A data description model for Cultural Heritage Hypermedia and Virtual Environments authenticated by archaeologists

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ABSTRACT
In this paper we will show our data description model conceived for avoiding the risk of realizing misleading Virtual Heritage (VH) reconstructions and for making accessible in a standardized way the background research material that lies under a "VR cultural product". The basic idea is to face the problem of the lack of standards for documenting sources in order to realize not only nice fast models, but also historically accurate models, proposing a model conceived by an interdisciplinary team, that involves 3d modellers, computer scientists and archaeologists. Thanks to this kind of collaboration, it is possible to rely on a deep scientific knowledge of archaeological data both for their selection and representation as Hypermedia and Virtual Environments and for the authentication of interactive prototypes developed in order to access Cultural Heritage(CH) data through the Internet and the CINECA's Virtual Theatre. The proposed data model developed for our case study, the *Casa del Centenario* in Pompeii, is based on an extension of the Dublin Core (DC) metadata standard in order to describe a hierarchical structure conceived for describing archaeological objects and their relationships with iconographic sources - and digital reproductions.

KEYWORDS: Archaeology, Hypermedia, Virtual Environments, Dublin Core

INTRODUCTION
With this paper we intend to promote a methodology for avoiding the risk of realizing misleading 3D reconstructions and of transmitting erroneous information that could bring to a misinterpretation of the past. Despite the visual appeal of many virtual reconstructions, we think that new Virtual heritage is unfortunately at risk. It's often tilted up like a movie set on a weak foundation of battling digital standards, less than accurate data and it's doubtful many of these modern

works will outlive the cultural heritage they seek to document. Dozen of virtual Pompeii's reconstructions now exist: there is a growing number of low resolution 3D and even semi-immersive virtual tours, but few really satisfy the preservationist's need for accurate documentation, the historian's need for archaeological interpretation or the public for engaging interaction and visual realism. Moreover, in our opinion the background research material that lies under a "VR cultural product" should be always easily accessible, and possibly, integrated with tools for analyzing the historical, archaeological and artistic sources. Consequently, the second aim of the proposed project is to develop an innovative interface system (implemented using a specific XML-based markup language) for accessing a corpus of Archaeological data from Pompeii, coded in tailored ways. From the point of view of applications the purpose is to allow different visitors (i.e. archeologists, students or museums) to access archaeological sources and explanations through the virtual reconstruction of buildings and objects of the past.

WORKING PHASES

In a period of great technological-digital evolution in all scientific fields, it is even more important to give particular attention to those interdisciplinary areas which will mark the *advant gard* of future research. In particular the great communicative impact that archaeology offers in itself is highly enhanced by using Hypermedia and Virtual Environments. In order to realize interdisciplinary projects it is fundamental to share different competences involving 3d modelers, computer scientists, and archaeologists. Thanks to this kind of collaboration it is possible to rely on a deep scientific knowledge of archaeological data both for their selection and representation as Hypermedia and Virtual Environment and for the validation of the prototyping activity.

Our work consists of realizing an authenticated virtual reconstruction of the *Casa del Centenario*, a very interesting double atrium house situated in Pompeii, as it was before the A.D. 79 eruption connecting this virtual reconstruction of the different rooms with the sources and the archaeological hypothesis on which they are based on. Moreover we consider equally important to reconstruct the house as it is nowadays in order to provide the users with a deeper understanding of what is the starting point of the archaeologists' studies (and also to give them a virtual access to an archaeological site in which and visitors are not admitted). The work is structured in three phases in which all the members of the interdisciplinary team are constantly involved and that are described in the following lines:

1. the first phase regards the creation of an appropriate data model and 3D modeling;
2. the second phase regards the definition of a markup language that describes archaeological objects, sources and 3D models for different user profiles and in accordance with different archaeological hypothesis and studies;
3. the last phase consists of designing and developing prototypes for visualizing virtual environments and related archaeological information through Internet and the Real Time semi-immersive display as CINECA's Virtual.

