The Nile Delta as a centre of cultural interactions between Upper Egypt and the Southern Levant in the 4th millennium BC
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Settlement architecture on the Eastern Kom at Tell el-Farkha. A 3D reconstruction.

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Introduction

Modern archeology is able to gain, interpret and present more information than it was in the first two centuries of the history of this science. In recent times, the three-dimensional computer reconstruction – one of the newest methods – has become more and more popular. In this paper I will present the reconstruction of Predynastic settlement architecture from Eastern Kom at Tell el- Farkha in Egypt. The reconstruction has been done within the framework of the project *The Nile Delta as a center of cultural interactions between Upper Egypt and the Southern Levant in the 4th millennium BC* conducted by Agnieszka Mączyńska from the Poznań Archaeological Museum. The project was financed from the funds of the Foundation for Polish Science in 2011-2014 .

Three-dimensional reconstruction in archeology is a method of visualizing the archaeological concepts using graphics programs which allow to modeling in 3D. The final result of the reconstruction process should be virtual model of the reconstructed structures or archaeological artifacts. Complete model should reflect the data obtained in the analysis of archaeological material and references and should also help to imagine how different structures from the past may look like (Forte 2006: 339-351).

This method provides access to architectural structures and monuments that no longer exist or for various reasons are not made available to the public. This makes it very attractive method, allowing to share the results of archaeological research to a wider audience in a form which is accessible to all, especially to those outside from the scientific community interested in a particular subject of research. However, despite the obvious advantages of the method in the dissemination of research results, it may be also a very useful research tool which enable us to answer questions raised during the process of archaeological reconstruction.

The site of Tell el-Farkha in Egypt is located in the eastern Nile Delta about 23 km east of the modern town Simbillawin and about 120 km to the north-east from Cairo. It sits right between the southern bank of the Ghazala village irrigation drain and northern border of modern buildings of mentioned village. The site covers an area of approximately 4.5 hectares and consists of three tells (koms) arising as a result of accumulation of archaeological layers containing traces of ancient settlement activity, including the numerous remains of mudbrick architecture (Chłodnicki 2012a: 9).

All three tells are located at the southern edge of the above-mentioned irrigation channel and due to its location have been given names: Western Kom, Central Kom and Eastern Kom. The position at the highest point rises to a height of about 5m asl. (Chłodnicki 2012a: 9).

Based on research conducted by the Italian expedition (1987-1990) and following Polish expedition, which have worked there since 1998, the site chronology was established, ranging from Predynastic Period, including the Lower Egyptian culture and Naqada culture phase II/III to the Old Kingdom, Dynasties III-IV (Jucha 2005: 19; Chłodnicki 2012a: 13, tab.1).

Past function of area located now at Eastern Kom seems to be the most enigmatic. In this place we have to deal both with the remains of settlement construction, (which reconstruction is the subject of this paper) as well as the grave structures. Among funerary structures we should mention a large mud brick mastaba from Nagada III period which is one of the earliest structures of this type in ancient Egypt. Studies conducted so far at this area have revealed also traces of Lower Egyptian culture. However, these remains are later than the earliest phases of this culture, recorded at two other tells (Chłodnicki 2012b: 19-21).

Data acquisition

The process of archaeological reconstruction begins with obtaining the relevant data during excavations. At the site of Tell el-Farkha, archeological excavation are conducted by digging ten-centimeters mechanical layers. After the removal of each layer and cleaning the level the photographic and drawing documentation are produced. With this method, numerous plans of stratigraphic situation are recorded every 10cm. After plan is done, the contents of each shall be interpreted and described to date in order to avoid loss of information related to the seizure of objects caused by ground drying and sand.

Drawings are drawn up on the basis of the coordinates reported with an electronic total station, at a time. Then the data are recorded in order to use it for further editing in a graphics program. It should be noted that the method of creating drawing based on observations obtained through total station has a significant advantage. It allows reduction of the so-called human error, which may occur with the traditional method of documentation.

Development of data

The files saved on total station in local x, y, z coordinates system are imported to a computer with a graphical CAD software. The data are in form of points that reflect the authentic locations of where the measurements were taken. Coordinates presented in the graphical software should be connected together according to information from earlier paper plan. This work is needed to refer to either an existing paper documentation and photographs, due to give maximum effect and prevent loss of data.

