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Reconstructing Ancient Kellis Part II

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Abstract: This is an investigation of an online interactive application that allows visitors to navigate their way through models of domestic architecture and see it as a citizen of Kellis would have seen it in historical times. The goal is to communicate a richer representation of domestic life at Kellis where excavated artefacts are given context through their inclusion within the reconstructed three-dimensional (3D) architecture. The digital recreation is reinforced by adding 'soundscapes' that subtly evoke the agrarian village environment of the period. The creation of an 'immersive' environment using computer game technology expands the possibilities for archaeological interpretation within a reconstructed space. While these digital technologies may benefit researchers in communicating archaeological sites in a cohesive visual form, their educational potential for high schools and the general public (museum exhibitions) is more immediately applicable. This publication is accompanied by an online website (see above link) where readers can explore and experience first-hand the virtual images and models that are discussed in the following pages.

Introduction

This paper extends the research into the digital reconstruction of architecture at the Roman period village of Ismant el-Kharab (ancient Kellis) published in *Buried History* Volume 41. The purpose is to present the results of ongoing research into the virtual reconstruction of Ismant el-Kharab, ancient Kellis, in Egypt's Dakhleh Oasis, through a detailed study of Houses 1-3, the buildings being reconstructed by the 3D process.

To place this project within its context, an archaeological overview of Houses 1-3 is provided by Colin Hope, while Gillian Bowen reviews the evidence for textile manufacture within the houses. The discussion of the Virtual Archaeology project and the work undertaken to date is provided by Tom Chandler and Derrick Martin, Faculty of Information Technology, Monash University.

Whereas the previous paper was primarily concerned with the digital reconstruction of excavated architecture, here we introduce readers to more advanced applications of virtual technology; specifically, the *interactive* reconstruction of Houses 1-3 and the excavated artefacts found within them. The following pages include images that depict the working online application in action. However, the images printed here are merely snapshots of the virtual reconstruction and readers are encouraged to visit the website to experience the application to full effect.

Domestic Architecture at Kellis

The site of ancient Kellis lies in the south centre of Dakhleh Oasis within Egypt's Western Desert. Occupying approximately three-quarters of a square kilometre, the site witnessed occupation from the late first century BCE until the end of the fourth century CE, and throughout this period underwent a series of major architectural developments. Within each phase significant areas of the site were devoted, quite naturally, to residential activity. Within the earliest phase of occupation, from the late first century BCE to early third century CE, the major residential areas were on the north and east of the site. On the north a series of imposing buildings was erected that included substantial residences painted with a variety of classical-style wall paintings (Hope and Whitehouse 2006) surrounded by less formal buildings, including two pigeon-lofts (Hope et al. 2006: 27-9). On the east the buildings are less pretentious but include courtyard houses arranged along alleys and areas that attest industrial activity: pottery making, metal-working etc (Hope at al. 2005: 35-7). While work has been conducted within these buildings for several years, further exploration will undoubtedly yield invaluable evidence for the early development of Kellis.

Within the next major phase of activity, throughout the mid to late third century until the end of the fourth century CE, the central part of the site was developed into an extensive residential sector, termed, for ease of reference, Area A. This was the first part of the site to be explored, and between 1986 and 2001 five house complexes were excavated. Three of these, Houses 1-3 (Fig. 1), form a contiguous block and appear to have been planned as such; they were constructed from east to west, but excavated in reverse order. The features of the houses are similar: the rooms mostly have barrel-vaulted roofs, though some are flat and supported on wooden beams; cooking areas are either within the courtyards (House 3) or in additions to the original core (House 1-2); white-washed areas frame significant features within the spaces, such as cupboards, lamp recesses, and roofs; light is admitted either through doors or small angled windows set at roof level; and many spaces appear to have been multi-functional. Much activity took place upon the roofs. Only House 2 preserved a dining area: in room 7 a horseshoe-shaped construction at the south end permitted diners to recline in good Roman fashion around a table; this structure is typical of various features within the domestic architecture at Kellis that

