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Journal
Near Eastern Archaeology, 77(3)

ISSN
1094-2076

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Publication Date
2014-09-01

DOI
10.5615/neareastarch.77.3.0233

Karanis in 3D:
Recording, Monitoring, Recontextualizing, and the Representation of Knowledge and Conjecture

Karanis landscape. Photograph by URU Fayum Project/Jolanda Bos.

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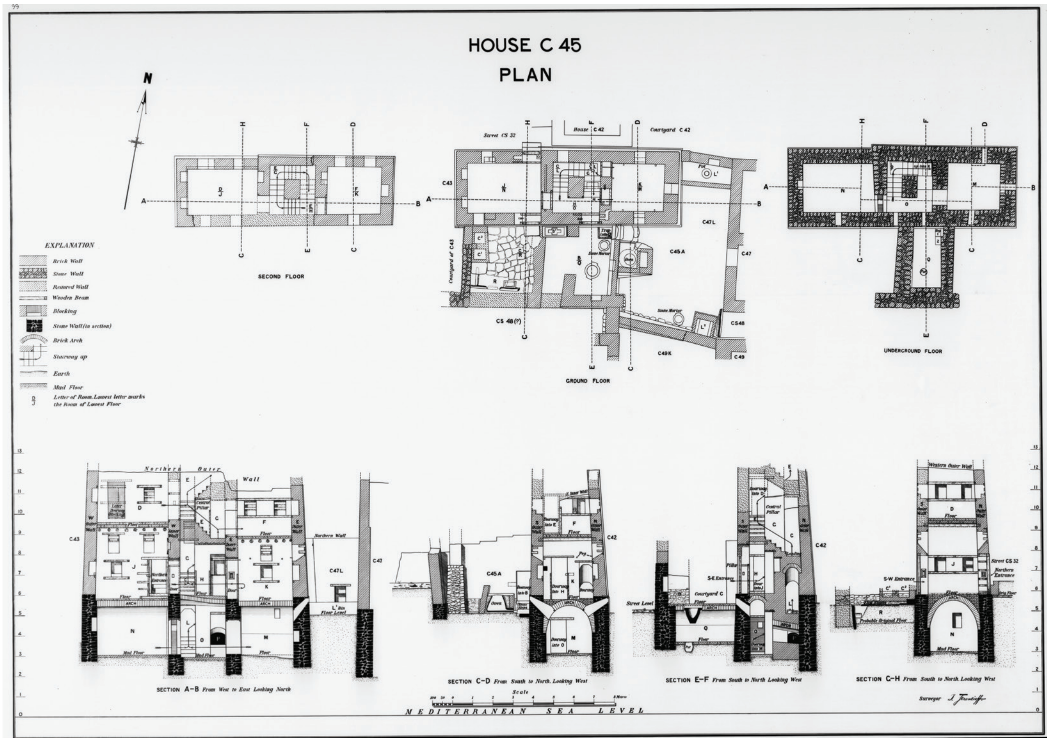
The context for human social interaction is created, built, and shared space, much of which is traced in archaeology, but little of which is directly observable in the archaeological record. Buildings are complex material expressions that are multi-layered: the same space might reflect shelter, safety, power, piety, posturing, negotiation, justice, or threat. Sharing space is a sign of social or ritual belonging. Location, orientation, context, building materials, decoration, re-use, and cleanliness all potentially inform us on what the space might be about. Added to that are the experiential aspects of space: the light, the sound, the smells, and the movement of people and animals.

Using advanced technology does not necessarily help us to critically assess the way we understand space, and especially the intangible elements of the function, use, and experience of space in the past. In some cases technology might actually hamper us, unless used critically. Geographic Information Systems, used widely in archaeology, flatten the world in two dimensions: GIS combines layers of information that are linked to spatial X, Y coordinates, but are not a reflection of archaeological layering. Archaeological stratigraphy enables us to trace developments over time, for instance the activities that took place within a space through a building's foundation, use life, and abandonment. In archaeology the three dimensions of length, width, and depth/height should therefore be combined with a fourth dimension, that of time. Displaying archaeological space in three dimensions and in multiple iterations, which represent the time factor, is the best way to understand ancient space. Most importantly, GIS and most other information technology approaches to data are incapable of showing ambiguity or uncertainty, while much of the archeological data are exactly that. Once a coordinate or a time frame has been put in, it gets an aura of finality, certainty, and objectivity that does not reflect the nature of the data.

