THE CONTRIBUTION OF MODERN GEOMETRIC RECORDING AND VISUALIZATION METHODS IN THE IMPLEMENTATION OF A NEW MUSEUM CONCEPT

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ABSTRACT:

Technological development increases the value of a museum as a means for information dissemination by redefining its features as well as its new relationship with space and people. The creation of virtual reality systems and the development of a worldwide network society offer the museums the ability to promote their exhibits or their education material at a global audience at a relatively low cost. Great help can be offered by the new techniques in 3D geometric recording of objects-monuments of any size and the advanced spatial information management systems.
In this paper the basic principles of a new concept regarding the 'space' of the museum is developed. In this concept a museum is examined as a building with its operational characteristics and also according to its information and activity: from the classical serial narration to the creation of different and multiple routes varying from the 'real' to the 'hybrid virtual' space where the real object and the virtual reality co-exist.
Such an initiative is proposed for the new local archaeological museum in the archaeological site of Mycenae. Mycenae was the biggest centre of Prehistoric Hellenism during the second millennium BC. Now it is one of the most important archaeological sites at global level. It is worth noticing that only the ruins of building foundations have survived through centuries in situ and moreover most of the significant finds and gold masterpieces are exhibited in other central museums thus diminishing the amount of artifacts of the local museum to ceramic items only. Therefore there is a great potential for implementing the new museum concept using digital recording and visualization techniques for an integrated functioning of the archaeological site and the neighbouring local museum. A proposal for using digital photogrammetric techniques (for the processing and the 3D stereoscopic visualization of the existing monuments and the data of the destroyed monuments derived from old photos or plans) together with terrestrial laser scanning data of complicated artifacts and the implementation of an archaeological Spatial Information System (SIS) containing text, vector, raster, video and image data, is given.

1. INTRODUCTION

The use of new technologies in museum design and in applying new ways for exhibiting the finds is becoming an important issue among museum professionals. The development of new tools for an analog or digital demonstration of the artifacts, the possibility of having the museum visitors moving within a real, virtual or mixed reality environment (i.e. Hall et al 2001; Sticker et al 2001), and the ever increasing use of the Web are a real challenge for modern museums, and at the same time they generate essential questions regarding not only the practice of museology but the general operation of the museum as well.

According to the definition given by ICOM, "*a museum is a non-profit making, permanent institution in the service of the society and of its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment*". Under this concept, the influence of the rapidly developing techniques in computer graphics, visualization and animation can be very significant; it has already resulted in the creation of virtual museums on the Web with virtual walking routes along still existing or lost worlds with automatic sightseeing in archaeological collections, etc (for example see: www.virtualfreesites.com/museums.html, www.nga.gov/exhibitions/webtours.html, www.archimuse.com /mw2003/, //mpiro.ime.gr, or at the proceedings of the annual conferences of 'Museums and the Web', VAST,CAST).

Figure 1. Architecture is no longer fixed or static (www.oosterhuis.nl)

Yet, if we stay at the concept of a real museum and especially at the archaeological one, we have to admit that it is significantly influenced by the new technologies and the new architectural trends about 'space'.

In such an environment the museum should emphasize its distinguished nature as a place where material culture is preserved and which offers alternative experiences based on the participation of all senses. The geometrical recording of sites and finds, especially by using photogrammetric procedures and laser scanning, have contributed to the transformation of the traditional museum and to a new definition of its relationship with space and visitors.

2. THE NEW CONCEPT FOR THE LOCAL ARCHAEOLOGICAL MUSEUM

Recent technological achievements tend to replace the classic anthropocentric way of representing and memorializing cultural heritage. Very frequently a lack of clear exhibition program and

a common tactic is noticed, when mounting an exhibition and presenting it to the public.

The relationship between the exhibit, the space and the commissioner of the exhibition appeared an issue of conflicting approaches (Fox 1998), a relationship which recently seems to have been redefined on the conceptual level. Nowadays exhibits and space must co-exist in a uniform composition, which demonstrates the uniqueness of an integrated work. The most crucial issue is the importance of the *narrative* character the exhibition should provide in space, at a time when the classic narrative plot is considered to be *passee*, if not superfluous. There is a need for a critical approach in organizing an exhibition.

