UOC
www.uoc.edu

Digit·HVM. Revista Digital d'Humanitats
May 2004 ISSN: 1575-2275 No. 6
www.uoc.edu/digithum

Article

Archaeology, museums and virtual reality

http://www.uoc.edu/humfil/articles/eng/pujol0304/pujol0304.pdf

Laia Pujol

Digit·HVM. Revista Digital d'Humanitats
May 2004 ISSN: 1575-2275 No. 6

Article

Archaeology, museums and virtual reality*

http://www.uoc.edu/humfil/articles/cat/pujol0304/pujol0304.pdf

Laia Pujol

Abstract
This article looks at the idea that the virtual archaeological reconstructions seen in museums cannot be considered Virtual Reality (VR) as they are based on an artistic conception of the discipline. The cause is to be found in the origins of Archaeology, which began in the 18th century and was closely linked to the History of Art. In the era of New Technologies, this concept has become both the cause and the consequence: determining the characteristics of VR from within the discipline, whilst simultaneously reinforcing the virtual reconstructions.
To assess the relationship between VR and Archaeology, we must first establish a definition of Virtual Reality. Subsequently, we can take a brief look at the history so as to be able to understand the evolution of Archaeology and museums. This leads us to the analysis of some examples of VR in museums, from which we can gain conclusions on the current use of VR. Finally, we look at the possibilities for VR in terms of publicising Archaeology.

Keywords
virtual archaeological reconstructions, virtual reality, museums, Archaeology

Introduction

The boom in new technologies, which aid the circulation of information at high speeds and in different formats, is radically transforming the traditional paradigm of communication. The formation of «cyberspace» has given way to «cyberculture», which, according to (Lévy 1999), can be seen to be a new era in the history of humanity, characterised by interconnection of different lesser contexts to form a large virtual space that can be accessed remotely. This leads us to question the role of the traditional forms of obtaining and transmitting knowledge, particularly in the case of archaeology, which brings together computational techniques in the different phases of the research process, from fieldwork to publicising.

In this last aspect, museums have been framed by the traditional interchange of knowledge between archaeological research and the non-specialist public. The adoption of ICT has accelerated the trends begun with the **new museography** that, since the last third of the 20th century, has looked to transform the Victorian conception of the museum as a temple to knowledge, broadcaster of a standardised and static discourse based on objects, converting it into a node to transmit a range of information and circulate ideas. This has led to an enormous increase in the importance of educational and pedagogic criteria.

One of the most successful introductions has been that of virtual reconstructions, which, shown as exhibitions or web pages, substitute the original remains. Most of these reconstructions consist of closed, static and hyperrealistic images of objects, characterised for their high artistic or architectural value. This has nothing to do with virtual reality, which is understood to be a dynamic and explanatory model. This difference means that virtual reconstructions in archaeological museums are not based on the definition of virtual reality, instead being based on a completely different concept.

* This article is based on the Post-Graduate Research Work presented at the Autonomous University of Barcelona (Pujol 2002). The work forms part of a PhD thesis project that received a pre-PhD grant for personal researcher training (RT), awarded by the Catalan regional government's Department of Universities, Research and Information Society (DURSI) within the framework of the 3rd Research Plan for Catalonia 2001/2004.

A complex concept

VR is not a univocal concept. This can be seen in its origins, given that successive terms were coined to designate each stage in the transformation of the technology:

- Myron Krueger (1970s): Artificial Reality
- Jaron Lanier (1989): Virtual Reality
- William Gibson (1984): Cyberspace
- 1990s: Virtual Worlds or Virtual Environments
- 1990s: Enhanced or Augmented Reality

Indeed, these terms do not mean the same thing, instead they refer to different, often overlapping, aspects of the same complex reality.

The origins of virtual reality

The father of virtual reality is Myron Krueger, who, in 1974, in his PhD thesis talked of «artificial reality» as a digital substitute to the real world. Myron Krueger's definition already held the main elements that characterised VR, in general terms:

- It is wholly computer generated.
- It is interactive.
- Immersibility is also a fundamental characteristic at this stage of development.

