VI

COMUNICARE L'ARCHEOLOGIA IN RETE
USI E FRUIBILITÀ

COMMUNICATING ARCHAEOLOGY THROUGH THE WEB
USES AND USABILITY

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TELE-ARCHAEOLOGY

1. Tele-archaeology: a science fiction tale

Archaeology is dying here and now!

We attend of international conferences, we publish… Yes and no. Only a minor part of excavated sites are published; and most of the times we attend international conferences only to publish the same paper again and again. May be archaeological knowledge is being generated, but it is not circulating. The knowledge, which is not used, doesn't survive, and that is the main problem of the archaeology today, the reason why our discipline is dying now.

More than once, a lot of efforts are spent to some research and analysis, reinventing always the same explanation. Archaeological "results" will be hardly shared lately, often hidden within other reports and communications, or forgotten in the folders of research documentation. The process of incorporating new data in general archaeological knowledge seems to be too slow. As a consequence, we live isolated in our own research, without taking into consideration anything out of our site and analytical results. Archaeological knowledge is not a unique construction, but a series of stand-alone stairways, waiting rooms and halls, containing isolated activities and dispersed results.

But, it could be different, and should be different. The following short story tends to draw the science fiction scene which confirms: Yes, there is a life before death!

> Imagine that we live some time in the future. Then, society needs to know why people do actions. Why they live, why they die, why they kill, why they eat, why they love. And there is not a unique archaeological site for each why. We feel the need to know the lives and deaths of all people before us, to understand ourselves. And there are not enough historians nor archaeologists to study so many past livings.
>
> There is not a unique reason to explain why most of the participants of virtual consultative meeting were there last night. It was usual briefing of research teams from different countries, but this time it was specially interesting. The "Live@Knowledge 5.0" computer program will be presented to all those people who shared their data and knowledge to build knowledge needed to solve historical problems. It is not an "Intelligent but Automatic Historian", it is not a huge database, it is an interactive problem-solving assistant machine. Of course, it is not God. It cannot relate everything to everything, because historical and archaeological knowledge is almost infinite. But never before a so huge, exhaustive, coherent knowledge base has been built. It contains an incredible quantity of single data, potteries, tools, walls, occupation floors, etc. the products of human labour. But it does not contain all artefacts made by human beings. It contains analytical data, that is a sample of the variability inherent to human made things. Now the machine can be used. We do not need to relate any aspect of our present lives with a concrete feature of the past. We only need to understand in which way what we are doing can be related with the inherent *diversity* of human action.

> The participants to the virtual consultative meeting have contributed to the machine sharing their data and their knowledge, and now they can use all this integrated body of knowledge to solve their problems. They can discover the meaning of a specific spatial pattern, they can assign chronologies, they can relate material effects to social action, they can understand themselves, with the help of the understandings made by others. But the meeting is not only a consultation session. As soon as knowledge is used to solve a problem, a new bit of knowledge is generated, which can be useful to other people. The machine only grows because it is used. If nobody is interested, if nobody uses the knowledge generated by other, the knowledge will never survive!

What differs our story from a science fiction tale? Here, we are not telling about incredible projects as it is a time-machine, or about some other human dreams which do not dispose the technical means to become reality. The technological bases for this "vision" are real, are functioning, and are being applied in some other scientific disciplines, and even in a lot of ephemeral social activities.

It should not be a science fiction tale to analyze different type of samples, from different sites, when we are still excavating at the archaeological site. Information can be shared *at run time* between the field archaeologist and the laboratory technician. And simultaneously, specialists about this period or past society can be reviewing field data and laboratory results *at run time*, understanding archaeological data in the field with the help of augmented knowledge. And many people can collaborate in the understanding and in the way we extract knowledge from the ground, without being there excavating. That means knowledge sharing and knowledge growth. Everyone learns: the archaeologist in the field, the technician at the laboratory, the archaeologist at the university, the public at the museum, the student at the classroom. The idea is to generate knowledge, to share knowledge and to use knowledge, because only through its use, we will build significant relationships between bits of data which may be useless in their own.