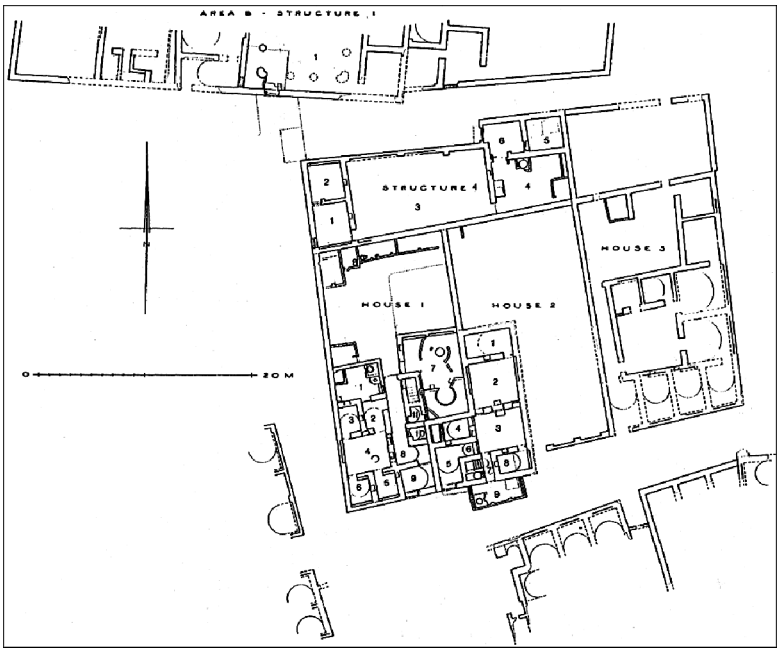

Figure 1: *Plan of Houses 1-3 in Area A.*

betray Roman influence on domestic architecture at the site. Courtyards were used for raising and stabling animals (donkeys, probably pigs and goats/sheep, chickens and ducks) in addition to other domestic activity. Throughout the excavation of these structures vast quantities of pottery, basketry, cordage, textiles, woven matting and inscribed material were found that enable life within the houses, and the wider village environment, to be reconstructed in detail.

The process of such reconstruction is very time consuming and often does not enable the non-archaeologist to gain a clear picture of ancient life. It is to overcome this problem, and to test various hypotheses concerning specific details of the ancient buildings, that 3D reconstruction work was commenced on the structures from Kellis, and now the more elaborate techniques described below extend greatly the range of possibilities. Not only can the buildings themselves be reconstructed, but objects can be placed within the virtual houses, people can be represented undertaking their daily tasks, animals can be inserted and sound introduced. These reconstructions are firmly based upon the archaeological record, as for example the suggested manufacture of textiles discussed by Gillian Bowen in the next section, and thus have wide potential for understanding the use of ancient space. One of the most immediate results of this task has been the realization that domestic architecture within Dakhleh has not changed dramatically until relatively recently, indicating its suitability to the harsh environment of this part of Egypt.

Textile Production within a Domestic Context: Digital Reconstructions and Archaeological Evidence

Numerous artefacts that have been recovered from all of the houses excavated at Kellis indicate that the occupants were involved in spinning and weaving. These include spindles, spindle whorls, loom weights, shuttles, unspun yarn and sections of warp that have been removed from the loom prior to completion of the fabric (Bowen 2001: 19-20). In many cases it can be assumed that the items produced were simply to cater for family needs. Textual evidence, however, has confirmed that a small-scale weaving and tailoring business was conducted from House 3 under the direction of a woman, Tehat, in conjunction with her husband, Hatres (Gardner et al 1999: 46; Bowen 2001: 24). The documents indicate that some of these garments were sent to the Nile Valley (P. Kellis I. Gr. 51.3-6; Worp 1995, 147-49). Items produced in House 3 include garments, such as cowls, headscarfs and tunics; larger items, which would have required more sizeable looms, include blankets (P. Kellis V. Copt. 44.24-5; Gardner et al 1999, 254-59; Bowen 2001: 24-5). Although no corresponding documents survive from House 1 to indicate that a similar business might have been conducted there, it has been tentatively suggested that gouges in the walls of Room 4, into which wooden beams were set (fragments of which remain *in situ*) may have been used to stabilise loom frames (Hope 1985: 118). These beams, along with most timber fittings, were removed when the occupants abandoned the premises, a practice discernable in all of the structures excavated at Ismant el-Kharab. Other material evidence for the production of cloth found in House 1 includes spindle whorls, loom weights, combs, and what appear to be heddles and shed bars. Quantities of worked wood from frames were retrieved from the house; some may have formed part of the looms. Peg holes in the walls could well have been used for measuring out the warp yarn, which was wound around such pegs as indicated in a model from the tomb of Meketre (Barber 1991: 85 figure 3.6; 89; Robins 1993: figure 28). Barber (1991: 89) notes that many hand-weavers use the same technique today.

