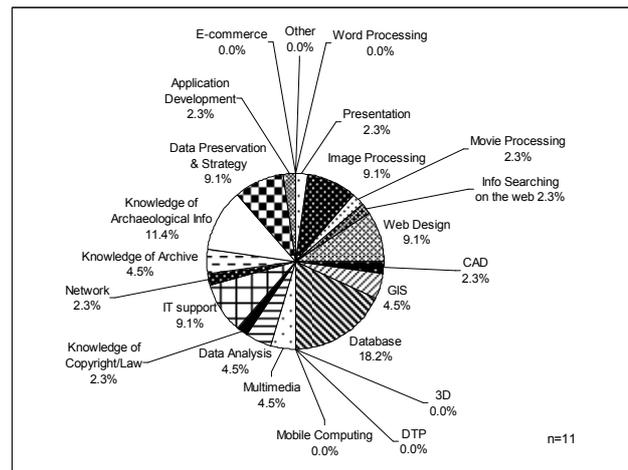


Figure 24-2 JAD2: Needs for skills (Org.)

Common Software

Over the past 8 years, the software market has changed significantly. The SDD survey revealed a wide range of variations for software used by archaeologists (Table 3-1). Partly because of this variety, the data migration was one of the biggest issues for long-term data preservation since the late 90's (Brown et al. 1999). Condrón et al. (1999) concluded that the diversity in data creation in the SDD survey resulted in difficulties with the re-use of digital data from completed projects. However, this variation has shrunk. In 2006, the obvious trend is the domination of Microsoft and Adobe software (Table 3-2). They occupy the most commonly used software in 7 out of 8 categories. Archaeologists seem to have chosen practical software which are either de-facto standard or open source. The improvement of functionality for data import and export also supports the preference to de-facto software.

To a great extent, Office software is standardized as a series of packages, so that the standardization is in progress. For example, the Open Document Format (ODF) is an open XML-based document file format for office applications to be used for documents containing text, spreadsheets, charts, and graphical elements (OASIS Open 2006). It is a counterpart of vendor packages such as Microsoft Office, avoiding proprietary documents and advocating the efficient data exchange and preservation. On the other hand, Adobe achieved a monopolistic status in the field of image processing and Desk Top Publishing (DTP). Particularly Photoshop, Illustrator, and Acrobat (PDF format) are almost must-items for these purposes.

Ichi-Taro is a real Japanese thing. The software focuses on the flexible use of Japanese character sets. Because of the difficulties of dealing with the Japanese language in English-based computers, the second position was archived in word-processing software. Needless to say, it is compatible with other major software, but this result exemplifies the fact that English-based computers and software are not always the best solution for different needs.

Open source software is widely recognized too. Freeware such as Open Office¹⁴, PostgreSQL¹⁵, and GIMP¹⁶ are such examples. Only GIS software does not seem to be standardized, and is still a field of exploitation. Similarly, the tendency for proprietary occurs in the field of large datasets in archaeology. Austin and Mitcham (2006) figured out that software packages used for big data creation are highly proprietary, although nearly half the projects support an ASCII export. Unfortunately, this area of study was outside the scope of the SDD and JAD2 surveys. In conclusion, the compatibility of the software currently used in Japanese archaeology is relatively high. Most software has a function of importing and exporting various file formats available. At the same time, open source gains more attraction from archaeologists. This phenomenon can be also found in the EPOCH¹⁷ and BRICKS¹⁸ projects in Europe.