If we are serious about understanding archaeology not as surface or floor plan, but as the space above and through time, then representing archaeology as such becomes very important. This already starts in the documentation phase where a standard approach is to measure and draw length (X), width (Y), and height or depth (Z). Total station measurements, laser scanning, and photogrammetry are three methods which enable detailed recording of all three dimensions. They all record the present state of a building or landscape, but they vary in precision, speed, ease of use, and costs. They do have in common that they are digital techniques: the information can be conveyed to paper, but is digitally born and can be presented in a number of visualizations.

Working with heritage data brings differences in recording and representation to the fore. From 1924 to 1934 the University of Michigan excavated at the Greco-Roman site of Karanis (Fayum, Egypt). In 2005 an international team (the URU Fayum Project) started work in the same area. The University of Michigan published printed top plans, elevations, and section drawings, which are still the most common way archaeologists share spatial data about ancient structural remains (fig. 1). With sufficient evidence three-dimensional renderings can be successfully "reconstructed" from two-dimensional records, as with the example of Karanis House C45 (fig. 1). However, the inclusion of such plans in traditional printed publications remains rare, largely due to the cost of publication, and reductions are made "primarily for reasons of economy" (Husselman 1979:xi). Nor are such two-dimensional renderings the most effective way of displaying spatial data: they must be made from a fixed perspective, limiting the user's ability to "view" space from other angles. Printed maps are also fixed in scale at a compromise between the portrayal of details and the legibility of the plans at the size of a printed page, and alterations introduce discrepancies of scale into the dataset that cannot be easily rectified.

Digital media enable the creation of more complex renderings of space: vector-drawn plans are neither fixed in terms of scale or point of view, allowing the user to zoom in or out, focus on fine details of space and structure, or to pan out and observe larger structural landscapes. Rather than being expensive to publish, once created such models are virtually free to disseminate via the internet, be it among members of an excavation team, the academic community, or the general public.



