



IST-2002- 507382

EPOCH

**Excellence in Processing Open
Cultural Heritage**

Network of Excellence
Information Society Technologies

D.2.5.2 Report on Common Research Agenda

Due date of deliverable: 29 April 2005

Actual submission date: 28 April 2005

Start date of project: 15/03/2004

Duration: 4 Years

Ename Center

| Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006) | | |
|---|---|---|
| Dissemination Level | | |
| PU | Public | X |
| PP | Restricted to other programme participants (including the Commission Services) | |
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1. Executive Summary

This document describes the Research Agenda from two points of view: on one hand, it brings together the research needs seen from the perspective of the Research Scope, which consists of museums, monuments and sites, and on the other hand seen for the technological point of view. Both approaches clearly meet each other and give a quite consistent image of the research issues that need to be met.

It is also clear that the needs from the CH community are much wider than research only. There is a very definite need for a better understanding of the opportunities that information and communication technology offers to the CH community, which needs to be met by information dissemination and training. There is also a definite demand for a better matching of the needs of the various CH stakeholders, as most technology for CH today has been designed in a technology driven way, not in a demand driven way. There is also a clear lack of mature, experienced companies that provide appropriate, state-of-the-art CH solutions in a sustainable way. This Research Agenda also deals with these issues and states what actions are already planned, or need to be planned to try to solve these problems.

In this report, the Research Scope provides a helicopter view of the specific needs of museums, monuments and sites, and combines the results from the Stakeholder Needs, Vertical and Horizontal Integration activities into a list of general needs and potential technological solutions. The detailed description of the needs and solutions can be found in the respective reports. The Research Scope provides also planned or potential short and long term actions resulting from this analysis.

The Technology section has been used to define technological research priorities that have been defined by network members in general and partners of the Common Infrastructure in particular. Membership voting has been used to derive a research priority for each item.

In the Standards and Business Aspects, additional issues about standards, guidelines and policies are discussed and a brief analysis is made of the CH business structure and potential actions to improve this structure.

2. Introduction

The Common Research Agenda summarises the results of the Stakeholder Needs, Vertical Integration and Horizontal Integration activities into a common agenda, and makes the link with the proposed methodologies in activities 2.6 (Socio-economic model) and 2.8 (Support of SMEs). Major input came also from the activity 3.3 (Common Infrastructure) to define the technological priorities. In this Agenda, proposals are made for actions to improve the integration of ICT in the cultural heritage domain.

Due to the delayed start of the network, and due to an induced delay in the hiring of personnel at most partners, it was too early to come up with a first proposal for a Common Research Agenda at the VAST2004 conference. Therefore, a Research Agenda workshop was organised with invited experts, mostly from EPOCH, on February 17-18, 2005 in Leuven, Belgium. These experts were chosen to optimally to represent the different research directions and constituencies in the network. They provided valuable input on the priorities for the ICT research in cultural heritage.

The following experts were present at this workshop :

- Lon Addison, Univ. of California at Berkeley, USA
- David Arnold, University of Brighton, UK
- Andrea Caiti, University of Pisa, Italy
- Paolo Cignoni, ISTI – CNR, Italy
- Tullio Salmon Cinotti, Università di Bologna, Italy
- Achille Felicetti, PIN, Italy
- Franca Garzotto, Politecnico di Milano, Italy
- Guntram Geser, Salzburg Research Forschungsgesellschaft, Austria
- John Glauert, University of East Anglia, UK
- Torbjorn Johansson, The Interactive Institute, Sweden
- Consuelo Lozano Leon, CHEDI, Belgium
- Jean-Louis Luxen, CHEDI, Belgium
- Franco Niccolucci, PIN, Italy
- Irina Oberländer-Tarnoveanu, CIMEC, Romania
- Christian-Emil Ore, The University Museum Project, Norway
- Paolo Paolini, Politecnico di Milano, Italy
- Daniel Pletinckx, Ename Center, Belgium
- Giovanni Randazzo, University of Lugano, Switzerland
- Nick Ryan, University of Kent, UK
- Neil Silberman, Ename Center, Belgium
- Luc Van Gool, KU Leuven, Belgium and ETH Zürich, Switzerland

- Tijl Vereenooghe, KU Leuven, Belgium

After this workshop, several other specialists from ICOM, ICOMOS, ICCROM, UNESCO, English Heritage and AVICOM were contacted, which resulted in a global analysis of the research priorities for the EPOCH research scope, which is targeted at museums, monuments and sites (paragraph 3).

This report also contains the results of input from many EPOCH members concerning the technological priorities that are perceived (paragraph 4). This list was used to issue a member vote on priority and a call for the Newtons (New Tools that fill in parts of the EPOCH pipeline where there is still a lack of available tools).

As the results of the different activities within the Integrating Activities only became available at the end of year 1, it was not feasible to finalise the results per application domain for this document. This process however continues and will be finalised by the review of year 1.

This report also provides remarks on the standards issues and business aspects of EPOCH, and concludes with the position papers that were presented at the Research Agenda workshop.

3. Research Scope

In this chapter, the research scope of the EPOCH Network will be described and highlighted, with regard to the potential areas of concern and future directions of cultural heritage technologies utilized by museums, monuments, and sites.

3.1. Introduction

Museums, historical monuments, and sites have specific needs for the integration of cultural heritage technologies, since they serve both as centers of academic research and communication of cultural information and values to the public at large. Each type of cultural heritage institution has its own requirements and these requirements must be accommodated to the technological solutions and applications developed or analyzed by the EPOCH network.

The institutional differences are perhaps most evident in the field of academic research for each deals with information processing in a slightly different way. For museums, the primary requirement is efficient collections management and the access to comparative material on individual objects or artifact types. Historical monuments require a more geographical approach in the context of urban planning and spatial patterning, though access to comparative information on architectural styles, building techniques, and conservation methods is also necessary. Archaeological sites require primary attention to methods of field recording both stratigraphic and artifact based. In that sense, archaeological sites combine the problematics of both museums and historical sites in their need for both database and spatial information.

Public presentation issues are to a large extent shared by all three categories of cultural heritage sites. The primary research challenge is to offer public interpretation of cultural information and values to a wide range of audiences with different cultural and educational backgrounds. An additional challenge that is becoming evident as community groups and individual citizens are more extensively involved in the planning and execution of cultural heritage projects is the need for interactivity and the opportunity for public comment and feedback. Interpretive programs are now being required to be dynamic, rather than set-piece presentations. Research into the possibility of utilizing technology to establish and expand two-way communication between specialists and the general public is already evident as a high priority.

The new paradigm in the field of public heritage interpretation is precisely this distinction between traditional “presentation” efforts and more ambitious “interpretation” programmes”. “Presentation” denotes the carefully planned arrangement of information and physical access to a cultural heritage site, usually by scholars, design firms, and heritage professionals. As such, it is largely a one-way mode of communication. “Interpretation,” on the other hand, denotes the totality of activity, reflection, research, and creativity stimulated by a cultural heritage site. Although professionals and scholars play important roles in this process, the input and involvement of visitors, local and associated community groups, and other stakeholders of various ages and educational backgrounds is essential to transforming cultural heritage sites from static monuments into places and sources of learning and reflection about the past, as well as valuable resources for sustainable community development and intercultural and intergenerational dialogue.

In the next paragraphs, we will look in a very general way into the specific research goals for museums, monuments and sites, and complement this with general goals that

were derived from the stakeholder analysis. This document aims to give a general overview, so we do not repeat here details on stakeholder needs, technological opportunities or feedback from the showcase development, for which we refer to the respective documents.

3.2. Sites

The term "Sites" denotes all topographical areas and landscapes, the works of man or the combined works of nature and of man, including historic parks and gardens, which are of value from an archaeological, historical, aesthetic, ethnological or anthropological point of view.

We discuss here the specific needs of archaeological sites, of underwater archaeology, of cultural and natural landscapes, and of historic towns, regions, parks and gardens.

3.2.1. Archaeological sites

Archaeological sites are defined in this report as areas of ancient remains that have been uncovered in the course ongoing or completed excavations. Unexcavated sites are included in the more general description of historical landscapes. In the context of this report, archaeological sites can therefore take four forms :

- an excavation, which is a scientific study without public character
- an ongoing excavation with public character
- an archaeological park
- an indoor archaeological park

An excavation is scientific research and has clear scientific needs. These needs can be situated in the improvement and support of the recording phase and in the improvement of the structure and interoperability of the data through the use of the appropriate ontologies and standards. We will expand on this in the chapters on technology and standards.

An excavation assumes a public character when the archaeologists not only excavate, but also present their work to the general public. This can be the case for example in an urban context where ongoing excavations attract considerable public attention and efforts are made by the researchers or heritage authorities to provide information to the public about the reason, methods, and results of the work. In many cases, ongoing excavations can be unsuitable for guided visits for safety, security, or conservation factors, so alternative ways of presenting the site are needed. During the course of an excavation, the information to be presented is also continuously expanding as more data is collected and often general conclusions about the nature of the site and its historical-archaeological significance change as well. So specific ICT solutions are needed for presenting sites at distance (Pletinckx 2002), and for providing authoring systems where the archaeologists can easily update and change the content of public presentations (Pletinckx 2003), linked to the scientific data they have recorded.

An archaeological park is in most cases a finalised excavation where the archaeological remains have been stabilised, where the terrain is brought in a maintainable state (grass and gentle slopes for example) and where infrastructure is present to acquire the visitors. Specific needs here are solutions for outdoor presentation, and for better understanding of the remains. Outdoor presentation requires weather proof and vandalism resistant hardware, that has begun to be

commercially available only very recently. A better understanding of the remains can be realised through augmented reality systems, both in fixed or portable form (see Pletinckx 2000 and EPOCH showcase 1), where virtual reconstructions of the historical buildings are visualised in superimposition over the extant remains. Contextual multimedia is becoming an important development to improve the ease of use and the effectiveness of portable systems, also in museums (see position paper “The next challenge” : contextual multimedia” in the appendix).

A major element where ICT can bring major support is the conservation of the archaeological remains or even complete sites (for example caves with prehistoric rock art). In outdoor archaeological parks, the remains suffer major damage from weathering and uncontrolled growth of vegetation. Current technologies (see showcase 8) allow the virtual reconstruction of vulnerable parts of sites or complete sites, which can be made accessible through augmented reality, leaving the archaeological site buried or inaccessible to visitors. Good ways to present such virtual sites are still under development and are needed to improve the conservation status of fragile sites.

Although an indoor archaeological park is in essence a covered archaeological park, there are some major differences from outdoor archaeological parks. As the archaeological remains do not suffer from weathering, they can be shown in a much more original state. On the other hand, the indoor space sometimes poses problems of climate control and moisture that pose specific challenges to the conservation of excavated remains. The great advantage of indoor or covered archaeological parks is that they permit the combination of the functions of a museum with the functions of an archaeological site. ICT technology can provide new paradigms to structure such site-museums, and allow new ways of interpretation by the visitor.

Generally, for virtual reconstructions of archaeological sites, a methodology needs to be established to generate those reconstructions in a multidisciplinary way, validate them against the scientific data and knowledge, and store the reasoning behind the reconstruction together with the 3D model in a standardised way. An important aspect of this methodology is how to deal with uncertainty, in the modelling as well as in the rendering phase.

The interest of the visitor on the other hand not only goes to the buildings but certainly also to humans that once lived in it. A much debated aspect of virtual reconstructions are use of virtual humans to populate the reconstruction. Technically, there are many opportunities to generate and dress and animate these virtual humans, and make them behave in a believable way (see position paper “Presence and Believability in Cultural Heritage). However, cultural heritage specialists are often reluctant to use virtual humans due to the lack of evidence of personal modes of behavior and other uncertainties about customs, gestures, and modes of facial expression in ancient societies. Multidisciplinary research is needed to produce a methodology for using virtual humans that can be endorsed both by ICT and cultural heritage professionals.

Finally, a technology that is not frequently used, but has a great potential is sound. Sound not only can be very engaging, but is also cost-effective to use, install and maintain (based upon technology from the MP3 domain). Nevertheless, there are only a few specialists in sound design for archaeological sites and museums. Sound is definitely a technology that merits more research, product development and integration skills in cultural heritage.

3.2.2. Underwater Archaeology

The application of ICT (Information and Communication Technology) to the activities and problems of underwater archaeology is relatively recent and it has mainly emphasized the possibility of making new discoveries. Recent successful experiments have shown that, through unmanned equipment, it is possible to explore depths far beyond those usually reached by archaeological diving, and that this can lead to important, if not fundamental, discoveries (Ballard et al. 2002). Though certainly of scientific relevance, and also valuable from the point of view of fund-raising, this "treasure hunt" approach may anticipate another potential of ICT application to marine archaeology, namely the possibility of automating much of the field work required for the exploration of an underwater site, in order to greatly reduce the costs and safety risks associated with human participation in this operation. Although in itself less spectacular, this application is the one that may eventually have the greatest impact on archaeological research. Experiences and field examples of this second kind of application have been reported (Grand Ribaud 2002, Mindell 2004, Vettori et al. 2004). However, in most of these works, the technology in use has originally been developed for purposes different from those of underwater archaeology. Moreover, some of the equipment in use requires skilled engineers for its proper operation, and it has a cost still very significant and such to prevent its use from most of the archaeological research groups operating in the field.

The sequence of tasks needed in the investigation of a marine archaeological site can be distinguished as follows: search and localization; inspection; excavation and recovering; shore analysis (documentation, rendering, etc.).

Search and localization is mainly done by selecting a specific region on the basis of historical knowledge (e.g.: ancient shore-line, shipping routes, etc.) and surveying the region with acoustical and/or optical means. Acoustic data, as side-scan sonar images, are usually analyzed by experts, who are subject to stress and fatigue and may miss (as often documented) the indication of a site. However, it has to be remarked that this problem is shared by the marine archaeological community with all the other scientific and technological communities employing acoustic data for search and localization of objects on the sea-bed.