Table 3-1. SDD: Programs commonly used by British archaeologists (Ind. and Org.)(Condrón et al. 1999)

	Text reports	Catalogues	Plans and images	Mapping contour and geophysical surveys
1 st	Microsoft Word (327)	Microsoft Access	AutoCAD (106)	AutoCAD (29)

¹⁴ <http://www.openoffice.org/> (Accessed 13 March 2007)

¹⁵ <http://www.postgresql.org/> (Accessed 13 March 2007)

¹⁶ <http://www.gimp.org/> (Accessed 13 March 2007)

¹⁷ <http://www.epoch-net.org/> (Accessed 13 March 2007)

¹⁸ <http://www.brickscommunity.org/> (Accessed 13 March 2007)

		(146)		
2 nd	Word Perfect (105)	Excel (81)	Photoshop (62)	Surfer (27)
3 rd	Aldus Pagemaker (15)	Microsoft Word (76)	Corel Draw (59)	Geoplot (20)
4 th	AmiPro (12)	DBase (28)	Paintshop (25)	Insite (11)
5 th	Wordstar (10)	Fox Pro (18)	ArcView (23)	Arcinfo (10)
	21 other programs	43 other programs	45 other programs	33 other programs

Table 3-2. JAD2: Programs commonly used by Japanese field archaeologists (Org.)

	Word Processing	Spread Sheet	Presentation	Database	Image	GIS	DTP
1 st	Word (10)	Excel (9)	Powerpoint (9)	Access (7)	Photoshop (9)	ArcView (GIS) (2)	Illustrator (4)
2 nd	Ichi-Taro (4)	Open Office Calc (2)	Open Office Impress (1)	Excel (5)	Illustrator (4)	MapInfo SIS GRASS IDRISI Google Earth (1)	InDesign (3)
3 rd	Open Office Writer (2)	Lotus1-2-3 (1)	Acrobat (1)	FileMaker (4)	PaintShop (2)		PageMaker (2)
4 th	Acrobat (2)			Oracle (2)	AutoCAD GIMP (1)		Quark Express (1)
5 th	Text Editor(1)			PostgreSQL(1)			
		No use (1)	No use (1)	No use (1) Open Office Base (1)	No use (2)	No use (7) In-house System (1)	No use (6)

Mind reading

This section attempts to read archaeologists minds by analyzing a part of the two survey questionnaires dedicating to the opinions on archaeological information and ICT. Archaeologists were asked to explain how they felt about the statements related to archaeological information and technology by choosing the following: “Strongly Agree”, ”Agree”, ”Disagree”, and “Strongly Disagree”. In particular 11 statements were prepared in the SDD survey and 26 in the JAD2 survey.

Information was sought about the use of standardized thesauri in Britain. A question that SDD made: “Are standard thesauri of archaeological terms are of no use in my work?” was also asked in the JAD2 (Figure 25-1, 25-2). There is common support for the use of standards in archaeology in Britain. That is the case in Japan too, but the refusal rate for the thesauri is relatively higher. This could be explained by the type of business (e.g rescue archaeology) and archaeological system in

Japan. Since MBCs concentrate on salvage archaeology, the employees may be too busy to finish up daily excavations without giving much thought to the necessity of standardized thesauri. In addition, the Japanese management system for underground cultural properties is relatively centralized, as opposed to the mosaic of various British archaeological organizations. 73% of staff working on underground cultural properties are employed by MBCs, compared to museums (10%), and local government (17%) (Kiyono 2005). In Britain, Aitchison and Enwards (2003) estimated that archaeological contractors occupy 42 % of whole professions. Thus, the current situation would be, if not desirable, satisfactory for Japanese.

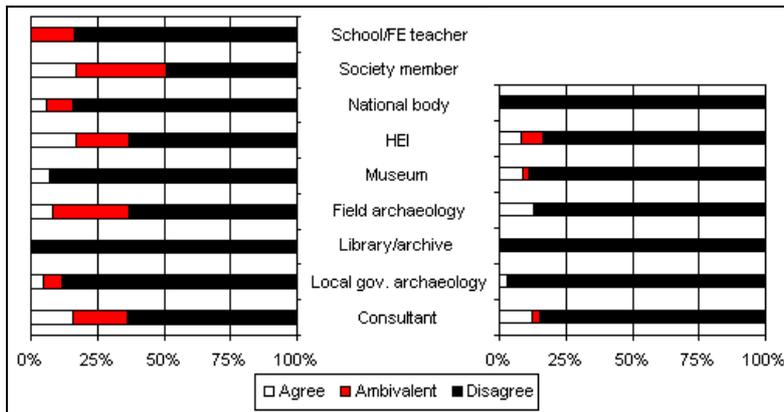


Figure 25-1. SDD: Are standard thesauri of archaeological terms for the British Isles are of no use in my work? (Ind. left, Org. right)(Condron et al. 1999)

