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Studies of the earliest urban settlements in the Nile Valley often neglect to address the significance of built environments for the 'poor' and their relationship with social organization. The western workers' quarter at el-Lahun; the ḫnrt mentioned in hieratic papyri, has received little scholarly attention in comparison to the eastern area containing the 'élite residences'. In 1889 Flinders Petrie noted that the western streets of the town showed signs of a greater degree of poverty. Later examinations indicated the presence of a type of corrective labor camp; what might be described today as a 'ghetto'. Convicts may have been forced to live in such places of confinement as a form of punishment. Life for a multitude of people in the ancient town of el-Lahun might, in fact, have been radically different from previously held views. Rather than a quiet township community, this article uncovers a social order built upon racial discrimination and cultural intolerance, marked by seclusion, coercion, and possibly violence.

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Architectural sketches showing profiles most likely used for constructing arched mudbrick and stone roofs and rock-cut vaulted chambers have been recovered from ancient Egyptian archaeological contexts. The procedures and/or mathematical principles used to construct the profiles and the data sets recorded on the relevant artifacts have been discussed for over a century. Certain interpretations seem to have attained the status of established fact, despite the lack of a solid rational basis. Catenary, elliptical, and circular arcs can often have similar pro-

files, so it has proved difficult to reach firm conclusions regarding the geometric construction methods, using the limited evidence available. This article revisits two of the major sources of evidence: ostracon JE50036, now in the Imhotep Museum at Saqqara, and a sketched form drawn out by tomb KV9, which is now, unfortunately, almost completely lost. The authors present a new combined analysis and propose that both of these arcs may have been constructed using the same elegant geometric procedure, which is based on a 3-4-5 triangle.

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This article presents an interpretive digital tool designed to facilitate the study of Egyptian domestic mudbrick archaeological sites. Ancient Egyptian domestic architecture is comparatively less well known than funerary or religious architecture. Traditionally, the discourse regarding ancient Egyptian houses has been built upon artistic sources such as tomb wall representations and models recovered from tombs and domestic spaces. These sources were generally produced by certain social groups and during certain periods, which limits their use to those contexts. In response to this situation, this article outlines a practical way in which an ethnoarchaeological study of Egyptian domestic architecture has been translated into the development of a digital tool for the recording, analysis and interpretation of Ancient Egyptian houses.

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Occam's Egyptian razor: the equinox and the alignment of the pyramids

Glen Dash

The builders of the Great Pyramid of Khufu aligned the great monument to the cardinal points with an accuracy of better than four minutes of arc, or one-fifteenth of one degree.[1] The Great Pyramid's neighbor, the Pyramid of Khafre, is aligned with an error of approximately 6 minutes, one tenth of one degree.[2] The builders of Snefru's Red Pyramid at Dahshur achieved an accuracy of 8.7 minutes.[3] All three pyramids exhibit the same manner of error; they are rotated slightly counterclockwise from the cardinal points.

How the Egyptians managed to achieve such accuracy has long been debated. In recent years, four of the candidate methods have been tested and found workable.[4] These include the pole star method proposed by Flinders Petrie,[5] the circumpolar star method tested by Joseph Dorner,[6] the simultaneous transit method proposed by Kate Spence,[7] and the solar gnomon shadow method suggested by Martin Isler.[8] Yet there is one straightforward method that scholars have largely ignored, perhaps because it was thought to lack any hope of achieving the requisite accuracy.[9] This is the 'equinoctial solar gnomon method'. It uses a vertical rod to track the movement of the sun on the equinox.[10]

The solar gnomon or 'Indian circle' method

The equinoctial solar gnomon method is a variant of the solar gnomon method suggested by Martin Isler.[11] The solar gnomon method is sometimes referred to as the Indian circle method, because it was thought to have been used on the Indian subcontinent.[12] In the solar gnomon method, a surveyor starts by placing a rod into the ground as shown in figure 1. The rod is known as a gnomon. As the sun rises in the east, the gnomon projects a shadow to the west. The surveyor watches

1 Dash (2015b), p. 11.
2 Dorner (1981), p. 80.
3 Dash (2015a), p. 359.
4 Dash (2015a), pp. 351-364.
5 Petrie (1883), pp. 211-212.
6 Dorner (1981), p. 146.
7 Spence (2000), pp. 320-324.
8 Isler (1989), pp. 197-199.
9 Magli (2013), p. 90.
10 A well-known method proposed by Edwards (Edwards (1947), pp. 250-251) uses a circular wall around an observer to identify true north. It was not included in this analysis because it has not been field tested.
11 Isler (1989), pp. 197-199.
12 Isler (1989), p. 197.

the shadow and at regular intervals marks the position of the tip of the shadow on the ground. As the day progresses, the surveyor's markings should, in theory, form a smooth curve. The curve will bend around the gnomon in the summertime and away from it in the wintertime. The curve is known as the declination line or more commonly, the shadow line.

At the end of the day, the shadow line being complete, the surveyor takes a string, places it over the gnomon and rotates the taught string around the gnomon, describing a circle which intercepts the shadow line at two points. These points lie on an east-west line.

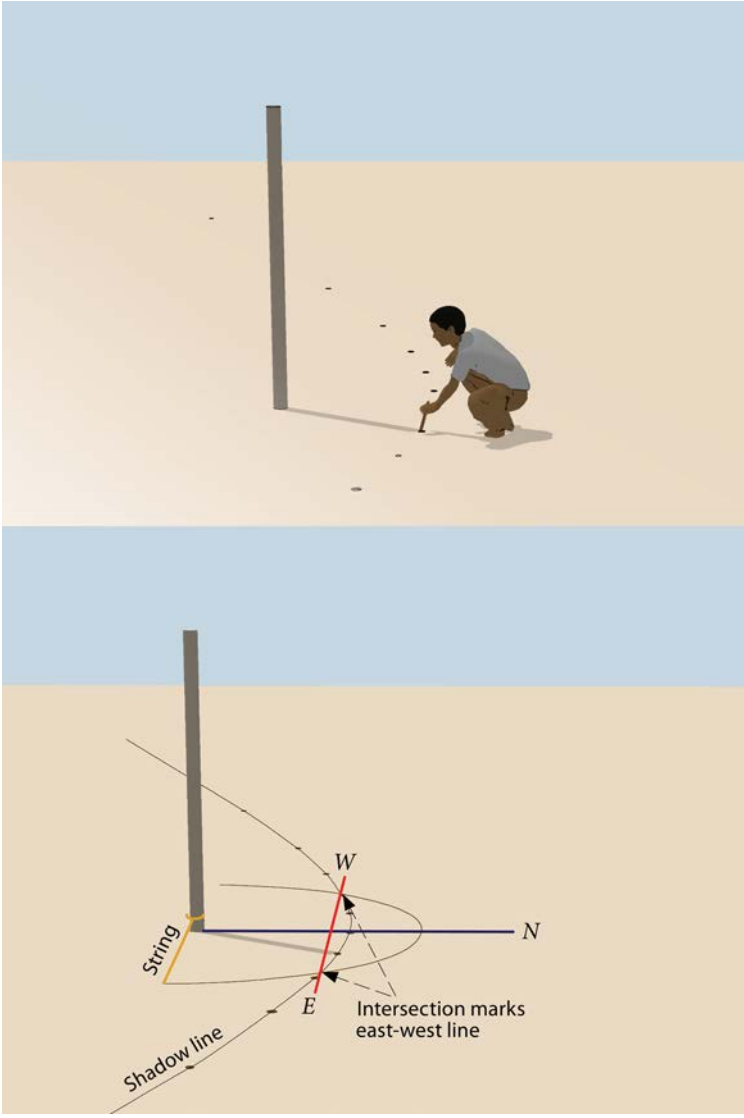

Fig. 1. The solar gnomon or Indian circle method. The shadow line shown is typical of that formed in the summertime. In the wintertime, the shadow line curves away from the vertical rod, or gnomon. (Illustration by Wilma Wetterstrom)