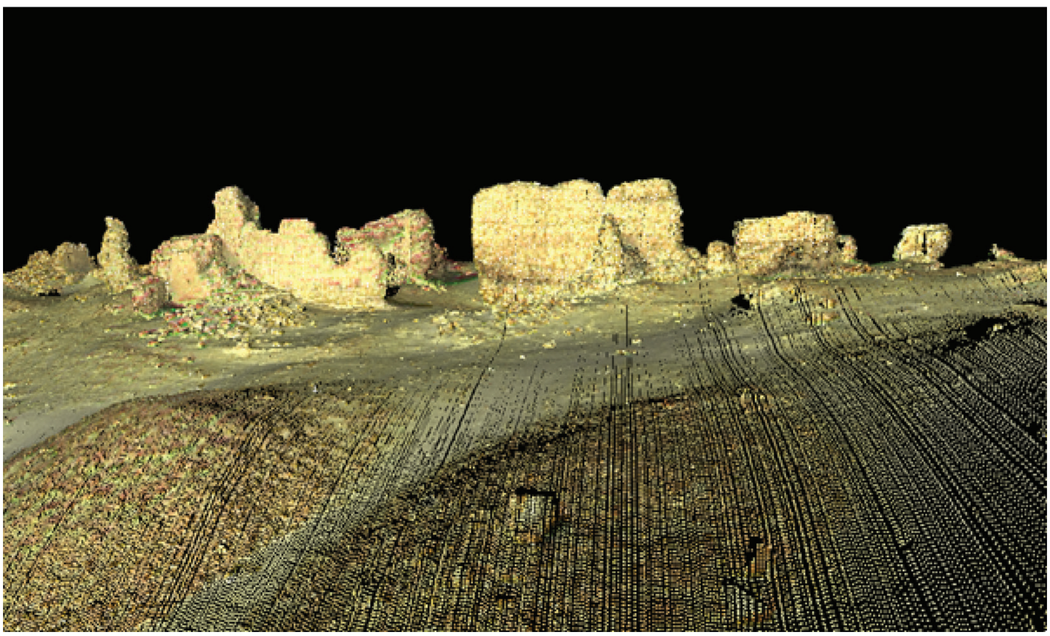


Figure 1 (above). Plans and sections of House C45, Karanis, Egypt. Courtesy of the Kelsey Museum of Archaeology, University of Michigan, KM 5.8396 Map No. 99.

Figure 2 (below). Detail of TLS point-cloud with color data applied. Visible striations in the foreground reveal gaps in the recording of terrain, but the average point-spread for architectural features is less than 2 mm. Courtesy of URU Fayum Project/B. Simpson.

From 2007 to 2011, a team led by Hans Barnard undertook a survey of all extant Karanis architecture using a Topcon GTS-235W total station and Trimble ProXRT DGPS receiver (Barnard, Wendrich, Nigra et al. forthc.). The survey information has been uploaded into GIS, making it possible to match measurements and observations from the ongoing architectural survey of Karanis (first implemented by Bethany Simpson in 2008) to their specific spatial coordinates. Thus Michigan and ongoing URU field data have been combined in order to create a sharable, annotatable, and spatially consistent model of Karanis architecture, both as it was when uncovered in the early twentieth century, and as it stands today.

In over six seasons of field survey, the whole of the site, over 800,000 square meters, was recorded, but the majority of points represent vertices of walls and architectural features, and preserved no information about the finer geometries: for example, Karanis' vaulted ceilings are not recognizable by regular formal geometry or structural engineering, the only indication being the placement of individual bricks. For such specific questions a higher level of recorded detail is important. In 2010, in collaboration with the University of Arkansas and their center for Advanced Spatial Technologies, we were able to bring a terrestrial-based Leica C10 laser scanner (TLS) to Karanis, to scan and record the visible extant architecture. The TLS records 50,000 points per second, 360 degrees horizontally, and 270 degrees vertically, mimicking the range of the human eye. The TLS records enough coordinates to form a dense "point cloud" of data, resulting in a visualization of space that is already fairly easy for the human eye to interpret, even before any points are joined into line segments or planar surfaces (fig. 2). Once individual scans from separate scan-station points of view are combined, the resulting cloud has a density of one point per every 2mm of surface. Joining these points into line-segments and planar surfaces reflects such details as brick and mortar placement, and even plaster rugosity and surface damage. Such a nuanced model is useful for future conservation efforts, serving as a benchmark to track the different problems of erosion and collapse that plague much of the mudbrick architecture (Barnard, Wendrich, Winkels et al. forthc.). To record the interiors of any