THE DATA DESCRIPTION MODEL

The *Casa del Centenario* is a large house with an impressive number of archaeological objects and sources. In order to set up a data model to describe archaeological objects -i.e. rooms, pavements, wall paintings, etc. - and their relationships with iconographic sources (i.e. photos, watercolour and drawings) that are on the basis of their virtual reconstructions. For example Figure 1.a shows a photo of the *lararium* taken in 1880 immediately afterwards the first excavations, while Figure 1.b shows the *lararium* as it is nowadays. It is worth noting that an area excavated over 120 years ago and not protected from raining and wind is now in ruins and so it appears very different and poorer of particulars. In the same way drawings and watercolors of details of wall-decoration painted in the 1880s can be very useful and interesting.

Figure 1: The lararium in 1880 and nowadays

The atrium has been selected as case study whether for his objective interest or his documentary situation, which offers stimulating possibilities of experimentation for 3D modelling and for data management. The atrium, one of the biggest in Pompeii, dates back to the original plan of the house, that probably dates back to the second half of the Third Century BC: it was a *tuscanicum atrium*, with *compluvium* and *impluvium*, surrounded on every side by rooms different in size and functions. In the following 300 years the atrium was rebuilt many times: we can recognize the traces of these reconstructions in the walls and, partially, in wall-painting and floor decoration. In the present situation, that corresponds to the situation shown by the excavation (1879-1880), the atrium shows the remains of the decoration realized nearly in the middle of the First Century A.D.: on the walls "Four Style" frescoes, including little pictures with tragedy and comedy scenes; on the floor, a simple black-ground mosaic, with parallel rows of *tesserae*. Almost nothing is kept from the original furniture: only traces (stains of rust on the mosaic) remain from the coffer placed in its north-eastern corner, on the left of the entering visitors. Certainly, in 79 A.D., the atrium was the main entrance of the house: the rooms gravitating toward it suffered instead a functional transformation, generally into store and service rooms. Once individuated the most important archaeological elements of the atrium we have organized them into a hierarchical structure (see Figure 2) conceived to be applicable to every room of the house. In general a room can be considered constituted by different archaeological objects as:

- founds retrieved during the excavations (e.g. pottery, statues, tools, candelabrums, jewels, lamps, etc.);
- single architectural elements (e.g. pavement, walls, roof, columns, etc.) that can be subdivided ulteriorly in subcomponents: i.e. in the pavement there can be fountains, thermal *suspensurae* or cisterns, a wall

can be considered as constituted by different wall-sectors and can include a door or a window;

- decorative elements relative both to founds and architectural elements.

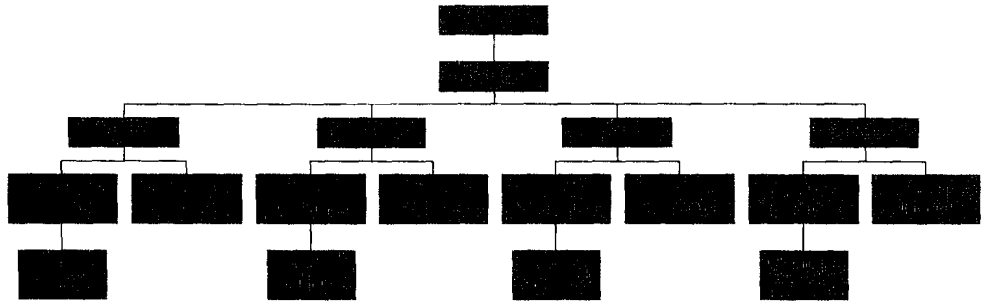

Figure 2: The hierarchical structure for a general room and for the case of the Main Atrium

Finally, each archaeological object of the hierarchical structure can be related with:

- **digital reconstructions**: **textures** reproducing disappeared or damaged wall paintings and decorations; **3D models** of archaeological objects reconstructing as they are at the present moment and as they were in AD 79.
- **iconographic sources**: **old and new photos, watercolors, drawings** or contact relieves;
- **written sources** that describes archeological objects (for example that now doesn't exist).

Figure 3 shows some digital reconstructions and iconographic sources related to the Main Atrium West Wall.