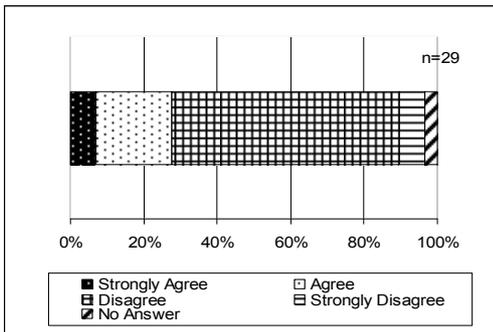


Figure 25-2. JAD2: Are standard thesauri of Japanese archaeological terms are of no use in my work? (Ind.)

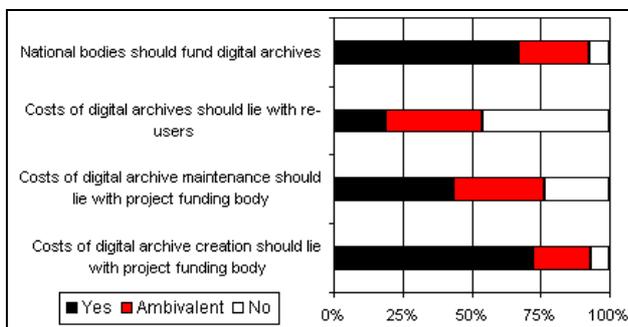


Figure 26-1. SDD: Responses to a range of questions (Ind.) (Condron et al. 1999)

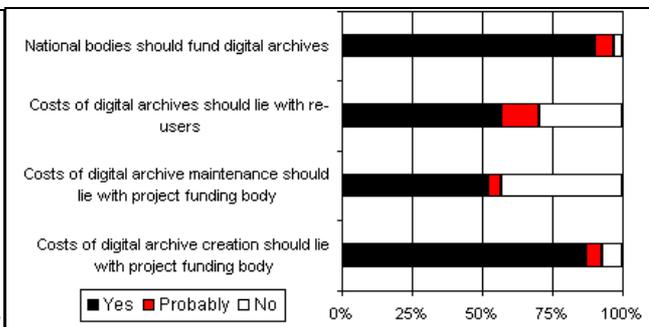


Figure 26-2. SDD: Responses to a range of questions (Org.) (Condron et al. 1999)

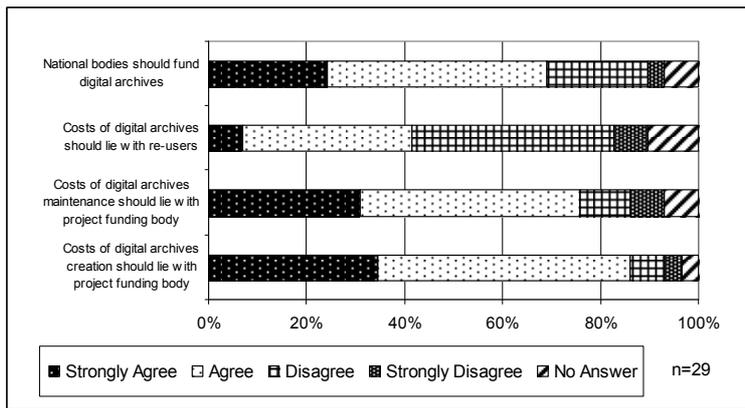


Figure 26-3. JAD2: Responses to a range of questions (Ind.)