The next step is to give the appropriate characteristics to objects located on the currently drawn up plan. In many graphic programs, such as CAD type programs, giving characteristics to each object on drawing is possible by using the tool calls „layers". It is one of the main tools on the basis of which many graphics programs are working. Although we need to know that "layer" in graphical programs has nothing to do with the archeological layer. It is a kind of defining characteristic of the object selected by the drawer, made of group of elements that consist series of vectors (lines, polylines, hatches etc.) which make up the picture of each object. In this way, a graphic layer is subordinated to the color, thickness, line and character name. For the preparation of computer drawings from Eastern Kom at Tell el-Farkha the graphical layers determinates objects such as: mudbricks with admixture of sand and silt, kilns, pits, pottery artifacts, remains of reed mats, stones and others archeological features. In the next step each of the layers gets suitable color and character of the line. Tool „layers" also allows to manipulate the objects created in this way. There is possibility to hiding and displaying them, which is important to the interpretation. As in the previous phase of creating the computer drawing also at this stage it is very important to refer both to the photographic documentation and the paper drawings bearing a precise description of archeological features. Only with this information it is possible to make correct documentation.

Each of those prepared computer drawings are then added to the so-called "main drawing", which shows all documented exploration layers to date (Fig. 1). With this solution, in the main drawing (by using tool „layers") we can freely manipulate the data by displaying different levels of exploratory drawings and objects within them. As already mentioned, it is important to interpretation process, because overlapping drawings of different exploration levels is much easier way to show us continuity of stratification of individual archaeological features. This seems to be very useful in case of analyzing specific architectural remains of mud brick buildings. Later, on the basis of this observations, the three-dimensional reconstruction is made.

Data integration

At this stage of reconstruction we should again compare different types of documentation in areas which for some reason (for example due to the high density of archaeological features) is needed to be look a little closer. In the presented project, a photographic documentation was combined with computer drawing using free and available via internet program Airphoto, which normally is used for the rectification of aerial photographs. This application is typically used to develop photographs taken from a large

Figure 1. An example of so-called main drawing which shows all documented exploration layers to date.

distance, but in this case it was used to insert photography documentation from excavation site into computer drawn plans. With tools that allow the incorporation and mixing the two forms of documentation we can obtain better view of archaeological features that occur at a particular exploration level. We can use a tool to create a "negative effect" in the pictures, which in some cases has revealed a slightly different boundary of archeological objects that drawer who making records could not see due to the light conditions prevailing in the field. These differences very often are not visible in the documentation pictures before color modification made in graphic programs (Fig. 2).

3D MODEL AND VISUALIZATION

Creating of three-dimensional model was began by prepare a base-drawing (a base for future 3D model) which presents the plans of buildings developed from the documentation presented above. The next step was using the right tools to create 3D features consisting of all elements of buildings and its companioning elements. At this stage of reconstruction is needed to refer to architectural traditions of ancient Egypt and different types of analogies that allow us to recreate the appearance of the reconstructed buildings. This is very important because the model characterize the appearance of entire reconstruction.

At this point we should create the characteristic elements of architecture, giving specific dimensions and appearance to elements like: doors, windows, roofing and walls. Also, fixing the appropriate height of buildings and other values of all the parameters that cannot be directly defined only on the basis of architectural remains discovered during archaeological excavations. In addition to the reconstructed architecture at this stage, the author may add some aesthetic elements of the model, such as vegetation or other accompanying features like reconstructed ceramic pots and hearths. Additives of this type are designed to improve the visual effect of the final reconstruction. Although they are purely aesthetic elements of reconstruction, they allows us to understand more easily the final image.

After creating a 3D model based on the different types of analogies and the data obtained during the measurements and the excavations, next step was to give the textures. This is done by assigning appropriate textures and colors to specific objects present in the model. This process is time-consuming and requires patience. After this we have fully color and textured model ready for rendering. During process of rendering software creates a series of virtual photos of the model. Before that we need to set specific parameters such as: light intensity, angle and distance of visualization. To achieve the best final picture is need to create a lot of visualization with different parameters settings. This is another time-consuming process requiring multiple trial and error.

Analogies

As we mentioned before, the reconstruction described in this article is based on a number of analogies, which can be divided into three main groups: the analogies to clay models of architecture from the Predynastic Period, analogies of transpositions of perishable materials in the stone architecture in the Old Kingdom and ethnographic analogies refers to modern mud brick architecture from Egypt.

Clay models created in times of Predynastic and Early Dynastic periods are perhaps the best material allows us to reconstruct the appearance and ways of constructing buildings from this periods. However, examples of such artifacts are very few, and even fewer of them show the settlement architecture in the strict sense. The most valuable clay models of homes are so-called „houses of souls" which sometimes were put in graves. The aim of putting this models to graves was to provide deceased with a home in his afterlife (Petrie 1907: 113-114). However, we need to keep in mind that these items were probably made in a very schematic way, showing only the most characteristic aspects of architecture occurring in that period.

The best example of these is the clay model of house from el-Amra. This model was discovered in the tomb no. a4 at el-Amra in Upper Egypt by D. Randall-MacIver and is dated to Naqada IId period. Today the artifact is located in London's British Museum in Room 64 (Badawy 1954: 23). A clay model shows a rectangular house with a pair of doors located on one of the two shorter walls of a building and two windows located on the opposite wall. Its dimensions are: 24.2cm high, 38cm long and 26.7cm wide (Vandier 1952: 499). Both windows are relatively small and are located in the upper part of the wall.

