Reproducing the Landscape of Ancient Egyptian Cities Using 3D VR Environments

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1 Introduction

One very effective way of delivering information resources on art and archaeological contents is to create an online teaching and learning site that features images of artefacts, maps, illustrations, narratives, 3D visualisation utilities, and other forms of teaching materials. This paper explores the media of virtual encounters as vehicles for learning about the cultural, social, technological and various other aspects of the past, using an online resource that is usable by a wide audience. Reproducing a destroyed historic landscape using excavation records and surviving artefacts provides us with the opportunity to visualise, explore and present ancient sites in their probable forms. Furthermore, it will allow us to compare them in a visible and, hence in the form that can be intuitively recognised, with alternative scenarios that have been suggested in the past. In addition, the 3D VR models reproduced to life size allow the visitors to virtually immerse into and walk through the scene.

Applications that build on 3D VR models are increasingly popular in a variety of fields (Shiode, 2001). For instance, several attempts have been made in the fields of art and archaeology, for virtual presentation and reproduction of historical or heritage sites (see, for instance, Forte and Siliotti, 1997, for a collection of various reconstructions). However, most projects are restricted to visualising an existing site or constructing a realistic model where the original plan is known. This paper proposes a generic method for visualising the possible forms of historic sites whose precise forms are unknown and have to be, therefore, reconstructed to their probable form based on the best assumptions and from the few surviving artefacts and excavation records from the site.

The 3D reconstructions featured in this paper seek to incorporate the known archaeological and geographical data, including landscape and other contemporary edifices in its vicinity, the past and present colouring of individual buildings, and the likely phasing of settlement construction. They are aimed at providing their most likely appearance at a certain time as a way of encouraging the viewers to evaluate the evidence for themselves, for example through comparison of the different paths that might have been taken in reconstruction. This represents quite a radical departure from the idealised versions that have often hitherto been produced for other sites. In broader terms, it can be considered as

consistent with a shift in archaeology from presentation of a single confirmatory representation that is based on one person's or group's interpretation of the evidence, to a more exploratory and participatory approach to sifting evidence and encouraging wider participation in the evaluation of scenarios.

This is a major breakthrough not only in the field of Egyptian archaeology but also for other archaeological and aesthetic applications. Many Egyptian sites have never previously been visualised using any form of 3D digital representation, let alone delivered with the options of walking through the models or comparing different interpretations side by side. The examples drawn in this paper are all adopted from a three-year project, "Digital Egypt for Universities"(*http://www.digitalegypt.ucl.ac.uk/*), which was a joint-initiative between the Petrie Museum of Egyptian Archaeology and the Centre for Advanced Spatial Analysis, both at University College, University of London (Grajetzki and Shiode, 2003). The project team was in a privileged position in that ready access to a huge range of artefacts and the archaeological records of W.M. Flinders Petrie and other excavators of the late 19th and 20th Centuries was granted. These are preserved at the Petrie Museum of Egyptian Archaeology in one of the largest collections of its kind in the world, comprising some 80,000 objects that cover almost all periods of Egyptian history from the Palaeolithic to the Islamic Period. Using a digital inventory of all of these objects and their copyrighted images, the project team assembled an important resource for higher education, which provides background information on many of these artefacts. The connection with related sources such as excavation notebooks, tomb cards and the publications of the British Institute of Archaeology also proved to be valuable assets for the users.

The methods that are proposed for and applied to each case study here are generic, and they potentially pertain to a vast range of historic environments. The contents are offered through a range of media including 3D VR models, audio files and digital images of archaeological finds, as well as information provided under several different cultural categories or based on temporal and locational classification. A combination of Java and VRML97 environment was adopted as a primary means to visualise texture and create 3D models to minimise the dependency on particular platforms or operating systems. This is complemented by other forms of online material such as movie clips and still images, to ensure access to the contents by users with slower connections and older computer environments, thus delivering them to a wider audience.

In terms of Egyptology, the contents offered by the project would also be a useful resource for archaeologists working in the 'field.' For instance, its typologies of pottery and everyday objects are essential for identifying the dates of the finds on archaeological sites, and, by offering an online resource, this knowledge can be served anywhere in the world through the Web. This is particularly useful, as Egyptological research often focuses on

single aspects of material or written culture. Although one role of the project was to concentrate on particular artefacts, the broader objective was and still remains as combining the knowledge of different research areas to provide a full picture of this important culture. In fact, any single object may be related to other objects and to the architectural context in which they were found, thus establishing a basis for comparison across space and time.

The rest of this paper comprises three sections. First, it addresses the methodology and techniques applied for developing the online learning and teaching resource. This is followed by a series of showcase examples each of which focusing on some of the individual sites that were reconstructed in the project. The paper is concluded by a summary on some of the insights obtained, and discusses some of the issues encountered whilst creating the online resource as well as those revealed during the evaluation surveys.

2 Reconstructing Monuments and Architecture in the VR Environment

Many of the archaeologically important places in Egypt have been either completely destroyed or are badly preserved, and this inevitably creates uncertainty in reconstructing historic forms. As such, the 3D VR models for each archaeological site offered in this paper comprise several different possible representations in order to present the various forms suggested by different groups of archaeologists including the project team for this study.

While Egypt is well endowed with well-preserved temples and tombs, there are only a handful of well-preserved settlements. Paper reconstructions have always played a vital part in studying the architecture of the Egyptian and the Near East regions (Heinrich 1982). For instance, Badawy's (1954, 1966, 1968) history of Egyptian architecture exhibits an impressive number of reconstructions. The reconstructions by Emery (1991) of the Early Dynastic palace tombs at Saqqara (about 3000 BC) are also known as an important source, as are the two earlier versions of the reconstruction of the Sun Temple of King Userkaf (c. 2500 BC: Ricke 1965). The latter is an unusual example in that two different possible reconstructions of one temple are provided, in recognition of the uncertainty arising from the degree of destruction of this temple structure. However, with the exception of Ricke (1965), most reconstructions are offered as a single most probable form of the site and thus failing to address the issue of the ambiguity that arises from the poor conservation.