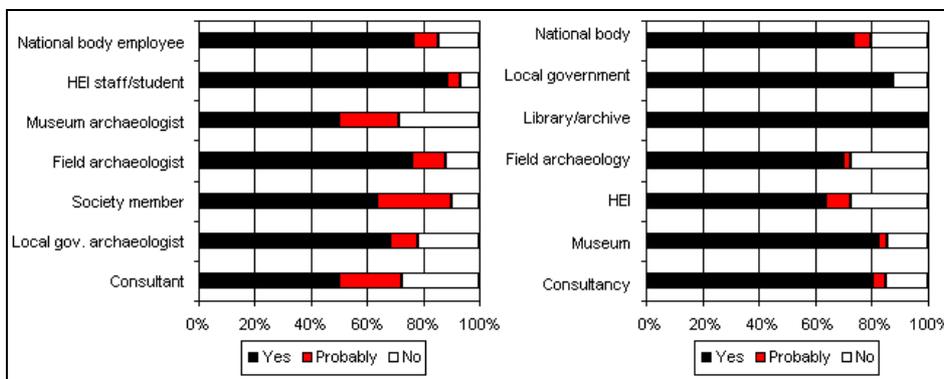


Figure 27-1. SDD: Should data in SMRs be available on internet? (Ind. left, Org. right) (Condrón et al. 1999)

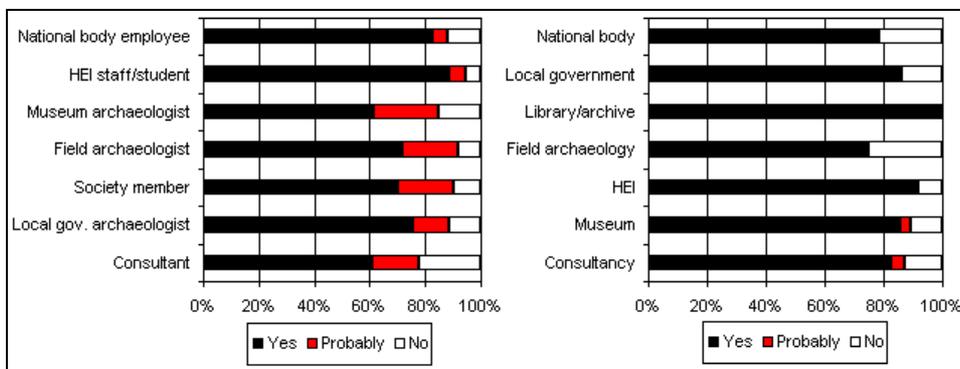


Figure 27-2. SDD: Should data in NMRs be available on internet? (Ind. left, Org. right) (Condrón et al. 1999)

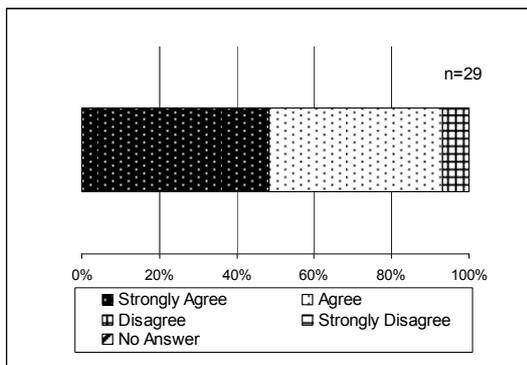


Figure 27-3. JAD2: Should data in MBCs be made available over internet? (Ind.)

People are probably more familiar with commercial services on the web in 2006. To some extent, the establishment of web business models during the past 8 years influences the attitudes of Internet users.

The security of online shopping and authorized access has improved, and the variety of web-based services has increased, therefore people have an understanding that information and services on the web are, not necessarily free. This may cause a slight separation for individuals between the UK and Japan on the statement “the costs of digital archives should lie in re-users”. On the other hand, both the British and the Japanese generally agree that the cost of digital archives should be funded by national bodies (Figures 26-1, 26-2, 26-3).

A subtle difference is recognized for the questions regarding the costs of digital archives. Whereas Japanese archaeologists did not distinguish the cost of archive creation and maintenance, the British seemed to be more keen to consider the two issues separately. It is often the case that data creation and its dissemination is the goal of a project, but there are some data which should be maintained properly and frequently in order to increase the value of the archives and gain more access to them. It is particularly true in case of the Internet. It is wiser for archaeologists to consider the whole data process from data capture, manipulation, and analysis, to dissemination and preservation.