Figure 2: *View from a rooftop in the Bashendi Village.*

Figure 3: *A narrow lane in the Village of Balat.*

The discovery of loom weights of various sizes and made of both sandstone and mud indicates that the villagers of Kellis used warp-weighted, vertical looms on which bundles of warp were tied together with weights in order to maintain the tension. This follows Greek practice and is in contrast to the traditional floor and non-warp weighted vertical looms used by the Egyptians in pharaonic times and which are illustrated in tomb paintings, such as that in the tomb of Djehuty-nefer at Thebes (Carroll 1988: figure 2) and the model of textile manufacturing in the tomb of Meketre. Heavy, dense fabric required a heavy loom weight whereas the fine and loose-woven cloth required a small, light weight loom (Barber 1991: 92). The looms comprised a wooden frame, which could be dismantled when not in use (Barber 1991: 270). No such ancient looms have been found intact and there is considerable debate on just how upright the looms were: vertical or on an angle (Barber 1991, 103). Both positions were possible as long as those on a vertical alignment were far enough away from the wall to allow the arm of the weaver to pass behind. If the beams in the wall of House 1 functioned as loom supports this would indicate that these looms were indeed vertical. There is every possibility that the traditional floor loom was also in use at Kellis for weaving smaller and more delicate fabrics.

The reconstructed looms used in the virtual reconstruction of House 1 follow a diagram in Barber (1991: figure 3.27), which is based upon Greek vase paintings. Some indication of the width of the looms used at Kellis may be determined by the depressions in the wall, the largest of which is just over one metre; the maximum width of fabric found at the site is 1.07 m (a shroud, which is fringed at the top and bottom where the warp was removed from the top beam; it is 1.85 m long). Tunics with *clavi* were woven sideways (personal communication, Rosanne Livingstone) and therefore a loom width at around 1.60 m could be expected for an adult's garment. The latter is based upon surviving garments found at Kellis.

Colours, Sounds and the Living Past

Because the teaching of Ancient History must necessarily deal with fragments and vast uncertainties, the virtual reconstruction of ancient history for education can reveal new opportunities for its interpretation. Traditionally, educational texts explaining ancient cultures are augmented with maps, photographs and diagrams of excavated artefacts, ruined temples and damaged statues. While these isolated visual representations are accurate and 'speculation-free', envisaging how they were used and the context in which they existed often presupposes a studied familiarity with the historic culture from which they derive. By placing artefacts within their reconstructed domestic environments, we are able to examine the contextualisation of the excavated material culture. For example, tentative reconstructions of weaving looms were placed in the areas where loom weights were uncovered in House 1 and pottery assemblages were reconstructed and placed close to the areas where nearly complete vessels were discovered. Similarly, doors, lintels and the shelves found in the niches were reconstructed and replaced with the fittings which had been removed.

