Reconstructing past landscapes for virtual museums

Ivana Cerato, Sofia Pescarin

CNR-ITABC, Virtual Heritage Lab, Via Salaria, km 29, Monterotondo St., Roma, Italy
{ivana.cerato, sofia.pescarin}@itabc.cnr.it

Abstract. For the present work, we have considered two types of users: common users (mainly not expert on the content) and expert users (belonging to the scientific community).We have assumed that the main aim for common users, is to understand the past, to live an experience and build "affinity, empathy" that can help in finding joy and motivation to increase their knowledge. On the other side, expert users, have other requirements: they need to read a reconstruction, propose alternative possibilities of sites and landscape reconstruction. This represents a shift from past research with a significant impact on how material culture is documented and understood.

Keywords: landscape reconstruction, transparency, data integration, visualisation, dissemination, virtual museum

1 Introduction

The reconstruction of ancient landscape is a challenging research activity that implies the management of a high level of uncertainty, on one side, and, on the other, requires the cooperation of several different disciplines.

The traditional two-dimensional mapping output from GIS was not enough to represent landscape complexity and dynamics. Static visualisation, moreover, could not fully answer the request of updating interpretations and simulations. For these reasons three-dimensional modelling and interactive applications have been more and more adopted by the scientific community, coupling the growing interest of not expert users for virtual reconstructions and interactive/immersive virtual museums.

No matter how many disciplines are involved, no matter how much information is acquired on the field, in the archives, etc., the whole picture would never be complete, the number of variables being always too high.

Although landscape has significantly changed (or completely disappeared), we could still use and integrate within a GIS environment available information from very different sources, such as archaeology, cartography, historical geography, soil science, geophysical surveying, geomorphology, landscape and historical ecology.

Through landscape analysis, remote sensing, cross-disciplines analysis we are able to highlight a full range of aspects of past landscapes; through interactive or not inter-

active visual applications it become easier to communicate them to wider audiences, in most cases far away from the landscape under study.

The archaeological landscape, as we can observe today, is the result of a long process of transformation and it is very important to store diachronic relations describing as territory and sites changes over time, to propose a reliable interpretation of the ecological context. The digital reconstruction of the archaeological landscape is a very complex process, which includes considering many kinds of data and setting up several activities, in a multidisciplinary approach. Environment and archaeological structures can be reconstructed through different techniques and data sources, integrated in a coherent methodology of processing and communication: (such as cartography, remote sensing, photo-interpretation, field survey, laser scanner and photogrammetry). Each technique/source is selected according to the type of structure, its characteristic and to needed information (fig. 1). The management of these data is an essential task for the use, analysis and communication of the information gathered.

Fig. 1. Landscape reconstruction workflow.

Digital and spatial technologies are changing how archaeology and related disciplines approach the past, in relation to the contemporary world. These technologies provide alternative ways to study and understand past and present

2 Uncertainty towards transparency

One of the most important research challenge in landscape digital reconstruction is the definition of how digital models may be used to convey uncertainty and different hypotheses of how buildings were constructed or used, which relation they have with the territory, to examine relationships among different phases of the same site, to explore visibility inside and outside structures. On the other side, one of the critic commonly raised by archaeologists is that 3D models are a “closed box”, with no possibility of evaluation and often without a particular aim, the emphasis being on computer graphics and artistic aspects, rather than on the attempt to solve a particular scientific problem. 3D reconstruction (reality-based or not reality-based [15]) have to declare the methodology and the type of data from which they have been obtained, so to allow discussion, and critical awareness. One of the most significant consequences of the introduction of digital 3D modeling in the Cultural Heritage field is the possibility to use 3D models as highly effective and intuitive means of communication as well as interface to share and visualize information collected in databases [10].