Artificial reality formed part of scientific theory, but soon entered the collective imagination through science fiction literature and films (image 1). Its being made banal by the leisure industry and the technical impossibility of reproducing such a complex reality led to disappointment. It is for this reason that, towards the mid-1990s, these expectations led to the conviction that the true function of VR was to simulate the real world through independent mathematical forms that allowed for the interpretation of specific aspects thereof (Gillings and Goodrick, 1996).

The change from «artificial reality» to «virtual reality» shows the move from one reality which, as a substitute for the world, had to be wholly immersive to a «hyperreality» which looked to increase knowledge of certain aspects or phenomena and, thus, merely required a partial reconstruction. The adoption of this new conception brought with it the appearance of different branches within virtual reality: immersive virtual reality and augmented reality.

Immersive virtual reality

IVR can be considered to be a direct evolution from Myron Krueger's artificial reality. In this type of VR, the computer generates all the information received within an isolated environment, separated from the real world (Brooks, 1999, p. 16). Images 2, 3 and 4 show three possibilities for entering the virtual world.

Image 1. *The Lawnmowerman*. One of the first appearances of virtual reality in cinemas

In IVR, the reference for visualisation is the head, which constitutes a natural interface for navigating through the space. This is shown on a human scale and has objects that can be interacted with realistically, given that the virtual world can be manipulated. Other resources for augmenting the feeling of reality include stereoscopic vision and tactile and audio technologies (Beier, 2001). For this reason, according to some experts (Brooks, 1999,

Image 2. Window on a World-type (WoW) virtual reality

Image 3. Head Mounted Display device

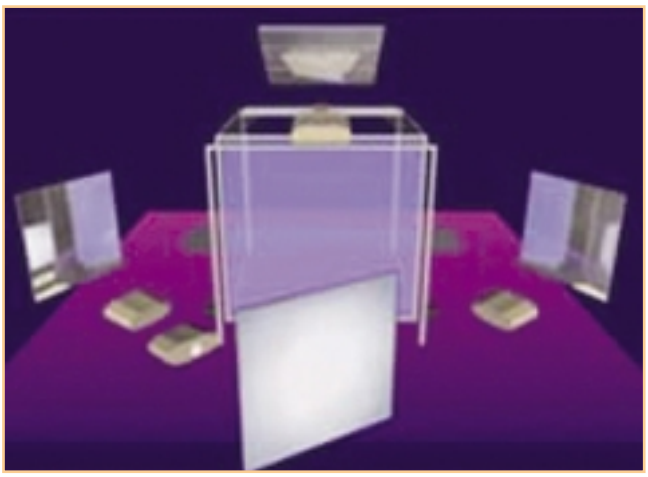

Image 4. CAVE

p. 17), PCs cannot be considered IVR, as they do not offer complete and realistic immersion: it is as if the user were looking through a window.

Augmented reality

For most specialists this does not constitute a separate technique, but, as with IVR, a derivation of the general concept of VR. Its objective is to improve people's interaction with the real world by providing them with information that cannot be perceived directly by their senses (More, 1995). Its characteristics are as follows:

- Interaction in real time (shared with VR).
- 3D recordings (required, as the workplace is reality).
- Combination of real and virtual worlds (specific to augmented reality).

The concept of AR differs to that of IVR as the latter creates a simulation based on the real world, whereas the former attempts to «augment» the surroundings, and this means that the sensation of physical presence in the real world has to be maintained. This difference in the relationship with the surroundings also imposes technical needs: IVR has to adapt virtual images to human movements; AR has to reproduce real images on which the virtual images can be superimposed.

A general definition of the concept

Most definitions of VR can be classified as one of the two following orientations: technological or epistemological. They are the two possible dimensions of the concept, which need to be brought together in a general definition.

The description of the type of interface is a neutral approximation and can be applied to any example. Despite this, the complexity of the «uses» of VR are not taken into account. Figure 1 orders all the possible meanings of the concept on two axes.