The similarities which Houses 1-3 at Kellis share with modern villages in Dakhleh meant that modern photographic references could provide lighting and material references for simulated representations of historic domestic spaces. Photographs taken of the rooftops in the modern villages in Dahkleh (Balat, Bashendi and the Islamic town of el-Qasr) were the source for the reconstructed placement of palm fronds, palm rib boxes and varied debris on the roofs of Houses 1-3 (Figs 2, 3 and 4). Photographs of the dim corridors, covered streets and narrow lanes at el-Qasr and Balat were useful in reconstructing realistic virtual lighting schemes for the interactive walk through of Houses 1-3 as many of the roofs had long since collapsed. Another useful comparative study for visual references and artefacts

Figure 4: *Courtyard at el-Qasr.*

Figure 5: *A representative selection of pottery from the excavation of Houses 2.*

could be found in the documentation of the University of Michigan's excavations at Karanis (Gazda 1983).

In a previous paper the authors introduced advanced digital graphic experiments such as being able to 'cut through' virtual structures to see the inside and outside of architectural structures simultaneously (Bowen et al. 2005). There are no such 'special features' in this reconstruction. Rather, the virtual visitor shares the viewpoint of an inhabitant of the houses in that they steer their way through the reconstructed architecture at eyelevel.

In as close a way as possible, the visitor to the virtual reconstruction should experience a sense of actually journeying back in time and this is often referred to as 'presence' or a sense of 'being there'. In endeavouring to maintain this illusion, a great deal of time must be taken in ensuring the graphics are as realistic as possible, but a consideration for the sounds of historical spaces is often overlooked. Sound in fact constitutes an extra dimension in the virtual world and, when integrated properly into virtual applications, adds a depth and realism that graphics can never achieve alone. Where moving photorealistic or almost photorealistic visual imagery is employed, similarly realistic sonic elements are required to fully engage the observer in order to avoid any 'cognitive dissonance associated with sonic elements that mismatch the fidelity of the image' (Doornbusch 2004:1)

In keeping with this consideration, an atmospheric 'soundscape' was assembled from a wide range of sound recordings sourced from modern villages at Dahkleh and the archaeological site at Ismant el-Kharab. Animals such as dogs, chickens and goats can be heard among the distant sounds of playing children and a woodcutter's axe. As the visitor moves from open courtyards to gloomy corridors, the soundscape muffles and echoes subtly to simulate moving from an interior to an exterior space.

Virtual Museum Exhibits and Interactive Virtual Heritage

In the previous article the authors pointed to the valuable role Virtual Archaeology has for the preservation of the Kellis archaeological site (Bowen et al. 2005). The fragile nature of the structures renders Ismant el-Kharab a dangerous site for tourists to visit. Numerous buildings are preserved beneath the sand; the tops of some vaults and stairwells are visible from the surface, others are hidden and can collapse should the unwary tourist venture across the site. Moreover, tourists walking upon the walls and roofs of such structures pose a threat to the monuments themselves. Virtual Archaeology can address this problem and make Kellis widely accessible to the general public in a comprehensible form.

The recurrent problem of tourists wandering around the site of Kellis raises an interesting point, as the ability to (virtually) walk through the reconstructed buildings of Kellis that this study hopes to address. Whether this virtual substitute would assist in discouraging tourists from walking around the actual site is unclear and is worthy of further research[1] What is also less clear at this stage is how and where an exhibition of a virtual Kellis might be communicated to visitors. A small touch screen kiosk in a covered area at the site is a possibility, but a more sophisticated and engaging option for a museum exhibition would require large screens and a dedicated viewing area not unlike a small cinema. For the interim, making a virtual walkthrough accessible online has its own advantages. Though an online walkthrough is physically divorced from the location of the archaeological site it remains available to visitors prior to or after their visit, or indeed tourists who are interested in Egypt but who may never visit Dahkleh Oasis.

In placing an interactive vision of Kellis on the internet certain considerations were paramount. Online content has certain advantages; in a purely graphic sense, it can display animations and many layers of detail through interactive menus. Online content is also easy to update and archive and it reaches a far wider audience than print media. However, 'broadcasting' digital content in the form of three dimensional (3D) walkthroughs has its attendant problems. While visitors who have grown up with computer games can comprehend and adapt quickly to the medium, many others will experience difficulties in running the program and figuring out how to interact with the simulated environment. In creating the virtual environment in this study the authors endeavoured to make things as uncomplicated as

Figure 6: *A tentative reconstruction of the weaving area in House 1.*

Figure 7: *A virtual rendering of the courtyard in House 3 at eye level.*

possible. The visitor to the site does not have to contend with pop up dialogue boxes, drop down menus or special 'keyboard shortcuts'. All that is required is to move backward, forward or sideways with the arrow keys on the keyboard while using the mouse to look around.