2. Archaeology is getting old

The world we are living in is changing, in front of our eyes. The old world is not dying, but it is being transformed and it seems, in some sense "new". This permanent renovation expands the horizons and accelerates knowledge sharing, circulation and growth. The world in which the wind filled the sails of merchant ships is not dead – only the merchant sailing ships are gone. The wind is now spreading a heavy smoke from fuel, burnt to move merchant ships from shore to shore, but, the "ancient" world of overseas trade is still here, changing the means and accelerating the rhythm through the time, but always serving a well defined purpose. Our own purpose is to discover this trend of human history. The idea of history is always research, to see what cannot be seen, and not to maintain an ancient order, or to justify past ways of doing things.

The "quest" for knowledge about past societies started long-time ago "rescuing" ancient utilities and works of art from mysterious places, and storing them in museums. Later, it was discovered the importance of a good ordering of rescued material. It was so long ago, and so many things seem to have changed in archaeology meanwhile, that sometimes we forgot that we are doing exactly the same things. Maybe we are using new tools, techniques and theories, but the way knowledge is being distributed and the way most people, scientists and general audience, have access to this knowledge has not changed in the last three centuries. Although the accent has moved from acquisition to explanation, the very mechanisms of knowledge production, distribution and use, lacks the necessary dynamics and diffusion. "Epistemological communities", a basic unit in charge to build and to control diffusion of knowledge, are concerned more about knowledge *politics*, and less or none about its *economy* or production/distribution/use (BURKE 2000, 20).

3. COMPUTER APPLICATIONS IN ARCHAEOLOGY

According to the objective possibilities of computer technology, different application domains of this technology in the archaeological process are established. Some schools would give advantage to one domain instead of another, but all will coincide with a majority of the practical necessities, which could be supported by the *machine*: storage, manipulation and data acquisition, as well as graphic, analytic and communicational support (Fig. 1).

The precise usefulness of computer technology can vary from one domain to another. Our assumption is that the advantage of using computer technology, regardless to the immediate usefulness in some particular domains of research, is in knowledge unification. This is the most important goal of tele-archaeology: to progress in knowledge unification and integration through the use of advanced technological platforms. Before modern computer technology, this goal was not even foreseen by archaeologists. But the formalisation in data structuring and inference rules imposed by computers is an advantage we should profit in order to obtain a completely new way of producing archaeologically relevant knowledge.

Computer technology becomes the medium for the cognitive process. We have left the world where paper and pencil were the tools used to generate knowledge. Verbally generated and transmitted knowledge is still useful, but we can go far beyond its limits. Formal knowledge, quantitative or qualitative, expressed in form of concrete data structures and inference rules gives us the opportunity to add knowledge from different sources, and to integrate different voices and thoughts into a single coherent, but diverse body of information, which can be used in an interactive way, without imposing a single way of thinking.

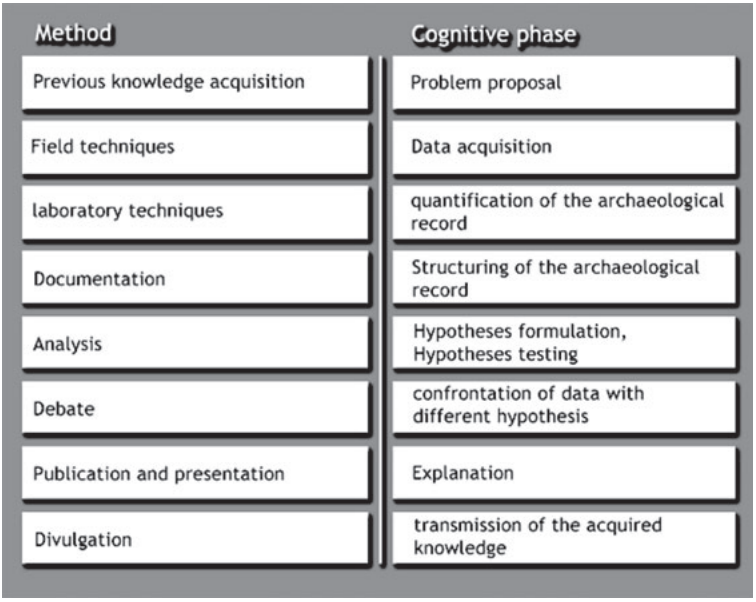

Fig. 1 – Archaeological domains and its respective cognitive phases, where the application of the computer technology is possible.