This problem becomes particularly pertinent when constructing an online resource that focuses on Petrie's excavation work, as many of the sites he excavated had been severely damaged (e.g. the Min temple at Koptos or the 'labyrinth' at Hawara). In some cases, it is difficult to estimate the shape and the scale of the monument, not to mention the original appearance of such places in ancient times. While more remains have survived at other sites, Petrie himself never tried to envision the design of the original buildings, and this task has

thus remained uncompleted to this date. One example is the governors' tombs at Qaw el-Kebir, where Petrie (1930) only published the plans of the structures that he found during his expedition, and the plans and a full 3D drawing were provided later by another archaeologist who also worked at the site (Steckeweh 1936). Figure 1 shows a 3D model reconstructed in this study after Steckeweh's drawings (1936).

As the Steckeweh's reconstruction has been reproduced in many other publications, it gives us an impression that the original appearance of the buildings is known down to every detail. Yet a closer inspection of the reconstructions and the surviving remains raises many questions. For instance, we do not know if the causeways were really covered with a roof. Also, the exact size and the shape of the temple-like buildings by the river are not known. Finally, whether or not these tombs were actually ever finished remains a mystery. These issues can be addressed by the use of a flexible 3D VR model, where different scenarios can be studied by comparing their 3D representations.

The Digital Egypt for Universities project covers several reconstructions for each of the sites excavated by Petrie and others (Grajetzki and Shiode, 2003). Some of these versions are published on the Web for public access, with the intention of showing the unknowns rather than what is already known, and to visualise the possible alternatives (Figure 2). These models can easily accommodate changes in the light of new research findings and to disseminate them to many interested parties. This paper will give a particular focus on such sites that are presented in various probable forms.

3 Relevant Studies

There has hitherto been little evidenve of pedagogic output on the internet in the field of Egyptology or archaeology. Also, despite the increase in the number of 3D reconstructions for single buildings or one particular site, few of them cover a wide range of sites and periods. In addition to this, many of the existing models are maintained by private individuals rather than research institutions. Some models are created by those who are not trained in this field, and they often do not have access to the relevant research publications. Their representations frequently suggest a lack of deeper knowledge about the wider ancient landscape and architectural settings. For instance, several non-contemporary building phases co-exist in some models; and the colouring of buildings - a very important consideration with respect to visual impact - is often neglected. Also, many 3D reconstructions have been published in monographs of a general interest nature in recent years; but a publicly available model maintained on the Web is still rare. It appears that many archaeological institutions, universities and museums alike, remain unaware of the full potential of the Web resource, especially with respect to the combination of 3D VR models and the related narrative.

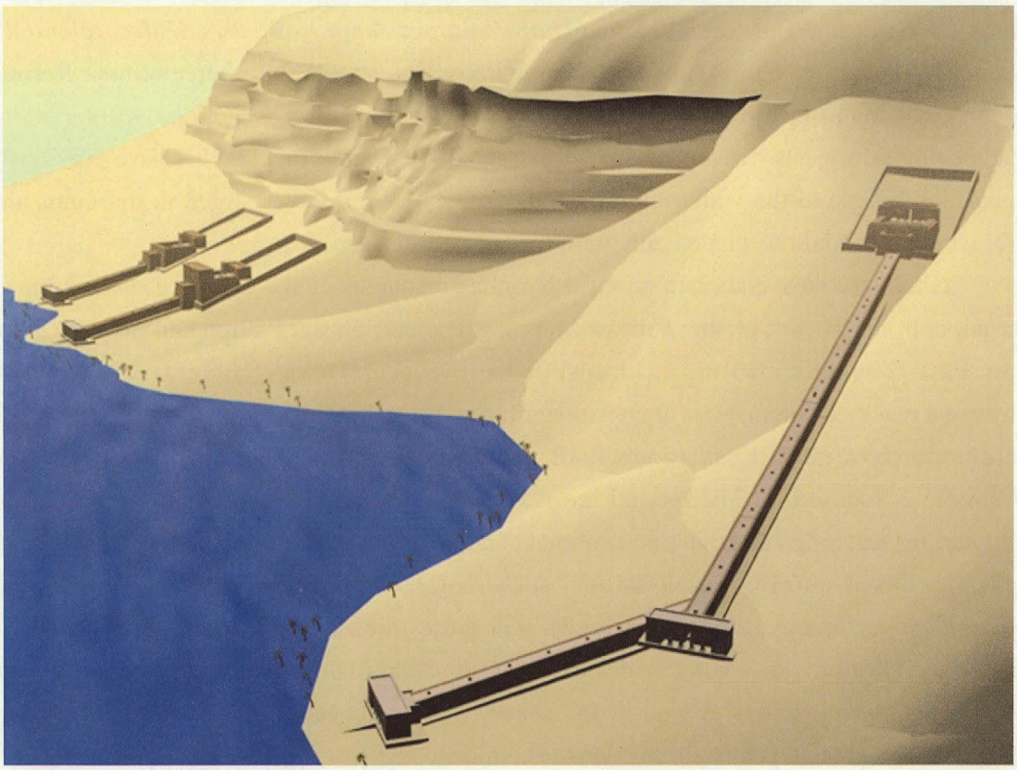

Fig. 1 Reconstruction of the tombs of the governors at Qau el-Kebir.
(The 3D model and image produced by Narushige Shiode, Copyright: University College London.)