Figure 3: Digital reconstruction and iconographic sources related to the Main Atrium West Wall: a. the 79 AD 3D model, b. a recent Photo, c. an old Drawing

It is worth noting that the data model conceived for the Casa del Centenario can be extended to every kind of archaeological site virtually reconstructed. Basic steps of the resulting methodology are:
to individuate a hierarchical structure of archaeological object specific for the archaeological site itself,
to connect each "archaeological object" with iconographic or written sources and digital reconstructions (virtual textures and 3D models) following the DC rules explained in the next section.

3D MODELING

The 3D models that will be developed for the *Casa del Centenario* will regard the virtual reconstruction of the main *atrium*, *tablinum* (already finished) and of *peristilium*, *esedra* and *ninfeum* (work in progress) that constitute the most important area of the Roman house. The two resulting Virtual Environments (VEs) will show the central area of the house:

- as it was in AD79 at the time of the eruption that destroyed Pompeii in order to visualize archaeological hypothesis and theories based on the study of ruins, and findings and iconographic and written sources (e.g. the reconstruction of the roof that doesn't exist anymore, the reconstruction of decorative elements);

as it is nowadays on the basis of CAD maps and photos, in order to stimulate comparisons and to make possible the access in a area where tourists are not admitted. and as they were in AD 79.

Figure 5: VE of the main atrium as it was in 79 AD

Both the VEs are realized with Multigen Creator and then simplified in VRML lighter versions accessible through the Internet. The original high resolution Openflight models can greatly benefit from real life scale visualization through the CINECA's Virtual Theatre: a structure based on the Reality Center SGI Technology dedicated to the semi-immersive three-dimensional computerized visualization with a surround-sound system and a semicircular screen that allows the spectator to experience the illusion of a three-dimensional vision. The availability of these technologies opens up a new perspective and a new way of interpreting also already known aspects, realizing once again the more authentic sense of the word "theatre", that ancient Greeks intended as the space of observing in order to understand. Future environments for the fruition and study of Cultural Heritage could be conceived as a Virtual Portal, a virtual reference room linked to sources[6]. At the present moment we are investigating about different technologies to connect 2D data to 3D models in semi-immersive virtual environments developed for Cultural Heritage contexts.

THE DESCRIPTION LANGUAGE

The next work phase regards the implementation of a structured mark-up language describing archaeological objects, iconographic sources and digital reconstructions.

The starting point is the Dublin-Core (DC) standard [4], a metadata 15-elements set intended to facilitate the discovery of electronic resources. Actually it has also attracted the attention of formal resource description communities such as museums and libraries and its usability is tested by Consortium for Interchange of Museum Information (CIMI).

In order to describe in a coded way archaeological descriptions tailored on different languages (i.e. Italian and English) and on different users profiles, we have introduced some extensions: in particular we have considered to give different information to archaeologists and tourists and also to give the possibility to obtain "pure" DC records in order to assure the interoperability with other international Museum and historical archives and repositories.

Moreover we have introduced some extensions in order to include in the different archaeological descriptions hypothesis and comparisons with other finds or sources (in these cases the name of the archaeologist who made the hypothesis or the comparison is specified) and quoting (specifying author and references). The result is the definition of new tags and attributes

```
<description                type="..."
lang="...">
  <comp author ="..."> ... </cfr>
  <hyp author="..."> ... </hyp>
  <quot
author="..."ref="...">...</quot>
</description>
```

The use of customized extensions of the DC standard grants the possibility to obtain in a very easy way "pure" DC records to assure the interoperability with other international Museum and historical archives and repositories. Moreover, using some "qualifiers" provided by DC itself to specify the type of relationship element[5], it is possible to describe either relationships among archeological objects in the hierarchical structure (using qualifiers *IsPartOf/HasPart* to describe the son-father relationships) or relationships among archeological objects, iconographic and written sources and digital reconstructions (see the use of qualifiers *IsReferencedBy/References, IsBasisFor/IsBasedOn HasFormat/IsFormatOf* in Figure 6 and 7 below).