It is hoped that by simplifying the controls and dispensing with additional information the primary content is limited to the reconstruction itself. However, the way in which these controls are used and understood cannot be predicted until the online prototype is subjected to rigorous user testing. It is hoped that this testing will be of benefit in informing interactive design decisions before a more costly application is developed.

From Rendered Images to Immersive Worlds

Generating the virtual environment begins with the construction of 3D representations of the buildings and their associated contents and features (doors, steps, shelves, etc). This process relies on interpretation of archaeological data as described in the previous edition of Buried History (Bowen et al. 2005). Building the 3D environment typically requires a specialised 3D construction program and *Autodesk Maya* was chosen for the recreation of the models featured here. There are a wide variety of possible 3D creation tools available, most capable of creating (approximately) similar results. The choice of programme is largely dictated by the software available to the research team and does not reflect any study done to assess whether *Autodesk Maya* is superior to any other programme in this field.

During the 3D reconstruction process, the constructed 3D environment remains non-interactive within the 3D modelling program. Although changes may be made by the designer, non-technologically oriented users would only be able to view the construction through pre-generated images (Figs 6-12) These pre-generated images are called *renders*; they could be a single image (for example, a jpeg image), or an animated movie (a series of hundreds or thousands of sequential images compressed together).

In order to allow a user to experience the environment intuitively, the 3D data needs to be placed inside a program where interaction can occur. The most common program that displays 3D objects in an interactive environment requires 3D game editors or *game engines*. Publicly licensed versions of these game engines are relatively easy to obtain and use and many derive from the gratuitously violent computer games know as 'first person shooters' [2] where the player runs, jumps and stalks though increasingly challenging game levels while dispatching scores of adversaries with various lethal weapons. These games are remarkable in that they allow real-life understanding of distance, speed, size and relative motion to be translated to a computer screen. While on the one hand it is inspiring to realise that game technologies that were developed primarily to facilitate shoot outs with monsters and villains can be usefully applied to communicate archaeological research, it should be pointed out that 3D games do not necessarily need to be based around violence to be successful. Games such as *Myst* allow the player to wander around a 3D environment, solving puzzles to advance in the game narrative. The popularity of the first person format in these games indicates that a 3D environment is as important as the interaction for the immersion of the player in the virtual world.

Once the 3D objects have been created, the models can be transferred into the game engine, though each model requires reformatting to be correctly interpreted in the virtual environment. For the interactive reconstruction of the houses at Kellis, the *Unreal Engine* and *Virtools* were the game engines of choice. Each of these programs was useful in specific circumstances.

Our analysis of the separate programs indicated the *Unreal Engine* was preferable for reconstructions that have limited interactivity and would be available from a single computer or a network of computers. In these circumstances,

Program	Advantages	Disadvantages
Unreal Engine	• Free version available • Mature, stable software • Easy to use • Many in-built features	• Final project size very large • Requires Unreal Engine to be installed • Limitations to possible interactivity
Virtools	• Allows wide range of complex interactivity • Can be viewed on Internet Explorer	• Problems occur when not using Internet Explorer • Expensive • Complicated to use