The equinoctial solar gnomon method

The equinoctial solar gnomon method is simply the Indian circle method used on the equinox (fig. 2). On the equinox, the surveyor will find that the tip of the shadow runs in a straight line and

nearly perfectly east-west. Since the shadow line is already straight and already runs east-west, the second step in the solar gnomon method, drawing a circle around the gnomon, is not needed.[13]

Testing the equinoctial solar gnomon method

To test the equinoctial solar gnomon method, I built a 0.91 meter by 6.10 meter (3 foot by 20 foot) wooden platform at my home in Pomfret, Connecticut and roughly leveled it (fig. 3). I set the gnomon along the platform's midline near its southern edge. The gnomon was built from a 3.2 cm (1.25 inch) diameter wooden dowel rod capped with wooden half ball. A metal pin was inserted in its top.[14] Vertical 5 cm by 10 cm (2 by 4 inch) risers were used to suspend the rounded, wooden top of the gnomon 83 cm over the surface of the platform.[15]

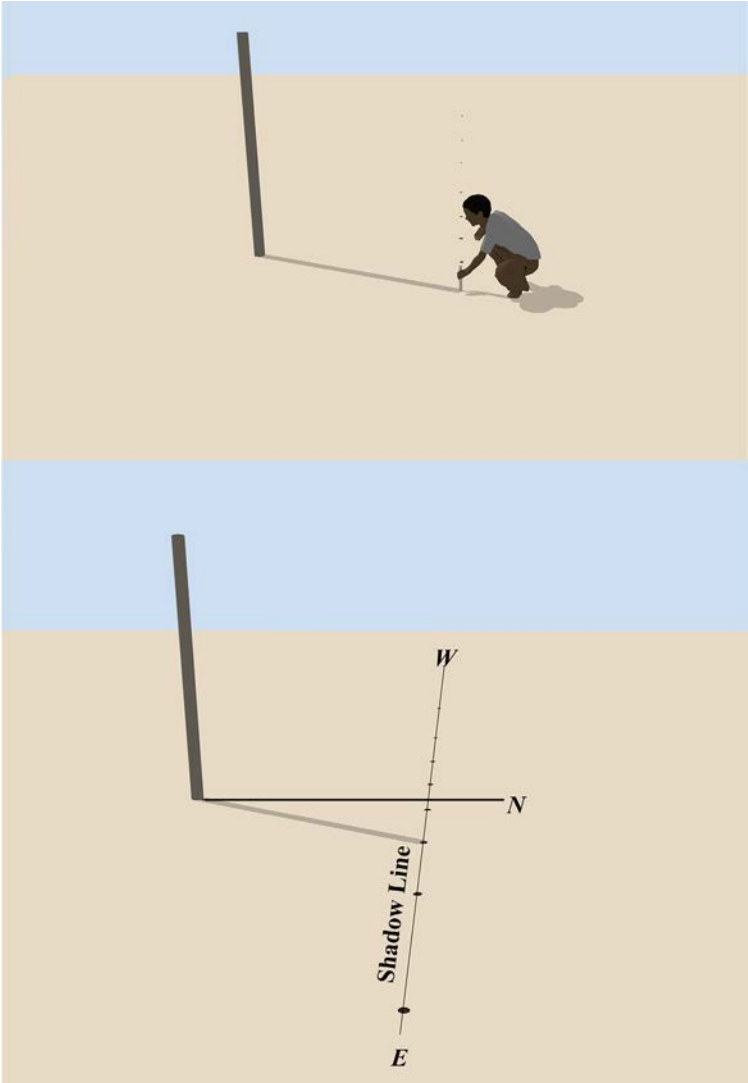

Fig. 2. On the equinox, the shadow line runs in a straight line, very nearly east-west. (Illustration by Wilma Wetterstrom)

13 The Egyptians could have established the day of the equinox by observing the solstice and counting forward 91 days.
14 The metal pin is not needed as part of the equinoctial solar gnomon test. It is used in the Indian circle method.
15 The design of the gnomon was a product of experiment. Dowel rods of differing diameters and different types of caps, including conical ones, were tried. The dowel rod and half round ball combination produced the most workable shadow.

I began the test at 8:04 am on September 22, 2016, the day of the autumnal equinox. Curiously, the gnomon's shadow exhibited a central core that was slightly brighter than the rest of the shadow (fig.4). I used the far edge of this central core to track the shadow's movement. I marked its place every minute or so.[16]

Fig. 3. The equinoctial solar gnomon method was tested on this platform, here viewed from the northeast. In the center of the platform is the gnomon, set along its midline on its southern edgen.

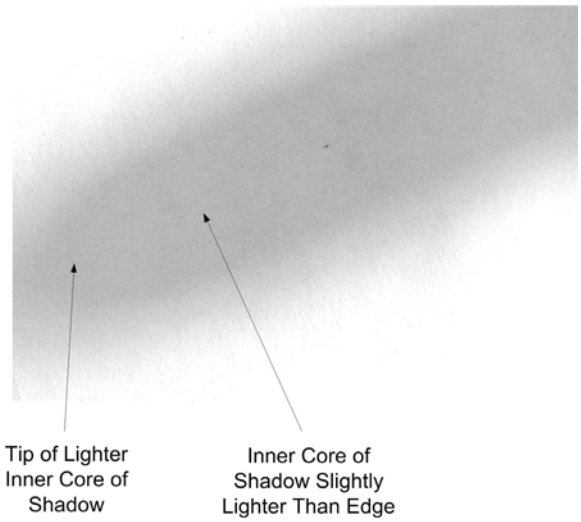

Fig. 4. The shadow produced by the gnomon is, curiously, slightly brighter in its central core. The tip of the central core was used to track the shadow's movement.

16 Dash (2016b) (http://www.DashFoundation.com/OCCAMMOV.MOD). This video shows the marking of the tip of the shadow as it moves.

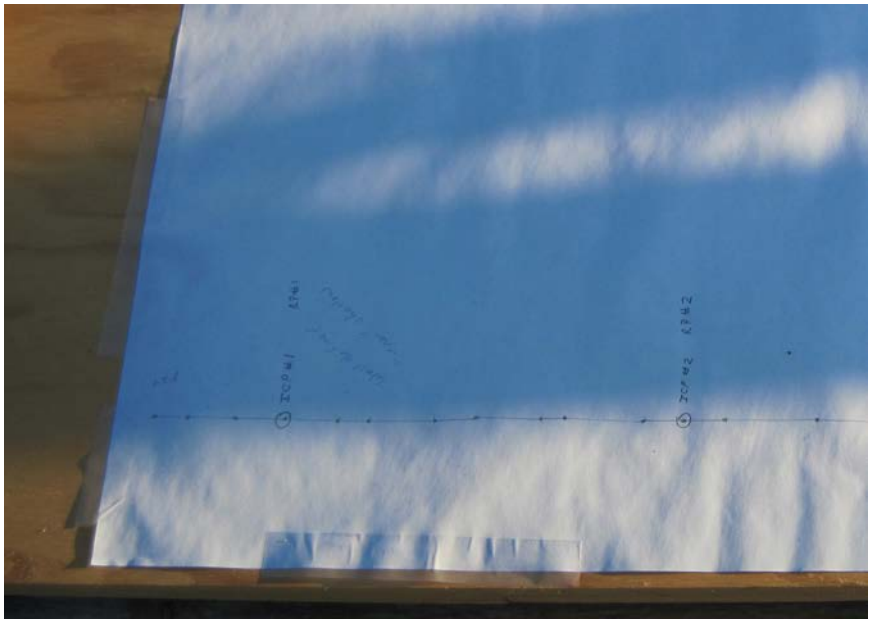

Fig. 5. Shown in this photo, taken in the late afternoon, is a portion of the morning's data. The two points circled were used to evaluate the method.

By 8:24 am, I had tracked the movement of the gnomon's shadow along a 63 cm long path. As expected, the line ran relatively straight. I circled two points along the shadow line where the points were particularly well aligned (fig. 5). Later I would use these two points to test the accuracy of the method.