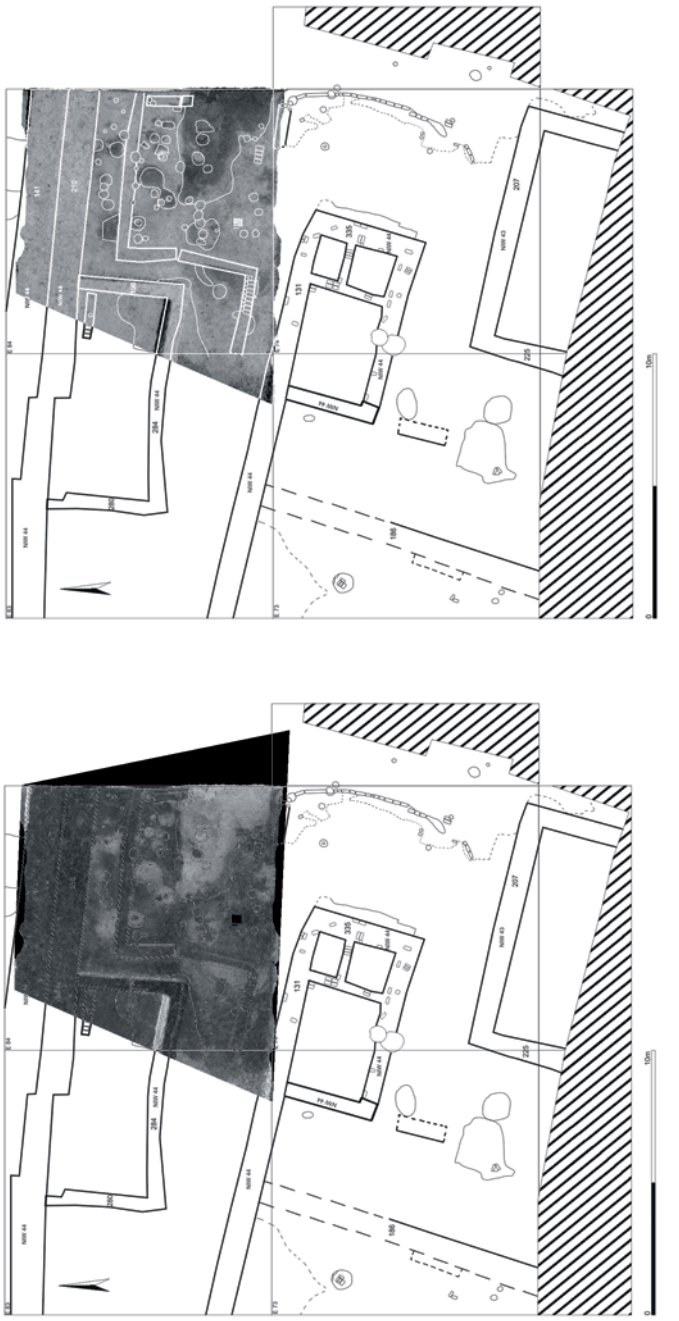

Figure 2. Examples of mixed-up field plans with photography. On the left – photography with negative effect.

This position is likely to protect the interior of house from unwanted intruders, such as scorpions and snakes. On the other hand, a small window allowed for admitting only the necessary amount of light into the homes, so that the interior there was no getting too heated by sunlight. This treatment is also evident in the modern residential buildings in Egypt (not just in the mudbrick architecture). The windows depicted in the model that have also two protective bars on top and bottom of each window. Square shaped beams were roughly three times longer than the edge of the window, which reinforced. It seems that the purpose of these beams was to provide protection against damage associated with the erosion of mudbricks and support wall construction above an empty space in a place where there was a window. Doors that are shown on the opposite wall also have a massive part, interpreted as a wooden door frame elements. Doors hole was consisted of a vertical jambs and massive lintel in the form of a beam having a square cross-section and located above the upper edge of the door, as in the case of the previously described beams over the windows. A common feature of both: the door lintel beams and door beams located above the windows are the proportions. Door lintels beams, just like window lintels beams are much longer than the door hole, which was secured by them. Both wood jambs and lintels act as strain relief. Their task was to relieve the empty space created in the place of the door hole and to protect mudbricks against erosion and abrasion. The upper part of the doors also has an additional element similar to circular in cross section and positioned slightly below the upper lintel, between two jambs. This element is interpreted as a depiction of rolled-up reed mat, sometimes called in the literature *drum* (Arnold 2003: 77). From the one hand this door mat allowed to the closure of the home space and reduce the darkness inside, but on the other hand it also allowed the free flow of air. Moreover, the empty space created between the upper edge of the reed mat and door lintel, formed space providing additional access of light when the door mat remained lowered. As can be seen from the analogy with ethnographic and archaeological documentation, the lower part of the door was equipped with a threshold likely placed just above the ground level. This type of solution may supported the need of protection against water and moisture remaining after a temporary inundation. Door thresholds are also used today in residential construction in the Nile Delta. The high threshold made of mudbricks or pisé was supposedly protected by another massive wooden beam which protect threshold bricks from mechanical damage caused by passing inmates.