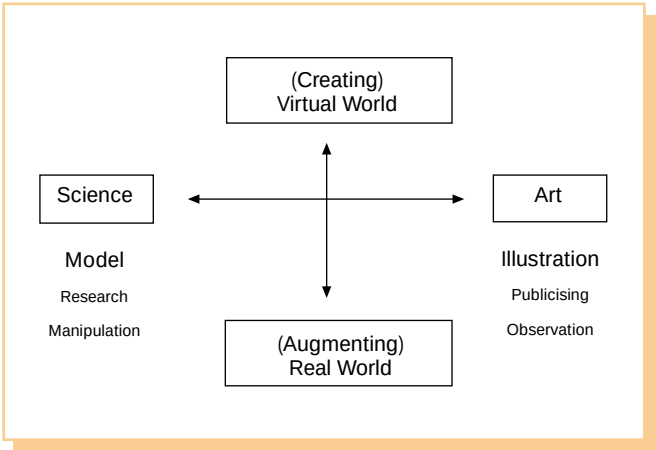

Figure 1. Definition of virtual reality

The vertical axis represents the type of VR: from the construction of a virtual world (IVR) to the augmenting of reality (AR). The point in common is interaction. The horizontal axis represents the uses of VR: the closer to science, the more it is conceived as a research model; the closer to art, the more it becomes a static image designed for publication and contemplation.

A brief history of archaeology

Interest in previous civilisations and their material vestiges was to be seen as early as the Aztecs or Babylonians. In Europe, from the Renaissance onwards, «cabinets of curiosities» began to appear, which contained a blend of antique and exotic natural objects. From the 18th century onwards, some owners started increasingly systematic exca-

vations of monuments that could be seen on their land, so as to recover the architectural remains and other objects of artistic value, which they then classified in accordance with stylistic logics. The birth of archaeology, as we know it, can be situated in the 19th century when the age of the human being was recognised and demonstrated and the bases for current research techniques and methodologies set. In the 1960s, the **new archaeology** revolutionised this tradition of historical classification and a completely scientific discipline was proposed. This ambition has been greatly criticised by postmodernist postulates (Renfrew and Bahn, 1993, pp. 20-42).

The origin of the use of quantitative methods and computational applications in archaeology dates back to the second half of the 20th century, when certain scientists used archaeological examples to verify solutions to their problems. Since the discovery of carbon 14 and mass access to computers, the «hard sciences» have progressively impregnated each of the phases of the archaeological research process, from the excavation to the publicising (Doran and Hodson, 1975, pp. 4-5). Despite the holding of several international congresses, a concept has not spread throughout the practice and to an even lesser extent the general theory of archaeology: in most cases the old tradition centred on the recovery and description of objects and structures persists.

The precedents to VR are to be seen in the models and drawings which show monuments in a specific era. PCs brought added advantages in terms of three-dimensional images that could be easily transported and modified (Reilly, 1991, pp. 134-135). Likewise, some researchers see them as more than simple illustrations: they were dynamic visual research models (Reilly, 1992). These two conceptual lines are those currently developed.

A brief history of museums

The precedents to museums are also to be found in the «cabinets of natural curiosities» of the 16th century, whose origins are entwined with those of archaeology. These collections of diverse objects were a sign of the economic prestige of the social elite and inaccessible to those outside a small exclusive group. Access to private collections began to grow with the Enlightenment and, above all, the workers' revolts of the 19th century, but entrance continued to be considered a privilege. The development of nationalist thinking was the basis for the great national museums, universal accumulators of objects, destined to show the State's grandeur in the past (founding civilisations) and present (imperialism). The 19th century was also fundamental, as the great universal exhibitions convinced curators of the need to open their collections to the wider public and present the objects in a way that they could be understood (Koester, 1993, pp. 5-6). During the 20th century, these collections were not only designed to educate, but also to entertain.

The most important change to museums came in the 20th century and was due to a series of interrelated factors: the arrival of the information society, market influences through competition in the leisure and tourism sector, democratising of access to knowledge and, finally, the changes in educational theory and practices (Hooper-Greenhill, 1998).

In this context of change, ICT (the Internet, expert systems, databases, multimedia, etc.) accelerated the process through which museums abandoned their traditional function as centres broadcasting a standardised and authoritative discourse based on objects and became nodes for communication, information, interaction and dynamics.

