

REALTIME 3D MULTIMEDIA SYSTEM FOR THE DISTANCE VISITING OF CULTURAL HERITAGE. A CASE STUDY ON THE CHAMBER TOMBS IN VIA CRISPI, TARANTO

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KEY WORDS: 3D, Archaeology, Photogrammetry, Real-time, Virtual Reality

ABSTRACT

The case under study constitutes an example of a "distance museum" for an item of historical and artistic interest. A project in which the preserved structures of the tombs in Via Crispi, belonging to the Magna Graecia necropolis of Taranto, represent the information base for the development of a navigation platform in RealTime3D. This technology makes it possible to experience at a distance an item which, in the current state of affairs, is inaccessible to the public.

At the heart of the RealTime navigation system, which represents the final moment of the entire workflow, is the reconstruction of this hypogeum structure in a fully three-dimensional form. All of this 3D work was carried out using digital photo-modelling and digital photogrammetry. The three-dimensional model was subsequently integrated into the multimedia authoring system, in which all the media available for the item in question (audio, video, VRML, QTVR, VR Object, images, tables, etc.) could be integrated into a single viewing environment. This brought together the descriptions of a historical and critical nature (historical background, relationships with the various contexts in the ancient world, critical analysis, etc.) and the technical and scientific methodologies used for analysis and diagnosis (analysis of the constituent materials, state of conservation, study of the architectural characteristics, etc.).

The knowledge base for the item is thus complemented by direct access in the 3D environment to copious archaeometric data, for example relating to the pigments, which may be viewed by a simple click of a mouse. In an interactive environment it is possible to interact with the internal structures of the tomb and search the internal Data Base for architectural drawings, topographical data, ortho-photos and historical documents, but also to explore in QTVR (QuickTime Virtual Reality) all the objects that were found during the excavation.

1. THE TOMB OF THE FESTOONS IN TARANTO

1.1 Problems of documentation and recovery for enjoyment by the public

Unlike mobile items, fixed archaeological monuments cannot in most cases be taken to a museum. Thus, their fate is often very different to that of mobile items, which, even if they are not put on display, are catalogued, cleaned, studied and properly looked after. Fixed archaeological monuments are often stripped of their most important elements (assuming they have not already been looted before excavation), hurriedly restored, and in many cases then closed to the public. A similar fate awaits those sites which, due to problems of accessibility or the impossibility of setting up an adequate system for public viewing, are closed to the public, who then remain unaware of their existence. These sites, which constitute the pieces of the by now illegible jigsaw puzzle of our historical towns, pose serious problems of how they can best be publicized and documented, as well as problems of how to monitor their state of conservation, which is often compromised by their having been neglected for so long. The right approach to resolving some of the problems described here involves bringing to light the true value of these ancient structures, making the public aware of what the items actually represent and "giving back" the knowledge of these fragments of history to the community.

The case under study here is a concrete example of a computerised "virtual itinerary", designed to promote cultural exchange and assimilation by means of a virtual exhibit, understood as the digital representation of an item of historic, artistic and cultural interest (Forte et al. 1996). In this sense the



Figure 1. The entrance of a chamber tomb

'virtualized' item, far from being a pedantic simulation of reality, or even worse, yet another "hyperrealistic" alternative to the real thing, becomes the jumping-off point for the creation of an artificial world that enhances and decodes the real world, recreating it, but above all *interprets it*. Following this principle, we may define this research as an attempt to collocate an item - the *Tomb of the Festoons* in Taranto - in a "distance museum", starting with a digital survey of the structures of which it is composed. The digital model constructed of the tomb thus provides the informational basis for the development of a navigation platform in RealTime3D, allowing the public to



Figure 2. The 3D environment of RealTime platform

enjoy at a distance an item which, in its current state, is inaccessible and unknown to the public. The more information this museographical operation succeeds in transmitting to the final user, the more useful and effective it will be. The aim is to highlight the item's intrinsic value, with suitable methods and means of communication which are also appropriate for many different levels of interest and comprehension.