Another type of analogy is example of transposition of perishable materials in the stone architecture of the Old Kingdom. Most of the stone buildings which mimic the structure of perishable materials over time have entered the canon of architectural forms of ancient Egypt. In addition, many forms of sacral architecture (and such forms were constructed mainly of stone) reached its proper and culturally recognizable shape long before the introduction of stone material into Egyptian architecture. Therefore, these forms often retain the appearance of characteristic structures made of perishable materials. In the case of stone buildings those elements became only parts of the decorative function

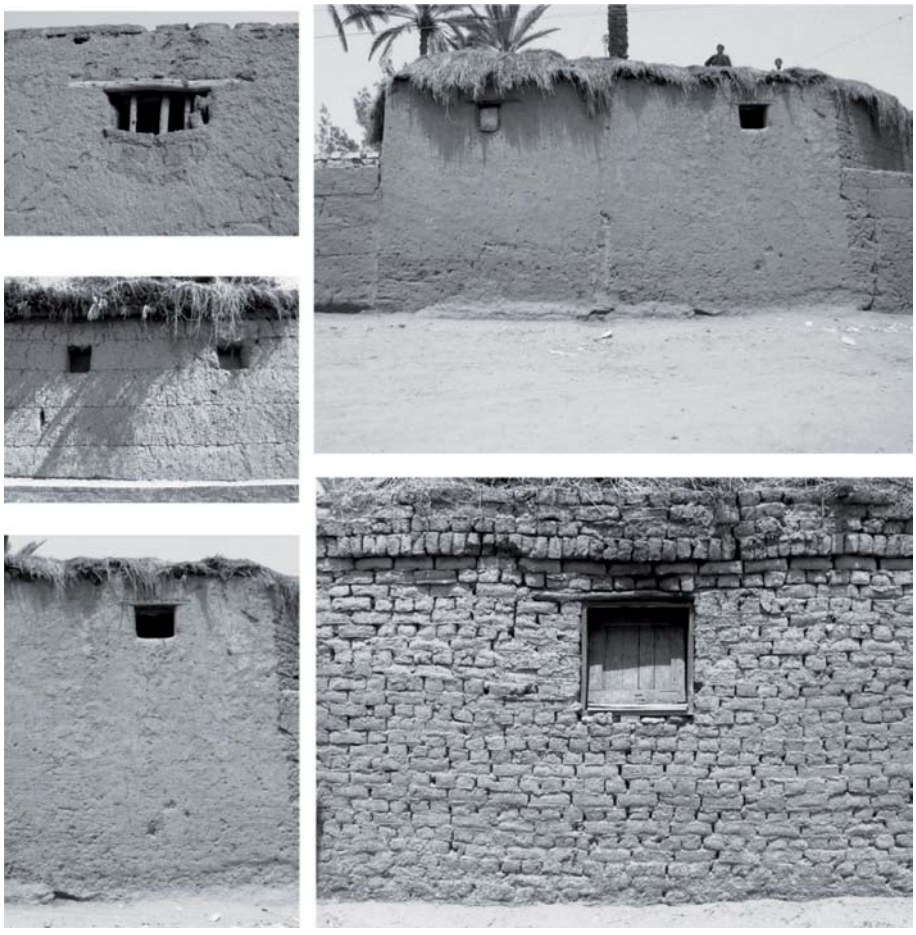

Figure 3. Examples of windows in modern mudbrick architecture in Egypt (photo by L. Szumlas).

by which the architectural form was recognizable. Numerous forms of imitation materials such as wood, mudbrick and reed mats can be found in the Step Pyramid complex at Saqqara.

Visible transpositions of traditional construction forms have numerous examples in the underground part of the complex (Lauer 1939: 13-14). Lining of faience tiles located in the chambers of so-called South Tomb and in some rooms under the pyramid was likely to imitate plait. Also, the lintels in the doors holes are likely to mimic the rolled up reed mat (*the drum*). They were also reflected in faience plates (Lauer 1936: 34-37). As we mentioned above, this element can be also seen in the model from el-Amra. On the base of this example we can see evident identity of architectural elements existing both in

sacral architecture of Old Kingdom and settlement architecture from Predynastic period. And this may indicate the efficacy of such analogies. Please remember that from the earliest times mortuary architecture tries to imitate the construction of a settlement because, in the ideology of ancient Egyptians, tomb was the future house of deceased in afterlife.