The reality of virtuality

Twenty years after the great boom in VR in museums, their relationship is still difficult to define. It is increasingly used, but irregularly and superficially as the transformation in museology and museography of the 20th century has not wholly permeated the sector. The social role of the museum has been modified, as have the notion and means for communication, but the aim is still a traditional one. It is for this reason that technology is seen to be something alien to museums: it is negative competition, yet necessary as it attracts visitors. To justify their reticence, museum managers produce technical arguments, but, at heart, this reticence comes from the historical and philosophical roots of museums (Sanders, 2002). This lack of confidence comes from the fact that they still understand VR in terms of the old conception, ie, as being a perfect substitute for reality. They also have doubts as to the credibility of virtual reconstructions as they do not consider them to have any value beyond being attractive images.

It is evident that VR cannot be used properly without there being a change in the museographic conceptions and the removal of the object from the centre of their universe. VR also requires a change as it proposes a different paradigm for communications, replacing passivity with interactivity, the contemplation of artistic values with the construction of knowledge, elitism with social and intellectual diversity. VR is a computational technology for the interactive simulation of reality. It constructs virtual models that have certain properties that have to be understood and analysed dynamically, ie, through the transformation of the model in response to the data introduced (Barceló, 2001). Even the choice between immersive and augmented virtual reality ensures the introduction of a better approach for understanding the phenomenon, process, etc.

The evolution of archaeology shares some points with that of museums, as the discipline was born from within the history of art. Despite an obvious evolution (in part caused by ICT), the concept of archaeology and its publicising continues to be closely linked to objects and monuments and their artistic value. This can be seen if we analyse examples of the virtual reconstructions of archaeological sites in Europe: they are more akin to an artist's impression than to the scientific model proposed in the definition of VR.

Some examples of virtual reality in museums

A window on the past

Dudley Castle (Boland and Johnson, 1997) (image 5) represents the most common application: the virtual world appears on screen

Image 5. Dudley Castle

and can be observed or navigated though from a superficial point of view.

Walking through a virtual world

The CAVE system is better than a screen as it can hold groups (museum experiences are always collective) and reproduces the actual atmosphere at given sites with a greater level of realism, for example the Dunhuang caves (Weidenhausen and Stricker, 2000) (image 6).

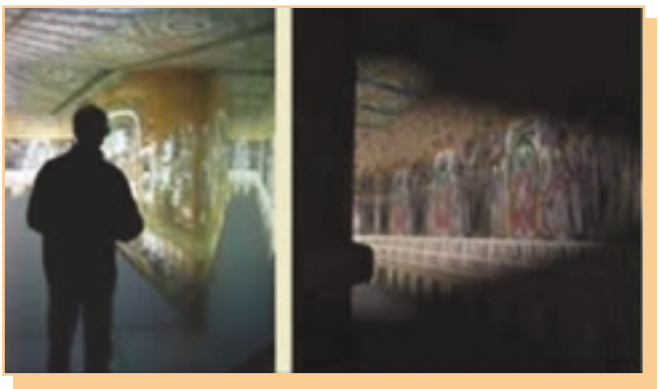

Image 6. Dunhuang caves, CAVE system

The Virtual Theatre (image 7) also increases the levels of understanding of objects in their original context. It allows for scenes to be viewed at 1:1 scale on a large panoramic screen and, thus, is very useful for showing landscapes and urban environments (Guidazzoli, 2002). VT is the mid-point between WoW and CAVE, as it takes the idea of the image as the media for communicating information and extends it until it becomes semi-immersive.

Image 7. Virtual Theatre

In both cases, the audience plays a passive role as an observer and, at most, can navigate through highly realistic images.

Augmenting reality

ARCHEOGUIDE (image 8) provides information *in situ* on the archaeological remains and completes them with a superimposed virtual image of their state in their «moment of splendour». Different ways of naturalising the interface and integrating the technological resources in the exhibition's discourse are explored in the three types of mobile unit.

Ename974 (Callebaut, 2002) (image 9) is another example of a hybrid: it is a solution that falls between AR and traditional VR, which we could call «static AR», as the images are superimposed from fixed boxes distributed throughout the site.

AR proposes a new type of visit as it can combine a physical visit with navigation through space and time, which is perfect for archaeology. Despite this, in actual applications it is still focusing

Image 8. ARCHEOGUIDE

Image 9. ENAME974

Image 10. Iberian site at Els Vilars

overly on the presentation of the way the objects or monuments originally looked.