I followed the same procedure in the afternoon. At the end of the day, I had four points circled, two on the east side of the platform and two on the west, which would be used in my evaluation.

Previous to the tests, I had established a local control grid using a total station. I aligned the grid with due north by first focusing the total station's telescope on Polaris and then loading Polaris' exact location at that time into the total station. I verified the alignment's accuracy by checking the location of Kochab. The total station's read out of Kochab's position was accurate to within ten seconds of arc. I then set a control point to the east of the wooden platform and randomly assigned it a location of N=1000 meters and E=5000 meters. This would serve as the origin of my control grid.

I used the total station to establish the exact locations on my control grid of the four points I had circled (table 1).

Point Number	Northing (m)	Easting (m)	Elevation (m asl = meters above mean sea level)
1	1004.477	4938.173	178.120
2	1004.475	4938.001	178.120
3	1004.487	4942.992	178.124
4	1004.486	4943.081	178.124

Table 1. Measured data.

I then calculated the angle of the lines formed by pairs (1, 3) and (2, 4) with respect to due east-west (table 2):

Point Pair	Northing Distance Between Points (m)	Easting Distance Between Points (m)	Azimuth angle with Respect to due East-West (minutes) [17]
1, 3	.010	4.819	-7.13
2, 4	.011	5.080	-7.44

Table 2. Evaluation of derived East West lines.

The mean error of the two lines was -7.3 minutes of arc. This represents a slight counterclockwise rotation from cardinal points. This type of error was expected. The earth's tilt with respect to its orbital plane around the sun, the 'declination', changes over the course of a day. In theory, this change produces an error of -5.9 minutes of arc on the autumnal equinox. [18] Thus the test produced results within 1.5 minutes of the expected value.[19]

The mean error of the three pyramids mentioned above, Khufu, Khafre and the Red Pyramid of Snefru, is -6.2 minutes. The magnitude and direction of these errors suggest that it is possible that all three pyramids were aligned using the equinoctial method on the autumnal equinox.

Comparing Fourth Dynasty pyramids

Table 3 shows the alignment of six pyramids of the Fourth Dynasty with respect to cardinal points. Note that the largest pyramids are the best aligned, and their corners are the best squared. Clearly, the Egyptians took greater care when building their largest pyramids, both in squaring the corners and aligning the monuments with cardinal points. In particular, the problems the Egyptians encountered in building the pyramid at Meidum and the Bent Pyramid at Dahshur may have taught them that large pyramids needed well-formed and well-aligned foundations. Later pyramids such as the Pyramid of Menkaure tended to be smaller, and these pyramids may not have required such well-ordered foundations. For these, the Egyptians may have simply economized.[20]

Extending the line

The equinoctial solar method described here produces two points on the ground about 5 meters apart. To lay in a baseline for a pyramid, the Egyptians would have had to extend the line formed by these two points for hundreds meters with little error. Several methods have been proposed by which the Egyptians might have achieved that.[21]

The Egyptians could also have started with a larger gnomon, but they would also have needed a larger platform on which to trace the shadow, and one which was precisely leveled. Such a platform

17 Surveyors measure azimuths clockwise from true north. A clockwise rotation with respect to cardinal points is reported as positive, a counterclockwise rotation, negative. In this case the difference is given with respect to the true East-West line.

18 On the vernal equinox, the expected error is of the same magnitude but opposite in direction: +5.9 minutes of arc.

19 This small error could be explained by the imperfect leveling of the platform which was 4 mm higher on the east than west.

20 Lehner also speculates that a shift in emphasis away from the pyramid and toward the temples may explain the diminutive size of the Menkaure Pyramid (Lehner (1997), pp. 134-135). Petrie notes that the base of the Pyramid of Menkaure is highly irregular (Petrie (1883), pp. 110-111).

21 Dash (2014).

would have been available, however, as the platform around the Great Pyramid is leveled to within a few centimeters over its entire 920-meter periphery.[22]

Pyramid	Date (B.C.)	Source	N	E	S	W	Average
Meidum	2522	Petrie[23]	-35.4	-20.6	-23.6	-18.1	**-24.4**
Bent	2507	Dorner[24]	-7.5	-17.3	-4.2	-11.8	**-10.2**
Red	2496	Dorner[25]		-8.7			
Khufu	2476	Lehner/ Goodman[26]	-2.9	-3.4	-3.7	-4.6	**-3.6**
Khafre	2444	Dorner[27]	-5.2	-6	-5.7	-6	**-5.7**
Menkaure	2411	Petrie[28]	16.8	12.4	13.0		**14.1**

Table 3. Alignments of the casing sides of selected pyramids with respect to cardinal directions (angles in minutes).

Conclusion

The equinoctial solar gnomon method appears to be workable. It joins the list of methods the Egyptians might have used to align their pyramids.

As to the methods they actually did use, the Egyptians, unfortunately, left us few clues. No 'engineering documents or architectural plans have been found that give technical explanations demonstrating how the ancient Egyptians aligned any of their temples or pyramids. No Egyptian compasses have ever been discovered, nor has any other type of sophisticated survey equipment'.[29] The records that do survive consist primarily of descriptions of foundation ceremonies for important buildings.[30] However, it is unclear as to what extent these descriptions describe technical details as opposed to the ceremonies themselves.

Nonetheless, among our choices, the equinoctial solar gnomon method has a certain appeal. It produces results that match the actual alignments of the largest pyramids of the pyramid age in magnitude and direction. It is also the 'Occam's Razor' candidate. It is hard to imagine a method that could be simpler either conceptually or in practice.[31]

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22 Cole (1925), pp. 3-5.
23 Petrie (1892), p. 6.
24 Dorner (1986), p. 51.
25 Dorner (1998), p. 23.
26 Dash (2012), p. 19.
27 Dorner (1981), p. 80.
28 Petrie (1883), p. 111.
29 Nell and Ruggles (2014), p. 305.
30 Belmonte, Polo and Miranda (2009), pp. 197-206.
31 Correction to this paper, if any, can be found at Dash (2016a).

the Line', http://glendash.com/blog/2014/06/20/how-the-pyramid-builders-may-have-found-their-true-north-part-ii-extending-the-line-2/ (Date Accessed: 23 November 2016).

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A Potentially Significant Dimension Recorded on an Old Kingdom Papyrus from Saqqara

Colin Reader

At a conference in June 2013[1] Professor Philippe Collombert of the University of Geneva gave a presentation of his work with a highly fragmented Old Kingdom papyrus.[2] The previously unstudied papyrus was found by Collombert in an archive at the IFAO in Cairo. An initial examination established that the text had been written in a hieratic script characteristic of the Old Kingdom. Modern notes associated with the papyrus fragments indicated that they had been collected at the pyramid of Unas at North Saqqara, leading Collombert to suggest that they had most likely been discovered during work undertaken sporadically at that pyramid by J. P. Lauer, sometime between January 1937 and May 1939.[3] Given the limited examples of Old Kingdom papyri known,[4] the potential importance of these unpublished fragments (hereafter referred to as the Teti Papyrus) was recognised immediately by Collombert. Despite its highly fragmentary state he separated and individually mounted a significant proportion of the fragments onto a series of seventeen plates.

Although it was clear from the outset that the condition of the Teti Papyrus precluded a comprehensive restoration and translation, a number of significant features were recognised by Collombert. On the basis of the most frequently occurring words and phrases, the papyrus appeared to be an account of a construction project. Recurring references to Teti (the first king of the Sixth Dynasty), and to funerary structures, led Collombert to the conclusion that the fragments represent a record of the construction of Teti's pyramid complex at Saqqara.[5]

One of the significant features that Collombert identified on the Teti Papyrus are references to specific dimensions that may have been used in the specification of the Teti funerary complex. For example, Collombert compares a dimension of 200 cubits given in the Teti Papyrus with one of the principal dimensions of the pyramid enclosure (see 'Width of the pyramid enclosure', Table 1 below).[6] In the general context of Old Kingdom pyramid construction, and the Teti pyramid complex in particular, the current author considers that a reference to a dimension of 441 cubits,[7] may also have particular significance.