4. Doing archaeology at distance

Distance appears to be the main problem when we are speaking about synchronized activities on the same object, or, in other words, when we use a specific knowledge (*use* in sense of: obtaining, generating, storing, application). Sometimes, we accept that objects, information and people have to travel (deleting distance), what needs some time, and has some costs. Physical impossibility to be on two distant places simultaneously, leads us to use only one knowledge location (deposit, source, object) at the time. Only in front of a radical situation of urgency or of a material impossibility to "be there", we are obliged to find a solution. That is why the term "telescience" can be associated, at the beginning, with Space research, due to the high costs and time consuming efforts of sending a large scientific crew to a satellite space telescope station.

For Ponyik (2002) telescience is «the ability to conduct a science investigation from a remote location in near real-time», and he provides an example from his own field: «operating science payload on the International Space station from a central Telescope Support Centre (TSC)», on the Earth. True telescience is something more: it is «telescience from one's home office with minimal or no use of a control centre such as a TSC» (Ponyik 2002, 2). A huge distance is drastically reduced, not only between the Space Station and the earth Support Centre, but also between the Space Station and every one of unlimited number of scientists who participate in the project.

The advantages of telescience were assumed in medicine at the beginning of the 20th century last decade. The urgency of application of a specific knowledge on a specific place exactly on time, and the physical impossibility to do that always and everywhere, due to the costs related to distance, are the two main reasons for an orientation towards telemedicine. Telemedicine is used to bring healthcare to distant places, to bring a top expert knowledge and experience to any hospital, to share experience and knowledge among colleagues (see for more information: Telemedicine Research Centre, at http://trc.telemed.org).

Tele-archaeology, in its basic sense, may be defined as the use of telecommunications to provide archaeological information and services. It may be as simple as two scientists discussing over the telephone an archaeological excavation of some data, or as sophisticated as using satellite technology to broadcast an archaeological excavation between specialists in two countries, using videoconferencing equipment. The first is used daily by most archaeologists, and the latter has been used only on a few cases.

Two different kinds of technology make up most of the tele-archaeology applications in use today. The first, called *store and forward*, is used for transferring digital images from one location to another. A digital image is taken using a digital camera, ("stored") and then sent ("forwarded") to another location. When we are not using images, we can store and forward any other kind of data files. However, except in the case of numeric data (images are arrays of numeric data) the process of exchange can be slow and not very creative.

The image or the data file may be transferred within a building, between two buildings in the same city, or from one location to another anywhere in the world. The idea is quite simple, to send images or data from the field to another place for diagnosis and interpretation. For example, readings of magnetic prospection on site, taken by trained student (or whoever from the field team), forwarded to expert geologist, turn back in a form of analysis and profile interpretation.

The other relevant practice of tele-technology, is two-way interactive television (IATV), which is used when a "face-to-face" *consultation* is necessary. You can imagine this consultation between a field archaeologist and a local museum in one location and a specialist or laboratory technician in another location. Consider the case where you need some geological advice to understand the stratigraphy or deposits your are excavating. Videoconferencing equipment at both locations allows a "real-time" consultation to take place. The technology has decreased in price and complexity over the past five years, and many programs now use desktop videoconferencing systems.

There are many configurations of an interactive consultation, but most typically it is from Research Centre-to-archaeological site, between different archaeological sites and different Research Centres… We could mention now a lot of combinations for "face to face" consultation, but essentially it means to cancel the *distance* factor in archaeological knowledge exchange. Tele-archaeology brings knowledge when and where it is needed.