Virtual reality in Catalonia

In Spain, Catalonia is pioneering in research into ICT thanks to the great number of initiatives being pursued at its public and private institutions. From among all the examples available, three cases have been chosen that best reflect the «Catalan» conceptions of VR.

The reconstruction of the Iberian site at Els Vilars (Junyent and Lorés, 2000) (image 10) is seen as an extension of the archaeological record. The model uses different media for communication (the museum, the Internet and visit *in situ*), to which the characteristics of VR are adapted. Navigation from the natural surroundings to the inside of the houses allows for the visualisation and greater understanding of the archaeological remains. At the Virtual Mur Castle (Sancho, 2001) (image 11), however, the reconstruction has been designed to support university education as a metaphor for navigation through the knowledge on the daily life in the late Middle Ages. The Baths of Baetulo (Gurri Costa and Gurri Costa, 2000) (image 12) also offer information on the daily life of the Romans using the archaeological remains, but the level is not as

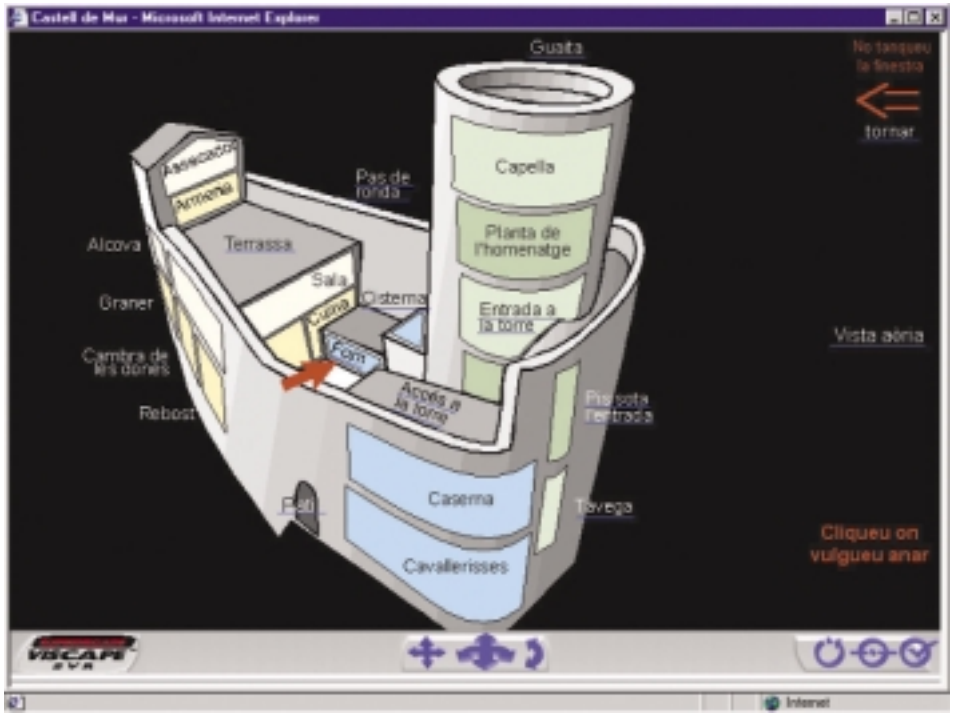

Image 11. Virtual Mur Castle

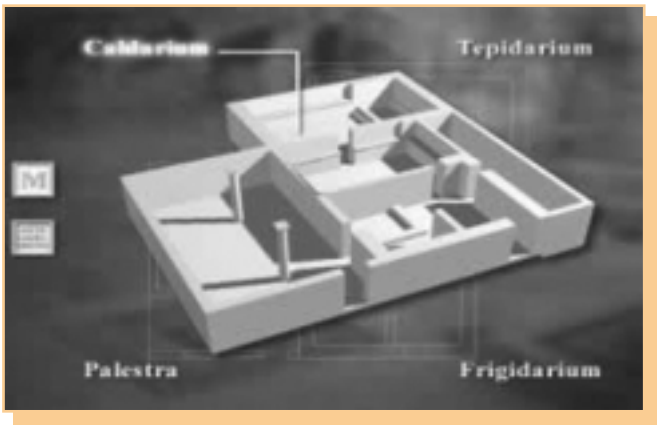

Image 12. Baths of Baetulo

complex as it has been designed for the wide range of audience visiting the museum.