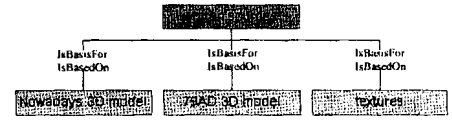

Figure 6: Relationships among written sources and digital reconstructions

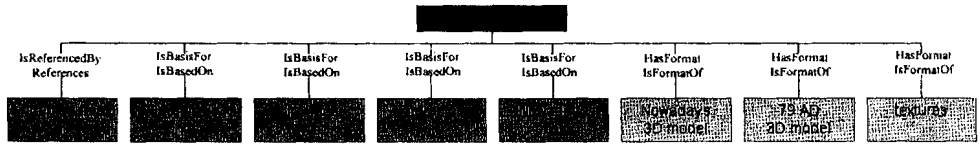

Figure 7: DC Relationships among Archeological Objects, written and iconographic sources, digital reconstructions

PROTOTYPING ACTIVITY

The last working phase regards the development of a web prototype in which the user, after having selected his profile and language, interacts with a VRML reconstruction of the main atrium. When the user selects an object in the VRML world a JavaScript function sends the corresponding XML file name to the server and the user's profile parameters to the server. On the server is installed Cocoon [5]: a Java publishing framework that returns to the JavaScript function a tailored versions of the XML file generated dynamically on the basis of the user's profile parameters. Finally the JavaScript function opens a window loading the resulting customized XML file and visualizing it as an HTML page using an XSL style-sheet.

At the present moment we have decided to visualize a pre-defined set of DC tags for each kind of users (archaeologists, tourists and DC users). Of course, using different XSL style-sheets it is possible to visualize the contents of a different set of tags. Figure 8 shows the information visualized for Italian archaeologists in the case of an archaeological object and of digital reconstructions (texture and 3D model): comparisons are visualized as lists, quoting in orange and hypothesis in green.

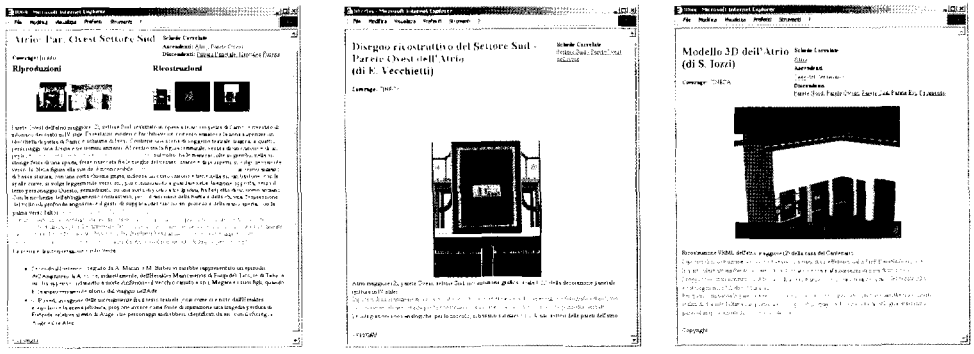

Figure 8: Some examples of information visualized for Italian archaeologists: the Atrium West Wall, a texture used for the same wall and the 3D model of the atrium

CONCLUSIONS

Summarizing, in this paper we have shown a methodology for avoiding the risk of realizing misleading Virtual Heritage reconstructions and for making accessible in a standardized way the background research material that lies under a "VR cultural product". In fact our prototype tries to face the problem of the lack of standards for documenting sources in order to realize not only nice fast 3D models but also archaeologically and historically accurate 3D models. Moreover the proposed work tests the efficacy of an extension of the Dublin Core metadata standard implemented with XML for a case study related to an archaeological site accessible through the Internet; but it is worth noting that we have worked in order to transfer the obtained methodology to other visualization platforms (i.e. the CINECA's Virtual Theatre) and also to other virtual reconstructions related to Cultural Heritage (i.e. the projects MUVI a Daily

Life virtual museum of the 20th century Bologna[8] and to NUME the historical reconstruction of a 4D city [1,2]). Currently this methodology and its XML implementation are used in the MUSE project[9], funded by MURST, whose aim is to realize a mobile multimedia system providing learning in museums and archaeological sites.

AKNOWLEDGMENTS
Authors wish to thank Tullio Salmon Cinotti (Bologna University), Fabio Sforza, Maurizio Malavasi (Boconsult) and all the people who collaborate to the MUSE project.

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