Table 1: *A list of advantages and disadvantages of Unreal Engine and Virtools.*

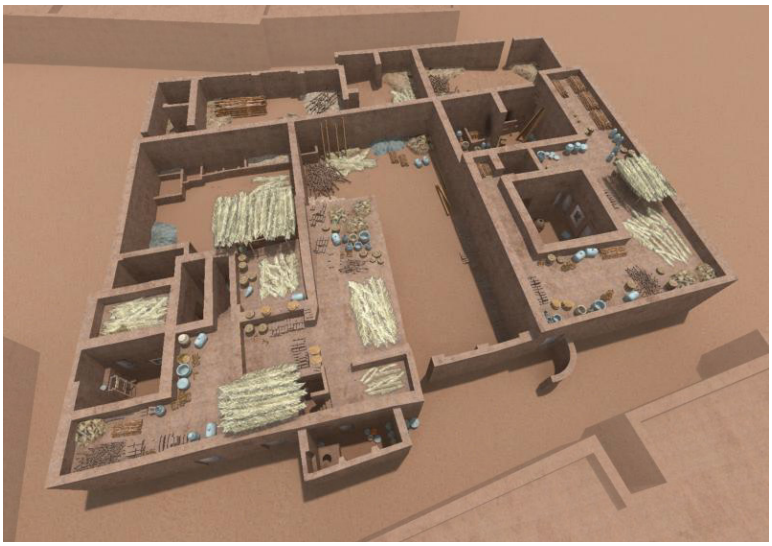

Figure 8: *A rendered aerial view of Houses 1-3.*

large file sizes would be less problematic. For access to the visualisation via the internet, Virtools was deemed a better solution. A browser (such as Internet Explorer) first loads a small add-in program and the 3D data is loaded onto the user's computer and experienced in the browser window. The speed of the loading depends on the user's internet speed.

Ancient Kellis in the Classroom: Future Developments and 'Game Learning'

We all recall the vivid illustrations of ancient events and daily life in the books we read when we were young. In many ways the small and modest italic captions '*An artists impression of...*' underneath these images belied their interpretive power in visualising a living past. With modern computer graphic technology, these 'impressions' are no longer a static artworks. Recent digital visions of ancient cultures not only retain the colours and detail of printed illustrations; they also *move* and allow students to *play* the part of historical personality and converse with or compete against other players or computer-generated agents. The increasing sophistication of these imagined historic worlds raises important issues. While the accuracy of such a virtual environment will rely upon archaeological and historical evidence, its appeal and playability might rely upon entirely different considerations, such as the cinematic 'suspension of disbelief'.

Much mention has been made of today's teenagers growing up in a world where computers and the Internet are taken for granted (Oblinger and Obliger, 2005), but less attention has been given to their specific expectations of virtual worlds and three-dimensional (3D) graphics. Whether they view seamlessly integrated digital scenes in the latest movies or play the part of interactive characters in an online game, teenagers today have grown up in a world where 3D graphics are ever present. These digital technologies have matured considerably since the computer game *Doom* and the movie *Jurassic Park* were released in 1993, and the hyped promises of 'Cyberspace' and 'Virtual Reality' made in the mid 90s are quietly becoming realised in forms quite unlike early conceptions.

Over the last decade, three-dimensional (3D) and Interactive technologies have matured to the point where the educational multimedia industry finds itself in a process of massive change. While the costs required to create and animate 3D worlds have decreased considerably, the average teenager's expectations for high impact visuals and complex interactivity in educational multimedia applications have risen significantly and will only continue to do so.

Foreman (2003) sees immersive interactive 3D spaces as the inheritors of the 'passivity and the visual monotony that are the norm in large lectures' because the student engaged in an immersive world has to achieve a set of complex actions to achieve desired learning goals.

Scholars such as Champion (2002) and Forte (2000) have pointed to the hermeneutic and narrative possibilities of

