

## 3D Tools for Scientific Visualization and Documentation of Archaeological Heritage

### Case Study: A Sassanid Shrine of Daregaz, Northeastern Iran

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#### **ABSTRACT**

*The virtual reconstruction of archaeological sites and monuments is becoming the most attractive method not only in the documenting archaeological heritage but for transmitting the results of archaeological inventions to the general public. The creation of 3D models and virtual reality visualization of archaeological heritages especially artistic monuments have been increasingly used for archaeological record documentation and conservation purposes. This paper aims at defining of the 3D Max visualization technique and particular focus is made on the methodology and application of graphical technique for the reconstruction of archaeological heritage.*

*The monument chosen for this purpose is the fifth century Sassanid shrine of Daregaz of Khorasan, Northeastern Iran which has been recently excavated. It is a complex buried building and is characterized by the interesting decorative stuccos around the inner walls of the shrine.*

#### **1. Introduction**

Three dimensional reconstruction techniques and virtual reality modeling have taken on a special significance in relation to archeology and it has attracted the views of archeologists especially those who are active in the different fields of processes of archeological documentations and reconstructions. The most important aspects of these kinds of technical studies which can be observed in the literature of archeology are as follows:

(1) -virtual reality sculpture and three dimensional reconstruction models with a view to buttressing archeological data such as archeological, artistic, cultural works and the like; (2) -setting up three dimensional database based on archeological data with a view to conducting studies and researches or creating conservation programs; (3) -creating and executing educational programs of archeological and historical facts to the public; (4) -creating virtual models from archeological excavations; (5) -synthesis of three dimensional data capable of GIS software analysis with a view to recording, documenting and analyzing spatial data; 6-using virtual models as an effective tool for the archeological analyses.

#### **2. The theoretical and technical bases of virtual reality models**

Even though archeologists made use of different methods such as delineating plans to embody archeological realities, the actual idea of archeological virtual models and its entry into the domain of its studies started with the ever-increasing and widespread use of computer. The first definition of archeological virtual reconstruction, which encompassed technical aspects and identification method, was presented through P. Reilly (Reilly 1991) in the late 90s. In his definition and for the first time in the field of archeology the notion of "virtual" was conceived as being directly related to "simulacrum" or "model" whose realism

depends on the quantity and quality of the existing archeological data. The progress of the above notion since it was presented up to now has been grounded in observations in which archeological data made up of virtual theories and techniques in the form of one system emerged and which is termed (virtual reality VR). The embodiment of the realities of virtual reality in this system doesn't only have a framework of identification method for using the various virtual techniques, but also attempts and efforts are made to find the right meanings for such activities as well as how to create a link between the systems of virtual reality. The ultimate result of the relationship between reality and virtual model isn't only to come up with a reactive representation of reality but also to produce a proactive virtual reality which in actuality aids archeologists in carrying out reconstruction researches and archeological analyses (Goodrick and Gillings 2000, Gillings 2000; Gillings 1999).

Therefore, an all-inclusive definition of virtual reality (VR) that has been offered so far includes processes of identification methods which regulate its use. In these kinds of definitions virtual reconstruction approaches consist in delineating quantity-eliciting of every archeological data in the form of graphic demonstration (geometric and spatial demonstration) or numerical demonstration of a set of scientific thoughts and their consequences which are made easier by perceiving their complexities. The important point is that virtual reconstruction isn't a simple demonstration technique rather it is a tool which is totally analytical and this ability is born out of a combination of a representational technique and an effective management tools for archeological data (Forte and Beltrami 2000). In principle, the analytical ability of a representational reconstruction model depends on how the extremely needed attention paid to it by its providers. The above principles can be summed up as follows:

First-reconstruction must proceed in a specific and predetermined path and for an accessible data. In this case the prepared model is interactive and susceptible to reaction or to put it simply the

relationship among the elements is appraisable. Second-reconstruction model should be part of a research objective or an answer to a research question. Needless to say the answer to a research question is in fact subtle in the relationship between theory and practice. Virtual models made on this basis should have the qualities of being flexible, capable, renewable, and should have the ability to relate to those who are interested. (Gillings 1999: 250). Third- by taking account of the above factors, virtual reconstruction models are successful in providing recontextualization that is considered as archeological evidence. In making recontextualization the above model should act in such a way as to make evaluation and comparison between the main concept and recontextualization possible. Fourth-three dimensional virtual reconstruction is one of the archeological phenomena whose interpretative use should be placed in the category of designing virtual models because there is a main difference between computer techniques of three dimensional models and the idea of extracting meaning from a three dimensional model. A main idea in this regard is creating a connection and union between the two above-mentioned approaches which is accomplished by the help of the standards of virtual reality models (Earl and Wheatley 2002: 8). The present article is about the use of some 3D models and representational techniques in Bandian Shrine which is a recently discovered and unique monument of the Sassanid period whose purpose is to present a new approach to archeological heritage management as well as basic archeological studies. Archeological heritage management is a new system in archeology which involves scientific ideas with respect to conducting researches, recognition, conservation and maintenance of monuments, making archeology a public knowledge and understanding the reciprocal relations of archeology with cultural and social institutions of the society and the like. One of the ideas of this system whose progress is noteworthy has to do with documentation techniques of archeological evidence especially evidence and monuments which have special values and which are more likely to perish.

The Bandian Shrine was studied and appraised at the first step of this research under the below processes: (1) Analysis and measuring (2) planning (3) pictorial documentation (4) graphic placement (5) three dimensional model by the use of 3D Max and (6) transferring Auto CAD and 3D models into the visual demonstration format.

The operational process of the project resulted in reconstructing and producing a three dimensional model of structure of the above shrine building. This reconstruction is very helpful in understanding structure of the building architecture. The designed model needed to be prepared in a high clarity in which they should carefully determine the light, correctness of the approaches and details of decoration and other textures (for the detail of the technique see: Gottarelli 1995, Kantnre 2000, Lucet 2000). We should mention that two dimensional graphic documentations can be used in demonstrating three dimensional objects traditionally. Various data and numerous measurements are much needed for the three dimensional reconstruction. Therefore at this stage early plans with specific measurements were made in AutoCAD (for using AutoCAD in archeology see: Buzzanca and Griogi 1996). At the next stage visual formats of CAD were transferred into 3D Max and Premier software with a view to evaluating its files. The findings are as follows:

(1) -transferring CAD and 3D Max created reactive files that can be easily used in the web. The operational main codes are interactive. (2) -the above-mentioned codes which were meant to design various approaches, were labeled and each one of them is indicative of different parts of architectural structures. This way identifying architectural sections such as pillars, walls, paintings and so on, can be easily separated and re-evaluated. (3) -by using specific instructions and codes, the prepared virtual model has

enabled us to take into account changes in the further analysis processes.

### 3. Data of the study

Bandian, the study area is located between Hezar Masjid and Allah Akbar Mountains about two kilometers away from Daregaz City in the Khorasan Province, Northeastern Iran. This area is made up of the remnants of three small hills. The middle hill was leveled off in 1369 and it is no longer called a hill. The obtained information plus aerial photos show that its height was at the same level as the other two hills. The maximum height of these hills is 2.5 meters above the level of the surrounding agricultural lands. Studies reveal that they contain some archaeological materials of Sassanid and Parthian periods.