Of course, tele-archaeology is not limited to a consultation between people without knowledge and people with knowledge. The idea is to use telecommunications software and hardware to *share* knowledge. The greater the number of archaeologists using shared knowledge, the greater the quantity of new knowledge that will be generated.

5. Producing archaeological data at distance

Archaeological data are the preliminary source of knowledge. They are produced by archaeologist's action in two different places: the archaeological site, and the laboratory. To transform data into knowledge, we should integrate these preliminary bits of information into a coherent body of problems and solutions. And the only way of doing that is by using data to ask questions and to look for their answers.

A passive transmission of data through telecommunications channels is an example of tele-archaeology, but it is not what we are looking for. The idea is that data produced during the excavation or laboratory work be integrated into already existing knowledge in such a way that knowledge circulates dynamically in the two senses: from the field to the knowledge-base, and from the knowledge-base to the field. As a consequence, knowledge is transformed. Let we see some examples.

Suppose we are excavating an archaeological site. In this case, field data can be expressed in the form of digital pictures and data files with topographical coordinates of artefacts and structures present in the images. Additional data files contain descriptions and measures of excavated materials. If computer availability is limited, we can send those data using any available telecommunications channel (satellite communication, wireless Internet, etc.) to an archaeological laboratory with enough computer equipment. Images are then orthorectified with the help of topographical coordinates, and integrated into a Geographic Information System with all other data sent by the field team. If the GIS is accessible by Internet (IMS Technology, for instance), then the field team can make queries to the system *during* excavation: a laptop or portable computer, or even a palmtop can be used to understand what the archaeologists are excavating at this very moment.

Of course, there is a delay between the sending of data, and its integration into a GIS framework accessible through Internet, but our experience shows that in less than 20 minutes images and topographical coordinate data can be sent to the laboratory, and in half an hour it is possible to orthorectify images and produce a georeferenced mosaic joining all captured images. The integration of all those data into the GIS framework is a bit slower, but given that updates are being produced *at run time*, each update is relatively fast. Data sent in the afternoon, after an excavation day, can be available to query the next morning.

Archaeological excavation is totally transformed in so doing. It is no more a blind unearthing of hidden objects, but an understandable production of new data using a coherent framework made of previous knowledge. You can understand the activity areas, occupation floors, walls, etc. you are excavating, because you can recognise them as such when integrating all data at the same moment you obtain them. It is not a question of waiting for the end of the excavation to understand what you have been making.

Of course, the way we excavate changes. Now you need a minimum of four specialised teams. Three groups in the field, and one field connected through the tele-archaeology network. Groups in the field are: excavators, the people capturing topographic coordinates and making digital pictures, and a documentalist team describing and processing all unearthed materials just after their recovery. The use of the tele-archaeology network does not require any specialised knowledge of computer technology, just using Internet, modems and mobile phones.

Another suggestive example comes from laboratory work. Most of laboratory practice consists in classification or recognition of features at macroscopic or microscopic level (use wear in tools, taxonomic determination of organic remains, fracture patterns, etc.). Therefore we need a lot of comparative material in order to carry out our work.

Archaeological experimentation of ancient labour practices is essential to understand the meaning of what we have observed in the archaeological record. These experimentation and replication activities produce reference knowledge in the form of reference collections for the study of archaeological materials. In most cases, every researcher reproduces the same experimentation in order to construct his/her own collection. In the same way, bioarchaeologists spent a lot of time burning wood or seed, preparing thin sections of wood to be observed through the microscope, cleaning bones, extracting the silica body of plants, etc. The goal is always the same, to obtain comparative samples to study archaeological remains.