For the present work, we have considered two types of users: common users (mainly not expert on the content) and expert users (belonging to the scientific community).We have assumed that the main aim for, common users, is to understand the past, to live an experience and build “affinity, empathy” [19] that can help in finding joy and motivation to increase their knowledge [6]. This process was also described by Thomas Mann: “for a significant intellectual product to make a broad and deep im-

mediate appeal, there must be a hidden affinity, indeed a congruence, between the personal destiny of the author and the wider destiny of his generation" [11]

On the other side, expert users, have other requirements: they need to read a reconstruction, propose alternative possibilities of sites and landscape reconstruction. This represents a shift from past research with a significant impact on how material culture is documented and understood.

It is therefore essential for the scientific community to avoid "closed boxes" and to approach digital reconstructions in a more "transparent" way (principles 3 and 4 of London Charter:.[1]). But this requirement is not just limited to expert users. Common users should also have the possibility, at least on request and in accordance with the type of media, to access further explanatory information on how reconstructions were made and which sources were used. This is particularly true with Virtual Museums [V-MUST DEL 2.1] where the focus is communication that should not just be aimed at demonstrating technical or artistic skills, , but rather to attain a degree of 'visual fidelity' and accuracy.

Therefore a "transparent" approach enables a better evaluation of 3d visualizations and a more efficient way to share information within the scientific community, thus avoiding the risk of duplicating works, resources, etc. starting each time from the beginning. It offers potentially a rapid advance of the research.. Metadata are now taken as a practical way to follow this approach [3]. Are metadata useful to make the process transparent also to final users? [7].

Normally data, used for the reconstruction, remain hidden to the users, leaving them a vague perception of what there is "behind the scene" and which is its reliability. How expert users could handle and improve the transparency, keeping track of reliability and uncertainty in Virtual Archaeology (VA) [5] project?; Should data used in the reconstruction process be transparent to final users? How they can serve to improve users understanding of the past?

We have tried to understand how these issues are considered important in scientific publications, presented in the last couple of years at conferences, and in virtual archaeology (VA) applications or virtual museums (VM), how these issues have been solved. We have finally tried to understand the trend in the research domain and the gaps that needs further developments. We have therefore carried out two surveys: one (see 2.1) related to VM and VA applications, among those presented from 2006 to 2012 at Archeovirtual international exhibition (www.archeovirtual.it) [14] and those analysed by V-MUST.NET (www.v-must.net) [V-MUST DEL 2.3] and a second one (see 2.2) related to papers published in the last two years (2011-2012).

In the first survey we wanted to obtain information regarding how reconstructions are communicated to a public (Q1), in the second one how the scientists communicate the results of their surveys and interpretation to the community of researchers (Q2).

We have considered projects focused on archaeological landscape [5] and ancient potential landscape [5; 12]. To widen the research, we have included beyond landscapes, also sites (medium/small range) and urban reconstructions (urban landscapes).

We have finally taken into consideration projects related with "reconstructions", whose concept included the entire process, from acquisition and interpretation to reconstruction and visual representation of results (interactive or not interactive).

2.1 Virtual Museums and Virtual Archaeology survey

In the first survey, we collected information on 112 VM and VA applications:

- 57 applications/demo presented at Archeovirtual;
- 55 virtual museums surveyed by V-MUST.NET.

Among these applications, 42 deal with a wider concept of landscape/site/city reconstruction (both "restitution" and "reconstruction"), only 34 regard strictly "reconstructions" not necessarily based on spatial GIS-based data. Among these last, 20 applications deal with spatial digital assets. One might think that not GIS-based is more oriented toward narration, while GIS-based toward researcher, but what came out is that 50% of GIS-based projects use a narrative approach regarding metadata and transparency.

They were taken into account only by the 5% of most recent projects (2011-2012) (2/42, among those who deal with a wider concept of landscape reconstruction). When we consider all virtual museums surveyed within V-MUST and Archeovirtual the percentage is higher: 10% (11/112). Nevertheless in 38% of cases (16/42), although we cannot talk about metadata, there is an attempt to propose different ways to provide extra information, although often not in structured way. If we consider projects with narrative approach, we see that all 5% are not interested in narration, while 19% (8/16) are interested.