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1 Ancient World Conference, London, 8 & 9th June 2013.
2 Collombert (2011).
3 Collombert (2011), p. 17.
4 For a brief summary of the previously identified Old Kingdom papyri, see Collombert (2011), p. 19. Note that Collombert (2011) predates the discovery of papyri from the reign of Khufu, that were found on the western shore of the Red Sea, for which see Tallet and Marouard (2014) and Tallet (2016).
5 Collombert (2011), p. 25.
6 Collombert (2011), p. 27.
7 Collombert (2011), p. 20.

Fig. 1. The Teti pyramid (photo: Franck Monnier).

The Teti Pyramid Complex

As reconstructed,[8] the Teti pyramid complex consists of a main pyramid within a walled enclosure, with a single 'cult' pyramid in the south east corner (figs. 2 and 3). Although a number of elements of the pyramid temple lie within the enclosure wall, the foreparts of the temple extend some distance eastward beyond the enclosure, to connect with the upper end of the pyramid causeway. The only remains of the causeway that have been identified are at the point where it meets the pyramid temple, at a position that is offset to the south of the central temple axis. It is also notable from published reconstructions that the surviving upper elements of the causeway are orientated to the south of due east (figs. 2 and 3).[9] The position and alignment of the pyramid causeway (as indicated by the remains of its upper elements) may have been designed to avoid the nearby pyramid Lepsius XXIX, which is located to the east (fig. 2). Its construction has been dated to the earlier reign of Menkauhor.[10] In addition to Lepsius XXIX, at least two other small pyramid complexes (attributed to Iput and Khuit, royal women associated with the reign of Teti) have been found in separate enclosures to the north of the pharaoh's funerary complex. No evidence of a valley temple associated with the Teti funerary complex has so-far been identified.[11]

8 See for example, Lehner (1997), pp. 156-157.
9 Lehner (1997), p. 157.
10 Collombert (2011), p. 29.
11 Lehner (1997), pp. 156-157.

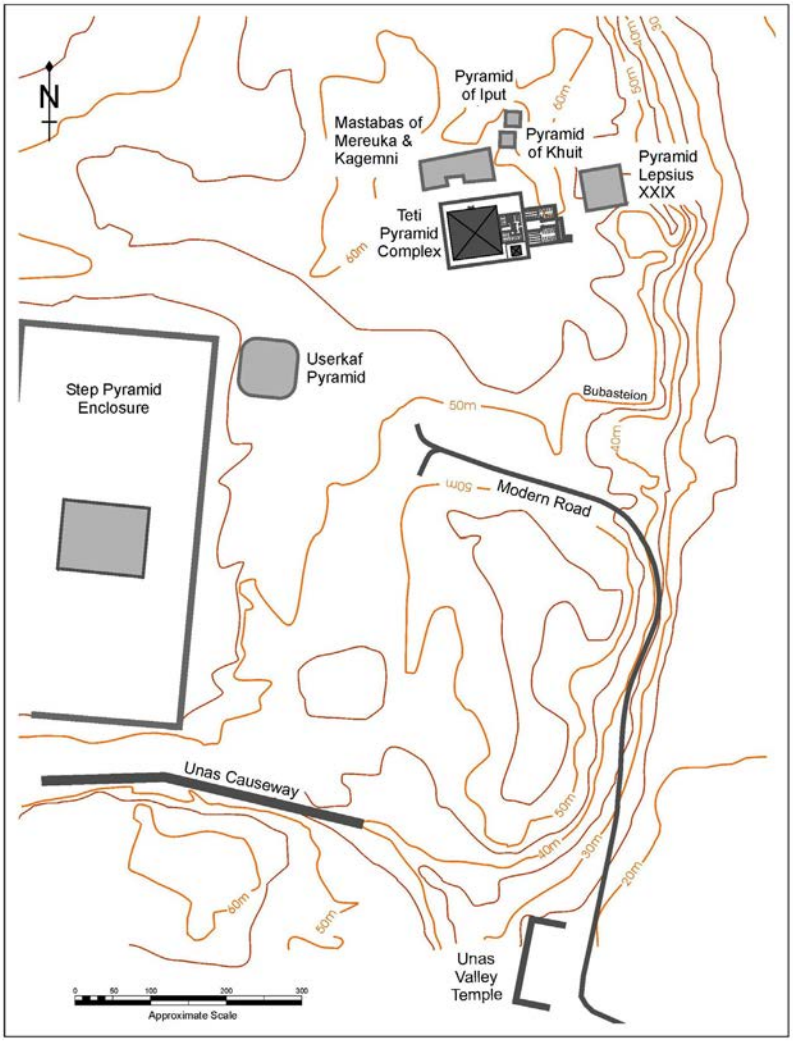

Fig. 2. Overview of North Saqqara showing the relative location of the Teti Pyramid complex (after Egyptian Ministry of Housing and Reconstruction, Sheet Cairo H22).

Feature	Dimension (cubits)	Dimension (m)
Base length of the main pyramid	**150**[12]	78.75
Vertical height of the main pyramid	100	**52.5**[9]
Base length of the satellite pyramid	**30**[12]	15.75
Length of the pyramid enclosure (N-S)	**243**[9]	127.58
Width of the pyramid enclosure (E-W)	**200**[9]	105
Maximum dimension from western enclosure wall to eastern limit of the pyramid temple.	356	**187**[13]

Table 1. Principal dimensions of the Teti Pyramid Complex. Figures given in bold have been taken from published sources, figures in plain text have been calculated using the value of 52.5 cm to 1 cubit (Rossi (2007), Table 2).

12 Rossi (2007), Appendix.
13 Scaled from Lehner (1997), p. 157, Figure.

Table 1 summarises the key dimensions of the Teti Pyramid Complex. When compared with this data, the figure of 441 cubits (231.53 m) identified by Collombert in the Teti Papyrus, evidently represents a more substantial feature. The current author considers that there are two commonly recognised elements of pyramid complexes which could have had such large dimensions:

1. The pyramid causeway.
2. A temporary linear ramp used in the building of the main pyramid.

The Teti Causeway

As discussed above, little is known of the Teti pyramid causeway except for the point at which it meets the south east corner of the pyramid temple, and indications of an alignment for the upper elements. Given that no location for the Teti valley temple has been identified, the length of the Teti causeway remains unknown. Mark Lehner points out that the Teti pyramid stands at a relatively elevated position near the eastern edge of the Saqqara escarpment. Lehner also states that a causeway serving the elevated site of the Teti pyramid would have needed 'an enormous' embankment to carry it from the low-lying inundation plain to the edge of the escarpment.[14]

Based on the photogrammetric maps issued by the Egyptian Ministry of Housing and Reconstruction,[15] the ground level at the Teti pyramid is approximately 58 m (figs. 2 and 3).[16] The position of the undiscovered Teti valley temple can only be inferred, based on considerations of topography and comparisons with nearby pyramid complexes. The valley temple of the preceding pharaoh, Unas lies just below the 25 m contour at the edge of the inundation plain at Saqqara (fig. 2). It is generally understood that one of the roles of the valley temple was to serve as a functioning interface between the pyramid complex and the system of canals and harbours that connected it with the Nile. Given that water within any specific section of the Old Kingdom canal system can be assumed to have stood at the same general level, it is considered likely that all the valley temples at Saqqara will have been built at the same general elevation.[17]

Given these considerations, a number of factors can be identified which allow a general location for the Teti valley temple to be inferred. In turn, these factors allow us to speculate on a suitable route along which the Teti causeway may have been built. These factors are:

- The elevation at the site of the Teti valley temple, which is likely to have been comparable with the elevation of the Unas valley temple.
- The alignment of the upper end of the Teti causeway, as suggested in published reconstructions of the Teti pyramid complex.
- The location of Lepsius Pyramid XXIX, which is generally assumed to have pre-dated the reign of Teti.
- The local topography, inferred from modern photogrammetric data.

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14 Lehner (1997), p. 156.