Inspection, i.e. systematic survey and photogrammetric documentation of a found archaeological site, is mainly done by divers; this is a potentially dangerous and time consuming operation, and it cannot be performed at depths beyond 60-70 meters, which are likely to be the most interesting from an archaeological perspective, due their preservation from the occasional diver and oceanographic/atmospheric turbulences. These operations may require a consistent effort in ICT development toward the goal of a fully automated inspection of the site; some examples on the use of underwater vehicles (ROVs – Remotely Operated Vehicles, AUVs – Autonomous Underwater Vehicles) in a semi-autonomous mode, carrying acoustic and photographic sensors, have been documented, but they are far from being an accepted standard practice. Acoustical imaging of buried artefacts of small dimension is of course desirable, also to guide the subsequent excavation and recording phase, but is apparently beyond the capability of any available commercial equipment.

Excavation and recovering operations are performed by knowledgeable and trained divers, with the same potential problems described as for the inspection phase. Also in this case, there has been documentation of few attempts to excavation and recovery with automatic equipment teleoperated from surface. The importance of high-

resolution acoustical sub-bottom imaging in this phase has already been mentioned in the previous paragraph.

Shore analysis activities employ procedures and tools that are similar, or at least closer, to those employed by land archaeologists in off-the-field work. A peculiar aspect, however, is related to the rendering to the public of the underwater site. A marine archaeological site is not visited underwater by anyone but the specialist: the fascination of the site, as well as the visual information that can be gathered by looking at the site before excavation and recovery, is mainly lost in traditional museum exhibits. A well-developed immersive environment capable to offer visitors the virtual experience of diving over an underwater site can be of very strong impact and become a consistent cultural pay-off of the application of ICT in cultural heritage.

3.2.3. Cultural and Natural Landscapes

The World Heritage Committee's definition of 'cultural landscape' includes organically evolved landscapes and associative cultural landscapes.

The organically evolved landscape is relict (or fossil) landscape which shows evidence of previous civilizations, with still very visible features such as prehistoric sites in the Sahara, or a continuing landscape, which retains an active social role in modern society and is linked to a traditional way of life.

The associative cultural landscape shows powerful religious, artistic or cultural associations with the natural element rather than material cultural evidence, which may be insignificant or even absent. Sacred groves for example, protected by religious taboos, are areas which have been preserved thanks to cultural practices. These areas, which are genetic reservoirs, help us to better understand biodiversity. So cultural practices protect the environment as well.

ICT can play several roles here. Innovative visualisation of landscapes from oblique or vertical aerial photography allows to see the evolution of landscapes through time (for example Vergauwen 2004), yielding a powerful interpretation of the forces that shape landscapes. Internet applications on the other hand can make sacred places not only accessible in a virtual way, hence preserving the place, but allow also the interested visitor to understand the importance of the place in a specific culture (for example Ayers Rock in Australia where local aboriginals collaborated to make a presentation system, explaining the meaning of different cult places at the Rock, Ogleby 2004). In these cases, it will be crucial to deal with the intangible heritage that is connected to the tangible heritage that is presented (at Ayers Rock, the rites and animistic belief of the aboriginals is linked to the rock art that is presented).

The UNESCO World Heritage Center also emphasizes Cultural and Natural Heritage Sites in a prominent location on its webpage :

“By regarding heritage as both cultural and natural, the Convention reminds us of the ways in which people interact with nature, and of the fundamental need to preserve the balance between the two.”

UNESCO has stressed the use of satellite imagery for monitoring World Heritage Sites. Actually, ESA has signed a contract with UNESCO to contribute substantially in form of satellite images to a project of Cultural Heritage in Central Africa. As we can see from the UNESCO World Heritage List, many recent additions can actually be classified as „Large Sites“, both in terms of culture and nature.

Worldwide there are strongly growing activities in the development and use of (high resolution) satellite and aerial imagery and aerial laserscanners for Cultural Heritage exploration, recording, documentation and monitoring (see position paper “Recording and Data Representation of large Cultural and Natural Heritage Sites”). Voting by the EPOCH membership has also shown major interest in “Large Cultural and Natural Heritage Sites”.

Data can come from satellites, aerial photography, model helicopter images and terrestrial laser scanners. However, improvements, integration and testing at the different stages of the data processing chain are necessary, especially for methods and software for automated and semi-automated processing of this data, ranging from the image data acquisition down to the administration of the processed data in a GIS and 3D visualization and animation. New paradigms of presentation and interpretation of large sites (for example the Geoglyphs of Nasca in Peru) need to be developed to make such sites accessible for a general audience.

3.2.4. Historic Towns, Regions, Parks and Gardens

Historic towns, regions, parks and gardens are places where a historical setting is still preserved, and where these places still have a function today, or in other words, these buildings and spaces are used in a modern context, and have inhabitants, owners and users.

Presentation technology in this context should not be conspicuous or invasive, but respect the local setting and people. Therefore, portable systems have advantages over fixed systems. There is a wide variety of PDA and mobile phone based systems that came on the market recently and seem to fit well for this functionality. Research projects have produced wearable systems that give information in an augmented reality way. Further research and product design is necessary to make these systems reliable and fit for use.

Another approach is the use of a central system that gives background information before sending the visitors out to explore the city or region (see Pletinckx 2004 and showcase 5). A central system is a very cost-effective solution as typically it will be indoor in a visitor centre or tourist office.

A major domain of research that can be useful in this area (but also for use in museums and on archaeological sites) is the use of contextual multimedia (see position paper “The next challenge : contextual multimedia”).

In the recording and modelling of historic towns, it is important to have efficient modelling techniques that can be used by non-technical heritage specialists. Research in this field is yielding very good results and will improve the cost-effectiveness and quality of such modelling significantly (see showcase 4 and position paper “EPOCH Future Research Directions”)

3.3. *Monuments and Groups of Buildings*

"Monuments" include all structures (together with their settings and pertinent fixtures and contents) which are of value from the historical, artistic, architectural, scientific or ethnological point of view. This definition shall include works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and all combinations of such features.

A "group of buildings" includes all groups of separate or connected buildings and their surroundings, whether urban or rural, which, because of their architecture, their homogeneity or their place in the landscape, are of value from the historical, artistic, scientific, social or ethnological point of view.

Today very little ICT technology is used in monuments. Nevertheless, specific opportunities are present to improve current methodologies or provide new approaches. Digital survey techniques, laser scanning and especially 3D from images (see showcase 8) are new and efficient ways to record architectural or construction elements of monuments, for use in restoration, conservation and public presentation. Techniques to reduce laser scan data to structural models still needs further research but are essential to the proper use of the created virtual models.

Presentation techniques in monuments need to take into account the (public) function of the monument. Many churches for example attract tourists but still have a religious function, which could conflict with the presentation function. Audioguides and PDA based solutions provide a good way to explore the monument as a single visitor. As many people visit monuments as a guided group, solutions need to be developed to allow groups to learn more about the monument.

3.4. Museums

The International Council of Museums (ICOM) definition of a museum is “a non-profit making, permanent institution in the service of society and of its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of man and his environment.”

The above definition of a museum should be applied to such institutions regardless of the nature of the governing body, the territorial character, the functional structure or the orientation of the collections of the institution concerned.

In addition to institutions designated as "museums" the following qualify as museums for the purposes of this definition:

- natural, archaeological and ethnographic monuments and sites and historical monuments and sites of a museum nature that acquire, conserve and communicate material evidence of people and their environment;
- institutions holding collections of and displaying live specimens of plants and animals, such as botanical and zoological gardens, aquaria and vivaria;
- science centres and planetaria;
- non-profit art exhibition galleries;
- nature reserves;
- international or national or regional or local museum organisations, ministries or departments or public agencies responsible for museums as per the definition given under this article;
- non-profit institutions or organisations undertaking conservation, research, education, training, documentation and other activities relating to museums and museology;

- cultural centres and other entities that facilitate the preservation, continuation and management of tangible or intangible heritage resources (living heritage and digital creative activity);
- such other institutions as the ICOM Executive Council, after seeking the advice of the Advisory Committee, considers as having some or all of the characteristics of a museum, or as supporting museums and professional museum personnel through museological research, education or training

Many technologies have the potential to be effectively integrated and utilised within a museum context. However, while audioguides and multimedia touchscreens have already been extensively adopted, more innovative technology can only be found in the larger museums or in the few places with substantial presentation budgets or where museum directors and curators are receptive to the adoption of new technologies.

The vast majority of the museums is reluctant to integrate technology for several reasons :

- in many cases, the heritage professionals are not involved in the choices and definition of the technology and its implementation, resulting in distrust and disappointment
- there is a definite lack of information on the opportunities and possibilities of museum technologies, no independent advice is available on specific innovative solutions for a specific museum (such as an architect is advising its customer when building a house)
- little information is available on the behaviour and needs of the museum visitor when using technologies, and on the fitness for use of specific technologies
- most current technologies still lack an open structure, are difficult to maintain or update and have a short life cycle
- most high-end technologies are simply too expensive for most museums, while basic technology does not get the attention it deserves from industry
- there is a clear lack of defined ethics of applying technology to cultural heritage

This situation can be improved by

- providing training and first-line consultancy for the museum management
- stimulating the industry to provide open solutions that are easy to update and maintain, and are cost-efficient, effective and reliable (see also position paper “Effectiveness of Interactive Applications for Cultural Heritage” in Appendix)
- stimulating the research to provide tools that are not technology-driven but solution-driven, based upon sound knowledge of the museum needs
- provide more research and testing of usability and accessibility (see also position paper “Accessibility and Usability for Cultural Heritage” in Appendix)

3.5. Stakeholder Needs

As the cultural heritage community becomes increasingly aware of the complex roles that CH sites play in contemporary society with regard to economic development, urban planning, heritage policy, education, and community identity, it is apparent that a wide range of stakeholder groups has an important role to play in the development of the field and the integration of CH technologies.

Within the context of the activities of the EPOCH Network, seven main stakeholder communities have been identified:

- National and Federal Administrations
- Cultural Heritage Sites, Museums and other Cultural Heritage
- Associated Communities
- Tourism
- Educational entities
- Technology

Among each of these main stakeholder communities, several sub-categories with specific needs in IT tools were identified. The specific needs of each stakeholder community were defined along the following steps in the conservation and management process of Cultural Heritage:

- Management
- Research (data collection, structure and analysis)
- Conservation/Preservation/Restoration
- Legal protection in relation with ICT
- Interpretation/Education
- Valorization (Enhancement of the values)

After defining the stakeholder needs for each stakeholder community the following preliminary conclusions can be formulated.

There is a clear gap between the ICT world and the Cultural Heritage world, both in knowing as in understanding each other. In most cases, there is even a clash of cultures, as most of the CH specialists have an education in humanities, while most ICT people have a background in exact or applied sciences or economics. In other words, CH specialists deal with uncertainty, while ICT specialists deal with certainty. The significant differences in financing, buying and decision making between both worlds are an additional issue.

More precisely, this means that ICT people have no knowledge of the highly regulated context of CH, so that technological developments lack accordance with international conventions and charters on cultural heritage. The activity 4.2 on Standards and Guidelines should pay attention to this issue and stimulate the creation of courses on this subject.

The key action that EPOCH should undertake is extensive training for both worlds. This has started already (for example, a CH course for technologists has already taken place in Ename in March 2005), but this should be intensified. Another important

channel for this kind of training has been defined by activity 2.8 where expertise centres will train and inform both CH decision makers and ICT SMEs.

An important part of this mutual comprehension is understanding the terminology used. Just as the HEREIN network has created a multilingual thesaurus of CH terms, EPOCH should investigate the creation of a similar thesaurus on technological terms plus the integration of existing CH thesauri.

Closely linked to this mutual comprehension is also the understanding and quantifying the socio-economic impact. Activity 2.6 will provide know how and models to do this, which in its turn should create a better understanding between the ICT and CH world. In this, the social aspect and involvement of people is important, so EPOCH should investigate the integration of “social software” that is available in other sectors.

Another high priority aspect is the quality and fitness for use. Cultural heritage needs ICT that can be easily implemented, that is effective and has a high usability and that can be maintained and upgraded easily to ensure a long life cycle. Independence of the technology provider (for example by using OpenSource software) and the ability to have systems created by the content specialist will yield significantly lower costs and higher quality of the data, as transfers of data and knowledge can be avoided. The new Sector Watch activity (2.1) that will start in the second year will deal with these issues and find the optimal match between stakeholder needs and available or emerging technologies. Also benchmarking, where the same problem is solved through different workflows or applications, should be a part of the EPOCH activities.

The best way to convey this complex information to the CH community is through the use of examples. The showcases, which have been developed under Activity 2.4 certainly have this goal, but the complete EPOCH pipeline should be disseminated through examples to the CH community. The Newtons (new tools) that will be developed from year 2 onwards, and are new building blocks within the EPOCH pipeline, have budgets allocated to generate these examples, and budgets are foreseen to disseminate this.

A general problem that is also of significant importance in CH is the data life cycle. Digital data in CH represents in most cases unique information, and being unable to not use specific data anymore in future generations is to be considered as a key problem and reason for not adopting digital technologies (especially within a world that has long standing traditions and methods to safeguard objects and its data). Therefore it must be a key objective of the Standards activity (A4.2) to provide workflows to bring data into standard formats that have a long life cycle and wide acceptance, but also to provide long term methodologies to migrate data through the life cycle of a platform, or from one platform to another, without loss or compromise.

CH professionals also warn that major paper archives get lost for the moment. Efforts to save and digitise these archives are most welcome. Optical character recognition for old letter types and semi-automatic transfer to databases (see showcase 7) are needed to do this.