The above examples show that VR is seen in Catalonia as a part of the multimedia environment designed to transmit knowledge on daily life in the past. This holds two implicit ideas: the assimilation of heritage and the past, and the static conception of VR. In this way, then, interactivity comes from the flexibility of the multimedia environment, not from the reconstruction, despite, in the second case, its being used as a metaphor to organise the information. This also shows the existence of different European trends in terms of the practical meaning of VR: in Catalonia, it is used for teaching and education; in Italy, it is more to do with the documentation of the heritage and in the Anglo-Saxon world it used to a greater extent as a tool for management.

What can we say about virtual reconstructions?

The analysis of the different examples chosen, compared with the definition of VR and the theoretical conception of archaeology, brings us to three conclusions:

- The level of realism always depends on the technological capacities and not the type of interface, use of the model or original archaeological data. VR does not explain life in the communities during a specific historical period; instead, it offers a static hyperrealistic description of the monument, which does not distinguish between the actual remains and hypotheses.
- Virtual reconstructions allow for navigation, but this is a purely technical interaction. Despite emphasising the potential of VR for learning, it is impossible to alter the model: it is not seen as an exchange, but as a one-way broadcast of information.
- There is an imbalance between the potential possibilities of VR and its current use in exhibition discourse. This is due not only to an uncritical adoption imposed by fashion and economic interests, but also and above all by a descriptive and artistic conception of archaeology and archaeological museums, reinforced by the current definition of heritage and its associated legislation.

The arrival of virtual heritage is a response to this phenomenon: it represents the artistic point of view on VR, in detriment to its actual capabilities. VH defines virtual reconstructions as a vehicle for preservation, access and economic development at the service of archaeological remains valued for their artistic qualities. It offers detailed and static illustrations of the monument at a previous time, showing undeniable truths from life in the past.

It seems that the technological evolution of VR depends on the interrelation between realism and interactivity, which leads to their stimulating or limiting each other. Despite this, in the case of archaeology, resources have been systematically destined to illustrative hyperrealism, without taking into account the scientific and didactic possibilities offered by interactivity. As a result, only very recently has low cost VR started to be developed (Anderson, 2003; Meister and Boss, 2003) (image 13). It represents the opposite of virtual heritage, as it demonstrates that to understand most archaeological phenomena a high level of realism is not required, with dynamic models to simulate spatial data proving more effective. Low cost VR is a possibility for the future for the following reasons:

Image 13. Low cost VR

- It is less expensive.
- It allows for the rapid creation of large models.
- Virtual worlds can be populated.
- It has an enormous interactive capability.
- The videogames industry invests heavily and the quality of graphics improves rapidly.

Low cost VR shows that there are different types of VR, each designed for a different environment, objective, etc. In each case, they have to share a common element, interactivity; if not, they cannot be considered «virtual reality».

Virtual reality as a tool for science and publicising

If archaeology is defined as a scientific discipline that looks to explain present phenomena through the material remains from the past, VR has to be an especially useful tool as it is interactive and can reproduce spatial links and bodies. VR accomplishes the following functions:

- Virtual model; thanks to its dynamism, it allows for the validating of hypotheses (architectural solutions, reconstruction of fragmented objects, transformation of an element over time, etc.).
- It is a flexible tool for visualising the site and its surroundings. It can aid in the management and protection of the excavation by simulating the original context.
- It contributes to defining abstract ideas and providing evidence for spatial patterns.
- It aids the storage of data, which instead of being dispersed is organised in a coherent model which takes a visual form.
- Virtual reconstructions become objects for study in their own right. As an interpretative model, they show the inferential chain and, thanks to this transparency, contribute to specialised theoretical debate.