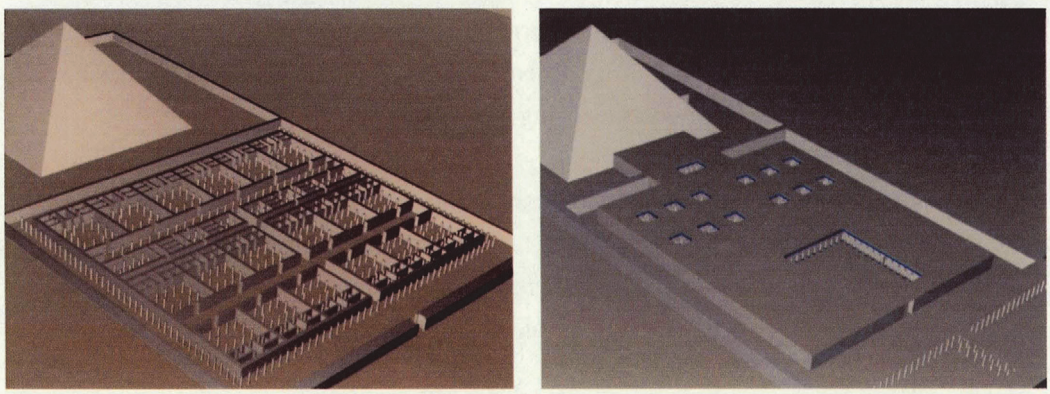

Fig. 2 Virtual reconstruction of the great labyrinth and the pyramid complex of Hawara based on different proposals.(The 3D model and image produced by Narushige Shiode, Copyright:University College London.)

In fact, it transpires that there are only a handful of known Web-based research projects. Among them is the Berliner Wöterbuch (a major institution for collecting Egyptian vocabularies), which hosts the entire archive of 2.5 million digital pictures of handwritten slips, written at the beginning of the 20th century (*http://www.bbaw.de/index.html*). Also, the Griffith Institute in Oxford, UK is currently preparing an online archive on the excavation

record for the tomb of Tutankhamen (*http:// www.ashmol.ox.ac.uk/gri/ 4search.html*). Similarly, the Museum of Fine Arts at Boston is composing a Web resource of their Reisner archives of manuscripts and photographs (*http://www.mfa.org/giza/pages/ reisner.html*). Each of these projects delivers access to first-hand excavation records that have previously been inaccessible to the wider research communities, as they were stored in museums and archives which could be visited only with special permits.

Perhaps the most elaborate example of online resources on the virtual reconstruction of an ancient site is that of the Theban Mapping Project, an excavation mission at Luxor (ancient Thebes), which is housed in the American University in Cairo (http://www.kv5.com/). The Web site includes huge bibliographies as well as high-resolution pictures of the mission's finds, buildings inventories and historical notes. The Web site is focused on Thebes and the New Kingdom (ca. 1550~1070 BC) and can be adopted for teaching - although no on-line course materials are available. There are similar projects based on other excavations, such as the Tomb of Senneferi (http://www.newton.cam.ac.uk/egypt/tt99/index.html), and these initiatives are often connected with museums. They provide a general idea of the objects held in the museum and are thus useful for archaeological studies as well as the general school education. A summary of relevant Web sites is available at http://www.newton.cam.ac.uk/egypt/.

In sum, there is no comprehensive resource of Egyptian archaeology online, which makes this project unique (Grajetzki and Shiode, 2003). With the aid of the 3D models and other media, its online resource offer information on a variety of social, cultural and technological issues as well as data from different time periods; and it also provides a series of course modules that can be used as teaching tools in classes.

4 Case Studies of 3D Archaeological Reconstruction

This section illustrates some of the 3D VR resource produced by the author between the period of August 2000 and July 2003. We focus on three excavation sites from different time periods, and the relevant 3D VR models produced for each site.

4.1 Hemamieh

Hemamieh is a modern village in Upper Egypt. At the desert edge of this settlement, several cemeteries and some domestic remains have been excavated and surveyed. The site also features the remains of a small village, which was excavated in 1924 by Caton-Thompson (Brunton and Caton-Thompson 1928: 69-116). The village dates back to around 4000-3500 BC and belongs to the Badarian period, which was the first Chalcolithic (Copper-Stone Age) culture in this part of Egypt. The main aim of the excavation was not to produce a plan of a Badarian village but to