A very valuable source of information on possible appearance of the Predynastic architecture can also be found in the ethnographic analogies. Modern mudbrick houses in Egypt contain many specific elements that we can also see in archaeological documentation as well as in the analogies presented above. The windows in the modern mudbrick houses, as we can see it on the model from el-Amra, are always located in the upper part of the wall and usually have a small size. They are also equipped with safety wooden beams (or planks) located on top edge of the window hole. These elements are designed to carry the weight of the wall above the empty space which was formed by each window located in the wall (Fig. 3). It is a very valuable analogy, because the archaeological layers remains almost only the lower parts of the walls, what makes the identification and placement of windows impossible when you need to base only on archeological data. In the twentieth century mudbrick architecture doors are usually located slightly above the level of the foundation. The reason for this location is the fear of water from river floods, which in the case of threshold placed at ground level could break into the interior of the building (a similar method for protecting the homes we can see also in the local Egyptian architecture build from modern construction materials). In modern mudbrick architecture, the wooden jambs are also similar to those depicted on the model from el-Amra. We can also see strengthening of mud brick threshold with wooden planks or beams. In modern mudbrick houses wooden plank or beam above threshold (which is often one of the four elements of a solid wooden door frame) effectively protects it from erosion and mechanical damage.

The way of closing the door with a rolled-up mat, which is shown by the example of the el-Amra house and the doors in the underground part of the Step Pyramid Complex, can be also seen in nowadays contemporary mudbrick architecture. It is clearly visible on an example of one of the shed located on the outskirts of the village Ghazala (Fig. 4). In the picture we can see described solution, but in this case instead of mats the carpet was used. Roofs that can be observed in contemporary examples of mud brick constructions, like windows and doors are a very valuable kind of analogy because of the inability to restore the roof only on the basis of the excavation data. Roofing is usually created from lightweight materials such as pieces of tree trunks, branches of smaller trees or reeds. All this is supported by wooden beams (mostly the trunks of palm trees). Roof beams often extend beyond the front wall on which they rest, so it is easy to observe their irregular thickness and size. In addition to the mudbrick buildings in the Nile Delta villages we noted a number of other accompanying settlement constructions which have its parallels in the archaeological data. This examples include various types of fences from plant materials and fencing walls of mud brick or pisé. Structures of this type, which were not walls of particular building and serves only to separate some spaces, are also known