The first excavation in this area was carried out by Mehdi Rahabar, the archeologist of cultural heritage organization. Deep trench were made to identify cultural layers indicated that the area have been frequently inhabited from 5000 BC to the late historical periods. Cultural layers related to the historical period show three phases but apparently the second phase took on more significance on account of its architecture and its unique decorative stucco. Of the categories of reconstruction related to the second phase only its shrine was dug until 1999 which encompasses a huge hall with columns, a propitiatory chamber, fire temples and a ossuary chamber (*stodan*) as well as a veranda and a circular space (Rahabar 1997, 1999). The direction of the building towards the north has deviation of 40 degrees, something which has been observed in most buildings of Parthian and Sassanid. According to researchers' statements this shrine is part of a *Dastkart*. It should be mentioned that the term "*Dastkert-dastkerd*" involves several meanings: In *Matikan*, *Dastkerd* is a land which was cultivated by peoples thereafter it was used for the properties which had palace, tower, and resistant walls belonging to lords, and especially to the king himself (Luskaia 1998: 322). The equipment used in this building is partition, but in some cases 40×40×10 cm brick have been used as well. After accomplishing the building, they put a thin mud and clay layer on the partition surface then created some stucco upon it wherever it was needed. The thickness of the floor doesn't exceed 7 to 10 cm. (Rahbar 1999: 322).

#### 3.1. The columned hall of Bandian Shrine

The hall with columns in dimensions of 10.25×45/8 m. is considered as one of the most important architectural parts of this building, and it is located in the eastern side of the complex. The main and public entry which cuts across the hall in the eastern side is completely open. The roof of the hall were placed over four plaster pillars (figure 1). There are remnants of stucco over the walls of the hall which indicate various concepts. The remained height of the hall is less than 1m. The excavator of the building appraised the height of this place 4m with regarding the thickness of pillars and their accessories. As he didn't offer ideas about height of the whole building (Rahbar personal communication) and considering the mentioned height of the hall, the height of the whole building walls were appraised 4m. As mentioned above, the remnant height of this building was less than 1m and there is no information about the height of building entries. With reference to excavator's statements concerning that the height of the roofs of fire temple isn't exceeding 1.80cm when it was reconstructed, the height of entries was appraised the same measure. This presumption was used for the entries of building as well.



Fig.1- A reconstruction of columned hall



Fig. 3- Reconstructed format of columns with their decorative stucco

### 3.2. Room (B) or the place of preserving vows and letters

This room is located in the western part of the hall with columns. Entry of the hall was shown with arched roof and the height of entries appraised 1.80cm (figure 2). As mentioned above, the obtained height of the walls of the building is around 1m. and there are no signs indicating the existence of windows in the building. Since the room became too dark due to the lack of window, a window was devised in the wall. Shape of the window was inspired by those with arched roof used by Huff (1987) in reconstructing buildings like Firouz Abad of Fars Province.



Fig. 2- Reconstructed format of ossuary chamber

### 3.3. Hallway (C)

This part connects the hall with columns to the fire temple as a hallway. The existence of some platforms along the walls is the only feature of the hallway. According to excavator's explanation, the platforms were placed all over the above hallway with a height of 55cm. the existence of platforms in the southern part, in the entrance way to the veranda F, seemed a little strange, therefore the platforms of northern, western, and eastern part of hallway were only reconstructed (figure 3).

### 3.4. Room (H)

There is a long room in the eastern part of the veranda. The excavator presumes that a Zoroastrian priest rested at this place before or after the ritual (Rahbar 1999: 321). The room was destitute of wall in the southern part on the plan presented by the excavator. Of course, some rooms might have been built at the place but, according to the excavator there are no signs indicating existence of any roof. This part is shown as the wall of the hall of columns in the presumptive simulation.

### 3.5. Fire temple

According to statements made by its excavator (Rahbar 1999: 318) there is a small fire temple in the western part of the hall with columns and the hallway C. the above temple was a four-room building. There are incomplete four roofs in the drawings presented by the excavator where it's impracticable to build a dome on them; hence we had to make some changes in the categories so that it would be reconstructed in the form of a complete square as other Sassanid temples and buildings whereby it becomes easy to construct a dome on it. The excavator of the building estimated the height of the roof between 1.16 and 1.80 meters. Considering that 1.60cm, is short for people with medium height, so the height of the roof was put at 1.80cm (figure 4).