There are multiple reasons for introducing new additional elements, at all levels, into the museum and thus redefining its role, which make the adoption of Information Technology a critical need. Examples of such reasons could be:

- *Operational purposes* for the creation of better tour paths and the separation of the museum's functions.
- *Educational purposes* for better understanding and information sharing; exhibitions should be arranged in such a way that the visitor would have both conceptual and emotional contact and derive information that he/she will refer to in the future
- *Communication purposes.* The visitor should be close to the ancient artifacts and should experience the excitement of the discovery exactly like the excavator did at the moment of its finding.
- *Updating purposes.* The museum must keep up with the developments in all human activities in general (multimedia have been introduced in all stages of every day life: i.e. education, job, health, public life, entertainment, art, communication); for example, for a continuous enrichment and updating of the museum material. The creation of parallel tour paths in the museum space defines different levels of information interpretation.

A typical example of introducing IT is the extension of the museum into the Web. Most of the museums have a Web site. Yet, in most cases this "mirrors" the traditional idea about the way a museum should be promoted and how the museum uses the new technology. Frequently, the Web site takes after the paper information leaflets, the maps and the sightseeing guides. Obviously there are some bright exceptions to that, where the Web site also includes an extension of the exhibition by using IT tools.

Museums have, for a long time, been considered as places that objects were kept and protected for conservation, exhibition and research purposes. Now they can be transformed into places of knowledge, information sharing and interactive communication (Spiller et al 1995), and acquire more flexibility. A museum should be constructed as a shell to host not one particular exhibition but any kind of possible exhibits. The usual "limited available space/area" problem can be solved by a combination of "real" and "virtual space". The possibility to have all the existing collections in digital form overcomes the necessity of keeping all these finds stored in the museum and actually changes the 'space' with a data base that can be accessed by all visitors. Thus the simultaneous exposure of all finds is not all that important. Each time different pieces of the collections can be presented in relation to other objects of the museum or of other museums, which are in digital form, each time making the best combination.

Figure 2. Application of cyberspace in exhibitions (www.centrifuge.org)

The tour path through the museum becomes more personal and more dynamic and it obtains an educational purpose. The visitor should be given the possibility to experience the enthusiasm of excavation by making his/her own choices. For this purpose virtual reality rooms should be planned, where the visitors would be able to 'walk' through the area as it was before and after the excavation. This room then becomes a live cultural cell. The visitor is offered a variety of tour paths according to his/her questions leading to the answers (Holtzman 1994). A stable core for presentations is provided through small amphitheatres, computer rooms, digital library and convertible.

3. RECORDING AND VISUALIZATION TOOLS

In order to implement the above mentioned "new museum concept" it is necessary to use the advanced technological tools for geometric recording of monuments and the computer graphics in tune with the museum purpose and its development. The existence of many archaeological sites all over the Hellenic jurisdiction led to the parallel establishment and operation of a large number of local archaeological museums, which are hosting the artifacts of archaeological excavations. So, in Greece, the need for creating virtual museums on the Web is less than the need for inventing methods to emphasize and show the archaeological site's importance itself and the need to show the progress of the archaeological excavations through the visitors' path in a real museum.

The overloading of a local and relatively small museum with various numerous modern technological tools may have the same negative effect as the overexposure of numerous artifacts in a traditional museum; it does not help too much the information and knowledge sharing. The average visitor may be usually a tourist without any particular interest in information technology and digital tools. Consequently he/she acts more as a passive receiver of optical or audio information and especially user-friendly interactive operations. So, we have to propose an incremental mode in inserting technological tools to the operation of a local museum, such as:

- Screens with a predefined video projection, which can include information like text, photos, images or short movies from the excavation operations, etc.
- High brightness touch screen, located outside or inside the museum, with multi media presentation for personal use of individuals or for the use of small groups of visitors
- Spatial Information System for the archaeological site or some of its most important parts, which will contain historic, archaeological, architectural and technical information. It has a set of tools, not only for visualization, but also for querying by visitors/users, which would like to know more information about the artifacts or some parts of the site (Cosmas et al 2001; Ioannidis et al 2002)