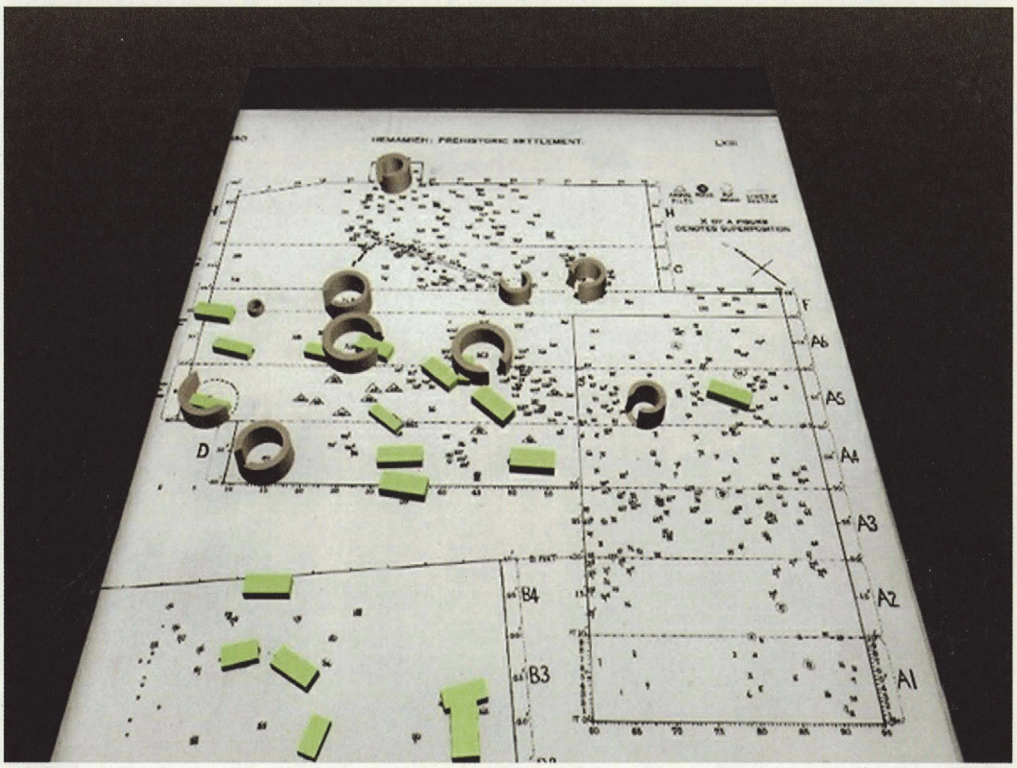

Fig. 3 The process of constructing a 3D model of Hermamieh based on the excavation record by Petrie. (The 3D model and image produced by Narushige Shiode, Copyright: University College London.)

gain insights on the connection of the Badarian culture to the Naqada culture, which was another prehistoric culture in Upper Egypt whose chronological relation to the Badarian was for a long time unclear. The result of the excavations revealed the Badarian level to be under the levels of the Naqada period, thus concluding that the Naqada was later. However, there has been little discussion of the nature of the excavated village until a growing interest in the prehistory of Ancient Egypt in recent years has brought our attention back to the village. There are several unanswered questions regarding the excavated structures. To begin with, most of the structures are in-ground, round holes of about one metre in diameter. It has been assumed that these were storage containers for grain. Figure 3 illustrates the process of constructing a 3D model of the Badarian village in Hemamieh based on Petrie's excavation record. It shows the circular structures from the Badarian period extruded in grey shade, overlayed with the cemeteries from the Naqada period. However, some had been found filled with animal droppings, implying that they may have been used as stables, at least for some periods. One of the 3D reconstruction models shows the use of these structures as stables (Figure 4).

4.2 Naqada

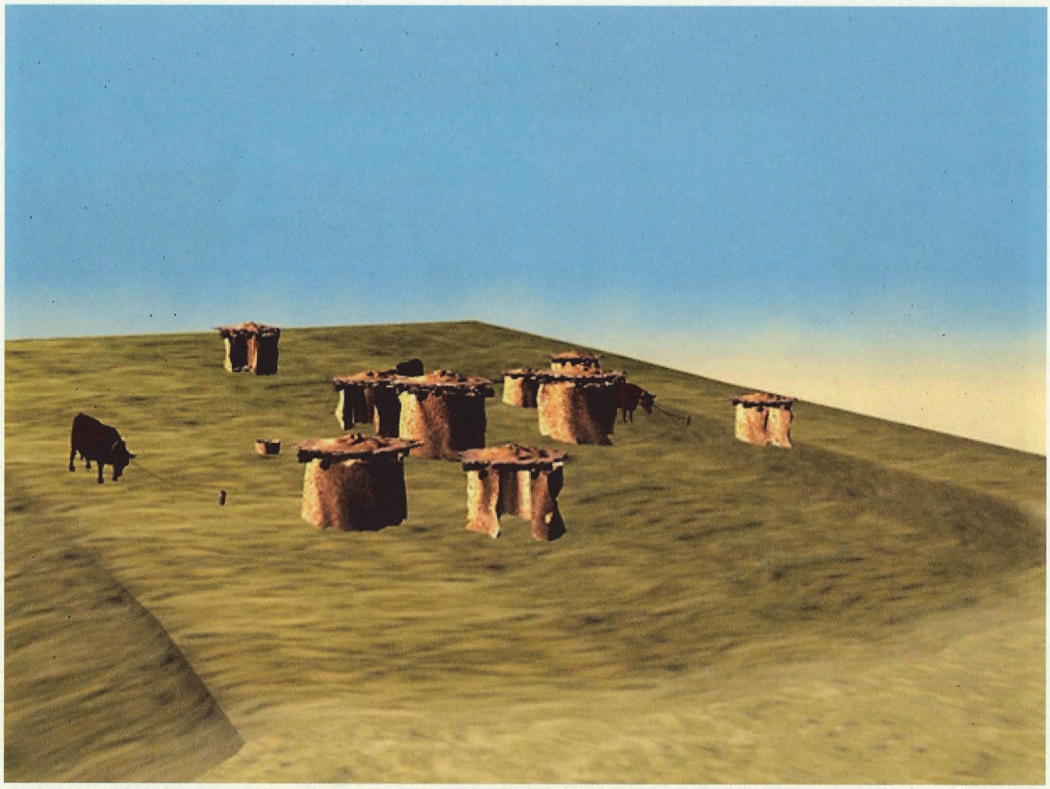

Fig.4 Reconstruction of the village excavated near the modern Hermanieh.
(The 3D model and image produced by Narushige Shiode, Copyright: University College London)

Naqada was first excavated in 1895 by Petrie (Petrie and Quibell 1896). The site actually consists of a series of settlements and cemeteries at the edge of the desert, about 24 km north of Luxor. The whole site is of special interest because it was here that Petrie first found tombs that date back to pre-Dynasty era (before 3000 BC). Petrie did not initially recognise the extreme old age of the cemetery and thought that the tombs belonged to a new race that invaded Egypt in the First Intermediate Period (ca. 2200-2050 BC). Nevertheless, subsequent research demonstrated that this was incorrect, and Naqada is now known as one of the major sites in Egypt from about 4000-3000 BC. Petrie concentrated his research on excavating the 2000 tombs, but also recorded and excavated structures at the site of the settlement.