Another problem for archaeologists who work in laboratory is related with the impossibility to publish all information recorded. Often there is not enough space in monographs or specialized papers to include all obtained data, specially when these data are a set of detailed measures or long lists of taxa identified in each stratigraphical unit. As a consequence we can not test our hypothesis or we can not develop more ambitious projects beyond data collected from our own site. People are afraid to share unpublished information, so the effort made by many investigators never sees the light.

Nowadays, there is an increasing number of Internet resources providing reference materials for scientific research. Although most of them are not related to archaeology, they are a good example of how to use new technologies to share knowledge. One of these examples is the database created by the International Taxonomic Databases Working Group (TDWG) using a flexible method for encoding taxonomic descriptions for computer processing (Dallwitz 1980). They use the DELTA format (DEscription Language for TAxonomy) as a standard for data exchange (Dallwitz *et al*. 1993, 1995, 2000). Also of related interest, we may quote the reference database created by H.G. Richter and M.J. Dallwitz (2000) which is very useful for archaeological wood and charcoal identification. DELTA has also been the format used to study and publish the wood anatomy of plant remains from the Sahara and the Sahel (Neumann *et al*. 2001). This work has been published in digital format as an interactive method to identify woods, but is no yet available in Internet. Given the cost to publish photographical material of quality, this is an optimal solution to put the information at disposal of researchers interested in a particular subject.

The creation of a standard descriptive language seems therefore the first step to reach the goal to share information about comparative reference material in archaeology. A different problem concerns the creation of databases with data obtained from laboratory research. In this case, it is necessary to establish fields of information that must be recorded, and unification criteria, also with the creation of a standard language, to learn how to record them.

6. Distributive interactive archaeology

The debate about the *unification* of archaeological documentation is oriented to a search for solutions for managing of information dispersed in books, journals and field documentation files, heterogeneous by its character. Propositions for utilization of centralized knowledge bases (Martin 1996) have the advantage of its unquestionable consistency, but it will be almost impossible to apply such a centralized concept in archaeology. Unifications and centralizations of all type, especially when the object is knowledge, can take us to a dangerous deviation, and in a last consequence to the ignorance. To integrate knowledge (or thought, or people, or art) is not necessary to make it uniform.

The DIA-spora project is computer experiment, theoretical research and practical application of dynamic and constructive use of World Wide Web and Internet in archaeology (Bogdanović, Tasić 1998; Bogdanović, Bar-

CELÓ, VICENTE 1999; BOGDANOVIĆ 2002). DIA-spora is the system for a collective construction of the archaeological knowledge in the Internet environment, and it is an interactive method for dinamisation and structuration of data for archaeological research. If Binford's *frames of references* are «special mechanisms for data structuration» (BINFORD 2001, 3), then in our case of interactive method we could speak about *dynamic frames of references*. Dynamic and interactive flux of references, or in other words: previous knowledge, is fundamental for a *reflexive archaeology* as it is understood by HODDER (1999, 178).

We will try to integrate a process of archaeological reasoning and data processing into a unique system. Following the theory of archaeological problem-solving (BARCELÓ 1996, 18), we will experiment with the construction of the environment on the web, which should reproduce the general archaeological research framework.

The objectives of the project are resumed in its title: ***Distributive Interactive Archaeology – synchronized platforms of research activities***.

The Distributive and Interactive Archaeology emerge from the assumption that archaeological knowledge building is a collective work, a dynamic series of tasks and processes. The explanation process needs knowledge as raw material, and this knowledge doesn't exist in mind of one individual scientist. It is distributed within the community of researchers, on a global scale. To be able to interpret data, every researcher needs a previous knowledge on which he/she will make a specific reference (ZANG, NORMAN 1994). The distributivity of the archaeological knowledge and the interactivity of a particular researcher, in DIA-spora is translated as a interaction of documents in all digital formats (distributed on a WEB server) with a final user, using the Interoperable Protocol. A final user can use a knowledge and transform it adding his/her documents and other related data.

Explanation is not only a logical and mechanical operation, but also a social process. This is the reason why the archaeological knowledge should be distributive – coming from a lot of different sources – and interactive – every new information transform a general collective knowledge.