It is clear therefore how metadata are in most cases developed for expert users, although there is a good percentage of projects that provide anyhow not-structured extra information (more multimedia), as part of their communication strategy.

Some examples of the projects that provide metadata are Locus Imaginis (fig. 2a; Locus Imaginis) and Behind Livia's Villa (fig. 2b) presented during Archeovirtual 2012, while examples of projects that present not-structured extra information are Virtual Rome (fig. 3a) and the Virtual Museum of Ancient Via Flaminia (fig. 3b).

In the Aquae Patavinae project [4], we tried to overcome the problem of the transparency, offering to the user a virtual reality navigation system on-line, different layers of exploration and tools to get into more depth the archaeological informations.

Fig.2 (a: Locus Imaginis: http://www.map.archi.fr/ldl/Locus/Locus_Imaginis/– b: Behind Livia's Villa)

Fig.3 (a: Virtual Rome: www.virtualrome.it – b: Flaminia: http://www.vhlab.itabc.cnr.it/flaminia/)

Fig. 4 Aquae Patavinae: http://www.aquaepatavinae.lettere.unipd.it/portale/?page_id=2174

2.2 Survey on published works

In the second survey we analysed abstracts or, when already printed, papers of most important conferences with topics regarding: 3D reconstruction, multimedia and virtual reality, and case studies:

- 4th ISPRS International Workshop 3D-ARCH 2011: ″3D Virtual Reconstruction and Visualization of Complex Architectures″ (http://www.3d-arch.org/)
- Virtual Retrospect 2009 (http://archeovision.cnrs.fr/spip.php?article144)

- VAST2012: The 13th International Symposium on Virtual Reality, Archaeology and Cultural Heritage (http://www.vast2012.org/)
- 18th International Conference on Virtual Systems and Multimedia - VSMM 2012 (http://www.vsmm2012.org/)
- The Computer Applications and Quantitative Methods in Archaeology (CAA) 2012 (http://caaconference.org/)
- International Conference on Cultural Heritage, oct. 29th - nov. 3rd 2012, Lemesos, Cyprus (Euromed) 2012 (http://www.euromed2012.eu/)

Fig. 5. Graph of the published works.

At the end of this analysis, we evaluated 686 publications (fig. 4). Among these, 149 (27%) projects deals generally with archaeological reconstructions, of which only 5% (29/686) strictly with landscape reconstruction. The majority of these describes the acquisition system, data presentation and visualization methods. In many case the focus is the presentation of new ways to visualise virtual reconstructions and landscape evolution. The goal of "Urban Archaeology" project, for instance, (3D ARCH 2011 - M. Capone, Urban Archaeology: How to communicate a story of a site 3D reconstruction but not only) is to highlight issues, propose possible but not unique solutions, stimulating cultural debate, and to make the cultural message understandable to a broad audience. For this reasons they have chosen a case study particularly complex, necessary to test a methodological path appropriate to the content to communicate. Another example is focused on the analysis of the use of remote sensing from space-based and airborne platforms to study ancient land management strategies at the ancient Greek agricultural territory (chora) of Metaponto in southern Italy (CAA 2012 - J. Trelogan, A. Rizzo, E. Moscatelli, Landscape change at Metaponto: a tale of two DEMs). The paper (CAA 2012 - L. Shaw, "There's an App for that": How can smartphones improve the ergonomics of landscape study, analysis and interpretation?"), focusing on the Stonehenge World Heritage site, details work carried out as part of a masters dissertation which looked at how smartphones and applications can be used to aid the ergonomics of landscape study, analysis and interpretation within archaeology.