The cultural heritage domain is presently a very fragmented sector. This means that information, from recording up to the use in public presentation or publication, goes through a significant number of steps. A major goal of EPOCH is to provide a streamlined pipeline, in which data can ripple through. It is an important factor of integration to create a pipeline process that can be implemented within the involved

partners, in a bottom-up approach starting with data collection and processing. Next to the technical aspects of identifying, creating, interfacing and optimising the multiple part of this pipeline, we need to disseminate this pipeline process, its characteristics, advantages and implementation towards the CH professionals and companies active in CH, and ensure that the pipeline applications are well supported and maintained by research institutes or companies.

Also, the CH professionals need to be able to discuss the pipeline and give input to its structure, goal and development. To quote a participant at the Research Agenda workshop : “it’s not about the fastest Ferrari, but about where the Ferrari is driving to”.

EPOCH has the intention to create structures to continue the Sector Watch (A2.1) and SME support (A2.8) activities after the funding period. A proposed structure is a Network of Expertise Centres (NoEC) with linked clusters of CH companies. The SME Support activity will start the creation of this NoEC from year 2 onwards and search for funding on national and European level to continue this NoEC beyond EPOCH. Further research is needed to find out if the Sector Watch activity and the support of the EPOCH pipeline can also be continued within the NoEC or if separate structures are needed for this.

Finally, EPOCH needs not only to integrate the ICT and CH world, but also provide the link with the other stakeholders such as National and Federal Administrations, Associated Communities and Educational entities.

3.6. Conclusion

The research into the future development and integration of CH technologies must take into account different types of sites and institutions as well as the primary needs of both academic research and communication with the general public. The ongoing work of the EPOCH network has begun to highlight specific solutions to research needs of data collection and access in museums, historic monuments, and in archaeological sites, both terrestrial and underwater. Through the development of new research tools, some of the most pressing needs of excavation, analysis, and conservation can be addressed.

In the area of public presentation, CH technologies offer some far-reaching advances in the visualization and explanation of the complexities of past societies. In addition, the needs of various groups of stakeholders in the planning and execution of sustainable public presentation programs can be effectively addressed through the development and integration of CH technologies.

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4. Technologies

4.1. *Introduction*

This paragraph provides technological priorities for the development of tools and systems for the cultural heritage sector, structured into the eight technological domains that are present in the Common Infrastructure activity. The order of the domains more or less represents the EPOCH pipeline.

Within each domain, a list of technological issues is presented together with a brief description. From the membership voting, we tried to derive a timing definition for each research item. As the membership could vote for Newton (implementation within 1 to 2 years), Common Infrastructure (implementation within 3 years) or Future Research (implementation in the future), we reinterpreted this in terms of research priority.

4.2. *Recording / data representation*

4.2.1. **3D file format compendium:**

To resolve the issue of lacking suitable 3D file format standards by

- collecting existing file formats supported by most tools (.dxf, .3ds, VRML),
- setting up recommendations for using them, and
- to define requirements for an open 3D file format for CH.

This research item is considered to be a medium term research priority by the EPOCH membership voting.

4.2.2. **Versatile 3D acquisition:**

3D scanning apparatus that

- is portable and hence can be brought to the objects,
- that can deal with a wide variety of object shapes and surface types,
- that captures both the shape and the reflectance characteristics, and
- that shows at least preliminary results during scanning, in order to assess data completeness and quality during acquisition, instead of after leaving the site when imperfections are hard or expensive to remedy.

Moreover, 3D patches or point clouds obtained from multiple scans ought to be registered and integrated automatically. Tools are needed to derive structure from scans.

This research item is considered to be a short term research priority by the EPOCH membership voting.

4.2.3. **Underwater data collection and photogrammetry:**

Underwater archaeology often is cumbersome or even impossible to carry out with divers, e.g. at depths larger than 60 meters. Use of fully or semi-automated techniques, through ROVs/AUVs (Remotely Operated/ Autonomous Underwater

Vehicles) still is in need of streamlining: guaranteeing data quality through stabilisation of position and altitude, data fusion of positioning sensors for better control, self-calibrating and automated photogrammetry, integration of acoustic and optical georeferenced imagery, and sub-bottom measurements.

This research item is considered to be a short term research priority by the EPOCH membership voting.

4.2.4. Recording of archaeological excavations:

Integrated functionalities: on-site input bringing in of finds (incl. photographs and videos) as well as metadata. Should preferentially also work on PDAs, should support coupling to D-GPS and Total Station, and should provide the integration with maps, GIS layers, 3D stratigraphy, and geophysical data. The tool should support parallel use by multiple users (data update in central repository) and annotations / additions of metadata in standard CIDOC-CRM format.

This research item is considered to be a short term research priority by the EPOCH membership voting.

4.2.5. Large Cultural and Natural Heritage Sites

Since UNESCO has lately addressed several times the importance of "Large Cultural and Natural Heritage Sites" it is proposed that we also deal with this issue. This must touch the data acquisition and the visualization phases. Data acquisition with aerial imagery (see also the very new digital aerial cameras based on CCD technology) and very high resolution space images (Quickbird with 60 cm pixel size) have here a very high potential. On the visualization side we face big problems with good quality real-time rendering of large datasets (> 1GB). It is proposed that this also be addressed in the research priorities.

This research item is considered to be a medium to long term research priority by the EPOCH membership voting.

4.3. *Databases / knowledge management*

4.3.1. Link repository for 3D primary data:

To set up a web portal with a reference (link) database for publishing captured 3D datasets as a central resource

- to permit searching based on metadata and/or shape,
- to permit browsing based on thumbnail models/images, and
- to link to the 'true' repository that actually holds the primary data.

The portal should also assure the quality of the published 3D data. Here, the issues of resolution, accuracy and fitness for use need to be taken into account. We need tools that store/assess the accuracy of the 3D data (including texture) and indicate if data can be used for a certain purpose, and reduce the accuracy of the data to fit with the purpose, while maintaining the link with the original data.

This research item is considered to be a medium term research priority by the EPOCH membership voting.

4.3.2. Multi-modal data retrieval:

Current retrieval approaches strongly focus on text, but

- other sources should be used in combination. Examples are image content, 3D model shapes, and spoken language on audio reels, and
- search possibilities should take CH ontologies into account. This includes bridging the infamous ‘semantic gap’.

There was no clear timing for the priority of this research item by the EPOCH membership voting, so it can be considered as medium term.

4.3.3. Semi-automated mapping to CIDOC:

There is a need for semi-automated tools that map data from existing databases to CIDOC, and that make the search of tools like those developed in Showcase 7 more usable - i.e. parametric, according to the above mapping system. Such tool would improve the usability of CIDOC-CRM itself. The tool must adapt to diverse cases, such as

- museum collections (well dealt with by the current CIDOC-CRM)
- archaeological sites (currently with a variable goodness of fit and with some flaws)
- monuments (much work to do)
- landscape (nothing available).

There was no clear timing for the priority of this research item by the EPOCH membership voting, so it can be considered as medium term.

4.3.4. Integrity management

If scientific data is used to create CH presentations, there should be a way to keep a link between the presentation data (for example a 3D model) and the scientific data to document the interpretation process and the data used in this process. There should also be a way to indicate where update of the interpretation process is needed if additional or contradictory scientific data becomes available. Integrity management probably is needed throughout the complete pipeline.

This research item is considered to be a medium to long term research priority by the EPOCH membership voting.

4.3.5. Two way communication

We need tools to allow users to add their ideas/views to a heritage database, so that these reactions are seen as part of the database. It is important that the users consider heritage as their heritage, and that they feel integrated. It also can be a useful tool to make people discuss their heritage as a community (also very useful for schools to create collaborative environments over the Internet to discuss/explore heritage)

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.3.6. Internet portals based on distributed systems

We need tools to integrate museums, sites and monuments into larger representations on the Internet. This can be useful to integrate museums, sites, and monuments in thematic clusters and have a common representation on the Internet, but also to create cultural routes. The technical aspects are in having the Internet superstructure updated automatically from the local databases that can be quite different

This research item is considered to be a short to medium term research priority by the EPOCH membership voting.

4.4. *Multi-lingual / semantic data processing*

4.4.1. Tools for conversion of existing catalogues

The advent of the CIDOC-CRM provides a potentially common ontological basis for disparate current digital catalogues. However manual conversion is extremely labour intensive. This area would investigate the use of metalanguage to describe common features in catalogues and use the metalanguage as a basis for automatic production of tools to assist catalogue conversion.

This research item is considered to be a medium to long term research priority by the EPOCH membership voting.

4.4.2. Multilingual systems for collection interrogation

Common ontologies record more information than unstructured language descriptions in language independent structures. This will assist the production of natural language responses to interrogations of collections descriptions and avoid some of the difficulties of translation between languages.

These tools would seek to address the production of responses in a range of EC official languages.

This research item is considered to be a medium term research priority by the EPOCH membership voting.

4.4.3. Characteristics of engaging stories:

As the Digicult quote notes there is a need for a sense of engagement in storytelling in order to create demand for the digitised collections and the knowledge of the artefacts, etc. This area of work would be to conduct experiments on particular experiences and through comparison of usability and engagement to produce tools to attempt to assess the likely engagement of alternative ways of conveying particular experiences. The aspect of target audience should be taken into account : engagement is different for a child and a tourist for example. This area of work should produce guidelines and tools to translate scientific data into engaging stories and experiences. Tools should be available to measure engagement and learning

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.5. Mobile / wearable / ambient systems

4.5.1. Contextual cultural information:

With the use of mobile devices, there is a need for much stronger contextual frameworks. Personal access to CH which is aware of what people are looking at (local context), but also what is popular among similar users, i.e. what my user profile is and what the behaviours of different user groups are, as well as what I have seen before and where (global context). Furthermore, there would need to be shift from predominantly single-user applications to cooperative situations.

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.5.2. Mobile applications from data capture to public dissemination:

A common, standards-based infrastructure for smart CH environments to support all stages from data capture through to public dissemination. At the capture end, enable existing prototype mobile data capture and information delivery tools to inter-operate with desktop and server-based recording systems in networked smart environments. Tool and environment support for information access and process recording throughout the conservation, analysis, interpretation and general management processes at CH sites, museums and other institutions: tools to support consultation and annotation of records anywhere, at any time, through to sensor networks for monitoring the condition of materials, structures, etc. At the dissemination end: tools to support the implementation of mobile visitor systems, integrated with parallel efforts aimed at more static systems, kiosks, etc.

There was no clear timing for the priority of this research item by the EPOCH membership voting, so it can be considered as medium term.

4.5.3. Supportive measures:

On top of being integrated within the Common Infrastructure, multimedia contents need to be understandable, adaptable to multiple channels, and configurable to meet the variety of user needs and profiles. To this end, the research should also concentrate on:

- mobile user needs (data integrity should be included, if data changes in the pipeline, it should propagate towards the presentation application of the mobile device, or at least warn that updating is needed)
- conceptualization of the mobile communication process and access method
- interdisciplinarity required to manage and deliver heterogeneous media formats
- management of cultural objects complexity along the entire Common Infrastructure pipeline
- creating paradigms to allow the user to give feedback on the content (user appreciation, user input, feedback for educational purposes for schools, ...)

In this context, a toolbox needs to be developed with

- tools for *data import/export on mobile devices*, and more generally, for heterogeneous data interchange to support the flow of data along the entire pipeline in any situation where a mobile device is involved;
- tools for *data customization and presentation* according to the technical requirements and constraints of mobile devices (production templates, coding, and annotation of multimedia contents);
- tools for information authoring via mobile devices (e.g., production templates for on site data input, annotation functionality, etc.);
- *accessibility tools* that improve the accessibility of a mobile application for special needs, e.g., transforming the textual output into audio output (the so called ‘screen readers’);
- *input tools* to support alternative input paradigms, e.g., voice as input channel for application control and data entry. (These tools can also be regarded as accessibility tools, for example voice input is a requirement for visually unpaired people)

This research item is considered to be a medium to long term research priority by the EPOCH membership voting.

4.6. Visualisation / rendering

4.6.1. Unified framework for 3D applications:

To define a standard at the application level that bridges the gap between research and use of innovative visualisation techniques. Key is an extensible framework such as a scene graph engine that permits to integrate viewers for different 3D data formats into the same 3D application.

This research item is considered to be a medium to long term research priority by the EPOCH membership voting.

4.6.2. Authoring tools for 3D experiences:

To come up with an easy-to-use toolkit to create 3D multimedia presentations and good-looking 3D exhibitions, e.g. in museums. Target users for the authoring application are museum curators and CH professionals, whereas the user community for the virtual worlds is the public. Only secondary focus should be the Internet delivery of CH experiences. The tools should support the visualisation of sites as they evolved over time, and with a possibility to distinguish between fact, interpretation and hypothesis.

This research item is considered to be a short term research priority by the EPOCH membership voting.

4.6.3. Real-time underwater experience:

Realistic experiences of underwater sites have so far been off-line and non-interactive. New tools should provide graphical representations of marine life, sea-bed features, underwater visibility and illumination effects, and audio effects. Other modalities should preferably be added or other VR tools used, in order to reinforce the feeling of immersion.

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.6.4. Web tool for joint experiences:

A web tool to build multi-user cooperation mechanisms in 2D and 3D multimedia content spaces. The system should be flexible, modular, and scalable. Developers should be able to build their own 3D cooperative applications in CH by reusing and adapting a set of existing modules, middleware structures, interaction and communication tools, and templates of 3D virtual spaces. An example would be a visit to a virtual museum, while exchanging information and opinions with the (avatars of) other visitors, and interacting with virtual exhibits, like operating a CAD model of some old apparatus in an industrial archeology setting. Visitors see the same 3D space, and what other users are doing. Good paradigms should be available to have interaction with 3D as a group (e.g. a family or group of friends to give the use of such 3D environments a social dimension. Issues of the choice of 3D description and visualisation formats and tools will need to be carefully considered, and so should issues of sharing the same space, authorisation, load distribution,

This research item is considered to be a short term research priority by the EPOCH membership voting.