- Systems for 3D representations and animations of the existing situation or of the buildings and other constructions that have been distroyed or of mixed reality (Sticker et al 2001; Ogleby et al 2001)
- Virtual reality systems, with stereoscopic observation available to the visitors by use of special glasses in a specially structured room or of head mounted display (HMD), thus having the illusion of moving in the 3D space of the virtual environment (Hall et al 2001). An example of a similar application which operates in Greece is at the Museum of the Foundation of the Hellenic World (www.ime.gr/fhw/en/projects/edvr/vr_projects.html).

For the creation of the SIS, the 3D representations and the augmented reality based systems, the detailed 3D documentation of the present condition of the site, using the combined application of the following is of great importance (Addison 2001):

- automated digital photogrammetric methods, using large-scale aerial photos and terrestrial photos, for the production of vector drawings, orthoimages or 3D models of the archaeological site and the individual monuments or finds
- field surveys, using GPS and conventional means (total stations)
- terrestrial laser scanners, both triangulation close range scanners, for small objects and accuracy better than 0.5 mm, and terrestrial LIDAR for large surfaces (facades of monuments of the site, etc) The products can be 3D solid models, profiles, texture mapping etc.

The next stage is the production of 3D representations from archaeological plans and other information derived from ancient texts and their combination with the recorded existing geometrical information. The result, according to the editing and the existing visualization tools, can be the production of either videos with fly-over and walk-through the archaeological site, or augmented reality systems and virtual reality environments.

Predictably the near future will see a boom in the capabilities offered for 3D animation and progress in virtual reality, with a development of stereoscopic methods and a decrease of cost of those systems. There are already screens available (by Sharp, the DTI, the SeeReal, etc.) which allow the stereoscopic view without a need for any special hardware for the users (i.e. glasses) through two overlapping LCD where each one projects the same issue from a different point of view varying about a 4-5 degree angle or with layers of cylindrical lenses on a LCD surface. Moreover there have been constructed “volumetric screens”, such as the Perspecta Spatial 3D of Actuality, like a transparent dome at the center of which there is a flat screen which can be rotated at 730 turns per minute and on which 198 image frames of a resolution of 768 x 768 pixel, are projected sequentially, at 24 fps, so that a 3D sense will be created during the observation.

4. APPLICATION ON THE MUSEUM OF MYCENAE

The proposed new museum concept was applied in a proposal for the local archaeological museum of the Mycenae. The construction of the museum, next to the archaeological site, was finished in the year 1997. Until the year 1999 the exhibits found during the excavations at the Acropolis of the Mycenae and the surrounding area were kept into the museum’s store houses.

Mycenae, located 150km southwest of Athens, was the biggest centre of Prehistoric Hellenism, and was inhabited since the Neolithic era until the Roman times. It is one of the most important archaeological sites in the world.

The Acropolis of the Mycenae was built on a low rocky hill. The earliest most important constructions were made in the middle of the 2nd millennium B.C. and its fortifications, the famous Cyclopean walls, not earlier than 1200 B.C. The excavations at the site started since 1841 A.D. when the Lion Gate, with the oldest sculpture worldwide, was found. In the year 1876, H. Schliemann found the kings’ Graves, with unique engraved gold and other finds, which are kept at the National Archaeological Museum in Athens and in other museums. The excavations continue today.

During the last years, at the Acropolis (3.2 hectares) and at the surrounding archaeological site (60 hectares), there has been done a systematic and detailed documentation by the Lab of Photogrammetry of the National Technical University of Athens, Greece. The documentation includes:

- 3D geometrical documentation, with line drawings, facades, and orthomaps at various scales produced by digital photogrammetric procedures and laser scanning
- 3D model of the most important parts of the archaeological site, such as the palace, the kings’ Graves, the domed tomps,
- videos in predefined walk-through and flyovers (Figure 3), using 3D Studio MAX and Adobe Premier software
- Spatial Information System, with multimedia data (Ioannidis et al 2002), using the ARCVIEW of ESRI with the extension 3D Analyst.