As far as data availability is concerned, the popularization of the Internet can be seen. In 1998, some archaeologists were not sure if data in SMRs and NMRs should be available online or not (Figure 27-1, 27-2). On the contrary the figure in 2006 shows great acceptance of information delivery on the web (Figure 27-3).

Face the future: Conclusions*Summary of the comparison*

As the author expected, because of the factors of difficulties, it was, indeed, hard to compare these different surveys, however the comparison has shown, for the first time, some of important aspects of the use of ICT in archaeology in a global sense. This section will summaries the comparison and provide future prospective.

The SDD and JAD2 surveys confirmed the continuous growth of the use of computers. Japanese field archaeologists seem to prefer laptop computers more than desktop and PDA. The infrastructure of the Internet connection has been improved dramatically during these 8 years. Dial-up connection has been replaced by fiber. Accordingly, archaeologists use the Internet on a day to day basis. In parallel to the widespread of computers in the area of archaeology, archaeologists' ICT literacy improves. The majority of Japanese archaeologists has over 6 years of computer experience.

Similarly, the amount of data that archaeologists deal with have risen rapidly. The average quantity of data held in archaeological organizations has risen from Mega Byte to Giga Byte and Tera Byte in the last decade. It is likely to reach up to Peta Byte and Exa Byte level in the near future. Backup media correspond to the technological development too. Floppy Disk and tape media were replaced by CD and DVD, while hard disk and network storage were unchanged. In the meantime, there exist some risks. Information strategies such as long-term data preservation and sustainability do not seem to be widely adopted. Individual users do not regard it as important as information officers do. But the real threat is the situation for some organizations which do not backup as often as once in a week or a month. It is significant to disseminate a good practice of data preservation as widely as possible for the long-term sustainability of archaeological practice.

As digital cameras and scanners become cheaper, photographs are one of the most popular materials for digitization in 2006. Although British archaeologists use digital camera more and more, both film and digital formats are used for safety. For illustrations, they created more in digital format. Many reports were digitized in 1998, whilst the percentage of Japanese digital reports is quite low. Mirrored to the burning interest in public archaeology, event information is popularly created in both digital and non-digital format. The same result was found in the website evaluation survey. The lack of museum data reflects the MBC's activity which focuses more on field research.

Japanese MBC seems to be more open with regard to the level of access to data. Unlike the UK, the distinction between professional and the public is not clearly recognized.

Although the financial situation for the use of digital technology is similar, the perception of digital technology may be different in each country. For instance, copyright issues and the lack of IT skills were visible. The technological progress was also explained by the lack of required data, needs and online connection.

Japanese archaeologists' knowledge of ICT illustrated the separation between GIS related technology and database related one. GIS can facilitate database and spatial information together, so that more education on database has to be organized. It should be interesting to investigate the ICT knowledge of archaeologists in Britain.

In 1998 IT training was not fully given to British archaeologists, though organizations plan to provide it in the future. In contrast, Japanese organizations offer some forms of training, yet only half of them employs an information officer who often holds another post. They prefer to hire an information officer who has database, image processing and web designing skills, as well as the knowledge of archaeological information and the strategies and policies of ICT. As the first part of the comparison shows, computer technology is an essential part of current archaeological practice, therefore, the investment in proper IT trainings, as well as the employment of ICT officers will be necessary.

Archaeologists have adopted a more flexible approach to software use. The increase of open source and de-facto standard software was observed. On the contrary, it is assumed that archaeologists still rely on proprietary products in the area of cutting-edge technology such as GIS and 3D modeling.

Although the opinions of Japanese and British archaeologists on ICT vary question by question, similarities are also found. There is common support for the use of standards in archaeology in Britain, while the refusal rate for the thesauri in Japan is relatively higher. Whereas both the British and the Japanese generally agree that the cost of digital archives should be funded by national bodies, there is a difference between them for the attitude towards the cost of digital archives creation and maintenance. It is probably wiser for them to consider the whole data process from data capture, manipulation, and analysis, to dissemination and preservation.