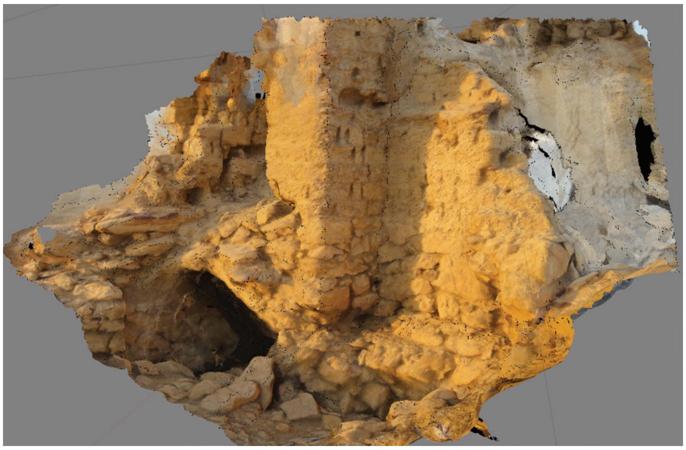
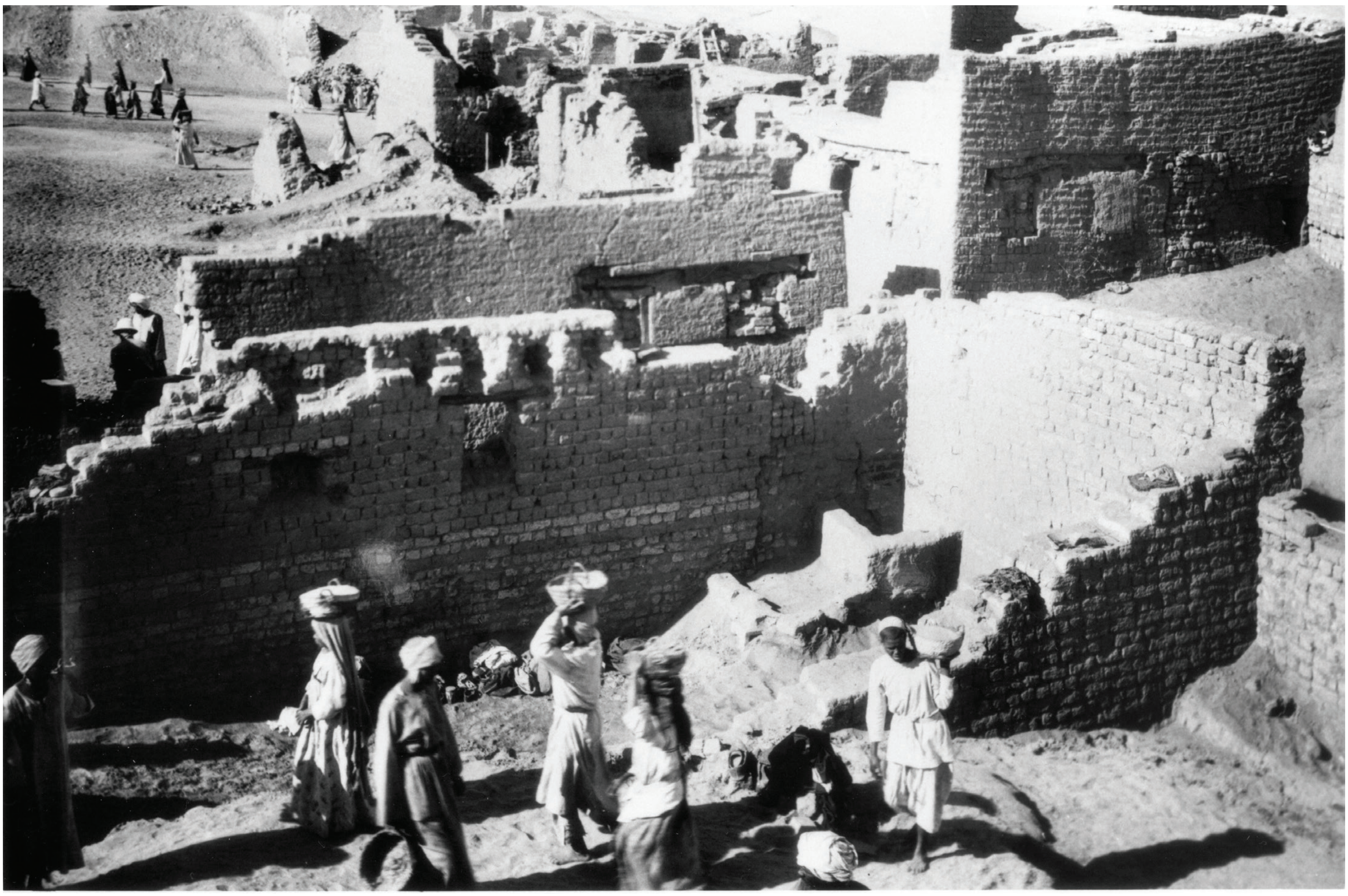


Figure 3 (above). Detail of extant Karanis stairway construction, modeled using photogrammetry. Courtesy of URU Fayum Project/B. Simpson.