15 Arab Republic of Egypt, Ministry of Housing and Reconstruction, Topographic sheets, Cairo H22, 1:5000.

16 Note the ground elevation at the site of the Teti pyramid taken from the relevant maps differs slightly from the value of ground elevation given by Google Earth, which for consistency in the data, has been used in Table 2.

17 In this regard, it is interesting to note that the elevations for valley temple locations given in Table 2, all lie within the range 20-23 m amsl.

On the basis of these considerations a possible alignment for the Teti causeway is shown in Figure 3. By scaling from the available maps it can be determined that this causeway would have been approximately 263 m long (approximately 500 cubits).

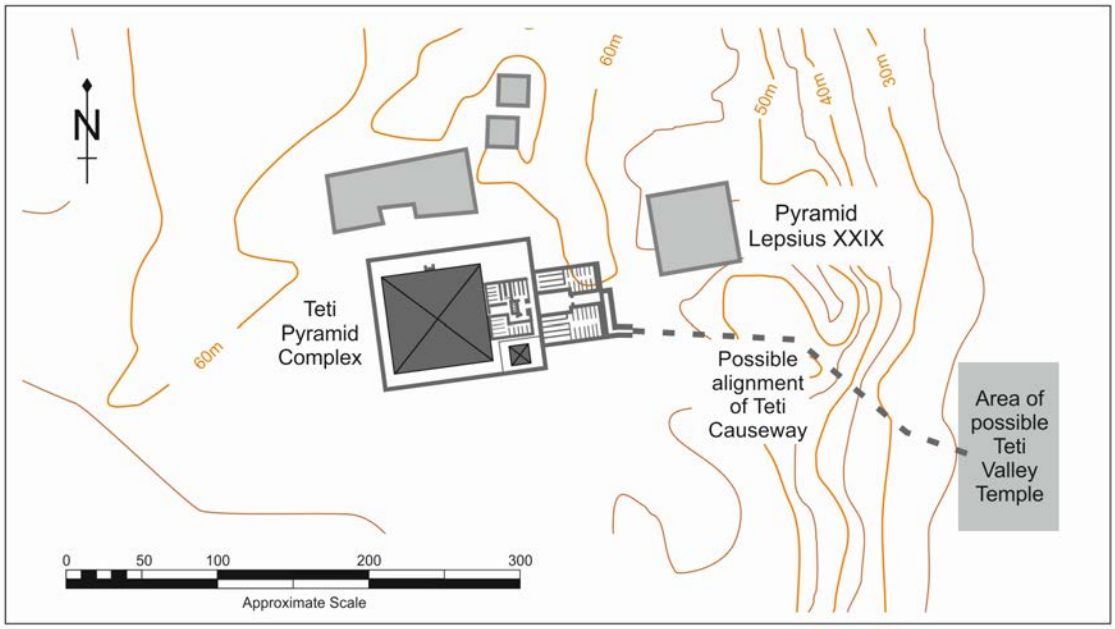

Fig. 3. The area of the Teti Pyramid complex showing the inferred locations for the valley temple and causeway.

The proposed causeway shown on Figure 3 follows one of several possible alignments, and it may differ in a number of respects from what was originally planned or built. It is important to note, however, that the 500 cubit figure derived above is likely to represent a minimum length for the Teti causeway. None of the possible routes that the causeway could have followed significantly reduce the inferred length much below the 500 cubit figure. Furthermore, given the difference in elevation between the inferred position of the valley temple and the site of the Teti pyramid complex, a 500 cubit-long causeway which followed an alignment similar to that shown on Figure 3, would have had an average gradient in the order of 1 in 8 (13% - Table 2).[18] When such a causeway is compared with other causeways from this period (Table 2), this gradient appears to be rather steep. If by contrast, the form of the Teti causeway had been determined primarily on the basis of gradient, conservatively taking the 1 in 12 gradient calculated in Table 2 for Khafra, then the Teti causeway would have been approximately 731 cubits long (approximately 384 m).[19] Given these considerations and if it was built, the Teti causeway is likely to have been significantly longer than the 441 cubit dimension referred to in the Teti Papyrus.

18 Assuming a causeway some 500 cubits long (263 m), with ground levels at the lower (valley temple) end of ca. 23 m and ground levels at the upper (pyramid) end of 55 m, gives a fall for the causeway of 32 m vertically over 263 m horizontally, or 1 in 8 (i.e. approx 13%).

19 Vertical separation is 32 m (see note 18). A 1 in 12 gradient (8%) gives a horizontal distance of 32 x 12 = 384 m or 731 cubits.

Pyramid	Causeway length (m)[20]	Approx elevation at pyramid temple (m)[21]	Approx elevation at valley temple (m)[21]	Gradient	Gradient (%)
Teti (postulated)	263	55	23	1 in 8	13
Khufu	740	60	22	1 in 19	5
Khafra	495	61	20	1 in 12	8
Menkaura	608	68	21	1 in 13	8
Sahura	235	37	21	1 in 15	7
Unas	750	57	23	1 in 22	5

Table 2. Data for a selection of Old Kingdom pyramid causeways and the resulting gradients.

Linear Construction Ramp

The methods used by the Ancient Egyptians to raise the blocks of stone used in pyramid construction remain a matter of some debate. Most of the details of the debate lie outside the scope of the current paper,[22] but the use of temporary ramps in a number of possible forms has been proposed.[23] One of the perceived disadvantages of ramps is that their construction would have required the placement and subsequent removal of significant volumes of fill material.[24] However, given that the Ancient Egyptians placed millions of tonnes of masonry and mudbrick when building the Old and Middle Kingdom pyramids however, the current author does not consider that the additional resources required for the construction of temporary ramps precludes their use. Furthermore, if compared with other hypotheses that have been put forwards (e.g. the use of levers, pulley systems etc.), it seems likely that any disadvantages associated with the construction of temporary ramps would have been offset by their versatility and relatively straightforward operation.

If for the purposes of the current paper then, the use of temporary ramps is accepted, there remains the issue of the form these ramps took. A spiral ramp would have required a much smaller volume of material compared to a linear ramp capable of reaching the equivalent height, as it would have relied in part on the underlying pyramid for support. On the other hand, the main disadvantage of a ramp wrapped around the growing form of a pyramid (i.e. a spiral ramp) would have been that any temporary structure would have covered the underlying pyramid masonry and would therefore have prevented the masons from using sight-lines along the sides and down the corners of the pyramid, to control the shape of the structure as building works progressed. A linear ramp would have left the corners of the pyramid exposed, allowing the shape of the growing structure to be constantly checked, something considered essential given the levels of accuracy evident in the construction of the major pyramids, most significantly, the Great Pyramid of Khufu.

The Great Pyramid has been subject to more detailed scrutiny than any other Egyptian pyramid, with some of the discussions focussing on the possible form of temporary ramps used in its construction. The Great Pyramid is built close to the northern edge of the Giza plateau and so the northern approaches to the pyramid would have been unsuitable locations for linear construction

20 Lehner (1997), except for Teti which as described in the text, has been inferred.
21 For consistency, all elevation data in Table 2 is taken from Google Earth, accessed 27th December 2016.
22 For further discussions see *inter alia* Lehner (1997), pp. 215-217, Arnold (1991), p. 79 *et seq*, Isler (2001), pp. 211-221.
23 Arnold (1991), pp. 98-101 and fig. 3.53.
24 Hodges (1989), pp. 10-16.

ramps. In addition, the entrance to the pyramid was located in the northern face and would have been obscured by a large linear ramp approaching from the north.[25] To the east and west of the Great Pyramid are the major necropolises built for the members of Khufu's court, so these areas were under development at the same time that the pyramid was being built.[26] In addition, to the east was the mortuary temple and causeway. Given these developmental restrictions, it seems unlikely that a temporary ramp would have approached the Great Pyramid from either the east or west. The features to the south of the Great Pyramid (including the two boat burials and a series of mastaba tombs), however, were built shortly after the reign of Khufu.[27] Lehner has already indicated that, in his view, a ramp was used in the construction of the Great Pyramid, and that it approached the structure from the south.[28]