Organized this way, knowledge produced and transformed by one individual scientist can be accessed by other researchers in a real time. This way, the use of the knowledge is synchronized: what I am using and transforming today and here, can be used in any other place, now and afterwards.

The DIA-spora project implements interactive distribution, by applying a *Collaborative Technology* (MAJCHRZAK *et al*. 1999). If we translate these terms into actions, we will say that DIA-spora should provide the synchronized and unsynchronized access to the distributed knowledge to individual users, or to users in the context of a research team. Any user can visualize an information in its original format and context, but if determined applications are run, knowledge can be shared through a series of actions: the new document can be added, comments can be associated to a document, a link of a specific reference with other document can be established, the documents can be ordered, related, compared…

There is no need to replace everything and begin from zero with each new idea. There is a lot of work done in a presentation of archaeological data on Internet, and in digitalization of data and of analytic process. DIA-spora propose solutions on how to overcome incompatibilities.

All applications on DIA-spora run through the Resource Description Framework (RDF), which provides interoperability between applications that exchange information on web (http://www.w3.org/TR/REC-rdf-syntax/). The general task of RDF is a description of resources without any reference to a domain of application, or a semantic definition of any application domain. A definition of mechanism should be neutral, as it has to describe information about any domain.

The idea of circulation or *distributivity* of archaeological information is opposite to data centralisation, and benefits a common right to Cultural Heritage. At the same time, a distributive system favours individual rights, rights of intellectual property, author's autonomy, and is tolerant to methodological and theoretical variability.

The *interactive* character of DIA-spora allows a direct intervention on collective knowledge through the usual research activities, developed in the DIA-spora platforms environment, or on autonomous computer systems (when they are linked to DIA-spora by RDF). The proposed interactive system provides a constant flux of data and knowledge, maintaining a scientific process alive and reflexive.

The *platforms of research activities* in DIA-spora are paradigms of phases of scientific reasoning linked in a relational system. The platforms consist of a series of formal assumptions and requirements for the exchange and adding of data, hypothesis and information, and they are packs of applications for a task related to each platform. Their common background is a relational database system, a system of explicative rules and communication protocols (Fig. 2).

Nevertheless, DIA-spora is not a tool for automatic explicative process, but the method for protection of archaeological record, the method of its critical evaluation, the protocol for information processing and its incorporation in collectively constructed knowledge.

7. Presenting archaeological knowledge at distance

Tele-archaeology applied to Cultural Heritage Management promises an accessible, highly visual, and interactive presentation means for difficult-to-see data, opening up new ways for promoting research, and developing education

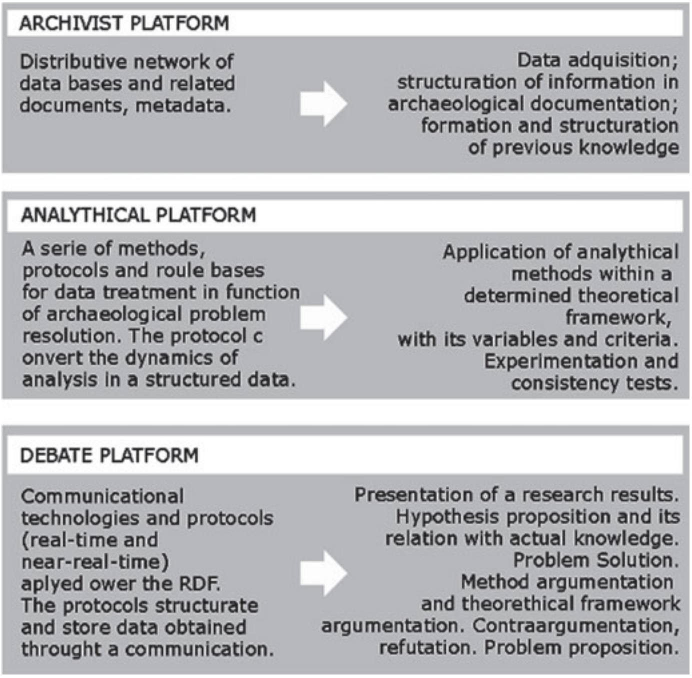

Fig. 2 – Platforms for research activities: methods and technologies for cognitive phases.

and tourist enterprises. The idea is to integrate the visit of museums and archaeological parks with computer visualization of reconstruction models.