In general, the comparison of the two surveys proved that the technological improvement reflects the use of ICT in archaeology. The JAD2 survey detected the obsolescence of the SDD survey and the burgeoning needs for up-to-date surveys. In addition, some parts of the questionnaires revealed differences between British and Japanese archaeology. But even though computer-literate archaeologists seem to join in the two surveys, there is still a lack of awareness of new disciplines of archaeological informatics. It is easy to assume that a large number of archaeologists do not know the risks and potential of ICT.

Future surveys

As to the improvement of the two surveys, there are several matters to be considered. As archaeological information is discussed more and more internationally, growing needs are

recognized to execute up-to-date surveys for the use of ICT in world archaeology. As stated, literatures of the kinds of surveys examined in this paper are very limited. In such survey, questionnaires should be simplified, specialized, or divided into several small surveys, depending on the goal of the survey. In fact, the SDD and JAD2 surveys are massive in size, sacrificing the response rates to some extent, therefore, a simplified survey would be valuable. It is also important to design a simple international standard for evaluation schema in order to compare surveys in different nations. The SDD and JAD2 surveys both focused on the use of ICT for archaeological experts, but another survey seems worthwhile if it concentrates more on non-professionals, because internet archaeological resources are fundamentally open to all. As the JDAA dealt with the Japanese museum sector, a wider perspective in terms of academic subjects is also needed.

A new challenge: ACT Archaeology

The preliminary purpose of the JAD2 survey is to obtain the up-to-date statistics of archaeological information in Japan and to understand its current state. However, with regard to the number of participants and the reaction to the survey, it was not very successful. In particular it was not possible to acquire data from all over Japan. The survey result was, eventually, distorted by Eastern Japanese archaeologists.

In order to solve such problems, Sugimoto and Igarashi (Forthcoming) have started to take a proactive action. We have been organizing a group to support a re-run of the JAD2 survey. The group is named “ACT Archaeology” (http://www.chiron-training.org/go_sugimoto/digital_survey/act_archaeology_eng.html) which represents the progressive attitude toward the stimulation of new archaeology. As an initial goal, ACT Archaeology attempts to submit a recommendation for the re-run of the survey at much wider level, to some leading organizations and academic societies, including the central government (Agency for Cultural Affairs)¹⁹, Nara National Research Institute for Cultural Properties (Nabunken)²⁰, Japan Archaeological Association (JAA)²¹, and Japan Society for Archaeological Information (JSAI). This activity of ACT Archaeology is done by a form of petition. It collects signatures from those who are interested in the recommendation plan. An invitation letter for the petition was dispatched to the MBCs and their employees who joined the survey. Then, the recommendation, together with the petition will be sent to the organizations mentioned above. Although, at smaller or bigger level, there has been some political involvement of Japanese archaeologists, this sort of action has not been, hitherto, undertaken in the area of archaeological information.

Another objective of the survey was to raise awareness of “archaeological computing” as a developing academic subject. It is thought that the survey provides a good opportunity for Japanese archaeologists to recognize and understand the discipline and encourages a discussion for the future. Although a conference such as JSAI promotes the development of this subject in Japan, it is not well recognized among most Japanese archaeologists. This situation seems to be more or less similar in other part of the world. For instance, the RecorDIM initiative was created in order to bridge the gaps that currently exist between the information users (conservation professionals of all trades, project managers, planners) and the information providers (photographers, heritage recorders, photogrammetrists, surveyors) (RecorDIM Initiative 2002). In this sense, ACT Archaeology can be an international propaganda campaign for the development of such academic subject. Thus, we also seek international support, examining whether there would be the possibility

¹⁹ <http://www.bunka.go.jp/> (Accessed 13 March 2007)

²⁰ <http://www.nabunken.go.jp/> (Accessed 13 March 2007)

²¹ <http://wwwsoc.nii.ac.jp/jaa2/index.htm> (Accessed 13 March 2007)

to create a temporary network of international professionals (and more) in the archaeological sphere, especially from the viewpoint of the use of ICT.