The recorded structures are large in scale and there is some debate about how these remains should be interpreted. In this study, they are reconstructed as three palace-like residential structures surrounded by a huge town (Figure 5). From later sources and from the importance of some of the tombs found at Naqada, it seems very likely that Naqada was the capital of an early kingdom. One possible interpretation of the remains of the buildings is that the heavily-walled structure in the North may have been a walled residential area with several buildings inside (that is, some kind of acropolis or fortress) (Figure 6). Figure 7

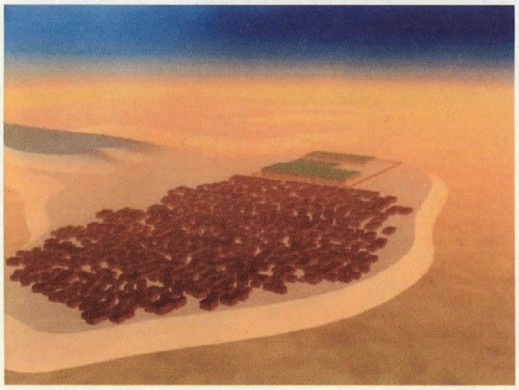

Fig. 5 3D model of the South Town of Naqada.

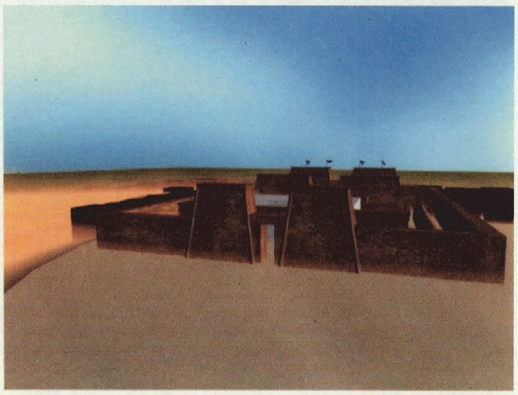

Fig. 6 3D model of the Temple of Seth in Naqada

(The 3D model and image produced by Narushige Shiode, Copyright: University College London)

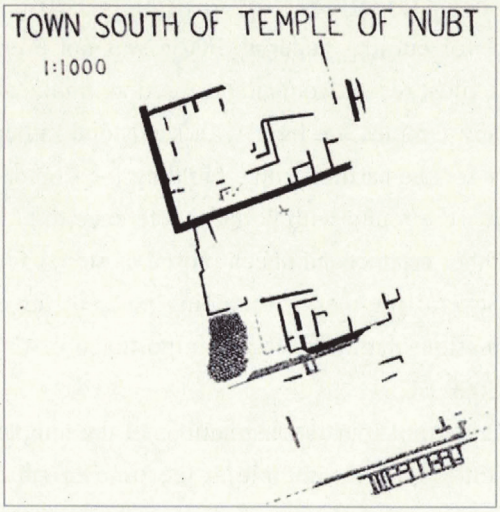

Fig. 7 The published plan of the settlement structures found at Naqada. (Petrie and Quibell 1896: pl.LXXXV)

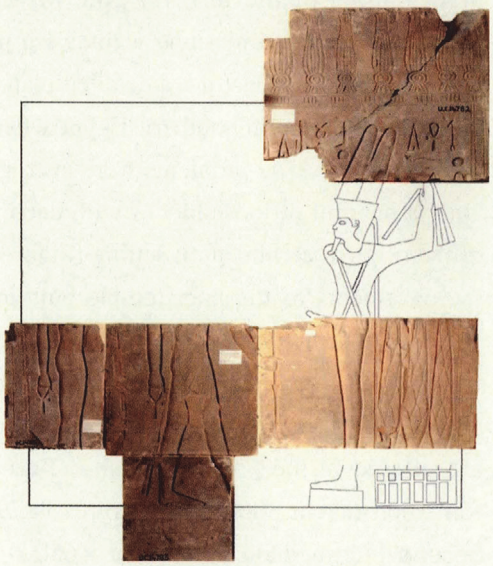

Fig. 8 Reconstructed wall from the Second Intermediate Period temple of Koptos.

shows one of the excavation records that indicates the large scale of these buildings.

Despite all the uncertainties concerning the exact size and the shape of this early settlement, the 3D VR reconstructions in the project clearly demonstrate that towns had been already developed in the fourth millennium BC Egypt, in a similar way to those traced to the same time period in Mesopotamia.

4.3 Koptos

Koptos is the site of an important town and temple, excavated by Petrie in 1893~1894. The

(a) (b)

Fig. 9 Reconstruction of the Temple of Min in Koptos in the Early-Dynasty Period(3000BC) based on two different interpretations.(The 3D model and image produced by Narushige Shiode, Copyright: University College London)

main temple of the fertility god, Min, had been largely destroyed prior to Petrie's excavations, as its limestone walls were perfect for burning material. Petrie was not even able to draw or reconstruct a detailed plan of the most recent Roman construction, unlike at other temple sites in southern Egypt where many temples are built with sandstone rather than limestone. The problems were even greater for the earlier temple buildings at Koptos. Only a handful of loose blocks with decorations were found with no clear reference to any of the original architectural setting (Figure 8). Other artefacts had been reused as stones for the pavements of the later temple buildings. Several fragments, including parts of three colossi statues dating to the time of state formation, demonstrate the importance of the temple in Pre- and Early Dynastic times (about 3000 BC).

In order to investigate different scenarios, a total of four reconstructions of the temple are offered in the project website. Two of them depict the temple at the time of state formation (about 3000 BC) (Figures 9a, 9b) and the other two show the temple from the Second Intermediate Period (ca. 1650~1550 BC) (Figures 10a~10d). The former set of reconstructions (Figures 9a, 9b) show the Temple of Min in Koptos in the Pre-Dynasty and Early Dynasty Period (3000BC).