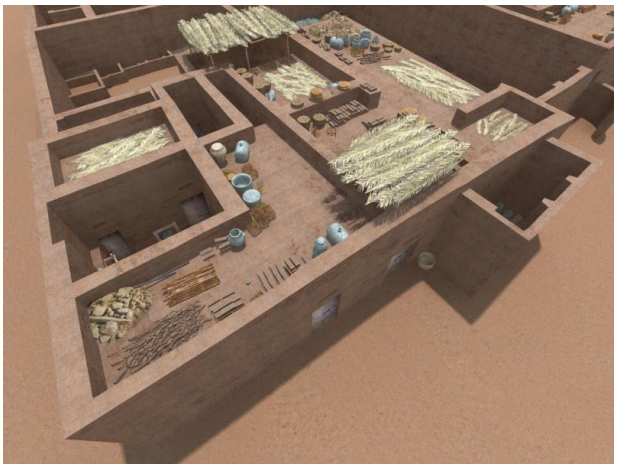

Figure 9: *A rendered view of the roofs of Houses 1 and 2.*

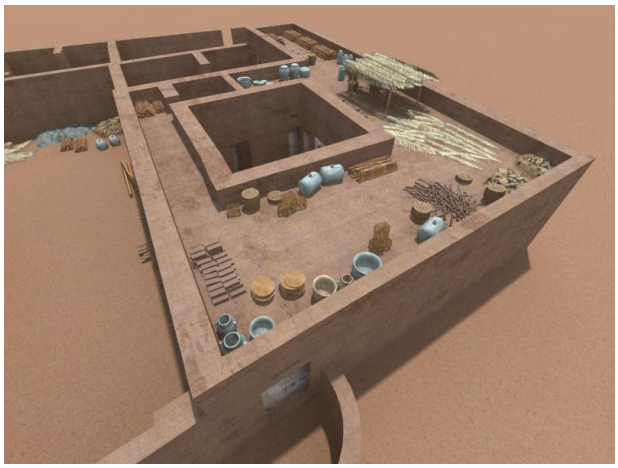

Figure 10: *A rendering of the roof of House 3.*

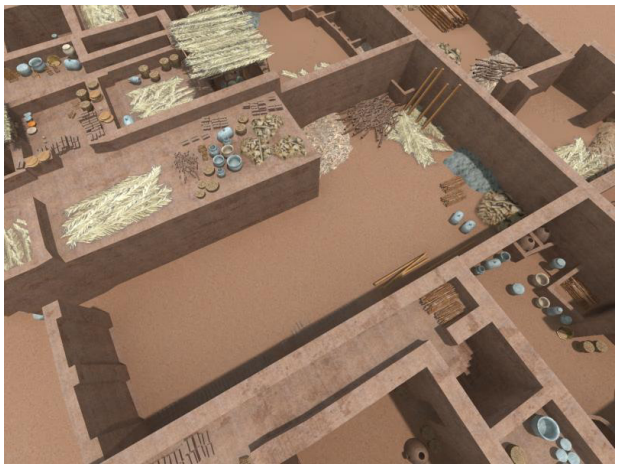

Figure 11: *A rendering of the courtyard of House 2*

Figure 12: *A rendering of the kitchen area in the courtyard of House 3, as from the roof .*

highly graphical, interactive virtual spaces in communicating historic cultures. Their studies represent a small sample of the wider academic debate emerging over the educational potential of 3D interactive spaces in the communication and interpretation of ancient cultures. Certainly the intersection of the virtual archaeology of Ancient Kellis with educational multimedia entails many avenues of ongoing investigation and research. Future applications of this technology may be explored as 'game learning' applications for secondary schools or augmented with GIS databases and detailed photographic and textual descriptions for first year tertiary studies.

However, these further developments depend upon sound foundations. In creating an interactive 3D model of an archaeological site, the groundwork is being laid for more sophisticated applications where layers of information and much more complex interactive features can be realised. It follows that the process of virtual reconstruction is in many senses never complete, for in addition to its translation into a virtual space, each step of digital development must necessarily be followed by reviews from experts in the field. Visitors to the interactive site of Kellis currently online will no doubt note the absence of the people themselves. Because they are heard and not seen and their existence is implied by the presence of their material goods, household industries and storage of food, fuels and animal fodder, these people are experienced by one degree of separation. Certainly the reconstruction and animation of the people at Kellis into a virtual environment constitutes ample material for further research in the coming year.

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Endnotes

1 It is also possible that a virtual walkthrough of Kellis may encourage more interest in examining the physical site and further tourist traffic.

2 So called because the player views the world from a first person perspective and usually behind a gun barrel