Returning to North Saqqara, in addition to the pyramids of the two royal women, a group of Old Kingdom tombs were found to the north of the Teti pyramid, including the tomb of Mereruka, a senior courtier and vizier to Teti (fig. 2). We can assume that construction of these tombs was underway contemporaneously with the construction of the Teti pyramid complex, and that a construction ramp could not, therefore, have approached the pyramid from the north. To the east of the Teti pyramid were other elements of the pyramid complex, the presence of which are also likely to have precluded the use of the area for a temporary construction ramp. The areas to the immediate west and south of the Teti pyramid, however, are currently understood to be free of substantial archaeological features which are contemporaneous with, or pre-date the Teti pyramid. The areas to the west and south could, therefore, have provided suitable areas in which to construct a temporary ramp.[29]

Given the need to import granite from Aswan for the pyramid chambers, basalt for the sarcophagus, and Tura-quality limestone for the casing of the Teti pyramid, a construction ramp approaching the pyramid from the west would have been less practical, in several respects, than a ramp located to the south of the pyramid. A linear construction ramp approaching from the west would have required a flow of imported goods; a main transport artery for imported stone, that first led around to the far side of the construction site, away from the Nile.

To the south of the Teti pyramid is a wadi through which the modern road connects the tourist entrance to Saqqara with the archaeological zones (fig. 2). Part of this wadi has been the focus of recent excavations by the French Archaeological Mission to the Bubasteion.[30] This wadi would have allowed construction materials brought to Saqqara by river and canal to be transferred to the elevated surface of the plateau. It would then have been possible to link the upper end of the wadi to the Teti pyramid complex by means of a linear construction ramp which approached the pyramid from the south (fig. 4). Photogrammetric maps[31] show that the modern road through the centre of the wadi lies approximately 270 m south of the foot of the Teti pyramid. The 50 m contour to the north of the modern road lies above the floor of the wadi and is some 220 m south of the pyramid. As shown on Figure 3, the foot of a 441 cubit ramp (approximately 250 m long) would have been located towards the centre of this wadi.

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25 Another disadvantage of a spiral ramp is that as it wrapped around all four faces of the pyramid, it would have blocked the entrance to the internal passages and chambers, delaying the construction of these important elements of the pyramid.

26 Lehner (1985), p. 118, item B2 (Western Cemetery) and B3 (Eastern Cemetery).

27 Porter and Moss (1974), pp. 216-228 and plan XIX.

28 Lehner (1985), p. 128, item C15.

29 The area immediately south of the Teti pyramid has been subject to geophysical survey and 'no large mastaba type structures' were found. See Mathieson (2007), figs. 2 and 4.

30 Zivie (2007).

31 Arab Republic of Egypt, Ministry of Housing and Reconstruction, Topographic sheets, Cairo H22, 1:5000.

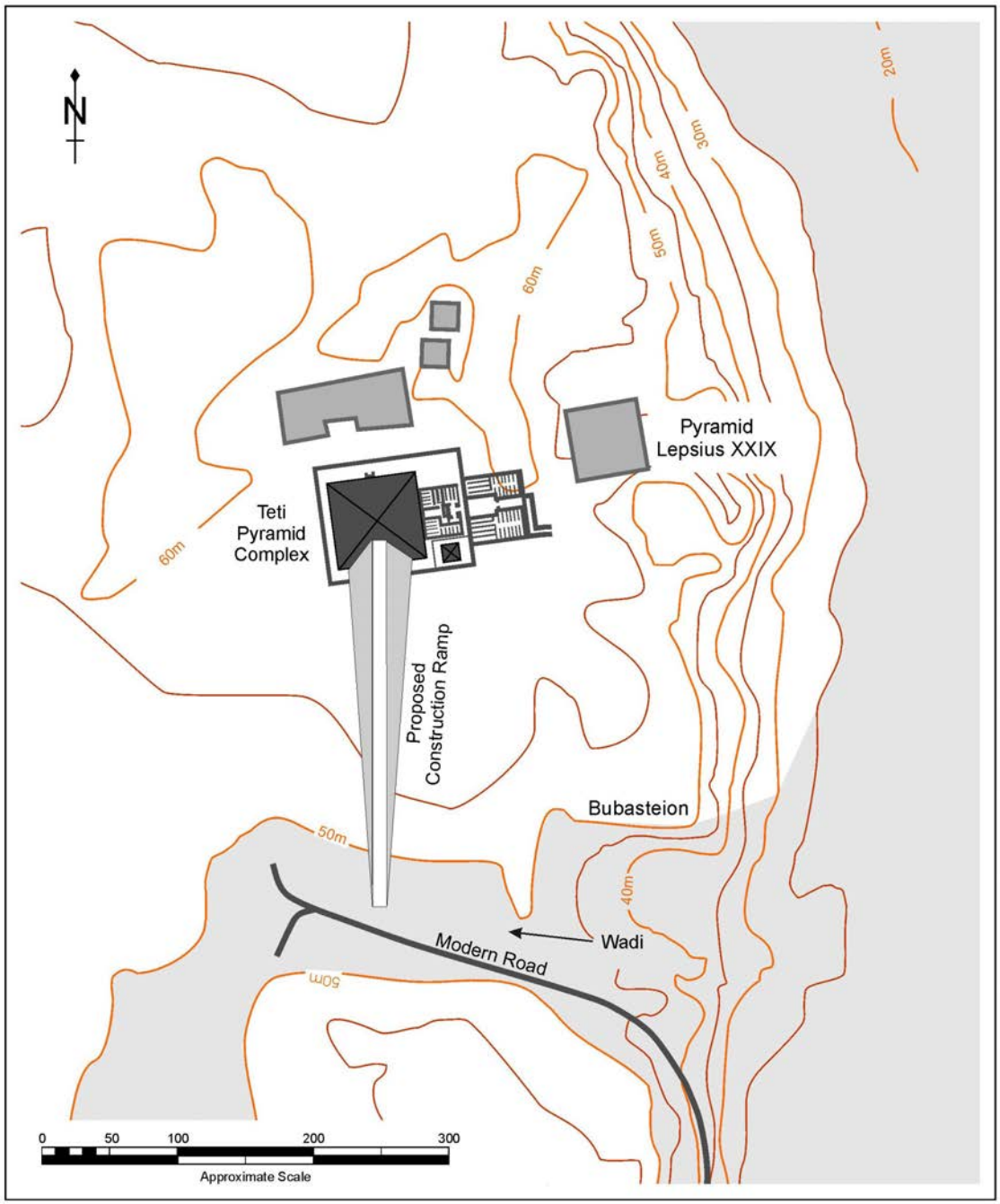

Fig. 4. The area of the Teti Pyramid complex showing a linear construction ramp approaching from the south.

Conclusion

The current paper was based on a purely desk-based analysis and it was necessary to use a combination of scale maps and other publications to obtain and compile relevant data. Notwithstanding the use of a number of different sources of information, it is reasonable to say that the data on which this paper is based are sufficiently accurate to support the general conclusions that have been reached.

Although a causeway approximately 500 cubits long can be postulated (fig. 3), when the topography of the area around the Teti pyramid is considered, the gradient of the resulting causeway (1 in 8 or 13%) would have been rather steep. On the other hand, if the gradient of the Teti causeway was consistent with those of other, more typical Old Kingdom causeways, its overall length would have been substantially greater than the 441 cubit figure referred to in the Teti Papyrus. On this basis, it seems reasonable to conclude that the reference to 441 cubits identified on the papyrus by Collombert is not a reference to the Teti causeway.

The foot of a 441 cubit linear ramp which approached the Teti pyramid from the south would have been located in the wadi which today carries the modern road from the inundation plain to the surface of the Saqqara plateau. During the construction of the Teti pyramid complex this wadi would have provided ready access for imported stone brought along the Nile and its associated canals from Aswan, Tura and other quarries.