The latter set of reconstructions are of particular interest, as several reliefs found at the temple site are now housed in the Petrie Museum, and these make it possible to reconstruct several decorated walls (Figure 8), which are the starting points for our reconstructions. These blocks bear the name of the little known King Nubkheperra Intef who reigned at this time in Egypt, and for this reason are also of some historical importance.

Several sources are available for the temple reconstructions of the Second Intermediate Period. These include other better preserved temple buildings from the same period, and the reliefs preserved in several different museums, which are believed to have come from at least six different walls and several doorways of two small chapels.

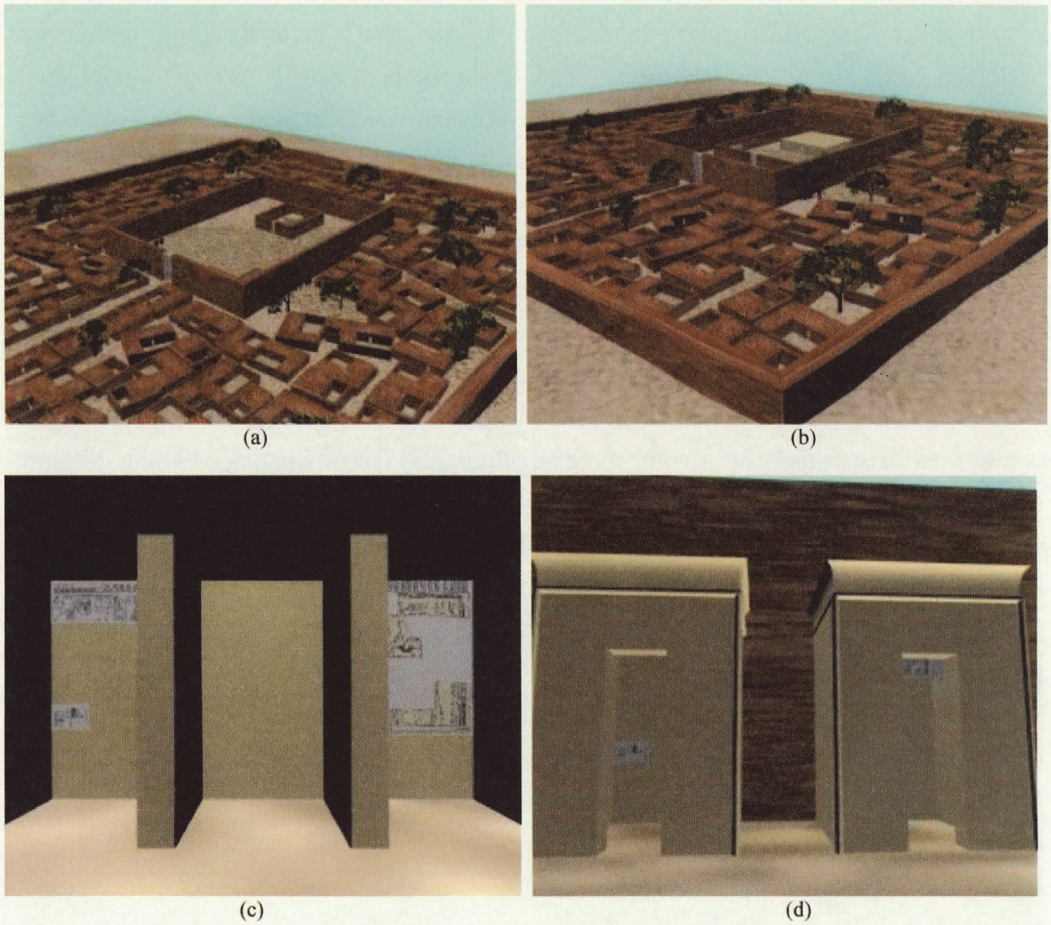

Fig. 10 Reconstruction of Koptos in the Second Intermediate Period (1650-1550BC): (a) with the reliefs of King Intef Nubkheperre in the main sanctuary, (b) with the reliefs in separate chapels, (c) details of model(a) with the proposed arrangement of the reliefs in the main sanctuary, and (d) details of model(b) with the reliefs in searate chapels.(The 3D model and image produced by Narushige Shiode, Copyright: University College London)

Figures 10a~10d show the two different versions of reconstruction of Koptos in the Second Intermediate Period (1650~1550 BC): (a) and (c) showing the reliefs of king Intef Nubkheperre in the main sanctuary, and (b) and (d) with the reliefs in separate chapels outside the main sanctuary. The two different reconstructions provide a useful illustration and example of the exploratory approach to visualisation that is taken in this study. Several reliefs found at Koptos by Petrie and by the French Egyptologist, Reinach, date from building activity in the reign of King Senusret I (ca. 1956~1910 BC). It appears that he added some reliefs to a temple that already existed at that time, and may perhaps even have rebuilt the whole temple complex during his reign. In the first version of the 3D VR reconstruction, it is assumed that the main temple of the King had been ruined by the onset of the Second Intermediate Period, and was

rebuilt under King Nubkheperra Intef. Assuming that the Middle Kingdom temple was destroyed during the Second Intermediate Period, the reliefs of King Nubkheperra Intef would seem to have been a part of the decoration of the principal sanctuary, and they would have been entirely rebuilt under that King. The principal sanctuary most likely had three chapels standing next to each other: There is a central sanctuary with raised reliefs, and two other sanctuaries that are decorated with both sunken and raised reliefs. The existence of three sanctuaries in one temple was very common in this period. Well-documented examples include a temple in Ezbet Rushi (Lower Egypt) and the Renenutet temple at Medinet Maadi (Fayum, Middle Egypt).