Figure 3. Video fly-over frame of the 3D model of the Acropolis


Figure 4. Views of proposed first room: lower level (LEFT), upper level with 3D restoration views of the Acropolis (RIGHT)

4.1 The Present Situation at the Museum

The organization of the exhibition will be finished soon and the Museum will begin operations soon after. The study for the museum so far has been based on the existing exhibits, something very common for most museums of Greece. The study is focused on those parts of the archaeological site where most of the finds were found and ignores locations with less exhibits and the finds that are displayed in other museums.

In brief, the arrangement of the rooms of the museum is mentioned (Figure 7): At the entrance hall there is an exhibition with texts and photographs from excavations and the excavators and a model of the Acropolis. At the first room there are exhibits from houses inside and outside the Acropolis. At the second room there are exhibits from the cemeteries. The most important part, the Grave circle A, is missing, since the finds from that part are kept at the National Archaeological Museum in Athens. At the third room there are exhibits from periods later than the Mycenean era and some groups of the finds according to their use or their role in everyday life or in religious ceremonies.

4.2 The Proposal for a new intervention at the Museum's arrangement

The proposed arrangement of the museum inquires the possibility of breaking the 'real' space into different spatial subunits, which will be related to its function (exhibits, public, information, other uses). A scenario is created about the type and level of multiple walk paths inside the museum. In order to solve the problem of the limited available space, a good use of its height is proposed: the visitor is smoothly led towards a suspended rising corridor, where the information either is provided by digital means or is mixed with the exhibits, thus creating space and virtual images which provide all necessary information for the better understanding of the site and its history.

Within the existing space, the construction of an additional grid is proposed which operates independently. So the natural level with all the exhibits and the database of the museum with the digital technology tools and the virtual images produced by them acts separately. The basic elements of the new arrangement of the museum space are:

- The display of the finds is no longer based on their numbers but on the excavation period. So the visiting routes are similar to the paths the excavators followed. Where this is possible, the walking path follows the ancient route, resulting in a more direct approach.
- The existing exhibition, as an array of display cases along the perimeter of the room, remains as such
- The suspended rising corridors act as transitional staircases between the building and the pieces of work and they organize the space by defining new relationships and tour paths. This is achieved by projecting on the surface of the corridors images of the finds.
- It is proposed that the constructions are made by a material which fits well without absorbing light from the exhibits
- The various levels operate based on long distances and optical axes
- The whole concept creates flexible spaces, able to accept new exhibits that will be found in the future.

An application that can combine all existing and virtual information is shown in Figure 8 and transforms the rooms as following:

- The entrance of the museum at first level brings the visitor to the natural space surrounding the Acropolis, through some open areas, while it prepares him/her for the further walk path along the suspended rising corridors and the screens for video projections, where 3D models of the fortifications are projected
- The pass to the first room offers the choice of either selecting to visit the conventional exhibition (lower level) or the "new space" (upper level). The second choice leads the visitor to a path where screens present perspectively 3D representations of the site and, through the openings he/she can observe exhibits displayed in cases (Figure 4). At the end of this route, the visitor will be at the same lower level that he/she was at the beginning and can go on to the second room, where
- the space created is structurally composed of transverse ribs which embody cabling for data transmission, an LCD screen for viewing finds through laser scanner, not found in situ due to the fact they are exhibited in other museums. The whole system will have different purposes depending on how one wants to converse, actively communicate or passively watch. With a route similar to the one in the first hall, the visitor finds himself watching representations of arched and vaulted graves
- At the third room the visitor can watch, in a specially structured space, through an SIS, the excavation phases of