1.2 History of the discovery

In Taranto in June 1990, while building work was being carried out at via Crispi n. 32, two hypogeum monuments from the Magna Grecia necropolis were 'rediscovered', their exact location having been forgotten subsequent to their original discovery in 1919 (Dell'Aglio et al. 1990). Access to the two chamber tombs is by a trap door in the courtyard of one of the ground floor apartments. The object of the present work is the tomb called α , or of the Festoons. The chamber has a rectangular plan (3.45m x 2.15m x 1.40m high) on a North-South axis with the entrance on the West side. It is partially carved out of the rock and partially constructed, and covered with six large slabs of "carparo" stone (biocalcarenite). The internal walls of the chamber are plastered and decorated with paintings (Tinè Bertocchi, 1964; Steingraber, 1997; Lippolis et al., 2003). The entrance reproduces the monumental entrance of a house, and was closed by a painted and plastered stone door. Inside, placed near the East and South walls, lie the scant remains of two funereal beds (*klinai*) made of embankment and blocks of stone covered with a layer of plaster with traces of painted decorations. The white walls bear a motif of festoons of garlands, hung and tied up with ribbons, in red, pink, yellow and green. In the centre of the North wall there are painted figures relating to the spheres of cult and mysticism, such as a torch, a crater, a palm leaf and a basket decorated with small human figures, recalling Demeter and Dionysus. From both literary sources and archaeological finds it is well-established that cults and festivities in honour of Dionysus and Demeter/Persephone held a special importance in Taranto. Although problems of historical interpretation remain, it is certain that the importance of such cults in the area of Taranto is closely linked to the edict (*de Bacchanalibus*), by which Rome in 186 BC prohibited the practice of the Bacchic cults, considered excessive and dangerous for the political and social

order. This year might provide a suggestive *terminus ante quem* for the dating of the monument, which, in any case, archaeological and stylistic considerations indicate as being some time in the third century BC.

Inside the chamber were found materials belonging to two groups of funerary items, disrupted when the tomb was looted, making it difficult to recompose them in their original arrangement. Studies carried out on them make it possible to date the use of the tomb to a period between the third and the second century BC. The materials include a basin with a lid and painted reliefs (Lippolis, 1996), objects and ornaments (Guzzo, 1993) documenting the presence of a female deposition, probably of a young age considering the basin, part of the 'nuptial service', indicator of a specific social condition and of a nuptial ceremony that never took place.

2. THE REALTIME 3D APPROACH

2.1 interactive navigation and cognitive models

The development of the navigation platform proposed in this paper is aimed at the reconstruction of a highly interactive environment, dominated by the presence of a three dimensional model with a low number of polygons (about 1800), which is interconnected to a multiplicity of multidimensional data. The choice of the development environment was crucial for the success of the entire project. After a careful analysis of the objectives, which were set in consideration of the available technologies (VRML2.x, OpenFlight, OpenGL, C++, etc.), Shockwave technology implemented in Macromedia Director version 8.5 was chosen. The use of commercial software with levels of programmability dependent on the experience of the user lived up to expectations and had the advantage of being easily handled by operators skilled in the management of digital content. In addition, since it is not necessary to call on the services of highly specialized programmers, the whole prototype can be distributed as an Open Source model and re-used in different sites, by different users, who do not need to reprogram the entire platform but simply substitute the source models, with a consequent increase in productivity.

The model implemented is entirely explorable in real time, i.e. without the need to calculate every change of position of the chamber with long pauses. This because Shockwave technology, by making reference to OpenGL and DirectX graphic libraries, removes the burden of calculating the representation of the model from the CPU, directing this to a large extent to the graphics card. Consequently, the three dimensional model can be manipulated rapidly even on a desktop computer of average power and can be easily distributed on a network. The most obvious advantage in using Director, however, lies in the possibility of combining the RealTime 3D visit with practically any *medium*, in a single programming environment, producing a visiting experience that takes place with no interruptions.

The user is free to explore the three dimensional model from any point of view, but can also activate at any time a menu, from which they can access sources of information which in theory are inexhaustible. This is the start of an integrated journey of discovery, which goes beyond the logic of a merely 'aesthetic' virtual experience, typical of virtual reality applications of the nineteen-nineties. As provided by our navigation platform, the viewing process involves much more than the mere contemplation of the object in itself, but rather aims to decipher the content of that object, by whatever means.