Figure 4 (below). A general view looking west from C62, House C45 is at the top right of the photograph. Courtesy of the Kelsey Museum of Archaeology, University of Michigan, KM 5.2704.



of the small storage spaces, narrow passages, or stairways common to Karanis architecture, photogrammetry was used (fig. 3). These data are fully compatible with the results of the TLS, allowing for incorporation into the same digital model space. Together they provide a way for creating a digital model of the site with an extremely high degree of fidelity to the rendering of space created by the complex architecture.

among which many items of daily life usage. Pottery, glass containers, lamps, baskets, textiles, and even children's toys help to reflect many aspects of daily life of a town of this period. Thousands of finds were divided between the University of Michigan and the Egyptian government. At present these finds are displayed at the Kelsey Museum of Archaeology in Ann Arbor, as well as different museums in Egypt among which are the Kom Aushim Museum in Fayum, the Egyptian Museum and the Agricultural Museum in Cairo, and the Greco-Roman Museum in Alexandria. Some of these museums are closed to the public and several objects are kept in storage and are unknown and invisible to researchers and public alike. The pilot research project "Reviving Karanis" is motivated by the importance to bring the collections virtually together in an evocative way that can explain to scholars and the general public what the original context and importance of the objects was. Reviving Karanis uses a creative virtual-real dialogue between the place of origin of these objects (the site of Karanis) and the faraway places in which the house contents are displayed in two distant countries. This proposed dialogue is going to be achieved through building a hyper-realistic 3D virtual environment which visualizes some selected houses from Karanis and courtyards in which the finds will be re-united and placed in their original context. The virtual interactive environments could be installed as dynamic interactive digital displays in the museums and also be shared through the internet.

Figure 5. South façade of the virtual model of House C45 and courtyard. Courtesy of URU Fayum Project/E. Elgewely.

Important as detailed recording of the present situation is, it does not allow the involvement of the fourth dimension of time. Representing the present state of a building is by definition a temporal snapshot. Reconstructions can provide an understanding of developments over time, but necessarily involve a certain degree of uncertainty and speculation. An example of understanding the development of architectural space over time is the Digital Karnak project, developed at UCLA (http://dlib.etc.ucla.edu/projects/Karnak/). This enormous temple complex was built over a period of at least two thousand years. Most Egyptian kings have added important monumental buildings to the complex, and in the process sometimes removed enormous building works of their predecessors. The virtual reality reconstruction, based on published excavation results, includes a time slider which enables the "visitor" to envision the lay-out of the temple with its towering pylons and impressive halls and decorations at any point in time (Wendrich 2014).

Apart from the time factor, VR reconstructions enable several other important aspects. Karanis houses, excavated in the 1920s, have suffered rapid decay so their laser scanned appearance now is very different from their condition immediately after excavation, or during their use life (fig. 4). Secondly, the belongings of Karanis' people who used to inhabit these houses have been separated from their original context into different cities and museums inside and outside Egypt. The large scale excavations by the University of Michigan yielded an unexpected wealth of finds,

The combination of well-curated museum collections and recent archaeological research enables a reconstruction of the material culture in its original context. Knowledge about Karanis informs us about life in similar towns of this period in the Fayum, in other regions of Egypt, and in neighboring countries in North Africa and the Middle East that have much in common. The presentation will also present to a large audience the results of recent and ongoing research on the material culture, the plant and animal remains, the demography, the building technology, the religion, the economy, and many other facets of life in the town.