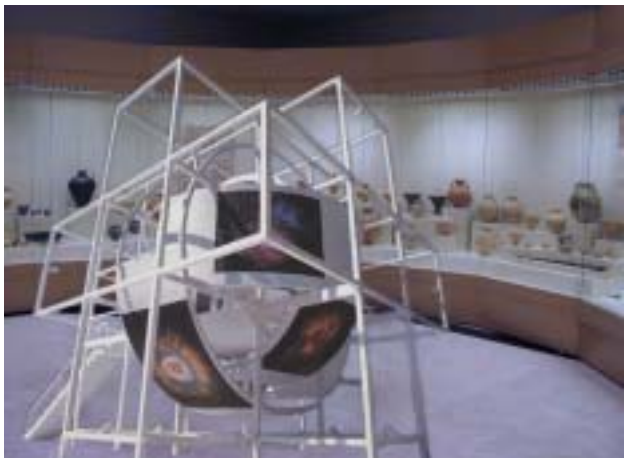

Figure 5. View of proposed third room: screens with 3D solid models of finds

the Acropolis and the ways of using all these exhibits of the third room (Figure 5).

- Going upwards to the entrance hall, the visitor is guided to a perimetric platform from where he can see a large screen on the floor of the entrance hall, where an overview of the Acropolis will be projected (Figure 6).

Figure 6. Entrance hall: Existing view; the proposed suspended corridor and the floor screen (INSERT)

- Finally, the virtual reality on the descending corridor to the exit, offers the visitor the illusion of another era and provides him/her with useful information and knowledge.

5. CONCLUDING REMARKS

The digital era and the expansion of virtual reality in all kinds of presentation of cultural heritage, the museums included, is now a fact. This cannot be treated either by 'technophobia' and catastrophic negative approach, nor with 'thechnomania' and piling on of all kind of new technological tools; both approaches can lead to unfortunate results. A third path based on a critical, theoretical and historical approach, with the virtual space as a new dimension, existing in parallel to the three conventional ones, could be an alternative solution. This new museum concept provides a global and complemented view by exhibiting fewer finds and more information.

The contribution of the modern geometrical documentation and visualization methods is critical for the aesthetic, educational and operational success of this new means of demonstration. Two-dimensional or raster drawings are no longer adequate, not even for the full development of an archaeological SIS. Laser scanning and automatic photogrammetric procedures for DSM production allow the compilation of 3D representations and solid models. The appropriate management of new technological tools, at all levels of production and presentation, provides the best way for promoting the proposed 'new concept' and contributes significantly to its approval by all museum professionals.

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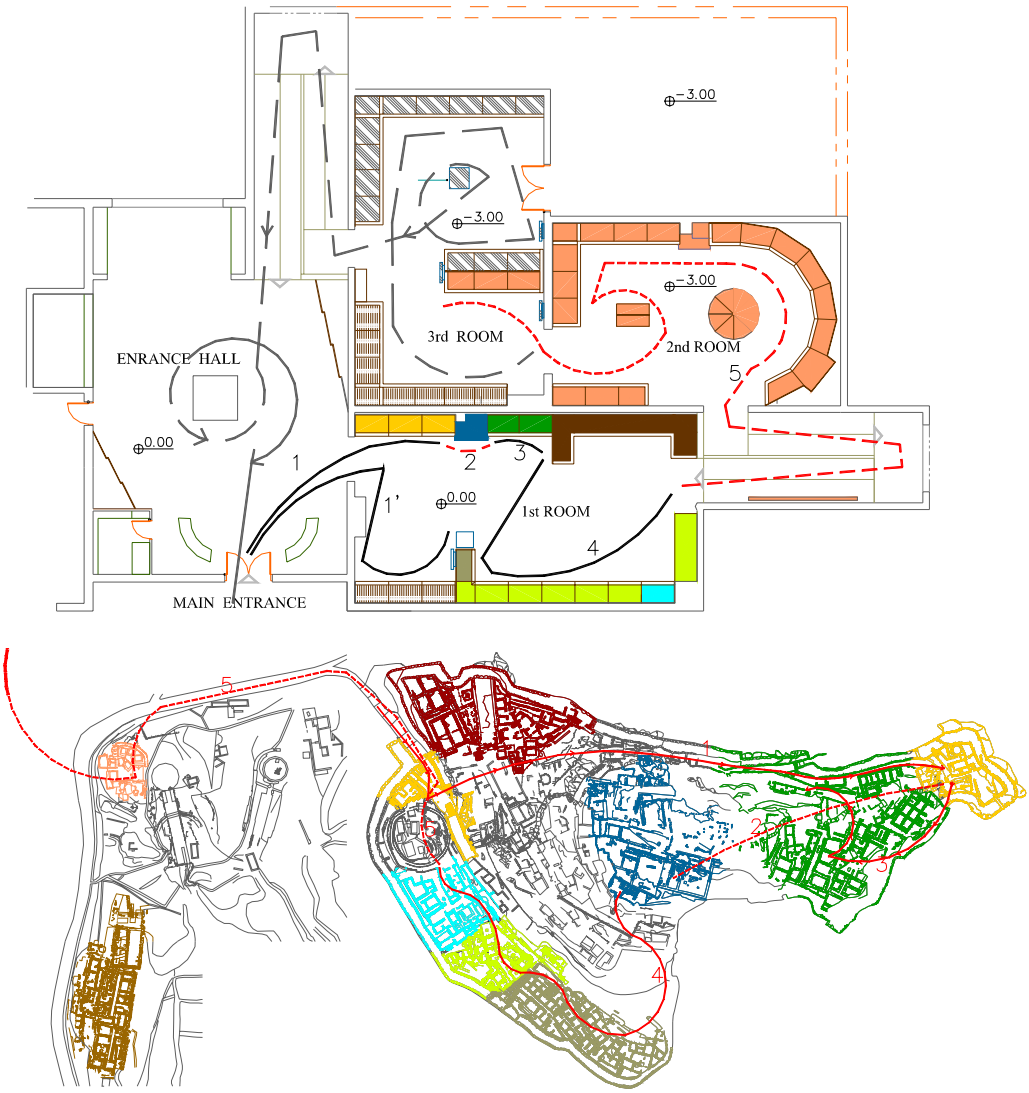