4.7. Multi-modal interfaces

4.7.1. Human -Idea -Thing Interaction:

Interaction can be given an extra dimension by integrating powerful agent based simulation techniques for complex adaptive systems, wireless communication and new sensor technology. By that we can extend traditional Human-Computer Interaction and Human-Machine Interaction to Human Idea - Thing Interaction (HITI). ‘Thing’ stands for all kinds of stationary and mobile physical artifacts equipped or integrated with information technology. ‘Idea’ represents information in various forms such as numbers, texts, pictures, emotions, sounds, simulations that is captured, stored, presented, processed and transmitted with the help of information technology.

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.7.2. Emergent interaction

How can we create multimodal interfaces that

- allow for emergent interaction, i.e. the system responds adaptively to the visitors’ behaviour and emotions, allows ‘what if?’ scenarios’,
- support interactive multimodal communication with agent driven ‘intelligent’ virtual humans responding with emergent adaptive behaviour, and
- pick up a visitor’s emotions, joy, enthusiasm, frustration, contentment, annoyance, rage, etc.

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.8. Virtual humans / avatars

4.8.1. Populating 3D Environments

It is useful to add interest to 3D presentations of objects or sites using avatars, but this involves further expense and generally relies on bespoke tools. EPOCH is developing standards for representing 3D models and for attaching rich metadata to support a range of presentations of models and enquiries about them. New tools would make it possible to render the 3D models in an environment where avatars, acting in response to the model metadata, could add interest and realism. Further, avatars could provide interactive guides that would respond to the visitor according to their language, interests, and past experience. An application of the tools would be automatic generation of populated environments as prototyped in Showcase 4.

There was no clear timing for the priority of this research item by the EPOCH membership voting, so it can be considered as medium term.

4.8.2. Avatar Standards for CH

Just as standards are required for representing 3D models of CH assets, to encourage reuse, so it is desirable to employ standards for avatar definition and animation parameters or even avatar behaviour. Some commercial formats are proprietary and inadequate for detailed animation of manual gestures. Formats, including MPEG-4 FBA are avatar-specific. Work is needed not only on use of existing formats and tools but also in the development of formats that handle CH metadata. In order to achieve maximum reuse of resources, it will be highly desirable that motion files will be usable with a range of avatars. This will require the ability to retarget captured or keyframed motion, or to synthesise motion for a specific avatar definition. The aim of the new tools would be in conversion between formats, preserving CH metadata, so that existing commercial and open source tools could be used to process avatars in the EPOCH pipeline.

This research item is considered to be a medium to long term research priority by the EPOCH membership voting.

4.8.3. Avatar Development Tools

Avatars and their associated motion files are generally developed for a specific application. It is envisaged that EPOCH applications will have some common requirements for using avatars. To develop compatible avatars, it may not be enough to provide methods for linking authoring tools, since it is often necessary to return to an earlier stage in the development pipeline, thus losing detailed work further on. New tools would either provide a complete open source system for developing EPOCH avatars, importing simple avatars from other tools, or would provide a system for merging changes made during different stages of development.

There was no clear timing for the priority of this research item by the EPOCH membership voting, so it can be considered as medium term.

4.8.4. Mobile Avatar Platform

A benefit of using avatars as opposed to video for presentation of information is that animation data can be considerably more compact than video. The user has control of the presentation style and animation can be generated interactively. However, processing and memory resources on mobile platforms tend to be tuned for video and

not always sufficient for full 3D animation. In order to make avatars available on mobile platforms it would be desirable to track the development of devices and available multimedia tools. If available platforms are adequate, then new tools would be developed to transfer avatar animation specified in EPOCH formats to such platforms. Otherwise investigation would be made of the feasibility of porting existing avatar players to mobile devices.

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.8.5. Scripting avatar behaviour

The value added to EPOCH presentations by the use of avatars will depend on the avatars exhibiting realistic behaviour. It will be important that scripts can be generated in response to metadata about EPOCH sites and objects. This will require a sufficient repertoire of moves, gestures, and mouth movements for speech, along with avatars that are able to perform the repertoire. Several EPOCH partners have developed XML-based notations for scripting dialogues and avatar movement. New tools would combine these notations into a common framework for use in the EPOCH infrastructure, along with at least one reference implementation. Such a notation will have wider application outside the CH area.

This research item is considered to be a long term research priority by the EPOCH membership voting.

4.9. Games and Edutainment

The games and edutainment sector has in recent years become a massive industry sector, touching the lives of many people and engaging them in their leisure and spare-time interests. This sector concentrates on products for the home with an increasing use of role-playing game scenarios, many of which are educational as well as entertaining. To make the technologies work at low cost they have adopted specialist hardware solutions and development environments, and the industry relies completely on ensuring that products engage the interest of the consumer. This means the industry is experienced in storytelling, in effective user interface design and in usability testing. It is therefore proposed that an eighth area of technology is explicitly added to the existing seven areas in EPOCH in order to make more explicit the need to investigate the implications for Intelligent Cultural Heritage of developments in games/edutainment.

This research item is considered to be a long term research priority by the EPOCH membership voting.

5. Standards and Business Aspects

5.1. Standards, Guidelines and Policies

Under this definition, EPOCH includes three different sub-areas:

- documentation standards,
- technical standards, defining particular ICT functionality, and
- methodological standards, providing frameworks to address issues such as quality control in the design process and compliancy with international regulations such as the Ename Charter.

Documentation standards have been the focus of year 1 activity, to discover – not suprisingly – that much work is indeed required in this direction. Even if CIDOC-CRM is being considered as THE standard for archaeological and museum documentation, backed by ISO approval as a recommendation and the forthcoming acknowledgement as ISO standard, acceptance by professionals and antiquity authorities is still to be fully achieved. They are possibly afraid of the need of restructuring their information systems, and discouraged by the necessity of adapting it to a theoretical, and in fact rather technical, model. In this direction EPOCH may have a substantial impact by providing tools for the mapping of existing national documentation standards or widely accepted de facto standards (as the Italian ICCD documentation regulations, the Dutch Archaeology Quality Standards KNA, the English Heritage documentation system, etc.) to CIDOC-CRM, and envisaging conversion from one system to another.

This activity will require the co-operation of researchers, professionals and decision makers but is also a powerful attraction factor for national antiquity authorities as proven by the requests to join EPOCH submitted by some of them and the increasing involvement in the Network's activity by the already present ones.

To date, **technical standards** have been dealt with in EPOCH at an introductory/tutorial level. It is apparent also for this sub-area that a more substantial commitment is necessary in EPOCH's future activity. Agreement on common technical standards is a pre-condition for effective integration of work done by different partners, and for the usability of such work by other partners of the network and in general by users outside it. As the release of EPOCH products under an Open Source licensing scheme is a foundation of the Network's mission, preference of public standard formats to proprietary ones is of course a priority. Research in this sub-area will therefore consist of surveying – selecting – tutoring about open technical standards deemed as such, or more generally accepted, or most suitable for our purpose.

The **methodological standards** sub-area concerns both general principles about cultural communication and their implementation, and general usability and accessibility issues for cultural IT applications.

The former is the application area addressed by the Ename Charter (see www.enamecharter.org). This document, dealing with general principles of public heritage interpretation is getting increasing support by museum organizations throughout the world and is dictating good practice rules to a substantial number of applications. Its main areas of concern—including accessibility, documentation of

information sources, inclusiveness of interpretation, and sustainability of interpretive programmes and infrastructure are of particular importance to the further development of cultural heritage technologies as effective communication tools for education and for the public at large. This initiative is being carried out with the cooperation of ICOMOS international and offers an opportunity for integrating general heritage policy concerns with the specific needs of the technology sector. Further work on the Ename Charter within EPOCH will consist of training courses, specialised workshops to deal with the particular problematics of technology-based interpretation, and supporting the partners' activity to promote the charter's main aims. A possible additional activity will be to develop and publish guidelines for its implementation, based on the feedback and needs of the members of the EPOCH Network.

Usability and *design* are more technical issues within the methodology sub-area of standards. Here the need consists in applying existing techniques for optimal interface design to the peculiar exigences of cultural communication. The production of guidelines, templates and a benchmarking/evaluation system for cultural applications is EPOCH's ultimate goal.

Finally, *accessibility* for all belongs to this sub-area as well. EPOCH's activity will consist here in providing guidelines for the implementation of accessibility standards within cultural applications. The selection of such standards for users with special needs is part of this commitment, which may require also their integration with additional features determined by the peculiarity of the heritage applications.

5.2. **Business Aspects**

The Cultural Heritage business – or at least that part that is involved in ICT – is a quite young and emerging business. In dealing with the CH domain, this business has major hurdles to take. Customers are nearly always local or regional authorities, museum or site managers, or educational specialists, who lack in most cases technological background and have no experience in dealing with ICT business and its codes of practice. CH professionals – most of them having a education in humanities – have a completely different “business culture” than ICT professionals, which is reflected in significant differences in financing, buying and decision making.

All these elements make that most ICT related companies, that are active in Cultural Heritage, do not consider this domain as their core business or still have significant pioneering characteristics. In other words, nearly all companies that have some degree of specialisation in cultural heritage are SMEs. Nearly all of these SMEs consider this market as an extra outlet on top of other markets that are core activities. For example, multimedia companies use their know how to provide multimedia solutions for museums, monuments and sites, or companies that provide outdoor installations also offer services to design CH presentation kiosks. The downside of this approach is that the specific needs of the CH domain are met only partially, causing frustration with the user and the CH responsible. Nevertheless, these SMEs are the thriving force behind the integration of ICT technologies in museums, monuments and sites.

The above mentioned profile of the CH market, combined with the pioneer characteristics of most ICT companies active in this market, defines already clearly the problems to tackle :

- **insufficient innovation support** : most of these SMEs take on the burden of providing innovation on top of their normal business. Although the financing

rules have improved in the 6FP, the overall conditions of European projects are still far from optimal to support these innovation activities

- **different business characteristics** : most companies active in ICT have severe problems in getting a good grip on the CH marketplace, that is characterised in some cases by long lead times, complex and ill defined tenders, political influence and untransparent decision processes
- **lack of knowledge** : CH customers sometimes compensate the lack of technical and conceptual knowledge in the ICT domain by using the ICT companies as free consultants (a frequently heard complaint is that many offers are never rewarded by tendering or commissioning a project)
- **lack of focus** : because the rentability of CH related business is low (or even negative) due to the here mentioned problems, most companies are obliged to take on other business. This diminishes their focus on the CH business, which is already complex and difficult in nature

For EPOCH to have a lasting effect on the Cultural Heritage sector, it is necessary to establish a mature layer of businesses that is delivering CH projects that

- fit with all needs (including usability)
- are cost-efficient and effective
- comply with policies and guidelines (including accessibility)
- have a long life-cycle (open, easy to maintain and update)
- are state-of-the-art (use the best technology and methodology available)

The activity “Encouragement of SME Involvement” (A2.8) has proposed a two level network structure to provide solutions to the above mentioned problems and fulfill the stated prerequisites. Seven partners in the network have expressed interest to join this Network of Expertise Centres and the new JPA has provided the appropriate financial resources to start up this network and find funding to establish this network on permanent basis.

6. Appendix : Position Papers

In this appendix, we provide position papers that were presented at the Research Agenda workshop:

- “Presence and Believability in Cultural Heritage”, MIRALab, University of Geneva, Geneva, Switzerland & VRLab, EPFL, Lausanne, Switzerland
- “EPOCH Future Research Directions”, Institut für Computergraphik, TU Braunschweig, Germany
- “Effectiveness of Interactive Applications for Cultural Heritage”, Hypermedia Open Center, Polytecnico di Milano, Italy & TECLAB, University of Italian Switzerland, Switzerland & Istituto per I Beni Culturali dell’Emilia Romagna, Italy
- “Accessibility and Usability for Cultural Heritage”, Hypermedia Open Center, Polytecnico di Milano, Italy & TECLAB, University of Italian Switzerland, Switzerland & Istituto per I Beni Culturali dell’Emilia Romagna, Italy
- “Recording and Data Representation of Large Cultural and Natural Heritage Sites”, Institute of Geodesy and Photogrammetry, ETH Zürich, Switzerland
- “Workflow Manager and Quality Certification System (QCS)”, Oxford ArchDigital, UK
- “The Next Challenge : Contextual Multimedia”, University of Bologna, Italy
- “Priorities for Monuments, Sites and Museums”, CHEDI, Belgium

Presence and Believability in Cultural Heritage

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ABSTRACT

Virtual Cultural Heritage in conjunction with Mixed Realities and their concept of cyber-real space interplay invoke such interactive digital narratives that promote new patterns of believability and presence. Believability is a term used to measure the level of realism in the interactive MR environments. Presence is defined as the measure that is used to convey the feeling of 'being there'. A storytelling case study is used as an example for illustrating the effects of introduction of real-time virtual characters in cultural heritage sites. Although presence is strengthened, believability is not keeping its pace, due to limited interaction between the real participants and the virtual characters, as part of limitations of mobile technology. We argue that future steps in Mixed Reality Enabling technologies should cater for enhanced social awareness of the virtual humans to the real world and new channels for interactivity between the real users and virtual actors. Only then the believability factor of virtuality structures will be enhanced and allow for compelling real experiences through virtual environments.