Only 6 projects (1%), presented in the conferences, describe the use of metadata and suggest possible approaches to integrate 3D modelling into the archaeological research methodology, by describing some validation methods of the models. The Arcseer (3d ARCH 2011, F. Lynam, Arcrange and Arcseer: presenting a new approach to archaeological data management and representation) project, e.g., presents the initial results of the prototype tool QueryArch3D. The goal is to create a web-based tool that allows interactive visualisation and queries of multi-resolution Cultural Heritage 3D models. The visualisation front-end allows the user to navigate interactively in a virtual environment, where existing structures can be explored and queried, at different levels of detail. It should be possible to distinguish (e.g. "switch" on and off) real structures from virtually reconstructed ones. Another example (VSMM 2012 - H. Richards-Rissetto, J. Robertsson, F. Remondino, G. Agugiaro, G,Girardi, J. von Schwerin, Kinect and 3D GIS in Archaeology) explores the potential of using Microsoft's Kinect to create a low-cost and portable system to virtually navigate,

through a prototype 3D GIS, the digitally reconstructed ancient Maya city of Copan in Honduras. As users move their "bodies" through the VR environment, the ability to click on 3D models and acquire archaeological information with a simple hand gesture maintains the continuity of the experience in the VR environment. In the "Plan the Rome" project [3], the expected results are: a digital 3D model of Rome as it was in the 4th century A.D.; a digital 3D model of the principal machinery used in the Roman world; links for each digital model to the body of ancient source material (documentary, archaeological, and iconographic).

Fig. 6. ArcSeer (www.arcseer.com)

Fig. 7. Kinect and 3D GIS in Archaeology. A web-based interactive tool for multi-resolution 3D model access and visualisation (http://mayaarch3d.unm.edu/).

3 Conclusion

Virtual reconstructions of archaeological sites, artefacts, and architecture play an important role, supporting scientific discussions among experts and bringing the past to broad audiences, through virtual museums.

Regarding initial questions of the current work: Q1 (How do we communicate reconstructions to a non-expert users) and Q2 (How do we communicate the results of our interpretation to the community of researchers?), these are some of the conclusions:

In the case of Q1: extra information is provided in not structured way (no database / metadata behind). There is an increasing interest in providing information regarding the level of uncertainty and reliability, in some cases connecting models to sources. The continuity of the experience is preferred to discontinuity, preferring a reconstruction of a full realistic ecosystem, obtained from raster representations derived from interpolation (colormaps). The majority of the projects are focused on reality-based reconstruction (or restitution) more than on reconstruction of the past. A narrative approach is in most cases the preferred communication style.

Regarding Q2, maps are often used to communicate results, with a preference of vector representation, stressing discontinuity and therefore just reliable data. Raster continuous visualisations are used especially for spatial analysis. Metadata are used increasingly, although their adoption is still at a very early stage.

Since the level of uncertainty is a challenge, transparency is essential to understand and build research hypotheses and conclusions, particularly in areas where data is questionable, incomplete or conflicting.

Some approaches used to distinguish what is certain from what is not certain (transparency effects, different colours, models without maps or with modern maps) or to access extra information in a not structured way are unsatisfactory for expert users, although they seem to be a good compromise for common users. In complex multi-phase models, some of these approaches can be unclear to users. If metadata could be the answer for researchers, there are still two open issues: how metadata could be easily used and integrated with reconstruction and which semantic model to

use? How virtual museums built not for expert users, could re-use matadata in a more communicative and efficient way, since some evaluation results show how weak is this issue [8]? How could they make users aware of the process, of used sources, of different possible hypothesis?

One of the possible way to solve this issue is to create interactive 3d environments were users could choose if to live a narrative experience or to explore them in expert mode, querying and accessing sources, texts, multimedia material, pictures, bibliography etc. [4]. Metadata access needs to be improved and their use adapted to landscape issues. From the User Interface and User Interaction perspective a lot needs still need to be done. A final remark regards the necessity to improve scientific publications on reconstructions, including evidence of results in an explicit theoretical approach. There is a high number of publications with no visible or accessible results connected with sources and methods used. Is this lack connected with not appropriate publication medium or evaluation system?

References

L.C. 2009. London Charter, accessed June 23rd 2012.: http://www.londoncharter.org/downloads.html.