As with any other language, VR serves to transmit information over different media (Forte, Kay *et al.*, 2003). In the specific area of museums:

- VR helps preserve the heritage thanks to virtual replicas or reuniting disperse remains (reconstruction of objects and monuments linked to their original context).
- Use *in situ* and over the Internet means that contact between the public and heritage is not lost when access is closed due to restoration or conservation needs.
- VR allows for the relating of objects and ideas through coherent, flexible and non-linear discourse; this avoids comprehension that is overly abstract or deferred.
- As a metaphor for navigation, it offers a conceptual and spatial preview of a place and allows for a more comfortable exploration of the exhibition.
- Thanks to the interactivity, this exploration is not limited to passive contemplation: the visitor has to actively construct their knowledge and this increases motivation.
- As part of a multimedia environment, the different formats for presenting information can be adapted to individuals' skills; whilst all of them together complement and reinforce learning.
- Understanding of the archaeological methodology and time processes is aided through simulations.
- It transcends the walls of the museum as it shows realities that this cannot contain, such as landscapes, houses, etc.
- It also allows for experiments with machines and mechanisms to aid understanding of how they work.
- At the site, AR offers permanent assistance to visitors; it serves as a spatial guide and offers a range of information in real time.

Conclusions

As a rule, archaeologists demand many things (image 14): a precise reproduction of the archaeological record, a flexible database, a scientific tool for data interpretation, etc. VR makes all this possible, as it meets all these conditions: it is a realistic visualisation, a data management tool and contains a geometric database that can be analysed spatially. It is also a language for communication that shows the public archaeological methodologies and conclusions, adapting them to their characteristics and to the elements reconstructed.

Image 14

The public's perception of the technology is always conditioned by technical, social, cognitive and other factors, but there is an invariable element: visualisation is more than the simple passive contemplation of things; it is an active construction based on an explanatory simulation of the reality. Its use depends on the tools that accompany it, ie, the type and level of interaction. In the same way as there are different ways of conceiving or presenting time and space, so there have to be different types of VR.

References

ANDERSON, M. (2003). «Computer games and archaeological reconstruction: The low cost VR». In: W. BÖRNER; J. EHRENHÖFER; M. GORIANY. *Enter the past. The e-way into the four dimensions of cultural heritage.* Vienna, CAA2003: in press.

BARCELÓ, J.A. (2001). «Virtual reality for archaeological explanation. Beyond picturesque reconstruction». *Archeologia e Calcolatori*. Iss. 12, pp. 221-244.

BEIER, K.P. (2001). *Virtual reality: A short introduction, virtual reality laboratory.* University of Michigan, 2002.

BOLAND, P.; JOHNSON, C. (1997). «Archaeology as computer visualisation: 'Virtual tours' of Dudley Castle c. 1550». In: T. HIGGINS; P. MAIN; J. LANG. *Imaging the past. Electronic imaging and computer graphics in museums and archaeology*. London: The British Museum. Iss. 114, pp. 227-234.

BROOKS, F.P. (1999). «What's real about virtual reality?». *IEEE Computer Graphics and Applications* [online article]. Iss. 19 (November-December), pp. 16-27. <http://www.cs.unc.edu/~brooks/WhatsReal.pdf>

CALLEBAUT, D. (2002). «The experiences of the Ename 974 project with new media: Where and how do virtual reality and interactivity fit in?» In: F. NICCOLUCCI. *Virtual Archaeology*. Proceedings of the

VAST Euroconference (Arezzo, November 24th-25th 2000). Oxford: *Archaeopress*, Iss. 1075, pp. 179-185.

DORAN, J.E.; HODSON, F.R. (1975). *Mathematics and computers*. Cambridge: Harvard University Press.

FORTE, M.; KAY, S.J. *et al.* (2003). «Aksum project: a virtual reality multi platform for reconstructing archaeological landscapes». In: W. BÖRNER, J. EHRENHÖFER, M. GORIANY. *Enter the past. The e-way into the four dimensions of cultural heritage.* Vienna, CAA2003: in press.

GILLINGS, M.; GOODRICK, G. (1996, autumn). «Sensuous and reflexive GIS. Exploring visualisation and VRML». *Internet Archaeology* [online article]. Iss. 1.
<http://intarch.ac.uk/journal/issue1/gillings_toc.html.>

GUIDAZZOLI, A. (2002). «Experiences of immersive graphics for cultural heritage». In: F. NICCOLUCCI. *Virtual Archaeology*. Proceedings of the VAST Euroconference (Arezzo, November 24th-25th 2000). Oxford: *Archaeopress*. Iss. 1075, pp. 89-92.