The fire temples of the Sassanid era have a four-roofed dome and the drawing of this shrine somehow copies the above shape. An attempt was made to build a dome along the lines of Firouz Abad temple with a view to hypothetically simulating a four-roofed Bandian dome. In this building (Firouz Abad) a dome was built by the use of conical corners where each corner was raised upward to form a circle, and in turn the circle itself was gradually closed and was placed in a four-corner room (Hermann 1994: 93). This way of constructing domes can be seen in building like Takht-e-Soleiman and Ghasr-e-Shirin. In view of the domes of the Sassanid era most of which were in the form of a hollow hemisphere. There are some small windows in the upper part of most of the Sassanid domes as a bonfire. Following Firouz Abad dome some small windows were designed in this dome in the eastern and western upper part. There is also a hearth in Bandian fire temple which is composed of three parts. The bottom part was made in the form of three cubic stairs and its shaft is in the form of a pulled up curtain. The upper part of the hearth is made of three cubes which increase from low to high.

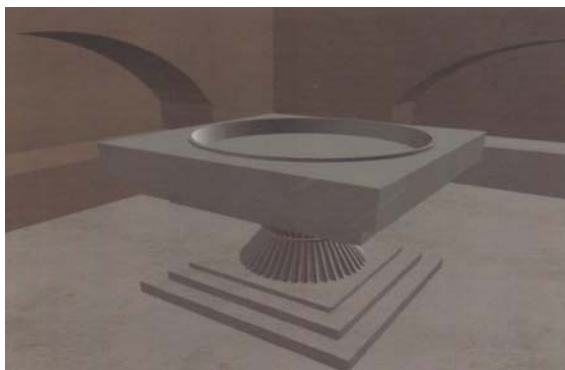


Fig. 4-Reconstructed format of fire temple

### 3.6. Ossuary chamber (*Stodan*)

There is a gate to the north of the temple which gives way to a room of  $2/4 \times 5/15$ m. Researcher believes that this chamber is used as ossuary. (Rahbar 1999: 320), in this regard the public believes that at the time of Sassanid the bodies of dead people were thrown to predatory animal and birds as a way to dispose of and decompose them. Then the remaining bones are placed in a sunken niche called *stodan* and which were created in rocks. (Trompelin 1994: 29).

Lack of bones in the *stodans* (see Rahbar 1999) and the presence of *stodan* besides the temple seem to point to further research and scrutiny in this domain. Simulation of these *stodans* like hearths was conducted by the use of reconstruction designs as presented by Moradi 1997.

### 4. Operational process

Following the completion of this stage and the making of all the parts of the building, relating materials to the constructed objects was granted a special priority. A lot of the extraordinary feats of 3D Max are run as editor on the materials. One material with specific feature is assigned to the surface of an object that acts as a key to material editor in 3D Max. Through the dialogue box different materials can be obtained and can be subjected to change and ultimately they can be assigned to the objects in question. All the visual images used in this project are Bitmap. One Bitmap is an image obtained by scanning or computer calculations and is displayed on a visual page through cell units of Pixels (Peterson 2000: 395). Based on a reported of an excavator mixture of mud and clay has been used to cover the walls of this building with the exception of the wall of the hall with columns and which are covered in plaster. A visual Bitmap of the plaster in the library of materials was used to display plaster-covered walls of the hall with columns. However, this image didn't have appropriate focus from a close-up and its colored material strikes one as unpleasant and for a proper use it should be edited. Editing was done in Photo Shop in such a way that the original image was largely obliterated so as to be used. Similarly hearths and *stodans* have plaster cover and this modified image was used to show the kind of materials in them. In relation to the walls made of mud and clay it should be said that there wasn't any software with a proper image in the library of material which can bring in focus this mixture of mud and clay. For this reason the image in question was taken from a project on the net (www.com 2001).