CR Categories and Subject Descriptors: Artificial, augmented, and virtual realities, Animation, Three-Dimensional Graphics and Realism, Visualization techniques and methodologies

Additional Keywords: Believability, Presence, Mixed Reality

1 INTRODUCTION

Mixed Realities [1] and their concept of cyber-real space interplay invoke such interactive digital narratives that promote new patterns of believability and presence. However, the "narrative" part, which refers to a set of events happening during a certain period of time and providing aesthetic, dramaturgical and emotional elements, objects and attitudes [2], [3] is still an early topic of research. Mixing such aesthetic ambiances with virtual character augmentations [4] and adding dramatic tension has developed very recently these narrative patterns into an exciting new edutainment medium [5]. Since recently, AR Systems had various difficulties to manage such a time-travel in a fully interactive manner, due to hardware & software complexities in AR 'Enabling Technologies' [6]. Generally the setup of such systems was only operational in specific places (indoors-outdoors) or with specific objects which were used for training purposes rendering them not easily applicable in different sites. Furthermore, almost none of these systems feature full real-time virtual human simulation. With our approach, based on an efficient real-time tracking system, which require only a small pre-recorded sequence as a database, we can setup the AR experience with animated virtual humans anywhere, quickly. With the interplay of a modern real-time framework for integrated interactive virtual character simulation, we can enhance the experience with full virtual character simulations, as depicted from our Pompeii case study in *Fig. 1*. Even if the environmental conditions are drastically altered, thus causing problems for the real-time camera tracker, we can re-train the camera tracker to allow it to continue its operation.

In the following sections we will be taking as example our mixed reality simulation and subsequently discuss the issues it raises in terms of Believability [13] and Presence [14]. Our premise is that these two factors are essential for enabling real

experiences through virtual heritage environments. However, taking into its limits current hardware MR enabling technologies as well as virtual human simulation storytelling frameworks, we were able to enhance Presence but not Believability in equal terms (with respect to previous mobile MR experiences), according to qualitative user tests performed during the described demonstrations. In the final section we propose new ways to ameliorate this shortcoming for the next, new generation of believable virtual heritage simulations.



Fig. 1. Example of mixed reality animated characters acting a storytelling drama on the site of ancient Pompeii (view from the mobile AR-life system i-glasses)

2 DEMONSTRATION AND RESULTS

2.1 Pompeii and the thermopolium of Vetutius Placidus trial

With the help of the Superintendence of Pompeii [12], who provided us with all necessary archaeological and historical information, we have selected the 'thermopolium' (tavern) of Vetutius Placidus and we contacted our experiments there. The results are depicted in the following *Fig. 2*, *Fig. 3* where the technologies [7] employed for simulating and authoring our virtual humans in augmented and virtual heritage sites are already described in [11].

3 DISCUSSION AND FUTURE THOUGHTS

The main scenario of our Mixed Reality simulation involved 5 virtual historical characters (Vetutius, Celer, Ascla, Specula and Lucius) re-enacting a short story based on a scenario created by the archaeologists of [12]. The scenario involved dialogues between the 5 characters, object manipulation, virtual human body and cloth animation and facial expressions according to each individual personality and emotions. The user has the ability in a wearable mobile manner to modify his position and orientation within the designated area and witness non-invasively the historical representation of ancient life.

Especially this representation constitutes one of the main limitations for presence and believability of such a complex simulation:

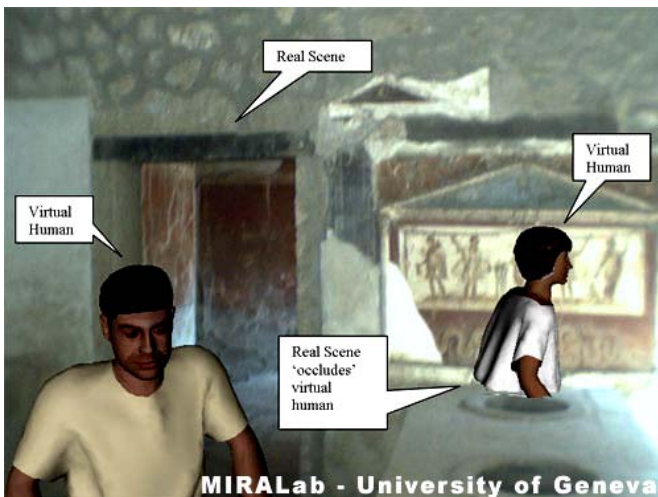


Fig. 2 Real-time virtual Pompeian characters in the real site of the Pompeian thermopolium. Note the use of geometry 'occluders' that allow part of the real scene to occlude part of the virtual human

- There is no social awareness of the virtual world to the real; i.e. the virtual humans do not notice the real ones
- There is no interaction between the real participants and the virtual characters, although such an approach was chosen in order to avoid 'Disney like' reconstructions.
- There is no common view/sharing amongst multiple real users of the same mixed reality experience; instead it is fully individualized according to each wearable device and thus each user witnesses the same scene in different timing than the co-participant.
- Although the geometrical registration of the virtual characters on the real scene is satisfactory solved, there is no photometric 'illumination registration'. Thus the lighting of the virtual humans is inconsistent of the one from the real environment.

Our belief is that Mobile MR can be a better vision for the future of cultural heritage simulations if the above shortcomings are met so that both notions of believability as well as presence can be reinforced.



Fig. 3. Further examples of mixed reality animated characters. In this example part of the geometrical structure of the 'thermopolium' is also reconstructed and another example of object manipulation is shown. A real human is also present in this MR scene.

So far, previous approaches regarded believability as related more closely with the platonic notion of inversed world of senses – ideas respectively used to represent the virtual-real world. In that representation, believable is what imitates reality (ideal) whereas actual MR experience is paralleled to the flawed sensual world. We believe that further synergies between Semiotics of Presence and Hermeneutical Phenomenology will help to establish a theoretical framework of the 'signs' of Believability and Presence. Furthermore, recent state-of-the-art research in the areas of neuroscience and psychological models can provide the needed clinical and physiological evidence. Only then MR, Vision and Wearable computer scientists will be

able to capitalize on the foundations of Believability and Presence for extending the virtuality MR structures and enabling new, compelling cultural heritage experiences.

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Epoch Future Research Directions

IST 2002-507382, Partner 19, "TU-BS"

TU-BS Position Paper

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February 16, 2005

Abstract

This paper describes our ideas concerning the future directions of Epoch, most importantly in relation to 3.3, *Infras-structure*, where we are active. These ideas also relate to our engagement in 4.2, *Standards*.

The proposed work plan for our group is explained in section 1. Then we have also noted down some general ideas concerning *Community building*, which we think should be intensified in Epoch, in section 2. Finally our work plan is complemented in section 3 with the full texts of our research proposals.

1 Common infrastructure

In December 2004 we have analyzed the situation concerning the area *CH Visualization and Rendering*, and identified the following missing items. All four of them were submitted as possible Newton topics, but three of them have been elected by the Epoch community to rather belong to *Infra-structure* than to *New Tools Needed*:

- *Infrastructure*: Unified Framework for 3D Applications
- *Newton*: Authoring Tool for 3D Experiences
- *Infrastructure*: 3D File Format Compendium
- *Infrastructure*: Link Repository for 3D Primary Data

The full texts of the four research topics can be found in section 3. Our group is going to work on one of these topics directly, on one indirectly, and for a third topic we have submitted a Newton project proposal.

1.1 Projects we plan to do as part of Infrastructure

We think the greatest benefit we can contribute to Epoch is a common infrastructure for interactive 3D. Second, we would like to contribute tools that make 3D easier to set up and use. And finally, we think that we have to make 3D readily accessible to the members of the Cultural Heritage (CH) community with a background in human sciences.

1.1.1 Further Promote OpenSG as common framework for 3D applications within Epoch.

Interactive 3D is key for CH dissemination. In response to topic 3.1, *Unified 3D Framework*, we want to intensify our engagement to establish OpenSG as a common application framework within Epoch. Its great advantage is that 3D approaches and techniques developed from different partners can be combined within one and the same application. An example would be a special geometry node from group A, a crowd simulation from group B, and a scanned dataset from group C.

We have promoted OpenSG so far mostly on a bilateral basis (e.g., with UEA, Pisa, Bonn) and given an OpenSG tutorial on VAST 04 in Brussels. Now we would like to establish an OpenSG cluster within Epoch. This implies that we monitor, collect, and coordinate contributions, such as new OpenSG nodes from Epoch partners. Second, we would like to help with requests for specific OpenSG applications – either by giving programming courses, or by establishing links to programmers. We also plan to tighten our liaison with Fraunhofer IGD (partner 20), the maintainers of OpenSG, to improve the documentation.

1.1.2 Provide GML as scripting language for OpenSG

OpenSG as common scene graph assures the interoperability of Epoch 3D software on the C++ level. With a scene graph, 3D applications can be developed much more rapidly and efficiently than with raw OpenGL. Yet still, one has to resort to C++ programming to create interactive 3D content.

On VAST 04 in Brussels the *Generative Modeling Language* (GML) was presented in the context of Gothic window tracery [12]. The GML is a full scripting language [2], but it is also very close to a pure raw data format for 3D graphics – very similar to Adobe's PostScript for 2D graphics. Its purpose is to serve as procedural representation for procedural 3D models.

The classical rules for window tracery can be coded into a GML model to instantly produce a multitude of windows with varying parameters. This is fundamentally different from classical 3D formats (triangles) which can only represent a particular instance of a 3D model, i.e., only the result

of applying the construction rules once.

One of the outstanding features of the GML is that GML code can be generated automatically, rather than manually, a property the GML shares with PostScript. GML code can even be generated by the GML – so a 3D model can actually contain its own modeler, to create new models interactively.

The process of attaching the GML to OpenSG is currently under way. This will not only make it possible to create scene graphs procedurally – but also to do the reverse, namely to store GML code in a scene graph node, and to trigger its execution with an interactive event.

This will also alleviate issue 3.3, *3D File Formats*, at least at the end of the pipeline: All different custom importers to load particular 3D formats into the scene graph can be used from within the same scripting language.

1.1.3 Tool for Rapid Virtual Reconstruction by Non-Specialists in 3D Modeling

Epoch needs to bring 3D technology to the users – but archeologists, museum curators and art historians usually have a background in human sciences rather than engineering or computer science. These persons are untrained in 3D modeling, but they have distinct three-dimensional ideas about history. We want to provide them with easy to use tools that permit to quickly develop a hypothesis of how a site has looked in the past – to open this very particular community to the serious use of 3D, and to Epoch technology.

The effectiveness of virtual reconstruction was demonstrated at VAST04 in Brussels with Showcase 4, *Multilingual Avatars*, where avatars guide the user through virtual Wolfenbüttel. The reconstruction was made with the *Charismatic Shell Modeling* software, based on the *shell* approach. We want to re-use the same approach in a more general setting where we use *convex polytopes* to build up models rapidly (in a CSG-like manner). This is also the model representation used in modern game engines (Quake II's *world brushes*), since convex polytopes permit to build efficient BSP trees, and they support fast ray intersection.

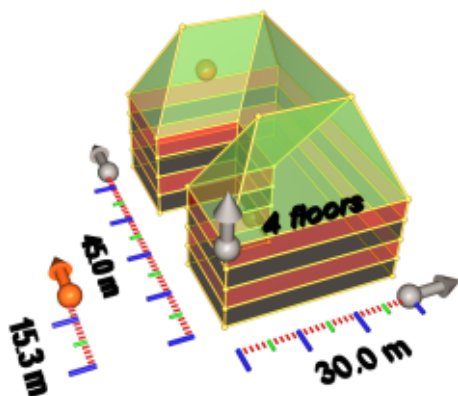


Figure 1: Easy to use but very restricted interactive house model (GML).

The optimized model representation will be used in conjunction with OpenSG and GML scripting, so that complex models can be handled with a configurable set of a few high-level parameters. Figure 1 shows a first example, an extremely restricted version of a house model where the user can interactively manipulate only four arrows to change the construction parameters. Refinable house templates will be used with flexible texture mapping to approach the vision of a '5 minutes per house' modeling tool.

1.2 Projects we do not plan to do as part of Infrastructure

Newton: 3D Authoring Tool. We want to do this as a Newton project together with CNR and Bonn (partners 33 and 21). The goal of our *3D Multimedia Kiosk* is to make 3D technology an obligatory standard for museums. Our project will realize an integrated turnkey kiosk solution, specially tailored for the needs and requirements of museums: Easy to use and affordable. It comprises a well-balanced package of hardware and software, and it touches also on the acquisition side, for small beautiful and precious artifacts such as jewelry or shiny coins.

We consider this project to be of strategic importance for Epoch, since it attempts to stimulate the demand for Epoch CH technology at the *end* of the pipeline, in the museum – rather than produce content without a demand ('in case').

Infrastructure: Link Repository for 3D Primary Data. As elaborated in detail in section 3.4, a repository with a collection of 3D data sets, providing high-resolution triangle meshes acquired from photogrammetry or through laser-range-scanning, is vital for Epoch.

A great opportunity for Epoch, or one of its partners, is to adopt the DOI approach to become *the* one official registration agency for CH primary data. The job of a registration agency is to assert the quality of a digital dataset before assigning a DOI to it – which is equivalent to an official publication of the dataset. But the quality standards are defined by the registration agency, which therefore has the power to grant or to deny a publication.

Unfortunately our group is not in the position to do this job – an Epoch partner with a focus on mesh acquisition is much more suited for it. It requires a whole suite of tools for processing large meshes, for measuring the mesh quality, for simplification, LOD etc.

2 Community Building

2.1 Partners' Epoch Profile

A network is like a graph with edges: Links are bilateral. But >90 partners, with whom should we liaise? Epoch TA has partner descriptions, but only as marketing texts. More reasonable: Standardized *Epoch profile* of each partner, with lists of keywords or bits of prose (e.g., 150 words max) as responses to the a few key questions such as:

- **Contributions to the network**

Fields of work / areas of research that might be relevant for CH, and where a group would like to do joint work with other groups (opportunities for collaboration). Position of group in CH pipeline.