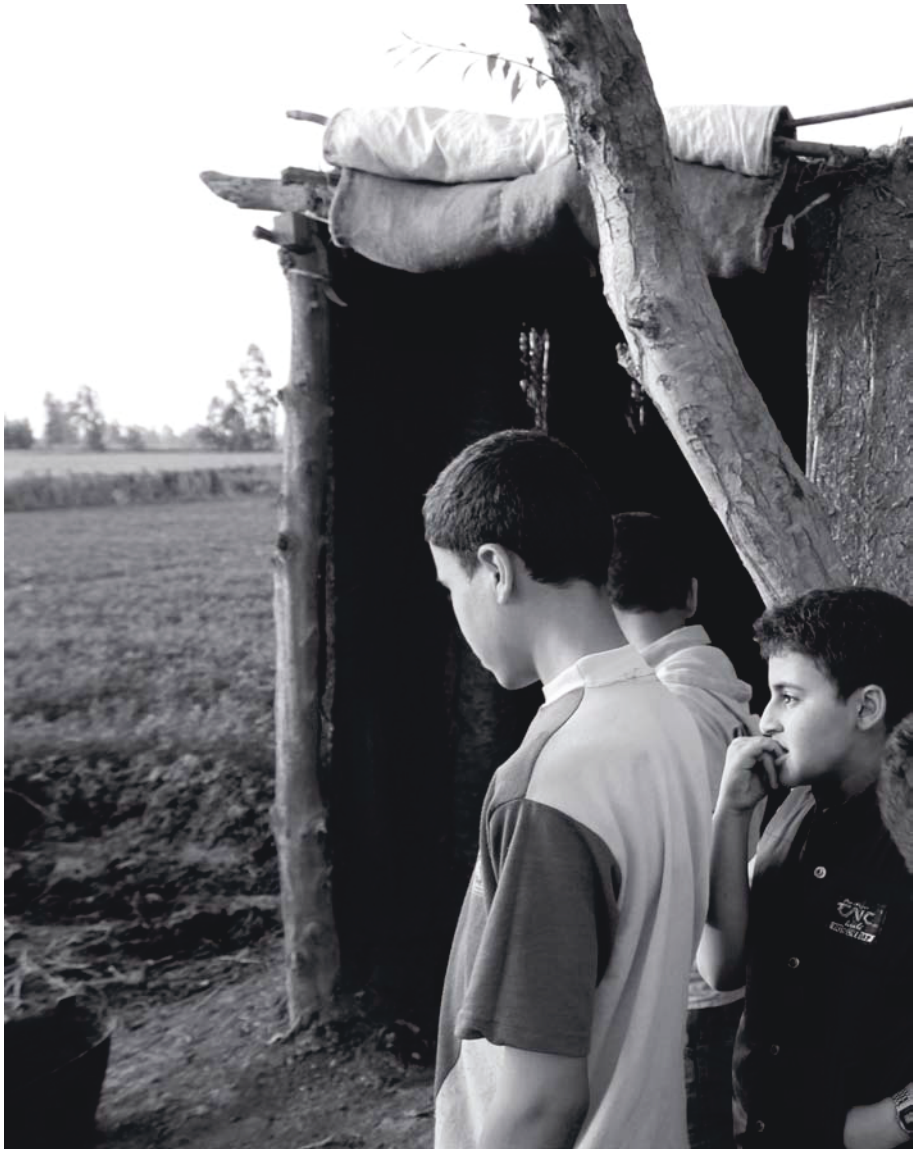

Figure 4. A rolled-up carpet above doors of the shed in Ghazala village reminding of so-called drum (photo by J. KARMOWSKI).

from archaeological layers at Eastern Kom in Tell el-Farkha. Fences made of perishable materials can be reconstructed on the basis of regular arrangement of postholes, which are a remnant of the vertical fence supports. A similar feature can be also seen in the Step Pyramid Complex, where stone wall of one of the shrines located in the *Heb-Sed* courtyard, has relief representation of this kind of structure (Fig. 5).

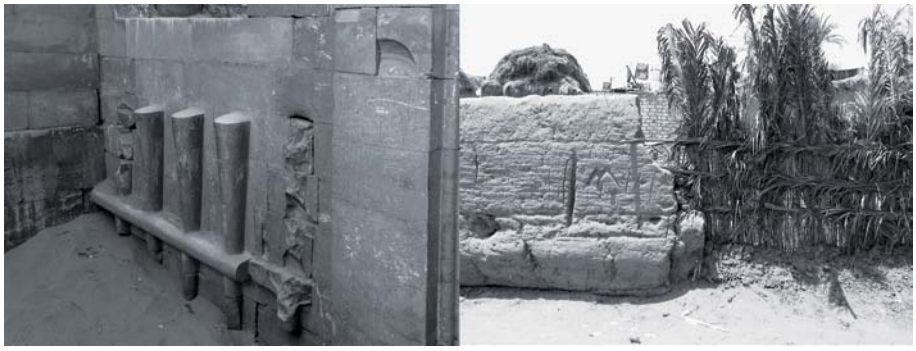

Figure 5. A stone fence depicted in relief (from Step Pyramid Complex in Sakkara) and a modern fence made of palm leaves and reed (photo by J. KARMOWSKI and L. SZUMLAS).

RECONSTRUCTION OF THE SETTLEMENT ARRANGEMENT AT EASTERN KOM IN TELL EL-FARKHA

Remains of the settlement arrangement that has been subjected to a three-dimensional reconstruction were excavated in the northern part of the Eastern Kom. This area includes trenches EN: 64, 73, 74, 75, 83 and 84. A 3D reconstruction was split into three distinctive zones, which were combined into a single model: the first covering trench EN75 , the second zone including trenches EN: 73, 74, 64 and the third zone comprising trenches EN: 83 and 84.

In the first zone, we can see three-dimensional visualization of buildings from trench EN75 with a wall separating them from the second zone. At levels from 43 to 48 it can be noted a two buildings located there. It is needed to add that one of the buildings is located in the northern part of this trench which has not been fully excavated to date. Its reconstruction is therefore only a suggestion based on the current state of research (in the future when new data will be acquired, its reconstruction should be updated). The second reconstructed building was discovered in a much greater part and it was divided into two rooms. Larger located in the north and smaller in the south. In a smaller room at few different layers numerous traces of burning and regular outline of the oven were discovered. This feature has been taken into account during making the visualization and the room was presented as a kind of annexe covered by lightweight roof (Fig. 6). Above the place where was a regular outline of kiln, on the roof in reconstruction was placed a skylight which may provide a proper air circulation. We can see similar skylights in the reconstruction of the remaining zones. In all cases they were located above areas where in the archaeological documentation was recorded regular traces of kilns located in the inner parts of buildings. Reconstruction of the location of the doors and windows in all zones is based upon analysis of the building arrangement. Unfortunately none of the described architectural remains reveals even the possible location of the windows and doors. In the reconstruction many windows were placed on the northern and southern

walls. This arrangement allows to illuminate the interior of the houses without letting in the direct sun rays from eastern or western directions. It is needed to add that certainly in predynastic architecture there were solutions to cover and uncover the windows, so in presented reconstruction widows not always have been placed only on the northern and southern walls. Considering this point, in visualization some of the windows appear on the other then northern and southern walls (especially when it was dictated by the building arrangement). However, windows are small in size and are placed on top of the walls.