Figure 3. The user interface of RealTime 3D platform

A visiting system organized in this way combines historical and humanistic knowledge with technical and scientific disciplines: as an object of value, the item is analysed in terms of its mineralogical, petrographic, chemical and physical components, also in terms of its historical and formal aspects, its relationship with the historical context. The virtual space becomes a topological space. Every 3D object included in the scene can be examined and measured, compared and restored to its original context. Even the data from the analyses of the materials can be accessed directly by clicking on the point from which they were sampled. The hierarchical structure of the available data thus becomes the indispensable premise for a virtual visit based on a cognitive model that is modern and flexible.

3. TECHNOLOGIES AND WORKFLOW

3.1 Photo-modelling

At the heart of the *RealTime* navigation system, which represents the final moment of the whole workflow, lies the restitution, in an entirely three-dimensional format, of the internal structures of the hypogeum monument. The main surveying technique used to achieve this is photo-modelling, a rigorous technique based on the methodologies of digital photogrammetry. PhotoModeler (photo-modelling software) is a Windows program that helps extract measurements and 3D models from photographs. By using a camera as an input device, PhotoModeler allows the user to capture a lot of accurate detail in a very short time. It then organizes the model building process as the user traces over photos on the screen.

To use PhotoModeler, one or more photographs of a scene or an object are taken. The photographs are displayed on screen and the operator marks each photograph with the mouse, tracing and tagging features of interest. PhotoModeler then combines the data and locates the marked features in three dimensions. The marks become accurately measured points, lines, curves, cylinders or surfaces in a single, unified 3D space. The result is a 3D model that can be transferred to any graphics or CAD program. In operational terms this means being able to reproduce, with great precision, both the polygonal model in 3D and the surface texture in high resolution (6 Megapixels) of all the walls, the latter as ortho-photos.

The accuracy of the final measurements achieved using photo-modelling depends on various factors:



Figure 4. The ortho-photos of frescoes walls

- the resolution and the number of the photographs;
- the angle at which successive photographs were taken;
- the number of referenced points;
- the accuracy of the 'camera description' parameter.

A detailed study carried out by NASA in 2002, concerning measurements made on a curve 5 metres in diameter, demonstrated that the use of this surveying technique makes it possible to achieve a level of precision equal to 0.02 – 0.05 inches (Pappa et al., 2003).

The use of photo-modelling for the surveying and the distribution of three-dimensional models has thus proved to be very productive, fast and precise, but above all it makes it possible to describe complex buildings at levels of detail definable by the user. The final model of the Tomb of the Festoons is composed in total of about 1800 polygons – an extremely low number in terms of its distribution on the web. In addition, for surfaces without any important micro-details, as in our case, the use for example of a laser scanner is not very practical, or even advisable. In any case, an almost flat wall can be described to a good level of precision with few points. When applied to archaeological contexts of a similar architectural type to that of our case study, photo-modelling has proved to be a flexible methodology: the three dimensional model produced by photo-modelling software can subsequently be enriched with further details, simply by acquiring new photos taken from other angles or at shorter distances. The original model integrated in the *RealTime* navigation environment can be substituted or accompanied by this new more complex model without affecting the platform overall, and the original interactivity will be maintained. By using this same basic technology and by correctly planning the resolution of the 3D models, it is possible to build large 3D data bases on a desktop computer and to share these resources on the web.

3.2 Setting up the scene

We may divide the successive phases of the work into five main categories:

- Importing the model into 3D software
- Preparation of the scene. Lighting.
- Implementation of the other objects, in our case the axes of reference, samples, etc.

- Export of the model in .w3d Shockwave format.
- Construction of the navigation platform in Director. Programming of interactive elements.
- Distribution of the product in its final form.

3.3 Characteristics of the platform

As we have already said, the three dimensional model, transferred to the multimedia authoring system, is linked to all the media available for the heritage item in question (audio, video, VRML, QTVR, VR Object, images, tables, etc.). In the interactive environment it is possible to interact with the internal structures of the tomb, activating or deactivating each object, but the interesting aspect here is that it is possible to enter the integrated Data Base to find out about every single find that was made during the excavations. The technology used to implement the Data Base within Director makes it possible to associate a compatible external file with the elements of the Data Set. This means that it is possible to add or eliminate records, change the structure of the layout or add a research engine to respond to queries that are typical of a relational DB. Director automatically recognises the modifications made to the external DB and updates the modified records with no additional intervention required. The user can further enrich his/her visit in this section by exploring the most interesting finds in QuickTime VR Object format. Thanks to this technology, the object can be rotated 360° on its Y axis; this enhances the interactivity between person and machine and at the same time prompts the user to explore the scene in every detail. The QTVR object can, in turn, contain clickable areas, which can activate further links. This then is a journey of discovery with many side roads branching off from the main route, with windows successively opening to provide ever more detailed information on the scientific aspects. Thus conceived, the platform is adaptable for any level of interest and understanding. The user with only a passing interest will find the experience provided by the RealTime navigation sufficient, while those interested in the historic and scientific aspects will want to explore all the sections. There is a specific section, for example, containing the reproduction of the frescoed walls in the form of ortho-photos. The images are produced semi-automatically and are extrapolated from the 3D modelling programme in a phase subsequent to their photo-modelling. For each ortho-photo it is possible to take measurements, but the