Given the congruence between the information provided on the Teti Papyrus fragment which refers to a feature associated with the Teti pyramid that was some 441 cubits long, and the geomorphology of the Saqqara plateau, in particular the position of the wadi lying at this general distance to the south of the Teti pyramid, it is concluded that the Teti Papyrus could present rare evidence for the use of a linear construction ramp on an Old Kingdom pyramid building project.

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The Dark Side of a Model Community: The 'Ghetto' of el-Lahun

David Mazzone

El-Lahun[1], also called *Kahun* or *Illahun*,[2] is the site of one of the largest state-planned settlements dating back to the Late Middle Kingdom period of Egyptian history (c. 1850-1700 B.C.).[3] This isolated site occupies an area of approximately 13 hectares in the present-day governorate of the Fayum (Fig. 2). The site lies on the west bank of the Nile, along the desert edge, north of the modern village of Al-Lāhūn (Fig. 3). It is around 1 km west of the pyramid of pharaoh Khakheperra Senwosret II.[4] Kahun, as it was originally referred to by Petrie, was excavated and recorded in two separate fieldwork campaigns funded by the Egypt Exploration Society (EES). Petrie and his colleagues mapped nearly three quarters of the existing buildings (approximately two thousand rooms), and uncovered an impressive grid of mud-brick structures above paved floors.[5]

The function of the relatively large, dense and permanent settlement of el-Lahun was connected to the cultic activities that took place in a series of temples and sanctuaries. Apart from its architectural features, the social characteristics of this rather isolated *Pyramidenstadt* are still largely unexplored. The recent publication of two documentary archives from the site, covering a duration of approximately four generations, is central to any attempt to reconstruct the daily life of its working population.[6]

El-Lahun was one of several settlements of considerable size that are considered urban centers of the multi-ethnic Middle Bronze Age society. Complex activities were carried out in these centers and they were often permanently occupied for long periods of time.[7] The appearance of urban

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1 I am grateful for many useful suggestions from S. Quirke, R. Bussman and R. Ambrosini. Thanks to *JAEA* for revisions, editing, typesetting, and formatting, and Angela McDonald for reviewing and editing transliterations and hieroglyphs. I wish to thank University College of London for the permission to use their library. Any faults which remain are my own.

2 For the origin of the locality's name see Gunn (1945); Luft (1993; 1998b; 2013).

3 Excavation reports: Petrie (1890; 1891); Petrie *et al.* (1920-23); Brunton (1920). Also relevant are Petrie's unpublished journals (October 1888-January 1890) in the Griffith Institute, Oxford. More recent site plans, architectural details and images are in Frey and Knudstad (2008). The 'El-Lahun Survey Project' is available at: http://www.kairo.balassiintezet.hu/en/hungarian-archeological-expeditions/

4 Circa 1897-1878 B.C. (Baines and Málek (1980), p. 36). The chronology of the reign of this sovereign is still uncertain (Stone (1997); Luft (2001; 2006); Edgerton (1942) and Wegner (1996)).

5 Gallorini (2008); Drower (1985); Quirke (2009). Most of the surveying records made by Petrie are preserved in their original draft form. They include sketches, detailed plans with dimensions of rooms, walls, structural elements and occasionally locations of finds. They are contained in a series of notebooks (39b; 39e; 48; 48a; 49 and 50) now in the Petrie Museum of Egyptian Archaeology (UCL), London.

6 For the so-called 'town papyri' (P. UC) see Griffith (1898); Collier and Quirke (2002; 2004; 2006); Collier (2009). For the second group, the so-called 'temple archive' (P. Berlin) see Borchardt (1899); Kaplony-Heckel (1971); Scharff (1924).

7 As a general principle, a 'city' is a relatively large and dense, complex, urban centre, permanently settled by a heterogeneous population and containing many urban functions. A 'town' is a smaller urban centre with fewer urban functions (Bietak (1979)). The definition of cities and towns remains a topic of vivid debate due to the lack of an agreed set of criteria which can be

centers in Egypt and on the ancient Levantine coast is often mentioned in conjunction with the emergence of urban planning. Social composition shifted from pre-urban rural to a partially urbanized state-controlled culture. In this context, el-Lahun is considered as a model of urban planning belonging to the 'classical period' of ancient Egypt.[8]

From the hieratic documents it is clear that the settlement was a compound with two zones of different names: *ḥtp snwsrt mꜣʿ-ḫrw* ('satisfied is Senwosret, true of voice') and *sḫm snwsrt mꜣʿ-ḫrw* ('powerful is Senwosret, true of voice', hereafter called *Hetep* and *Sekhem*).[9]

Chronologically, but also functionally, the *Pyramidenstadt* of el-Lahun can be compared with *wꜣḥ swt ḫʿ-kꜣw-Rʿw mꜣʿ-ḫrw m ꜣbḏw* ('enduring are the places of Khakaure, true of voice, in Abydos', hereafter called *Wa-sut*). It was a similar urban settlement built south of Abydos,[10] associated with the mortuary temple *Nefer-Ka,* for the perpetual cult of pharaoh Khakaure Senwosret III (c. 1878-1841 B.C.).

The original purpose of both establishments was to maintain the cults of their respective deceased pharaohs. These two satellite towns display features typical of state-controlled construction projects. Their architecture is extremely hierarchical and rigid in layout, organized into monolithic blocks along a strict orthogonal grid of streets.[11] The presence of similar buildings and comparable urban features at el-Lahun and Abydos, and to some extent at Qasr el-Sagha,[12] Tell el-Dab'a,[13] and Abu Ghalib,[14] indicates and confirms the existence of a consolidated 'idea in town planning', intended to organize the functions of collective life in the contemporary urban settlements of the Middle Kingdom'.[15]

Pyramid towns were associated with the pyramid complex and were located in the vicinity of the pyramid necropolis. The development of el-Lahun seems to conform to an essential principle of town planning in ancient Egypt in that they indicate a purely functional approach to the physical form of the urban environment. The state's first goal was to identify the functional requirements. An urban form would follow and then a particular social formation would result.

The complexes at Abydos and el-Lahun show the same orthogonal layout of residential areas, the same overall shape of the settlement, and both seem to have accommodated large and multi-cultural urban communities.[16] To modern observers the organization of the urban spaces in these towns

applied cross-culturally. For pre-industrial cities it has been argued that the 'presence of a literate elite remains the single most agreed (upon) criterion to distinguish (such) cities from other types of communities'.

8 An overview of urbanism in the Ancient Near East is in Smith (2007); Wilson (1960); Bietak (1979; 2010); Bard (1987); Hoffmann (1980); Seidlmayer (1996a, b). For a general discussion on the phenomena of urbanism in history and its sociological aspects see Wirth (1938); Castagnoli (1971); Badawy (1967); Moeller (2016); Uphill (1988).

9 Both topographical names are attested in several papyrus and in several seal impressions discussed in Quirke (2005); Martin (1971); Tuffnel (1975).

10 For a general overview of the site see Ayrton *et al.* (1904); Wegner (1998; 2000; 2001).

11 The architectural aspects of el-Lahun are discussed in Arnold (1989; 2008); Doyen (2000; 2010); Quirke (1998); David (1986). A recent reconstruction of daily life in this town is in Szpakowska (2008).

12 The so-called 'western settlement', consisted of dwellings strictly organized into compounds surrounded by paved streets (Herbich (2001); Eliwa (1992); Sliwa (2005)).

13 The ancient portion of the settlement, at the beginning of the 12th Dynasty, was located in the area of Ezbet Rushdi on the southern border. The area is still largely unexcavated but so far 342 dwellings have been recorded. The size of the houses indicates that the settlement could have been densely populated. See Czerny (1999a, b, c); Bietak (1996); Czerny (2008).

14 This site contained remains of a substantial settlement of the Middle Kingdom, perhaps a kind of industrial or production area with a residential area (Larsen (1935; 1941); Bagh (2002)).

15 Patterns in urban settlements can be recognized in the regularity of architectural remains within the same site or between different sites.