In the visualization wall EN308 (which separating zones 1 and 2) was reconstructed as adjacent to the wall EN336. Together they form a thicker part of the wall located in front of the reconstructed building from trench EN75. In addition, the visualization shows the lower wall that can be seen at the level 43 (3.80m asl). The lower wall is joining previously described building from trench EN75 with wall EN308.

In zone 2, on the basis of the reviewed data, we can see a dense buildings located mostly on trenches EN74 and 73. It is included a one-room building which is located in the southern part of the trench EN73 and northern part of trench EN64, a long house with room EN213, and complex of buildings placed at the eastern part of zone 2 which together have one common wall EN131. This wall is also separating zones 2 and 3.

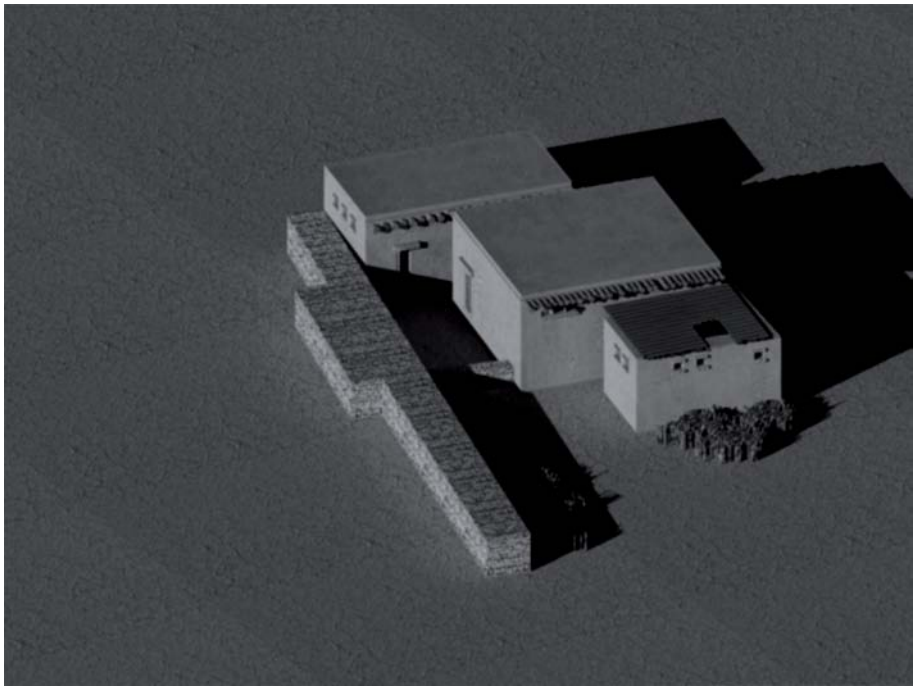

Figure 6. A 3D reconstruction of settlement architecture from zone 1. Trench E75.

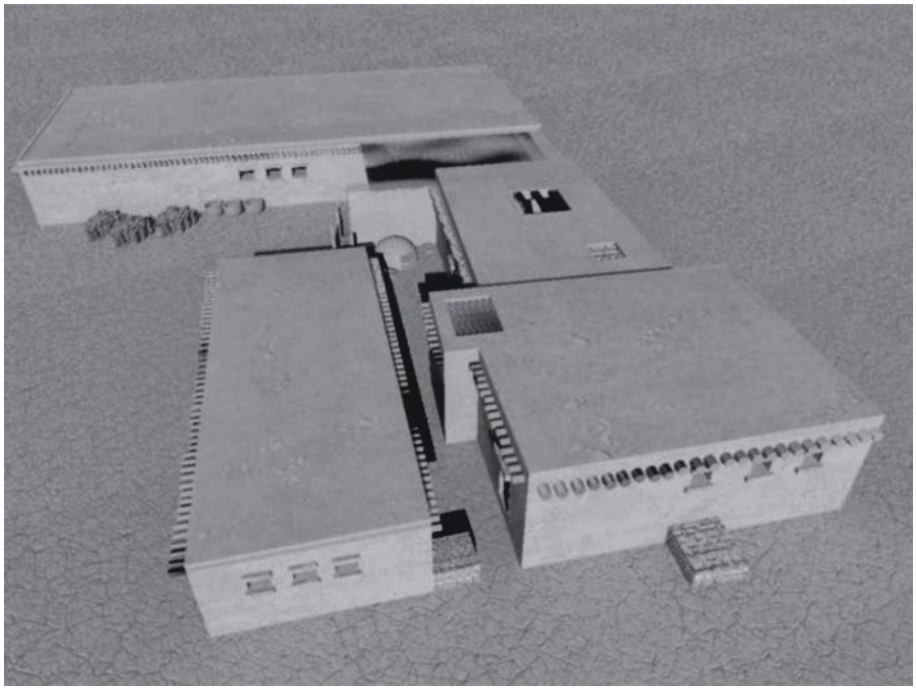

Figure. 7. A 3D reconstruction of settlement architecture from zone 2. Trenches E73, 74, 64.