Figure 6. The 3D virtual reconstruction enable the user to make a diachronic reading of the monument



Figure 5. The integrated Data Base to find out about every single find that was made during the excavations

interesting thing here is that it is possible to call up a representation of the state of conservation of the walls with the relative mapping of the main forms of alteration. This operation, subsequently repeated at regular intervals, could serve to monitor the state of conservation of the structures. Remember that the three dimensional model, in that it is created on the basis of photographs, is updateable by 'simply' substituting the initial photos with more recent ones. With reference to a specific wall, for example, at the end of this operation a model will be extrapolated which can be superimposed on the original one, but with the surface texture of the wall in question updated to the date of the new photographs.

In the section relating to the analyses of the materials, much of the data produced by the Institute (especially by Dr A. Calia) for the study of the mineralogical and petrographic characteristics of the paints and plasters of the tomb are available. The studies to identify the pigments used for the painting of the walls and the door of the tomb were carried out on very small samples of the painted areas, selected on the basis of macroscopic recognition of the colours: brown, yellow, pink, red and green, present in various tonalities. For the recognition of the pigments mainly observations on cross sections were made, as well as EDS microanalyses by ESEM electron microscope and in some cases observations on thin sections. The study of the stone of the monument itself was carried out via mineralogical and petrographic observations on thin sections and DRX analyses. These analyses can be activated from the main menu, but also by clicking directly on the sampling points, highlighted in green during the 3D navigation. The virtual visit to the hypogeum structures has been integrated with CG (Computer Graphics) reconstructions which enable the user to make a diachronic reading of the monument and to better understand the transformations it has undergone. A VR panorama, explorable through 360°, enables the user to observe hyper-realistic setting, in which the internal structures are reconstructed together with the now destroyed *Klinai*. The funereal objects have also been re-located in their original setting, and again more information on these may be accessed by clicking on them. This operation helps the user to perceive the relationship, by now severed, between the object and its

rightful context, and also helps to further clarify the significance of this work of virtual museography which represents the ultimate goal of this study.

The collection of documentary material is also enhanced by a bibliographical section available for tomb and by a section in which the archival documents, kept in the National Archaeological Museum in Taranto, are reproduced. These documents include the log of the excavation, and the entry records in the museum register for each of the objects found, all transcribed to guarantee readability.

It is hoped that the combination of all these informational elements within a single platform may represent the start of a systematic effort to recover a part of the necropolis buried under the inhabited area of modern Taranto, and that tools of this kind soon become vehicles for the diffusion of knowledge of heritage items, such as the Tomb of the Festoons, which otherwise risk remaining unknown.

CONCLUSIONS

The central point of this study concerns the possibility of consulting historical, archival, architectural and archaeometric data on a single platform, in an interactive *RealTime3D* navigation environment created on the basis of a model replicated to a high level of precision, conceived as the bearer of interesting content. The navigation engine of the Tomb of the Festoons is still in the prototype phase. The sections are not yet complete and others will need to be added. However, for each of them the operational ability has been tested, as well as their portability on the latest generation of desktop machines.

The final model of the Tomb of the Festoons is composed of 239 referenced points, 102 basic polygons (1817 triangles), 26 orientated photos, and 205 Mb of UVW texture at a resolution of 6 Megapixels.

Acknowledgements

Our thanks to Dr A. Dell'Aglio and Mr P. Angotti from the Superintendence of Archaeological Heritage in Puglia; Dr Maurizio Masieri from CNR/IBAM for the EDS microanalyses; the Strippoli family, owners of the property.

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