In the second reconstruction, however, it is assumed that the main building of Senusret I was still standing in the Second Intermediate Period. The reliefs of King Nubkheperra Intef would then have come from two or three small chapels constructed as additions to a pre-existing temple building. They are located inside an open courtyard that had been reconstructed in front of the main temple building. A similar arrangement was revealed by excavations on the island of Elephantine and dates to the reign of King Wahankh Intef (ca. 2100 BC). Here in Elephantine, the King had built an additional chapel in the courtyard of the pre-existing Satet temple.

Some further comments on the reconstruction of the town should also be made. To date, excavations have revealed nothing preserved from the actual town of the Second Intermediate Period. The reconstruction is therefore highly speculative. However, some other contemporaneous town sites have been preserved, and these provide a general impression of the towns of that period.

5 Evaluation

In order to assure the quality of this online learning-and-teaching resource, different groups of external parties were brought in at the end of each project year to evaluate the contents. The credibility of the materials and the validity of the web design as an online teaching resource were thus repeatedly tested and evaluated by external steering groups and users in the form of workshops (onsite) as well as online surveys (off site). The feedback was collected from the following three groups of people:

(1) a small number of Egyptologists from research institutions in the UK, who had first-hand knowledge of many of the site reconstructed,

(2) a group of environmental psychologists from University of York, who examined the validity of the contents as an online learning resource, and

(3) archaeology students and architecture students both at undergraduate level and graduate level, who tested the navigability of the website, accessibility to information, and the usefulness of the site.

Each participant of the workshop were given a brief explanation on the objective of the project and the nature of the contents, and were then asked to (1) follow a series of pre-selected links as well as (2) navigate through the contents and find the topics of their own interest; so as to measure the ease of finding the contents, the adequacy of the length, the level and the type of information provided, as well as to identify any issues. The highlight of these workshops was a visit to CAVE (Computer Assisted Virtual Environment) at Department of Computer Science, University College London, in which these 3D models were displayed at life scale. The visitors could immerse in to the virtual environment and "walk" and "feel" the scenes.

The precise examination of the survey data from the workshops is beyond the scope of this paper, and the details can be found in the project report to JISC (the Joint Information Systems Committee), but the main findings were as follows:

(1) The contents of this online resource are of significant value for academic use in the field of Egyptology and archaeology. The site helps making the field of Egyptology more accessible and interesting to a wider audience. It would be extremely useful to have a similar resource for other major museums.

(2) Some of the materials were buried among the vast amount of contents and were thus difficult to find. There should be several different paths that lead to the same contents; e.g. through the timeline, maps, and the general index.

(3) The visual representation of the past provides a very valuable pedagogic introduction to Egyptology. In particular, the 3D models are extremely persuasive form of representation, which can in fact give the false impression that the representation is known to be accurate in its precise details.

(4) Visualising more than one option helped the users retain an objective perspective. It demonstrates that the distinction between a known fact and an intelligent speculation can be clearly made in a visual manner.

(5) It would have been more interesting if the users could interact with the 3D models in such way that they could change the colour, scale, shape, and design of the models they were in.

In terms of the user interface, the surveys suggested that the structure of the project site should be kept as simple and user-friendly as possible so as to enable an easier navigation. The ability to offer a range of contents sufficient to encourage repeat visits may have the opposite effect of making the site more complex and less intuitive. The only feasible remedy for this issue would be to identify appropriate trade-offs, and also to provide as many alternative paths (including search functions) to each page as possible to increase the connectivity among the contents.