- **Vision of Epoch**

Description of a particular CH 'module'. Formulate realistic goals to achieve in a sub-area of the CH pipeline where the particular partner feels competent.

Introducing partners to each other maybe should have happened earlier. But it is not too late since now after first year partners have better overview, and can give better profiles.

The Showcase DVD should be extended to become a partner profile DVD.

2.2 Epoch Partner Clusters

'Bootstrapping' process during first year completed so that partners know better what a CH network is/could be. But now links must be intensified. Full partner list is more comprehensible if partitioned into sub-groups with stronger internal linkage.

- **Identify clusters**

From partner profiles identify common fields such as acquisition, standards, ontologies, or 3D visualization, respectively. Which are the fields? Make list of partners active within each of these fields. For each field, trigger the creation of a cluster (workshop, newsgroup etc).

- **Relate Clusters**

Each stage of CH data processing pipeline has input and output. For each stage there is a cluster. Relate clusters to connect pipeline: 'We have recorded data but we need visualization', 'we have avatar simulation but need reconstructed city', etc. – For the full CH pipeline, are there any fields missing?

2.3 Communication Platform.

Website should be portal to bring useful Epoch content to the 'market': Direct links to primary data and Epoch-supported tools and applications (see section 1).

Within the network, the website should support the crystallisation of new ideas within. Accredited partners should be allowed to change HTML documents directly. The ideal technology would be a Wiki: Every authenticated user has the right to touch on every document in the database, with a very simple interface. – Even better would be a full document management system (Hyperwave etc.).

Website should support clusters by providing the respective E-mail lists such as acquisition@epoch-net.org, and also archival of E-mails. It should be possible for partners to add new users to the system (user administration).

The website could react faster (large logo images), does it (have to) use Flash?

3 Research Proposals (for Newton)

3.1 Unified Framework for 3D Applications

To define a standard at the application level that bridges the gap between research and use of innovative visualization techniques. Key is an extensible framework such as a scene graph engine that permits to integrate viewers for different 3D data formats into the same 3D application.

CH is very demanding since it employs many different representations of 3D artifacts and sceneries. Examples include massive triangle meshes, point clouds, height fields for terrain data, lumigraphs/light fields, synthetic 3D reconstructions, volumetric objects, and animated virtual humans, to name the best known. It is vital to bring high-quality data to the public, in order to satisfy public expectations in CH, and to disseminate the results of the network.

The variety of software packages for public presentation is a great obstacle for integrating results from different fields. Example: The Foundation of the Hellenic World has created the EVS package for CAVE presentations driven by an 8-pipe Onyx2 [10], and the *VirtualInspector* from CNR Pisa is a dedicated tool for the public presentation and interactive inspection of scanned high-resolution meshes with millions of vertices [8]. In the absence of 3D file format standards (see 3.3), it is vital to create a set of compatible modules that permit to create interactive experiences at least on the application level. The technical prerequisite to achieve this goal exists: Extensible scene graph engines. Simply speaking, a scene graph is a tree where each node is either an (animated) transformation or a geometric object.

Scene graph engines exist that permit to create custom nodes. This way, a node to display a massive triangle mesh could coexist with another node showing an animated human side by side on the same screen. Examples of the feasibility of this approach from VAST04 include the populated Wolfenbüttel scene [14] using OpenSG [5], and the crowd spraying approach [9], which used the OpenSceneGraph engine [4]. More than a dozen packages can be found by a query for 'scenegraph' on sourceforge [6].

Subject to discussion is the issue of whether to use gaming technology or not. Current 3D games provide great interactive experiences, but serious concerns exist in terms of a) extensibility, b) long-term sustainability, c) platform (in)dependence, d) artistic skills required, and e) cost.

The network should achieve the following concrete goals:

- to evaluate possible alternatives with respect to the variety of different settings of CH presentation, multi-modal interfaces etc.
- to come up with a *recommendation* for the Epoch community which API/library to use
- to set up a repository with CH specific documentation and 'best practice' examples of using a scene graph engine,
- and to teach the partners how to use it.

3.2 Authoring Tool for 3D Experiences

To come up with an easy-to-use toolkit to create 3D multimedia presentations and good-looking 3D exhibitions, e.g., in museums. Target users for the authoring application are museum curators and CH professionals, whereas the user community for the virtual worlds created is the public audience. Only secondary focus should be the internet delivery of CH experiences.

There are many different authoring tools for multimedia presentations including commercial packages (Macromedia Director [3] etc.) and open source software (Ename's Timescope [13] etc.). Only very few tools exist that permit to create appealing 3D presentations easily, and again few of these were developed for the specific requirements of CH dissemination in museums.

It cannot be expected to create a fully-fledged 'Director 3D' within a Newton project. On the other hand it is not acceptable either to have no authoring tool at all. This problem was also specifically mentioned in the DigiCult report [11], p. 52 'Current limitations/barriers'.

Museum people are not programmers – and skilled usage of Director's LINGO language typically is too much of an obstacle. Another constraint is cost – ideally, tools for simple 3D presentations should be affordable. Finally, computer games have raised expectations to very high levels – and a 3D presentation must in any case be looking very good, and it must be very responsive to user interaction.

The dilemma between the 'ease of use' requirement on the one hand and the 'good-looking' requirement on the other can be resolved by radically reducing the degrees of freedom. Similarly as with DVD authoring software or MS Powerpoint, the author can only choose between a few different pre-defined looks (skins), display some text/images, insert a few 3D objects into the scene, define a viewer navigation mode, and show a few 3D GUI elements as (hyper)links. Optionally, events can be scripted for more flexibility. A straight way to realize an authoring tool would be, e.g., to integrate a 3D viewer with Timescope, or to create a set of skins based on a scripting language for a scene graph (see section 3.1). So the objective is a 'Powerpoint 3D' rather than 'Director 3D' for CH presentations.

Accordingly, the concrete goals of a corresponding Newton project are

- to review the state of the art in 3D authoring tools, and to collect a catalogue of commercial as well as affordable (open source) tools
- to define a conservative list of requirements for multimedia kiosks and internet experiences, based on concrete realistic application scenarios rather than a 'nice to have it all' attitude
- to realize a very simple (but extensible) prototype whose primary goals are ease of use and good-looking results.
- Internet delivery could be realized by a version of the presentation software working as an internet browser plugin.

3.3 3D File Format Compendium

To resolve the issue of lacking suitable 3D file format standards by a) collecting existing file formats supported by most tools (.dxf, .3ds, VRML), b) setting up recommendations for using them, and c) to define requirements for an open 3D file format for CH.

The lack of a suitable 3D file format standard is not only a problem of Epoch, but one of the most annoying obstacles to the further spread of 3D technology in general. Partly this is due to the aforementioned diversity of methods for the representation of 3D objects, from point clouds over CAD models to lumigraphs. Beyond the raw data description problem, CH as an interdisciplinary field demands for interoperability of different 3D formats. This ranges up to the extreme case of a CH storytelling experience that even requires procedural elements such as collision response, physical simulations, and crowd behaviour.

To alleviate the problem, it is necessary to compose a catalog of 'strategic' file formats that CH tools rely on and need to support. This must in fact be done before a CH processing pipeline can be defined. The pipeline is necessarily composed of different tools, each supporting a certain set of file formats. It is therefore vital to make sure that also the new tools created by Epoch do support these formats.

It is not necessary that every tool supports every file format. 'Strategic' file formats are those for which good converters exist. It is necessary to avoid 'dead ends': VRML for example is broadly supported, but not well defined in terms of precision. So VRML should be an output format rather than being used *within* the pipeline. DXF is well established in building design, but offers limited support for materials. 3DS is broadly accepted, but it is not clear whether it can be used in an open source environment. What are suitable formats to integrate novel representations such as light fields or point clouds into the process? And how can massive triangle meshes be stored reliably and in archiving quality?

It is also necessary to classify according to purposes and data sources: A house created in 3DS Max and a laser-scanned building can both be stored in the 3DS format – but they probably require totally different processing. So the choice of the optimal file format should be primarily determined by the requirements of the process. But which are the typical requirements?

A Newton project should clarify on this and other practical questions, and set up a catalog of recommendations of which file formats to use for which purpose.

It is quite likely that none of the existing file formats will entirely satisfy the needs of the CH processing chain, especially when it comes to questions such as long-term archiving for digital preservation. – It cannot be expected that the ultimate 3D file format standard for CH can be realized within a Newton project. It is possible, though, and also mandatory, to rigorously define the technical requirements of the CH processing pipeline in order to prepare such a 3D standard in a follow-up project.

3.4 Link Repository for 3D Primary Data

To set up a web portal with a reference (link) database for publishing captured 3D datasets as a central resource a) to permit searching based on metadata and/or shape, b) to permit browsing based on thumbnail models/images, and c) to link to the 'true' repository that actually holds the primary data. The portal should also assure the quality of the published 3D data.

It is vital for the network to get an overview over the digital 3D assets that exist among the partners. Epoch is a great opportunity to share not only scientific knowledge but also the vast amount of data produced by the partners that focus on data acquisition. Availability of raw data also fosters research in data processing, which in turn makes data acquisition more effective. Therefore a web portal with a catalog of available raw data is of strategic importance.

It is *not* necessary, though, to organize this portal as one big database containing gigabytes of raw data, such as the Stanford 3D scanning repository [7]. Neither is it necessary to give away the copyright and make the digital assets available for free to everybody. Both issues can be resolved by the concept of a link repository. One among several alternatives to realize it is by adopting the DOI approach.

The DOI foundation [1] realizes *persistent identifiers* in a decentralized way through a number of *registration agencies*. A registration agency has the right to assign a *digital object identifier* (DOI) as a 'certified web link'. A content provider can get a DOI only if it – by contract – assures that the link target will exist permanently. The target of a DOI such as doi:10.1228/0103000001002 can always be resolved as <http://dx.doi.org/10.1228/0103000001002>, which directly leads to the web page of the content provider. So the content provider has complete control over the data proliferation, and does not have to give the data away to any kind of data repository. An example of an existing primary data DOI is a 110 years climate data set with a size of 821 GB [15]. The great advantage of the DOI approach is that DOI assignment is equivalent to a publication: A DOI is broadly accepted as an alternative to the ISBN numbers used in the print sector to identify books.

The purpose of the web portal is primarily to give access to the information *which* models are available. In any case it should permit searching on metadata, such as country, location, size, style, completeness etc., and decorate search results with small thumbnail images. The basic functionality is very useful and can be extended in various ways:

- **Stable references:** Partners' CH multimedia collections have a reliable way to reference to primary data. Archaeological publications can officially refer to published 3D scanned data sets.
- **Ontology research:** Digital libraries of scanned artifacts can be grouped and classified in various ways, only few of which have been explored yet. The great challenge is

to find out more about the relation between artifact semantics and artifact shape.

- **Shape research:** Development of new shape processing tools, e.g., comparative studies or advanced style classification schemes, is only possible with a solid foundation in terms of primary data. Not all partners doing research in shape also have a focus on shape acquisition.
- **Shape dissemination:** Key is the development of new methods for shape delivery and access. The portal may offer the direct download of radically simplified scanned datasets. It may use server-based image generation with user-defined camera positions. It may offer alternative shading methods (including non-photorealistic rendering) for shape analysis and highlighting. It may apply automatic feature detection to a large-scale database of large-scale meshes.

These are just a few examples of advanced techniques that become possible only with a substantial repository of 3D primary data.

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EPOCH Workshop on Research Agenda - Position Paper

Effectiveness of Interactive Applications for Cultural Heritage

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1. Motivations

A larger number of multimedia interactive applications are being developed in the realm of CH (Cultural Heritage): from the Web, to PalmTop devices, from interactive installations, to Virtual Reality. If technology, for the time being, has provided the mean for impressive developments, it is necessary to observe that in many situations and for too many projects, the results are not we expected: technically speaking applications are (where) there, but the intended *benefits* (either cultural, or social, or economical, or promotional, ..) are (in most cases) yet to come.

It turns out that CH, with respect to other domains (such as eCommerce or eBusiness) is a difficult domain, where several stakeholders (with their points of view). Several goals, several types of users and several motivations must be considered at the same time. This situation, coupled with needs of taking into account the necessity of dealing with different cultures and the recent need of coordinating several “channels” of communication (from paper, to Web, to palmtop, to installations, ..), is creating the needs for a new understanding of the basis for the development of effective applications.

The WP2 EPOCH workshop, held in Bruxelles in October '04, has shown the relevance and the potential added value of enhancing our methodologies for understanding stakeholder profiles, stakeholder goals, user profiles and motivations, etc. in order to build a suitable set of requirements matching the “desiderata” (and constraints) of the stakeholders with the needs and interest of the user. In addition, always at the workshop, it emerged the need of sharing best practices, not just “piling them up”, but understanding them in details (e.g. understanding why and how goals were matched by requirements, or why users were satisfied).

For the above reasons it seems necessary to develop, within EPOCH, a modern state-of-art framework where the different factors (i.e. stakeholders, goals, motivations, requirements, user profiles, context of use, scenarios, ...) can be taken into account and exemplified through “vertical specializations” (e.g. museums, libraries, cultural tourism, archaeology, etc.) making the framework closer, with respect to generalist framework, to everyday needs.

2. General Approach

The general framework will be developed using the general methodologies already on the field (either developed by framework partners or outside the consortium), suitably specialized for CH.

Most important of all, the framework will be specialized according to “vertical” profiles: e.g. small museums, modern art museum, archive, archaeological park, etc. The framework, for each vertical profile, will include at least the following elements: characterization of typical stakeholders and of their typical goals, characterization of typical users motivations and needs, typical user scenarios that must be supported, guidelines for framework specialization (according to a set of parameters), design tips, best practices. Different groups of EPOCH partners will be needed for each “vertical profile”.