Karanis House C45 was chosen as a prototype for the study because it is an average size house similar to many other houses from the mid-first through early-second centuries C.E. (fig. 5). In this particular house over 497 complete or nearly complete objects were excavated between the years 1927 and 1929. These range from ceramic, lamps, glass bowls, architectural fragments of windows and doors, coins, beads, and terracotta figurines. Many of these items were divided between the University of

Michigan's Kelsey Museum, and two Cairo museums: the Museum of Egyptian Antiquities and the Agriculture Museum. House C45 consists of a basement, ground floor and a second story. To the south were three courtyard areas (A, B, and C). The east courtyard area (C45A) included a circular oven as well as storage bins and jars for grain and fodder (fig. 1). The house itself consists of two rooms on each floor, one on each side of the stairway unit. The windows, with steeply-sloped sills, are very small and high in the walls, just below the ceilings. Apparently their only function was to admit light and air. The dark rooms of the houses were usually illuminated by oil lamps. Both terracotta and glass types were known: conical glass lamps were probably set into tripod holders or suspended on ropes or chains, while many terracotta lamps had flat bottoms and were placed inside wall niches. Cupboard niches recessed in the walls below the windows were in every room in House C45 in both the ground and second story; these were mainly used for the storage of household goods such as tableware and glass (fig 6).

Figure 6. Left: photo-based models of finds from Karanis House C45 from the Kelsey Museum Collection. Right: interior view of Room C45J after adding the 3D models of the finds inside the house model. Courtesy of URU Fayum Project/E. Elgewely.

VR reconstructions enable us to put people back into the landscape or the architecture, which provides the research with a way of performing a different type of spatial analysis and coming to new understandings: questions of private and public space, performance, and presence can be addressed. VR reconstructions do not have to be of a life-like appearance, and might even distract if they are too picture perfect. Populating the model to address questions such as: who was watching and who could be seen; who was listening and who could be heard; how many people fit in this space; how can objects, materials, processions move along a particular route. These are reconstructions that are not just experiential, but also experimental (Johanson and Favro 2010).

Field recording with electronic means, such as total station, laser scanning, or photogrammetry all record the present state of a building or landscape. They vary in precision, speed, ease of use, and costs, but they have in common that they are digital techniques, which can be used in many ways. The information can of course be conveyed to paper, but most importantly it can be used in digital form to use as a basis for comparison and reconstruction. Detailed laser scans are used in Karanis to monitor the ongoing decay of the fragile mudbrick buildings. The scans can also be used as the basis for reconstructions that enable further exploration of the archaeological context. VR reconstructions can be representations of change, outlining developments; they can be used as the virtual re-unification of material culture that has been dispersed over various museums, cities, and countries. Finally, they offer the possibility to create an experiential testing ground, to better understand the effects of light, sound, smells, and movement of people and animals. In all this we should be very much aware that visual representations, however tenuous and speculative, strongly influence our perception. Images stick into ones memory, whatever caveats the accompanying texts or labels might give. We should, therefore, also take into account how we express uncertainty and ambiguity right in the virtual representation. We should ask ourselves how VR might misrepresent the past, whether it presents a particular perspective, such as that of the elite or the disenfranchised, and how our arguments that are inevitably embedded, are displayed and made explicit.

References

Barnard, H., W. Z. Wendrich, B. T. Nigra, B. L. Simson and R. T. J. Cappers. Forthcoming. The Fourth Century CE Expansion of the Graeco-Roman Settlement of Karanis (Kom Aushim) in the Northern Fayum. *Journal of Egyptian Archaeology*.

Barnard, H., W. Z. Wendrich, A. Winkels, J. E. F. M. Bos, B. L. Simpson and R. T. J. Cappers. Forthcoming. The Preservation of the Exposed Mud-Brick Architecture in Karanis (Kom Aushim), Egypt. *Journal of Field Archaeology*.

Husselman, E. M. 1979. *Karanis Excavations of the University of Michigan in Egypt, 1928–1935: Topography and Architecture: A Summary of the Reports of the Director, Enoch E. Peterson*. Ann Arbor: University of Michigan Press.

Johanson, C. and D. Favro. 2010. Death in Motion: Funeral Processions in the Roman Forum. *Journal of the Society of Architectural Historians* 69.1: 15.

Wendrich, W. 2014. Visualizing the Dynamics of Monumentality. Pp. 409–30 in: *Approaching Monumentality in Archaeology*, Proceedings of the IEMA Postdoctoral Visiting Scholar Conference on Theories and Methods in Archaeology, ed. James Osborne, Buffalo NY: IEMA.