However, in most cases the use of computer visualizations in Cultural Heritage Management seems more an artistic task than an inferential process. Virtual Reality is all too often the modern version of the artist that gave a "possible" reconstruction using water-colours. As a direct result of this uncritical acceptance, fundamental questions relating to issues such as what we actually mean by Virtual-Reality, and what our expensively assembled models truly represent have been left largely unexplored. The reconstructions run the risk of being reified, becoming in effect end-products, finished, completed, free-standing and there to be visually devoured (Barceló 2000, 2002). There is a danger that our public face become a mere simulacrum, behind which it is hidden our own technocratic image, consisting of drawings, photography, animation, or three dimensional images, and which will gradually become the identity card of all those who forget that it is merely a club-membership card.

If "interactivity" is the key word in modern tele-archaeology, then we should understand it not as a way of "moving" through a computer representation, but as a "construction" of a cultural or historical explanation. Just as the desktop metaphor allows users to interact easily with a computer, useful interaction metaphors are needed for virtual environment systems. This fact has lead to the concept of "enhanced" or "augmented" reality.

Augmented Reality (AR) has been defined as the simultaneous acquisition of supplemental virtual data about the real world while navigating around a physical reality. It is different to the concept of "immersive reality", where the eyes and ears or other body senses are isolated from the real environment and fed only information from the computer, providing a first-person interaction with the computer-generated world. For information pertaining to complicated 3D objects, augmented reality is an effective means for utilising and exploiting the potential of computer based information and databases. In an augmented reality system, the computer provides additional information that enhances or augments the real world, rather than replacing it with a completely virtual environment. AR provides a natural interface for processing data requests about the environment and presenting the results of requests. The user can then interact with objects in the real world, generate queries, and the computer provides information and assistance. Merging graphical representations of augmenting information with the view of the real object clearly presents the relationship between the data and the object (BARCELÓ 2001).

However, not all interactive tele-archaeology systems are augmented reality environments. We should build tools allowing researchers, students, tourists and any kind of people to "visit" historic towns by interacting with a virtual model based on historical data. It is the case of a virtual reality application of a computer generated *cyberspace*, inhabited by a multitude of participants joined by means of telecommunications. This cyberspace functions because of programming options:

– it is a distributed, three-dimensional inhabitable environment;
– it can support a potentially unlimited number of participants with different knowledge level. In this way, students can obtain answers from researchers, and tourists from museum staff;
– participants use tools to alter the environment while inhabiting it.

The interactive exchange between all kinds of user allows a Collaborative Virtual Environment (CVE). A CVE is a Virtual Environment in which more than one user can be present at the same time. So when a user enters the environment he/she can detect the presence of other users. The CVE medium is thus ideally suited to supporting collaborative learning. Although using complex networks for distributing all kinds of necessary data, this example of tele-archaeological system reinforce the concept of presence. In other words, instead of the fixed and linear nature of current simulation techniques, virtual interaction of real humans (the user) allows the understanding of the complex rules governing what seems unpredictable. A similar approach can be used for the simulation of archaeological excavation, offering the alternatives between a complete animated excavation simulator comparable to a flight simulator, and a database-expert system engine for understanding user actions in the simulated environment. In this way, archaeologists, university students and even high school students and tourists have access to one of the most important elements of our cultural heritage.