The careful blend of generic research and methods coupled with strong on-the-field expertise is expected to ignite the fire of new step forward in understanding the issues of effectiveness, and providing the ground for overcoming the current deficiencies of most interactive applications and also the lack of effectiveness.

The framework will be made more effective by developing suitable *tools* and *supporting actions*, as discussed in the next section.

3. Activities and Expected Results

The activities will be structured so that the following *methodological* and *technical results* will be achieved:

– General Framework

- An “all comprehensive” analysis, generally addressing the CH domain, of *all the different factors affecting effectiveness*.
- A set of *analysis-design guidelines* allowing designers to put in practice the general framework.
- A generic *impact/effectiveness evaluation methods*, applicable to all kinds of CH interactive applications.
- A restricted set of “*best practices*”, demonstrating the applicability of the above general framework (both for design evaluation)

- “Vertical” (Specialized) Frameworks

- The general framework is *specialized* considering the multiple facets undergoing the generic CH umbrella: museum websites, interactive installations, interactive tourist guides for archeological parks, libraries, etc.
- For each vertical framework a set of analysis-design guidelines will tell designer how to put into practice.
- For each specialized framework, a specific evaluation method will allow to assess in depth the effectiveness of a specific application.
- A restricted set of best practices will be used to demonstrate the applicability of each specialized framework.

- Supporting Tools

- General Tools

- These tools will support analysis of needs, the identification of impact analysis criteria and key performance indicator, the engineering of requirements

- Framework Oriented Tools

- These tools will support the reuse of the framework (either in general sense or in a more restricted sense), by comparing the user needs with “typical solutions”, already developed in similar contexts, providing all the needed examples of requirements and design solutions.

- Supporting Actions

The results (methodologies, framework and tools) should not be confined within the group who participate to their development but should be widely disseminated within EPOCH (since they are of general interest). Therefore an internal support action can be organized providing to all partners materials, on-line and traditional courses, workshops, coaching and consulting.

The achievement of the above results will mainly involve coordinated activities within EPOCH, but this work will also pave the ground for the development of other EC funded initiatives, where these results are extended, applied, and formally tested.

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EPOCH Workshop on Research Agenda - Position Paper

Accessibility and Usability for Cultural Heritage

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1. Why accessibility?

Accessibility, in the context of ICT, means to allow users with disabilities (which is more straightforward than the politically correct “with different abilities”) to be able to use, at some extent applications. Simple character oriented interface, and keyboards where reasonable accessible, if accompanied with specific devices (e.g. Braille devices or text to speech synthesizer), modern graphic interfaces, coupled with pointing devices and interactivity-multimedia, make accessibility a much harder problem.

At the same time there has been a growing concern, partially with serious intentions and partially as a political issue, to force the situation, imposing accessibility as relevant issue: in Europe and most other western countries laws are passed, requiring, especially public organization, but practically everyone, to take accessibility as a serious concern (if not mandatory as, for example, for new applications in Italy).

Accessibility, being originated by disabilities, takes a different flavor according to what disability is being considered; it is generally accepted the distinction between physical disabilities and mental disabilities. Within the first category the most important disabilities are related to vision (blind or low vision users), hearing (deaf or low hearing users), and capability to operate with hands. Any major deficiency makes it impossible to use modern interactive application, in some sense or another, since they are based on images, audio and the ability to coordinate the use of mouse, keyboards, etc.

Although “universal accessibility” is a catching concept, it is practically unattainable on the spot: disabilities must be considered one by one and dealt with one at the time. Also sometimes, the combination of two disabilities (consider blind-deaf users, for example) can't be solved just by adding single solutions (the one for blind and the one for deaf users).

Limiting our concern to physical disabilities, a major step has been taken by the W3C consortium, which in 1999 has published a set of guidelines (under the WAI initiative) for building accessible web applications; a new version of the guidelines is still in draft (and it has been so for a while), due to technical problems and the lack of consensus.

The merits of the (1999) W3C guidelines are clear: they have raised the level of awareness, they have proposed way to measure accessibility and to check it, they have proposed in some cases simple and effective solutions. They have also major drawbacks, however, that by now are clear to several researchers and practitioners:

- They focus on “accessible content” and technical details
- Some of the proposed solutions are bound to the technology of 1999, some others are purely arbitrary
- They recognize that, beyond technical details, something should be done, at higher level (e.g. design and interactivity) but do not offer solutions nor precise definition of the problems.

The above insufficiencies make it conceivable that an application, fully compliant with the guidelines is still not accessible, in the sense that is not actually and effectively usable by users with disabilities.

Culture Heritage in Europe (and also in many other parts of the other world) falls in the realm of “public sector”, therefore any interactive application (both for legal constraint and social concern) must address the issue of accessibility (at minimum understanding up to what limit it is supported or not supported, and possibly to improve it).

2. Why Usability?

Usability has become popular, as a term, but little applied in some areas, and in Cultural Heritage in particular. One of the reasons is that many application developer have little information about state of art research about usability, how it must be considered during design, how to evaluate it, etc. also there is the obvious consideration that, if at superficial level usability issues (e.g. a proper choice of fonts and labels) are easy to be understood and dealt with, at deeper level it requires specific methods and techniques, not well known by application developers.

It is known that in the field of Cultural Heritage insufficient usability (as long as insufficient analysis of stakeholders and users needs) is one of the major causes of customer dissatisfaction and ineffectiveness with many interactive-multimedia applications.

3. Proposed activities within EPOCH

As far as *usability* is concerned the lines of activities should be the following:

- Specialization of existing methodologies of evaluation for the CH, in its different version (e.g. interactive-multimedia applications for museums, archives, libraries, etc.).
- Development of a sizable set of best practices and examples
- Strong action of dissemination among EPOCH partners

As far as *accessibility* is concerned the lines of activities should be the following:

- Diffusion of current guidelines and collection of all the research results in the field
- Experimentation of the realization of best practices and case studies within the realm of CH
- Further investigation about the need for more comprehensive guidelines and solutions
- Development of new tools that go beyond the current set of tools (e.g. overcoming the current deficiencies of screen readers).
- Strong action of dissemination among EPOCH partners

4. Methodological Results

4.1 Methodological Results

- Usability

- Development of **educational material** (i.e. documents, traditional and online courses, best practices, etc.) and **guidelines about usability, specifically tailored for the CH sector** (in all its internal variations).
- A **support action**, toward all the EPOCH subprojects, in order to put them in the situation to consider usability issues and evaluation at the level of state-of-the-art research

- Accessibility

- Development of **educational material** (i.e. documents, traditional and online courses, best practices, etc.) and **guidelines about accessibility, specifically tailored for the CH sector** (in all its internal variations).
- A contribution to the **evolution (and improvement) of the W3C guidelines** about accessibility.
- A **support action**, toward all the EPOCH subprojects, in order to put them in the situation to properly evaluate accessibility to their applications and to find a way to fix the problem

- Standards

- A contribution at setting **international standards**, for CH applications, both for Usability and Accessibility

4.2 Technical Results

- Usability

- Developing “usability” **wizards**, supporting effective (semiautomatic) evaluation of usability for interactive applications.

- Accessibility

- Development of new **interactive tools**, supporting **specialized “dialogues”** (e.g. only audio, with no visual support), that overcome the several pitfalls of current tools (e.g. screen readers), supporting users with disabilities.
- Development of new content management tools for CH, taking into account the needs of accessibility (which requires, in general, to have several different versions of the same piece of content).

4.3 “Basic Research” Results

- Understanding the different communication values of the different media (e.g. comparing text, with audio, with images, etc.) in order to convey the same content on different “sensory channels”. This is useful both for accessibility (since some users can’t use some of the media) and/or for multi-device applications.

The achievement of the above results will mainly involve coordinated activities within EPOCH, but this work may fire the development of other EC funded initiatives, where these results are extended, applied, and formally tested.

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Position Paper Research Agenda Workshop, 17-18 Feb 2005, Leuven

Recording and Data Representation of Large Cultural and Natural Heritage Sites

We have realized lately that the EPOCH program does not address the issue of Large Cultural and Natural Heritage Sites so far, although this is a topic of increasing importance for the various communities (researchers and users) active in Cultural Heritage.

The UNESCO World Heritage Center for instance emphasizes this area in a prominent location on its webpage as follows:

„Bringing cultural and natural heritage together

The idea of combining conservation of cultural properties with those of nature came from the United States. A 1965 White House Conference in Washington, D.C. called for a World Heritage Trust that would stimulate international co-operation to protect "the world's superb natural and scenic areas and historic properties for the present and the future of the entire world citizenry". In 1968 the World Conservation Union (IUCN) developed similar proposals for its members. These proposals were presented to the 1972 United Nations conference on Human Environment in Stockholm.

Eventually, a single text was agreed upon by all parties concerned. The Convention Concerning the Protection of World Cultural and Natural Heritage was adopted by the General Conference of UNESCO on 16 November 1972.

By regarding heritage as both cultural and natural, the Convention reminds us of the ways in which people interact with nature, and of the fundamental need to preserve the balance between the two."

In a press release (No. 2002-77: „For UNESCO, Space Technologies should be Harnessed for Sustainable Development“) UNESCO has stressed the use of satellite imagery for monitoring World Heritage Sites. Actually, ESA has signed a contract with UNESCO to contribute substantially in form of satellite images to a project of Cultural Heritage in Central Africa.

As we can see from the UNESCO World Heritage List, many recent additions can actually

be classified as „Large Sites“, both in terms of culture and nature. See also the attached Appendix.

In summary we see worldwide strongly growing activities in the development and use of (highresolution) satellite and aerial imagery and aerial laserscanners for Cultural Heritage exploration, recording, documentation and monitoring.

Therefore we suggest to EPOCH to put future emphasize also on these issues.

In the recent voting process our suggestion of „Large Cultural and Natural Heritage Sites“ has resulted in a score of 168 well above average both in the *“Proposed Infrastructure Project“* section and in the *„Encourage proposals for future calls“* section. There seems to be a strong interest among the EPOCH partners to deal with this subject.

Our experiences and competence

Our group has done research an development in this area for a long time.

Some of our recent projects, which have attracted quite some scientific and public attention are (see also www.photogrammetry.ethz.ch under PROJECTS):

- + Bamiyan, Afghanistan
- + Geoglyphs of Nasca, Peru
- + Tucume, Peru
- + Inka settlement Pinchango, Peru
- + Machu Picchu, Peru (in work)
- + Mount Everest
- + Ayers Rock, Australia
- + Xochicalco, Mexico

We have worked with and have competence in the processing of images from different satellites, aerial images, model helicopter images and terrestrial laserscanners.

We have tested commercial photogrammetric and remote sensing software in order to find out how it performs at the different stages of the data processing chain. Our experiences are quite negative and discouraging. This is why we have developed methods and software for automated and semi-automated processing by ourselves. In particular we have developed various sensor models (Gruen et al., 2005), methods for automated and semi-automated precision-georeferencing (Gruen, Zhang, 2003), automated techniques for Digital Surface Model generation (Zhang, Gruen, 2004) and view-dependent texture mapping (Gruen et al., 2001). With CyberCity Modeler we also have a powerful semi-automated approach for 3D modeling of man-made objects (Gruen et al., 2003)., as used for instance in Xochicalco (Gruen, Wang, 2002).

Proposed work

As briefly outlined before we have already some efficient individual software modules available for processing. However, there is still some way to go until a fully operational methodology and software will be available. We would use our experiences and the existing packages as a starting point for further improvements, integration and testing.

These algorithms are part of an integrated processing chain, ranging from the image

data acquisition down to the administration of the processed data in a GIS and 3D visualization and animation. Our efforts would clearly help the sector because they would carry us way beyond what commercial software can offer. Given the relevance of the

applications it would also add value to the impact of the technological work. We are confident that we could find a sufficient number of partners and supporters within EPOCH to render such program a success. The results of this work can be represented in Showcases and can serve as the basis for training and teaching courses.

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APPENDIX

Excerpt from the document „How the UNESCO World Heritage Comnvention Works“

The criteria for selection

To be included on the World Heritage List, properties must satisfy the selection criteria (6 criteria for cultural properties and 4 criteria for natural properties). These criteria are explained in the [Operational Guidelines](#) which, besides the text of the *Convention*, is the main document on World Heritage. The criteria have been revised regularly by the Committee to match the evolution of the World Heritage concept itself.

Cultural heritage should:

- i. represent a masterpiece of human creative genius, or
- ii. exhibit an important interchange of human values over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town planning or landscape design, or
- iii. bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or has disappeared, or
- iv. be an outstanding example of a type of building or architectural or technological ensemble, or landscape which illustrates a significant stage or significant stages in human history, or
- v. be an outstanding example of a traditional human settlement or land-use which is representative of a culture or cultures, especially when it has become vulnerable under the impact of irreversible change, or
- vi. be directly or tangibly associated with events or living traditions, with ideas or with beliefs, or with artistic and literary works of outstanding universal significance (a criterion used only in exceptional circumstances, and together with other criteria).

Equally important is the authenticity of the property and the way it is protected and managed.

Natural properties should:

- i. be outstanding examples representing major stages of the earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features, or
- ii. be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals,
- iii. contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, or
- iv. contain the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The protection, management and integrity of the property are also important considerations.

Position Paper : Workflow Manager and Quality Certification System (QCS)

*Second Draft, 08-02-05
Tyler Bell, Oxford ArchDigital*

Overview:

This tool is a server-based application for heritage specialists to create a certified workflow process, against which other data creators may validate their work. A 'workflow process' is the term used in this proposal to describe a template, created by a specialist in their field, which documents the flow of data from their creation to their publication. This tool was conceived to attain three specific goals:

- 1.To provide a *standardised mechanism* for documenting professional workflow schemata and the data transformation process from inception to publication.
- 2.To provide a *validation tool* that can be used to assign a 'certificate of authority' for data that adhere to the workflow schema.
- 3.To provide an *API* that can be employed by third party applications to generate the required metadata automatically as information moves through the workflow process.