Reconstruction of the second zone has shown dense arrangement of reconstructed buildings. In the northern part of the zone a massive wall (EN131) is clearly visible. This wall constituting a common wall for at least two adjacent buildings and it is possible that in the past they were connected internally to form a larger system. Between the western boundary of this buildings and eastern wall of the long building with room EN213, there is more open space. On the reconstruction it was covered by lightweight roof structure based on the wall EN149 on one side and on the other site it is based on eastern wall of the long building (wall EN186). This has created a sort of covered space leading to the wall separating the zone 2 and 3 (Fig. 7).

By the wall EN149 a kind of reed mat fence was reconstructed. The four vertical supports were reconstructed based on the distribution of postholes discovered in that place. In the reconstruction behind the fence another kiln was located on the basis of regularly reported traces of burning. It is worth to note that many traces of kilns and hearths have a rather temporary character and often appear in various locations throughout the study area. Therefore, in visualization are presented merely some of the locations of such objects.

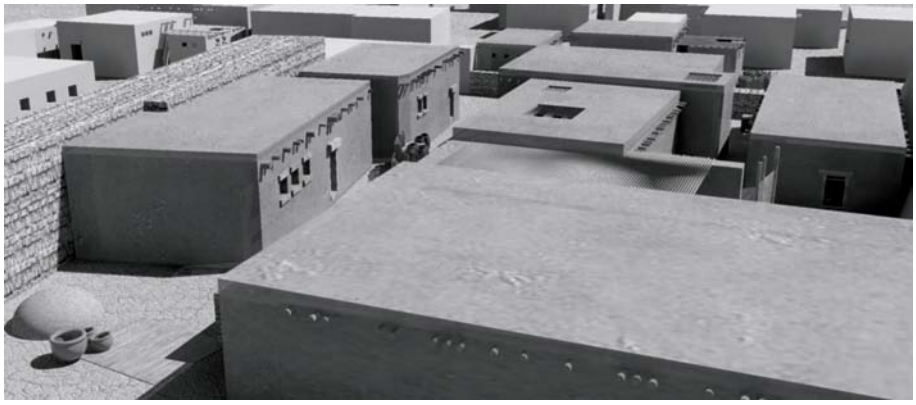

Figure 8. A 3D reconstruction of settlement architecture from zone 2 (visible on the left side) and zone 3. Trenches E73, 74, 83, 84.

The presented visualization of zone 2 shows also the reconstruction of a long house with room EN213. The building clearly dominates above the rest of the building arrangement in this area. Looking to the northern direction from it, we can see the wall EN283. This wall forms the border of very narrow street, just north of the zone 2.

The visualization of zone 3 shows two reconstructed buildings adjacent to the monumental wall located in the northern part of the zone (wall EN210/141). Apart from these, the kiln located in the eastern part of the zone 3 is shown and a small walled structure in front of the buildings was reconstructed on the south side (Fig. 8).

Described part of the study area caused many problems in case of interpretation. In subsequent layers only one building with room EN279 and a monumental wall EN210/141 were clearly visible. The second building, located to the east of the zone was manifested in the different levels of exploration. Thanks to overlaying several plans of different levels it was also possible to reconstruct his general arrangement. The most difficult was the interpretation of a small semi-circular structure and walls located in front of described buildings. In the visualization, it has been presented as a kind of fence with elements made from perishable materials.

The part located to the west of the buildings in the visualization is presented as a area of workplace nature. During the excavations in that place many traces of more or less regular objects with traces of burning was noted. In the visualization another kiln was reconstructed there.

The reconstruction clearly shows how little open space was located between zone 2 and 3. This impression is further increased by the presence of the wall EN283 and unstable structures located south of the buildings in this area.

Conclusions

To summarize, we can say that the architecture of the Eastern Kom at Tell el-Farkha was probably characterized by a very dense building arrangement with only a few open spaces left between some of the buildings. All buildings were mostly built on a rectangular plan, although there are also examples of the walls with a high degree of curvature. However most of the curve walls have not substantial thickness and probably did not belong to the structure of houses.

On the basis of the archeological material we can also make an assumption that in the construction of residential buildings, wood and other raw materials of plant origin were used. Although these elements do not remain to this day. It can be suggested that their use was common in Predynastic settlement architecture also on the Eastern Kom at Tell el-Farkha. We can deduce that from examples like clay model from el-Amra where wooden elements are depicted as well as from data gained during excavations which reveal numerous traces of organic material among stratification layers.

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