Figure 7. Plan of the Museum (ABOVE) and of the Acropolis and the surrounding area (BELOW).
The visitors' routes are marked in red. The display cases have matching colours with the locations where the finds were excavated

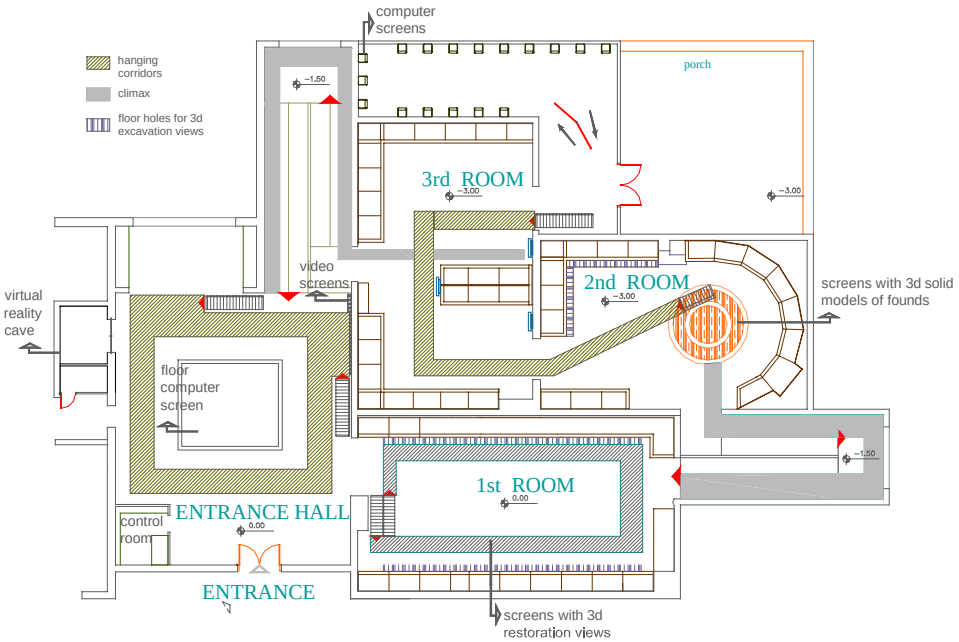

Figure 8. Proposed plan of the Museum