As was mentioned before throughout the hall there are bold drawings which unfortunately have seen a lot of damage and their upper part has completely perished. An excavator placed the height of these drawings from the floor of the hall at 0/07-0/60 and the height of the drawing itself was calculated to be

one meter (Rahbar 1999: 323). In order to create these drawings on the walls in the reconstruction phase, at first pages with the above mentioned photos were created and then were installed in the places on the walls. In this part the height of the bold drawings from the ground was calculated to be 0/65 meter and the height of the drawings in the highest part was 0/70. Images of the bold drawings were selected from the images of the articles of a building researcher (Rahbar 1998) and they were placed in the said spots, but these images had angles that needed modification. Moreover, in some parts a bold drawing made up of several images aligned together whose shades and light should be modified at the conjunction point of individual images in software (Photo Shop). As an example the number of the images at the southern wall was eight which should have been placed next to each other in such a way that the additional part of the image was deleted and was saved in a separate way using specific code. Following this by creating a new file and making a unified image, the individual and edited images were placed along side each other. The above image was placed as a Bitmap on the spot by the help of material in 3D Max. This method was also used in the reconstruction of the remaining images. Since there wasn't an image or painting on the bold drawing of the western wall next to the entrance of the hall with columns to corridor C, in this part plaster was used to show the presence of plastered and bold drawings. There is a wall between the entrance to chambers B, C on which bold drawing has been created and whatever has remained of this bold drawing is of a half body of a woman with some bouquets of lilies on her hand and an excavator introduced this character as "*Anahita*" (Rahbar 1998: 324). Drawings which were between these bouquets of lilies and *Anahita* perished despite this the remnants of drawings were experimentally reconstructed and were put in their place.

### 5. Compiling

In order to compile the simulation program of Bandian historical building, at first the created files of 3D Max, AutoCAD, and Photo Shop of the different parts of this building was carefully studied so as to control velocity, color, frame and other things. Then a folder "preview" was created which without interference arranged them next to each other and were displayed in a completely untouched and consecutive way. Considering the total time of the program at this stage music was selected which is harmonious with the rhythm and time. The next step was editing the program which was done in such a way that when connecting them there was no change in the movement of the camera and it was steady. While compiling for reconstruction there was an increase in the number of visual manifestations like the transitions of music at the beginning and end of the program. The result of compiling was a motion picture of the reconstruction of the shrine Bandian Daregaz with a bulk of about 275 MB and a time of 5/37 minutes which is easily demonstrated in all PCs.

### 6. Conclusions

The immediate findings of this research are as follows:

1-presenting the capabilities of three dimension models and discovering the structural relations of images of cultural heritage, 2-presenting and designing tools which as a result of the interaction between man and machine facilitate the input of data into machines and in consequence the output of data with the validity and values of virtual world, 3-presenting the ability of computer software which is used in designing and sculpturing huge structures such as architectural works and small objects, 4-demonstrating digital documentation values in archeology. Besides archeological knowledge the above objectives are also

in need of familiarity with how to use the relevant software programs. The output of such processes doesn't only help design various purposes but also it brings about study materials for the necessary analysis. Our main idea behind this project is to design virtual model of Bandian Daregaz Shrine, this made it possible to undertake reconstruction and study recording of a historical building through graphic documentation. A 3D reactive virtual model has been created which made it possible to quickly analyze the elements of the building and the relevant data. Furthermore, the presented model-though relatively incomplete due to numerous limitations- can be considered as a system and a guideline for graphic expression of many archeological monuments of the country, at the same time the above-mentioned model has been designed in such a way as to make it possible for new data to emerge as well as to be updated.

The fact that the virtual model of this project is reactive is a unique feature in which the direct study of used data in all the processes of the system has been made possible likewise it has made it possible for data to be transferred and connected. Our idea is that the capability of the above virtual model can be used in various ways with respect to researches.

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