GURRI COSTA, J.; GURRI COSTA, E. (2000). «The baths of Baetulo: from archaeological to virtual reality». In: J.A. BARCELÓ; M. FORTE; D.H. SANDERS. *Virtual Reality in Archaeology*. Oxford: *Archaeopress*. Iss. 843, CD-ROM.

HOOPER-GREENHILL, E. (1998). *Los museos y sus visitantes*. Gijón: Ediciones Trea.

JUNYENT, E.; LORÉS, J. (2000). «Virtual reality as an extension of the archaeological record: reconstruction of the Iron Age fortress Els Vilars (Arbeca, Catalonia, Spain)». In: J.A. BARCELÓ; M. FORTE; D.H. SANDERS. *Virtual Reality in Archaeology*. Oxford: *Archaeopress*. Iss. 843, CD-ROM.

KOESTER, S.E. (1993). *Interactive multimedia in American museums*. Archives & Museum Informatics. Technical Reports, 16.

LÉVY, P. (1999). *Ciberespai i cibercultura*. UOC. 2002.

MEISTER, M.; BOSS, M. (2003). «On using state of the art computer game engines to visualise archaeological structures in interactive teaching and research». In: W. BÖRNER; J. EHRENHÖFER; M. GORIANY. *Enter the past. The e-way into the four dimensions of cultural heritage.* Vienna, CAA2003: in press.

MORE, M. (1995). *Virtue and virtuality. From enhanced senses to experience machines*. [online article]. [Date of citation: 2002].
<http://www.maxmore.com/virtue>

PUJOL, L. (2002). «Arqueologia i realitat virtual: una aproximació a partir de les reconstruccions virtuals als museus». *Antropologia Social i Prehistòria*. Barcelona: Universitat Autònoma de Barcelona, Iss. 121.

REILLY, P. (1991). «Towards a virtual Archaeology». In: K. LOCKYEAR, S.P.Q. RAHTZ. *Computer applications and quantitative methods in Archaeology 1990*. Oxford: *Archaeopress*. Iss. 565, pp. 133-139.

REILLY, P. (1992). «Three-dimensional modelling and primary archaeological data». In: P. REILLY, S.P.Q. RAHTZ. *Archaeology and the Information Age. A global perspective*. London: Routledge, pp. 147-176.

RENFREW, P.; BAHN, P. (1993). *Arqueología. Teoría, métodos y práctica*. Madrid: Akal.

SANCHO, M. (2001). *El castell de Mur virtual*. UOC. 2002.

SANDERS, D.H. (2002). «Virtual archaeology and museums: Where are the exhibits?» In: F. NICCOLUCCI. *Virtual Archaeology*. Proceedings of the VAST Euroconference (Arezzo, November 24th-25th 2000). Oxford: *Archaeopress*. Iss. 1075, pp. 187-194.

WEIDENHAUSEN, J.; STRICKER, D. (2000). «New technologies for cultural heritage: The Siena cathedral and the Dunhuang cave. Prospects of augmented reality in European cultural heritage sites». In: M. ROUSSOU. *Peania*, Intracom, S.A., pp. 29-38.

To cite this document, you could use the following reference:

PUJOL, Laia (2004). «Archaeology, museums and virtual reality». *Digithum* [online article]. UOC. No. 6. [Date of citation: dd/mm/yy].
<http://www.uoc.edu/humfil/articles/eng/pujol0304/pujol0304.pdf>
ISSN 1575-2275

Laia Pujol
Researcher (Autonomous University of Barcelona)
laia.pujol@uab.es

She studied at the University of Bordeaux - I (*Maîtrise*) and the Autonomous University of Barcelona, where she graduated in History in 1999 and was awarded an extraordinary Prize for the course. She is currently a researcher at this university and developing her PhD thesis project, under the title: *Archaeology, museums and computers: analysis of the use of virtual reality in the publicising of archaeology through the design of a museographic project*. Her areas for research are prehistory, quantitative archaeology and teaching archaeology, in relation to which she has produced several publications and collaborated in the organisation of seminars and congresses.