However, the initial goal (ie. the re-run of the survey) is beneficial only to Japanese archaeological community, so that international collaboration would be difficult. For this reason ACT Community was established. It is a web-based international community in which the members of ACT Archaeology can communicate each other (http://www.chiron-training.org/go_sugimoto/digital_survey/act_community_eng.html). The contributors to the petition are able to decide if they would like to share personal information with others. The ACT Community website displays the list of people who wish to do so. In this way the petition becomes more open and useful for international information sharing.

Moreover, as archaeology is a very interdisciplinary subject, combining humanities, social and natural science together, it is also important to have support from many different professionals including anthropologists, geologists, historian, linguists, economists, ethnologists, as well as architects, chemists, informaticians, engineers, and scientists. It may include not only professionals such as researchers, fieldworkers, and curators, but also non-professionals including the general public who may be interested in the idea of ACT Archaeology. In summary, ACT Archaeology is a loosely connected, open-minded, and self-determined proactive group of international network that attempts to bridge such interdisciplinary and various range of people who are interested in future and better archaeology, by new types of communication in virtual and real environment (ACT Community). It is an enormous challenge, but there is no gain without action.

We are very keen to promote ACT Archaeology and Community in order to create the maximum result. We have several publications in English and Japanese, as well as conference presentations in JSAI, CAA, and CAA UK. A website was created in Japanese, English and Italian. In addition, we have already contacted an executive committee of JSAI to discuss about our activity and possible support from the academic society. Moreover, the information regarding the survey and petition was posted in the websites of Antiquist²² in the UK and BRICKS in Europe. Furthermore, our activity was introduced by a Japanese nation-wide newspaper (Asahi Newspaper)²³ on the 6th of March in 2007, which has about 3.8 million subscribers. We are planning to submit the survey proposal in autumn, so these promotions will continue by the end of 2007. It is hoped that all these activities will bring us the success of our campaign.

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²² <http://www.antiquist.org/> (Accessed 13 March 2007)

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He graduated from the Department of Ethnology and Archaeology in Keio University, Tokyo. The BA dissertation dealt with the tombs and urban planning system in Carthaginian archaeology. In 1998, he joined the excavation of an Islamic site in Egypt under the Middle Eastern Cultural Centre in Japan. In 2000 he started to study MA in Heritage Management in the University of Birmingham, UK. He successfully finished his placements in Herefordshire Sites and Monuments Record (SMR) in England and the Cregneash Folk Museum in the Isle of Man. Based on the placement, he specialised in the heritage management of the Cregneash Folk Museum and the Manx National Heritage. The overall management included various issues of conservation, marketing and tourism, finance and business, and education and interpretation. After Birmingham, he studied in the University of York, where he learned the use of Web, CAD, GIS and VR in archaeology. His dissertation specified XML (eXtensible Markup Language) for the creation of Aerial Photograph image databases. He used the photograph collection of Herefordshire SMR and built a relational database with XML/XSLT technology. This research became one of the early examples of the use of XML in archaeology, therefore, he archived distinction for MSc in Archaeological Computing.

In 2003, he started to work for Wessex Archaeology, one of the biggest archaeological contractors in the UK, as an IT project assistant. In Wessex, he was a part of IT team, and bridged different staff including illustrators, field archaeologists, finds specialists, heritage officers, and project officers/managers. He worked on a variety of projects, using CAD and GIS software to provide pre-excavation, post-excavation and publication standard graphics. He also designed a few databases and undertook a GPS survey in Cambridgeshire.

After some voluntary works in the Museum of Archaeology in Southampton and Armley Mills (Leeds Industrial Museum) in Leeds, he moved back to Japan and started another career in the National Museum of Modern Art, Tokyo (MOMAT) as a part-time researcher. The job was two-fold. One was system administrator and IT support for more than 50-networked computers in three corporate museums. The other job was to develop digital archives and services in the art library. He created and maintained an intranet site for the library, and built a MySQL database for the reference of the open bookshelves. In addition, he designed a library leaflet.

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