This system can also be described as a Virtual Museum. It is a kind of virtual theatre, accessible through Internet or any telecommunications channel from any place in Europe (or beyond), where it is possible to dive into a number of cultural visits through ancient monuments and even historic events. Key elements of such a virtual environment is the ability to not only "really" move in three dimensions, but bridging the gap between the "outside" material world (data) and the conceptual worlds of archaeological and historical explanation. For instance, visitors to the Virtual Museum should be able to view three-dimensional images of remote accessed archaeological sites and utilize telerobotic devices equipped with video cameras to view three-dimensional works and participate interactively, in real time, in art performances and installations.

This new approach to the Cultural Heritage Management for research, education, tourism etc. requires the development of new telecommunication facilities for the realisation of the requested "interactivity". However, modern technology is restricted to the creation of virtual environments, whose purpose is to sense, manipulate, and transform the state of the human operator or to modify the state of the information stored in a computer. We think that the advancement of virtual reality techniques in Cultural Heritage Management should not be restricted to "presentation" techniques, but to explanatory, integration and teledistribution tools. Description is not explanation; it is only a part of the explanatory process, and Cultural Heritage should not be limited to the presentation of past remains.

Cultural Heritage is the only way we have for understanding our society through the analysis of its formative process. We suggest the use of VR techniques, integrated with Artificial Intelligence and Telecommunications not only for description, but for expressing all of the explanatory process. An explanation can be presented as a visual model, that is, as a virtual dynamic environment, where the user may ask questions in the same way that a scientist uses a theory to understand the empirical world. A virtual world should be then a *model*, a set of concepts, laws, tested hypotheses and hypotheses waiting for testing. If in standard theories, concepts are expressed linguistically or mathematically, in virtual environments, theories are expressed computationally, by using images and rendering effects. Nothing should be wrong or "imaginative" in a virtual reconstruction, but according to what we know, dynamically, interactively modifiable. As a result, we can act virtually over inaccessible artefacts, buildings and landscapes *through* their models.

8. Tele-archaeology: more than a simple word

The advantage of tele-archaeology in respect of traditional Cultural Heritage Management is evident. 3D computer graphics, solid modelling, alternative human-computer interfaces, Artificial Intelligence-based queries and analysis, remote access networks, teleprocessing, sharing of computer resources and many other techniques and approaches can be used to facilitate public access to cultural phenomena, to improve comprehension, and allowing new degrees of public education. Computer models of archaeological buildings or artefacts, for instance, can be linked to text, image, and sound databases permitting self-guided educational or research virtual tours of ancient sites in which users can learn about history, construction details, or daily life with a click of the mouse. New techniques in telecommunications, interfacing, and augmented reality will permit onsite and remote inspection and manipulation of three-dimensional museum objects.

The next generation of communication and information technologies (Next Generation Internet, Digital Television, Large Shared DataBase (Data GRID, etc.), visualisation technologies (Virtual Reality, etc.), Artificial Intelligence etc. seem to be very promising for the objectives considered. This advanced technology will allow innovative experiments in creating, manipulating and aggregating knowledge. Nevertheless, to be able to use in a creative way this new technology, we need a deeper study of the specific aspects of the new technologies useful for increasing the access to scientific knowledge on European Cultural Heritage. That means, to increase the collaboration between museums, universities, schools, research groups, and cultural associations, in such a way that information flows from knowledge creators (research centres) to cultural heritage customers (museums, schools, tourist groups, etc.). Of course, we are not speaking about a one way flow, but a network of questions and answers from one side to the other.

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ABSTRACT

Tele-archaeology, in its basic sense, may be defined as the use of telecommunications to provide archaeological information and services. Two different kinds of technology make up most of the tele-archaeology applications in use today. The first is used for transferring information from one location to another. The other is multi-way interactive knowledge distribution. In this paper we examine the possibilities of tele-archaeology, and offer a general framework to implement this technology. The main positive effect of tele-archaeology is the move towards a real "distributed interactive archaeology", which means that archaeological knowledge building is a collective and dynamic series of tasks and processes. An individual archaeologist cannot fully explain his/her data because the explanatory process needs knowledge as raw material, and this knowledge does not exist in the individual mind of the scientist but in the research community as a global set.