The fundamental purpose of the tool is to document the transformation of data as they pass from inception to publication, and to encourage and formalise best-practice throughout the cultural heritage sector.

A *workflow process* consists of a series of 'nodes', or stages, through which data must pass, as well as definitions of the metadata that must be recorded at each node, and restriction on their format. The tool will allow specialists to build workflow nodes and paths, to mandate the parameters that are required at each node, and to dictate how those results are recorded in the metadata. These workflow process definitions will encapsulate best practice; they can be rendered in XML format, but will be stored within, and maintained by, the Quality Certification System.

As data move through the workflow process, an XML file will document its progress at each stage. This document will act as a 'certificate of authenticity', holding the CRM-encoded metadata, specified by the specialist. The tool will therefore act as a system that allows heritage specialists to codify good practice, and issue a certificate of validation when that good practice has been adhered to.

Note that the application will only generate and manage the metadata file for tools that have been integrated into a specific pipeline and have been connected via the API. The result of transformations of other tools, especially OTS applications, will have to be recorded manually.

Requirements:

- 1.Visualisation tool: a component that will create SVG-based representations of the workflow schemata
- 2.Access Control Layer (ACL): user- group-level access control relating to IP and copyright controls
- 3.Version control: must record multiple versions for modified and maturing

schemata

4. Workflow control: the schemata manager must have workflow restrictions to ensure that schemata can be managed by a specialist without being made publicly available.
5. The metadata documents must all adhere to a single workflow process schema.
6. Extensibility: Users can create schema that extend other schema
7. User management accounts: for recording individual data units, probably based on address space
8. Multi-lingual interface and content: the system interface and stored content will be UTF-8 based.

Milestones:

The system will have four primary components, which will also serve as the project milestones:

1. Workflow Manager: allows a specialist to create and document a workflow scheme for a specific information type.
2. Workflow Validator: performs comparisons between metadata documents and the workflow scheme, and reports on errors and inconsistencies in the metadata.
3. Interface Protocol: An XML-based protocol that will allow new EPOCH tools to plug into this system, for the purpose of reading and writing the required metadata automatically.
4. Pre-loading and Testing: the creation of five workflow processes representing a range of data from current EPOCH partners.

Deliverables:

1. QCS application released under the GPL
2. Documentation for end users and developers
3. XML schema for recording workflow processes, documentation, and instance documents
4. Protocol (API and associated XML schema) governing the interface between the QCS application and third part tools, documentation, and instance documents

Summary:

The intention is for any heritage specialist to design a workflow scheme and encourage its use, and provide a mechanism for specific groups or institutions to codify their best practice and official guidelines. The tool will not guarantee the quality of the data, but will ensure that all requisite metadata has been recorded, and the proper procedures followed. It both governs, and defines, data-flow pipelines.

The next challenge: *contextual multimedia*

Lesson learned, vision and research-to-business perspectives

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Introduction

A new wave of human attitudes and expectations are taking shape in this particular historical time, and they could significantly impact the incoming EPOCH Research Agenda. After more than three years of dark times which started on September 11, 2001, the future is starting to look bright again on many scenes including mobility and cultural tourism in the EU. The economy is growing fast in the largest countries of Asia (China and India) and the Iraqi people just showed their desire for new openings and a new life, a seed that can grow in time in other Middle East countries; we have just started to live in the Enlarged Europe, and new areas with deep historical meaning have just become - or should shortly become - accessible again to cultural tourism (Libia with Leptis Mania, for example). We can therefore reasonably expect a fast growing demand for mobility and cultural tourism joined to new opportunities for cultural development and mutual understanding.

In this scenario there has already been a lot of research done in the area of Cultural Heritage that could play a key role in fostering such civilization trend. But sustainable tools for effective dissemination are still missing.

This may seem a false statement, if we think of the dissemination power of Internet and multimedia.

But, according to their mission of being available at any time and in any place, the Internet and the digital products, focus the attention of all culture actors (the CH authorities and the public) away from the culture core, i.e. away from the places where the actual materialized testimonial of civilization are. In our opinion, we need now to start using our technologies for the rediscovery of the pleasures and the emotions originated by the materiality of the historic and cultural testimonials, and we should provide a methodology to enhance at the same time the education and communication power of tangible CH, arguably the ultimate cause and effect of human progress. This would have a fruitful impact on the EU cultural tourism and on the related business.

The need to disseminate and valorise the past research results as well as the digitised heritage resources is clearly stated in recent strategic papers (for example, FROM DIGITAL COLLECTIONS TO CULTURAL EXPERIENCE, LEARNING, AND KNOWLEDGE, DigiCULT, Thematic Issue 7, Dec 2004). It is a big issue and it requires a critical and heterogeneous mass that can only be achieved through partnering, as suggested by the *IST Work Programme 2005 – 2006*. Within EPOCH, we already have an operational interdisciplinary partnership, and, particularly, within activity 3, we are already committed to set up a Common Infrastructure that should support *the entire chain of practice in archaeology/museums, from surveys to public presentations* [Nick Ryan, University of Kent], overcoming the existing fragmentation in Cultural Heritage processing and communication.

So, this note argues that Epoch is a very exciting opportunity to “start an expedition” aiming to demonstrate the effectiveness of bringing digitised resources onsite, in front of the exhibits, turning the CH physical repositories into environments for lifelong mobile cultural development and contextualized learning.

Argument

Many CH institutions already offer, at least on an experimental basis, digital contents inside their museums, or archaeological sites, with the goal of supporting CH readability, thematic analysis and contextualization.

But it is a quite widespread opinion that bringing interactive digital visual media into current technology devices, such as smart phones and PDAs, is not impressive, nor that useful for education purposes. And the digital creators are not attracted by this issue, due to the negative impact on precision, realism and levels of detail, implied in current mobile devices.

On the contrary, we think that, rather than being a problem, this is our challenge and our opportunity. Digital contents can not only be used for scientific research purposes and as a decontextualized reality surrogate for the web, but they can also gain a new strategic role locally, inside the cultural site, as a fundamental means to fill the gap between perception and learning. We further believe that interactive multimedia on-site, when the user is surrounded by materialized cultural resources, has the potential to become a new type of medium,

it may open the way to new levels of perception, new learning models, new job and business opportunities, and, eventually, a new form of visual art, a sort of contextual-multimedia.

What are the requirements and what are the challenges to try to map this vision into reality?

The requirements are obviously set by the museum and the archaeological sites authorities (directors and curators); based on our experience - mostly gained in Italy - they are greatly concerned for harmonization reasons: on one side the technology is obtrusive and may not be compatible with the hosting architecture, while on the other side, multimedia turns away the visitor attention, disruptively breaking their emotional involvement. Many battles need to be won if we want to overcome these concerns.

Point 1: *the contents.*

When we access a medium, two actors are involved: us and the medium itself (e.g. the computer, the stage, the television screen, the newspaper); on-the-contrary, in a museum or in an archaeological site we have three actors: ourselves, the device and the “exhibit”; and the protagonist is the exhibit. Multimedia, therefore, must not be a surrogate of the exhibit, as it is in a DVD or on the Internet, but it should be the catalyst of the resonance between the visitors and their environment. So: we need to find new cognitive models, new ways of mixing audio, video and text, new methods to handle interactivity and to create “contextual multimedia” for on-site access. This issue is already considered by many institutions. The contents currently under development for WHYRE, for example, are based on this research, carried out with two Italian museums, the *Certosa e Museo di San Martino in Napoli*, and *il Museo di Storia della Scienza* in Florence. But, in order to become an asset of the Information Society, this approach should become a methodology, made of “procedures” applied to conformable CH digital assets, therefore harmonized within the framework of the Common Infrastructure.

Point 2: *the interaction models.*

If the visitors have to pay attention to the operation of the interactive guide, the resonance with the hosting environment is lost. We need to devise new sensory solutions in order to recognize the users activity and their focus of attention, with the goal of anticipating their intentions; research on sensor systems for wearable devices should be carried out, the main goal being closing the gaps - that is cancelling all discontinuities - between the visitor, the environment and the platform.

Point 3: *The mobile platform*

Platform ergonomics and performance should be optimised to meet the requirements of the above mentioned points 1 and 2. Current PDAs are mostly inadequate to our goals for many reasons, including:

- Their screen size and brightness
- Their lack of embedded context-management support
- Their inability to be accessed free-hand
- To a lower extend, their computational power and possibly their internetworking bandwidth

We envisage the opportunity to investigate the specification of the optimal mobile device meeting the requirements of the above mentioned points 1 and 2. This activity could be the result of EPOCH inspired research in the following areas:

- Context management and activity recognition
- Space modelling from the point of view of unobtrusive location detection
- Context-based usability policies
- Context-based resource management and power-performance optimisation
- Context-based two-ways communication

These activities should be first focused to access cultural heritage on-site, but they have a potential impact on many other mobile applications, they could be of interest for actions and strategic objectives of the IST Work Programmes 2005 – 2006, and could therefore foster further partnering initiatives.

Conclusions

This short paper suggests that there may be in the future an increasing demand for high quality, context-related presentations to be delivered on cultural sites using context-aware mobile devices. This can be an opportunity to valorize and disseminate digital knowledge conformable with EPOCH Common Infrastructure. A three players paradigm, with the context-aware presentation and interface acting as the catalysts of the learning and emotional cultural experience, is envisaged and the research issues involved are briefly introduced.

Priorities for the Research Agenda

Position paper
CHEDI, Brussels, Belgium

The priorities for the research agenda should better take into consideration the point of view of the stakeholders concerned by the **conservation and management of monuments, sites and museum, and theirs visitors.**

On the one hand, even if we understand the "contractual" necessity to establish a research agenda for 2005, it is also important and necessary to keep our scientific credibility. At this stage it is not possible to establish a serious research agenda adapted to the real identified needs, based on scientific criteria. We are at the beginning of the needs' identification task (we'll provide a first report by the end of March or the beginning of April 2005). We think it is **premature to set up a closed research agenda limited to only 8 "technical" themes.** We agree with Paul Van Lindt, of the HEREIN network : *“in the current circumstances, it would be best to launch only those NEWTON's in the first half of 2005 that are obviously a necessity without having to rely on an analysis of the stakeholders needs”*

Attention should be given to a logical process in the development of the whole project and particularly the research agenda. The report of the “WP2.1.Stakeholders needs” which was presented in December 2004 at the VAST Conference, as well as the CHEDI position paper following the stakeholders needs workshop in October 2004, show both clearly that an important number of the research priorities from the cultural heritage point of view, at this stage, cannot be translated in terms of technology. And yet these priorities, established after a clear identification of the real needs, should command the research agenda.
Successive logical steps should be identified.

Here are some **points that still need to be clarified:**

- Refine stakeholder's sub-categories;
- Understand specific needs in depth;
- Determine intangible dimension and related stakeholders;
- Question of interaction between different levels of stakeholders within a category;
- Analyse common and conflictual needs between stakeholder's communities and processes;

We would like also to bring your attention on **several aspects to be considered** when establishing the research agenda. :

- NTIC, yes, **but also new uses of existing technologies:** given the (always) limited resources, preference for a progressive, sustainable development, resisting the temptation of rushing to fast to sophisticated experiences;
- **Investigate the economic feasibility and sustainability** of ICT for Cultural Heritage Sites and Museums, especially for small museums and sites (the majority).
- **Cultural heritage must be seen as a fragile resource:** ICT to guarantee the awareness of conservation requirements, respect for authenticity and integrity, reversibility of interventions, limitations to physical access.
- NTIC to develop **multi-disciplinary co-operation;**
- **Bottom up approach,** in order to better take the field work into consideration
- **NTIC to overcome divergence of interests** of various stakeholders

On the other hand, in our opinion, the proposed research agenda seems to be **too focused**

- **on archaeology** (sites/ artefacts): what about museums, historic monuments and towns
 - **on heritage presentation**. We suggest **a more balanced approach**. Before presentation and interpretation, it is essential to deal with the previous phases of the conservation process in a coherent way: see the six domains below. Of course, we keep in mind that the use of metadata is involved during the whole development.
1. Knowledge (data collecting and processing)
 - All the technologies being of use for the acquisition of information (textual as well as digital technology) about the artefact or the site being considered.
 - Need to add additional information to the object. These data must be stored in a proper way and be preserved in a sustainable system. (Data standards, vocabulary tools, thesauruses...)
 2. Legal protection
 - Protection of the collected and processed data;
 - All the issues related to the intellectual property and the copyright;
 - Technologies to prevent and fight the illicit traffic of cultural properties on line databases of stolen objects, insert of microchips in objects...).
 3. Conservation/preservation/restoration (including monitoring tools, digital restoration)
 - IT being of use for the (local or remote) control of the appropriate conditions of conservation (preventive and active conservation, monitoring...);
 - Also the IT helpful for restoration and the preliminary studies.
 4. Mediation / communication (including interpretation, virtual reconstruction, augmented reality, multimedia and virtual reality tools...etc.)
 - IT to play a major role in the presentation and the interpretation process;
 - Joint use of all the multimedia and virtual reality tools, of augmented reality systems and virtual reconstruction.
 5. Valorisation (cultural tourism, digital resources)
 - This topic covers the economic dimension: the cultural heritage considered as a resource – reminder: a fragile resource!
 6. Training (E-learning, digital supports...etc.)
 - Techniques to train professionals and introduce the visitors to NTIC;
 - Techniques to train professionals and inform the visitors by NTIC;
 - Provide appropriate, continuous training and coaching for professionals.

Finally, it is **essential to keep 3 different activities** for the identification of the stakeholders needs, and the vertical and horizontal integration, and at the same time, **to improve the coordination**: common methodology and calendar, in order to avoid overlaps.