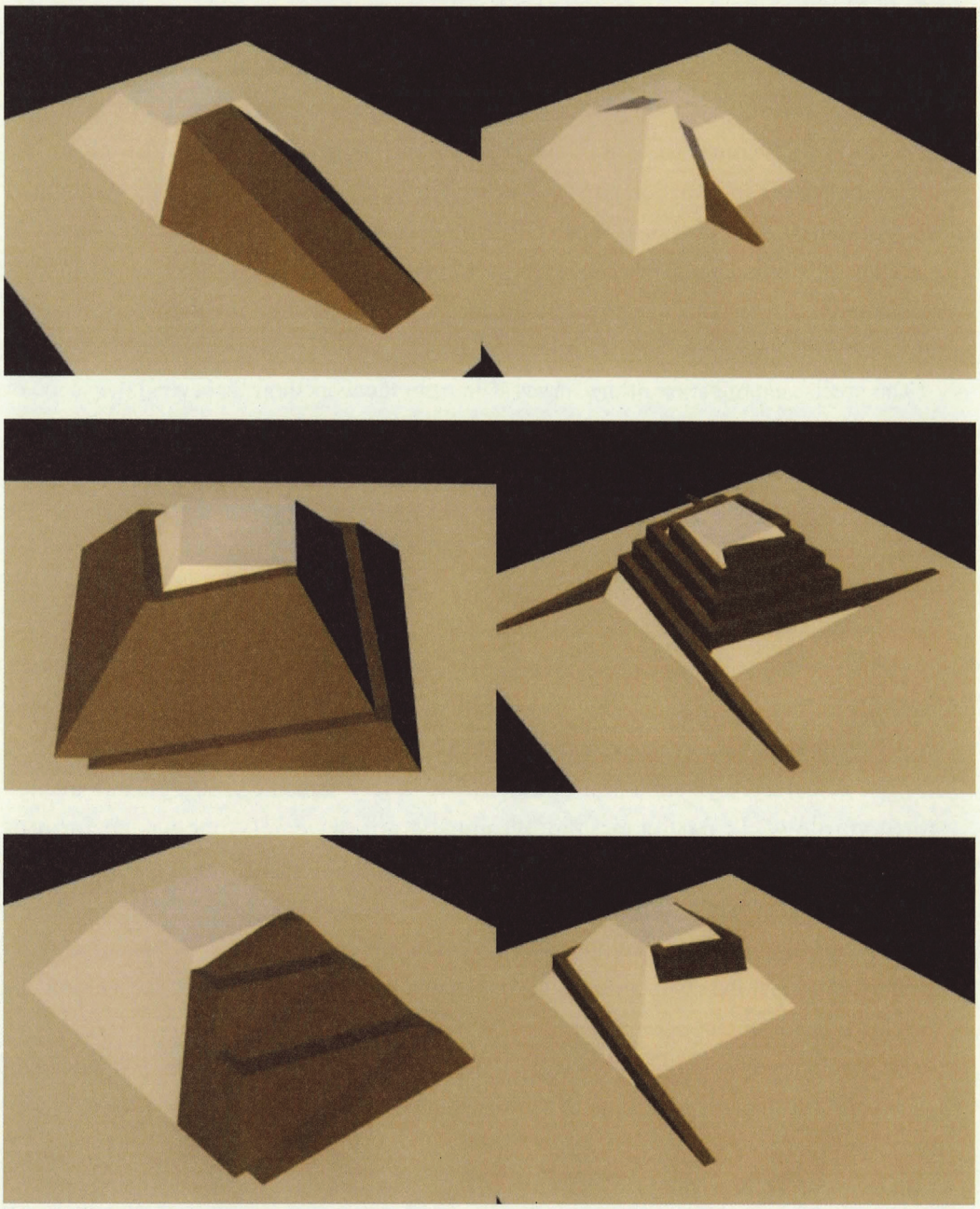

Fig. 11 How the pyramids were built still remains mystery. Here are some of the possible ways suggested by archaeologists for bringing stones to the construction level. There are many other possibilities, and it would be useful if the users could express their own idea using these 3D models.
(The 3D model and image produced by Narushige Shiode, Copyright: University College London)

6 Conclusion

This paper highlighted some of the 3D VR models that have a strong presence both in terms of its visual effect and also for their significance in the archaeological discipline. It also

illustrated the potential use of information space as a medium for visualising and providing information on ancient architectures and sites that have been long destroyed.

As part of the evaluation of the project, and also to draw the attention of users to the focal point of each excavation site, a list of 3D impact pages were created and were made directly accessible from each 3D model. These elicit user responses to the perceived impact of the 3D models, and seek to gauge the usefulness of the representations in relation to the user's research questions and requirements for that particular model.

As aforementioned, external evaluation panels were brought in so as to gauge the usability, perceived validity and usefulness of the site at the interim stage. This has clearly highlighted the various issues and helped the project team to address the problems. For instance, while the 3D models are visually appealing and intuitively plausible, they can on occasions be overly persuasive where users regard them as a precise reconstruction based on sufficient evidence. In fact, most of the sites studied in the project have been largely destroyed and the representations offered are only one of many possible forms. Where appropriate, several models of the same site or an idea were created (Figure 11, for instance, shows a series of models that suggest how the pyramids were built) and were compared among them. Nevertheless, many users still found all realistically-rendered 3D scenes to be equally persuasive and visually convincing, especially when walking inside these models with the aid of immersive virtual environment systems such as the CAVE. There is no immediate solution to this problem, but if we could offer an interactive environment where the users can move the artefacts and reconstruct their own version of the site by exercising their judgement, then perhaps we could provide a more flexible impression (Kanoshima and Shiode 1998, Shiode and Kanoshima 1999).

Fourteen different excavation sites were reconstructed in 3D VR model in total, featuring many parts and many time periods of Egypt (full contents of these sites can be obtained from *http://www.digitalegypt.ucl.ac.uk/ 3d/index.html*).

The methodologies described are generic in the sense that they can be applied to the development of online contents for other archaeological sites. They can be also used in the creation of online teaching resources in other contexts. The combination of various media types such as 3D models, audio files, excavation records and digital images of the artefacts offer a unique resource for students in Egyptology and archaeology but also in other areas. Furthermore, these resources reproduce historic landscapes at extents not developed previously, and in ways that are only possible through the use of information space. Many of the reconstructions offer new solutions for understanding buildings and some even offer a visual reconstruction of buildings for the first time. The reconstructions are supported by archaeological research conducted by the Egyptologists who have visited these sites, which also

provides important background information on many sites.

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三次元仮想空間をもちいた古代エジプト都市の景観の復元

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近年、考古学・博物館学を含むさまざまな学問分野で、三次元ヴァーチャルリアリティモデル(以下、3D VRモデルと略記)の活用がすすめられている。しかしながら、その多くは、現存する建造物ないし詳細な記録のある建物を復元するための手段として利用されるにとどまっている。3D VRモデルは、視覚に依存するさまざまな空間情報を一般利用者にも分かりやすい形で記述する力をもっており、崩壊して原形をとどめていない遺跡なども、断片的な手がかりから元の姿を推測し、再現することができる。本稿では、先史時代から中世・近世にいたるまでのエジプトにおける主な建造物や都市景観を3D VRモデルをもちいて再現し、そのモデルの有効性を検討する。具体的には、ロンドン大学ピートリー エジプト考古学博物館に保存されている約８万点の所蔵品と発掘記録をもとに作成した一連の3D VRモデルを紹介する。紙面の都合上、再現した14ヶ所の考古学発掘現場のうち、とくに三地点の遺跡に関する再現事例をあげる。いずれも原形をとどめていない遺跡を対象としていることから、従来提唱されてきたいくつかの学説や解釈にもとづいて、それぞれ複数のモデルを作成し、利用者が直接、目で確認しながら比較検証できる環境を整えた。また、外部の専門家グループや一般利用者を募って、これらの3D VRモデルを実際に体験してもらい、その有効性を検証・確認してもらった結果についても報告する。なお、本稿で取り上げた内容は、いずれもウェブ上で一般公開されており、高校・大学教育の教材の一部としても活用されている。

詳細は、"Digital Egypt for Universities"の公式サイト（http://www.digitalegypt.ucl.ac.uk/3d/）を参照されたい。