Calori, Camporesi, Pescarin. 2009. Virtual Rome: A FOSS approach to WEB3D. 3D technologies for the World Wide Web. Proceedings of the 14th International Conference on 3D Web Technology, Darmstadt, Germany: 177-180.

Felicetti, Lorenzini. 2011. Metadata And Tools For Integration And Preservation Of Cultural Heritage 3d Information. 23rd International CIPA Symposium, September 12 - 16, 2011. Prague, Czech Republic.

Fleury, Madeleine. 2012. Reviving Ancient Rome: Virtual Reality at the Service of Cultural Heritage. Progress in Cultural Heritage Preservation - 4th International Conference, EuroMed 2012, Limassol, Cyprus (October/November 2012), Proceedings, Ioannides et alii (eds.): 159-169.

Forte, Ryan Williams. 2003. The Reconstruction of Archaeological Landscapes Through Digital Technologies. British Archaeological Reports (BAR) International S.

Forte, Pescarin, Pujol Tost. 2006. VR applications, new devices and museums: public's feedback and learning. A preliminary report. Proceedings of the 7th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST (2006). Short Papers Volume. Eurographics: 64-69.

Gockel, Graf, Pagano, Pescarin, Eriksson. 2013. VMUXE: An Approach to User Experience Evaluation for Virtual Museums. Proceedings of the HCI International 2013. LNCS, Springer, Heidelberg.

Lucci Baldassari, Demetrescu, Pescarin, Eriksson, Graf. 2013. Behind Livia's Villa. A Case Study for the Devolution of Large Scale Interactive "in-site" to "on-line" Application. Proceedings of the HCI International 2013, LNCS, Springer, Heidelberg.

Meyer, Grussenmeyer, Perrin, Durand, Drap. 2007. A web information system for the management and the dissemination of Cultural Heritage data. Journal of Cultural Heritage 8, 4 (2007): 396-411.

Manferdini, Remondino. 2010. Reality-Based 3D Modeling, Segmentation and Web-Based Visualization. Third International Conference, EuroMed 2010, Lemessos, Cyprus, November 8-13, 2010. Proceedings: 110-124.

Mann. 1925. Death in Venice.

Pescarin. 2007. Chapter 14. Reconstructing archaeological landscape. Interpretation and integration in spatial and real-time open system. Space – archaeology's final frontier? an intercontinental approach. Ed. D. Keeler, R. Salisbury.

Pescarin, Fanini, Ferdani, Lucci Baldassari. 2012. Archeologia virtuale a Montegrotto Terme. Atti del convegno: Montegrotto Terme e il termalismo romano in Italia: aggiornamenti e nuove prospettive di valorizzazione. Giugno 2012: 305-322.

Pescarin, Pagano, Wallergård, Hupperetz, Ray. 2012. Archeovirtual 2011: An evaluation approach to virtual museums. 18th International Conference on Virtual Systems and Multimedia (VSMM). Proceedings of the VSMM 2012 Virtual Systems in the Information Society. 2 - 5 September 2012. Milan, Italy: 25-32.

Remondino, El-Hakim. 2006. Image-based 3D modelling: a review. The Photogrammetric Record, 21(115): 269-291.

Trapp, Semmo, Pokorski, Herrmann, Döllner, Eichhorn, Heinzelmann. 2012. Colonia 3D Communication of Virtual 3D Reconstructions. Public Spaces in International Journal of Heritage in the Digital Era, volume 1, number 1: 45-74.

[V-MUST DEL 2.1]. Consortium of the V-MusT.net: Terminology, Definitions and Type for Virtual Museums. Deliverable Report: V-MusT.net – D 2.Version 3 (2013).

[V-Must DEL. 2.3]. Consortium of the V-MusT.net: State of the art on Virtual Museums in Europe and outside Europe. Deliverable Report: V-MusT.net – D 2.Version 1.6 (2013).

Zeki. 2009. Splendors and Miseries of the Brain: Love, Creativity, and the Quest for Human Happiness.