16 Wegner (2001), pp. 283-284, figs. 1-2. At *Wah-sut*, the large area of lower status houses is almost certainly still to be discovered

Fig. 1. The remains covered with sand of the city of el-Lahun (photo courtesy of Franck Monnier).

invokes a narrative about life within. Their somewhat excessively institutional aspect together with the function and scale of the architectural features conveys a sense of both social inclusion and exclusion of specific groups from the center of social activity. A strict separation, defined by a rigid zoning system, created areas for the 'élite' and areas with 'dwellings for the masses'. These were common features of the urban layouts of both el-Lahun and Abydos.[17] Despite scant architectural remains, the footprint of the original grid-iron town planning at el-Lahun left significant evidence for a fundamental and rigid form of social stratification. The town planning and the consequent social order at el-Lahun may have imposed a condition of coercion over the population, effectively caging people in 'ghetto-quarters' with the intention of centralizing the resources of thousands of individuals.[18]

In this light, and in the sections that follow, this article reviews the contextual evidence from el-Lahun that seems to indicate that a punitive institution known as a *ḫnrt*[19] ('prison', 'fortress/enclosure' or 'workcamp') was in existence in the western part of the town called the *Sekhem*.[20]

under the floodplain.

17 For the concepts of 'élite' and 'lower status' in the Middle Kingdom Egypt have been recently explored in Wegner (2001), p. 282.

18 'Ghetto' is generally adopted through the present work to refer to 'an impoverished, neglected, or otherwise disadvantaged residential area of a city, usually troubled by a disproportionately large population'. The term is used metaphorically to describe slum areas and represents the overcrowded area of a settlement in which the immigrant finds his first dwelling after the arrival in a new country (Wirth (1928; 1938); Calimani (2001)). Almost certainly 'ghettos' existed much earlier than they received a specific designation, doubtless much earlier than the 16th century, when persecuted Jews were forced to live in confinement in Europe.

19 Written with the house-determinative (Gardiner-sign U31+X1+O1). The term is also used figuratively in literary compositions (Gardiner (1957), pp. 544-548). For the writing of *ḫnjt* (Aa1+N35+M1+X1+U31+A24) with the omission of 'r', attested in the Old Kingdom see Roccati (1982), pp. 36-38; 18 note (a). For the occurrence of the architectural house-determinative see Quirke (1988), p. 83.

20 The name *Sekhem-Senwosret* is written with the logogram S42 'sekhem-scepter'. This symbol is most associated with concepts such as 'power', 'might' 'control', 'strong arm', 'authority' (Gardiner (1957), p. 509). The scepter is defined essentially as a 'symbol of terrifying power, tribal in essence, and its origin divine'. Its symbolic role may have originated in Abydos as a fetish

Fig. 2. Map of Egypt with locations mentioned in the text.

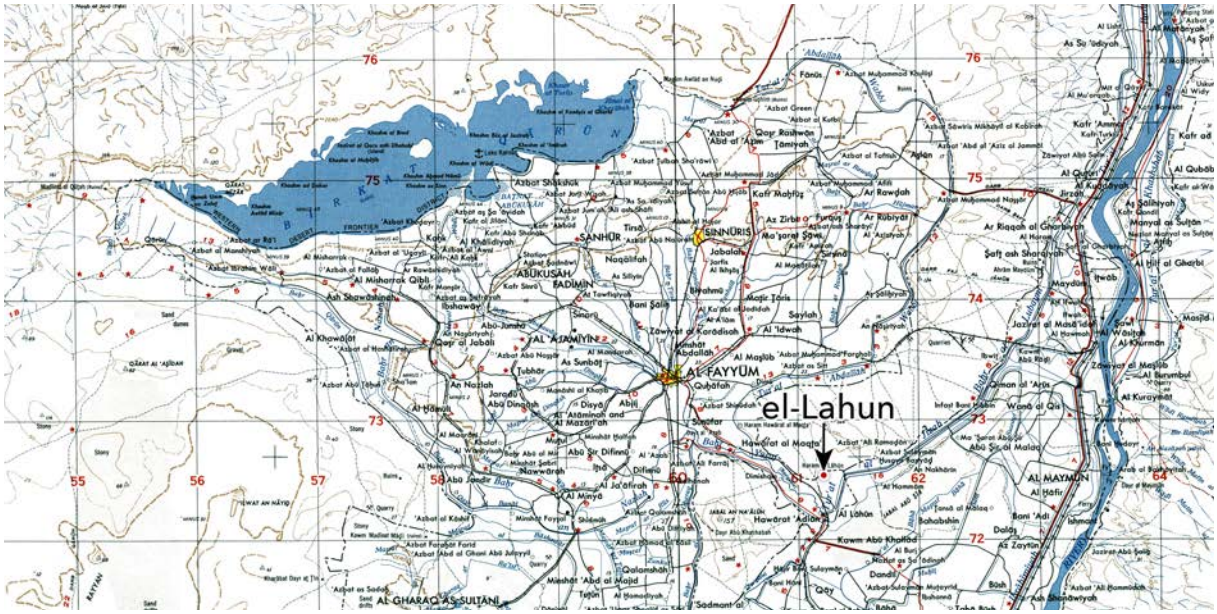

Fig. 3. The Fayum area in Egypt with the location of the ancient site of el-Lahun at 29°14' N, 30°59' E (AMDE, map compiled in 1953).

Overview of the urban form

At el-Lahun, Petrie unearthed evidence of significant poverty from the lanes of the *Sekhem*.[21] As reconstructed in his conclusions, the all-urban compound was originally surrounded by an enclosure wall of monumental proportions, which gradually disappeared over time due to erosion and the depredations of fertilizer diggers. Recent excavations have confirmed Petrie's first impression that the western block of *Sekhem* was a later addition against *Hetep*'s enclosure wall. This was revealed by the remains of a low thin lining of limestone in the north-west corner of the enclosure wall.[22]

It is possible that an earlier nucleus of the town was already in existence, named *ḥtp snwsrt ꜥnḫ ḏt r nḥḥ* ('satisfied is Senwosret alive for ever and eternity'), perhaps built to support the numerous irrigation projects in the area prior to the establishment of the pharaoh's funerary cult.[23] *Senwosret-ankh* would have been located in the middle of a series of projects to govern the abundant produce of the region of ancient lake Moeris (modern Birket Qarun). The town's name appears on several clay seal impressions and is followed by the epithet *ꜥnḫ ḏt r nḥḥ* ('alive for ever and eternity') instead of the expected *mꜣꜥ-ḫrw* ('true of voice').[24] *Senwosret-ankh* could have been established at the beginning of the reign of Senwosret II, sometime around 1897 B.C. In the Fayum region it would undoubtedly have played a significant administrative and religious role. It seems that el-Lahun was therefore built in two successive chronological phases. A first phase, when *Senwosret-ankh* functioned as a local administrative center, and subsequently a second phase when the funerary cult was established, with a compound formed by a core town *Hetep* and a western 'ghetto' built against the first enclosure.

of Osiris (Harari (1950)).

21 Petrie (1891), pp. 5-8.

22 Frey and Knudstad (2008), pp. 54-55, fig. 35; Arnold (2008), p. 78.

23 P. UC32184 in Collier and Quirke (2002).

24 Petrie (1891), pl. 9.

Circulation within el-Lahun seems to have been restricted, due to the limited number of roads and the calculated subdivision of the urban area into separate sections. Blind alleys divided the settlement into uniform and equal blocks, with the majority of these blocks being long and narrow. Dwellings are small in floor plan and often similar in style, indicating a relatively constrained system of public interaction.[25] At el-Lahun, like in most ancient Egyptian towns, it seems that streets did not have names. A stele, Cairo JE 47261, provides evidence that blocks probably had specific designations and that streets were just the empty space in-between. Few main streets appeared to be dominant, but in *Sekhem* the *cardo maximus* was oriented north south and intersected by constricted secondary east-west lanes which ended in *cul-de-sacs*.[26] Buildings facing these lanes show similar plan arrangements. The high density of the housing and the narrowness of the streets may have conveyed a feeling of bureaucratic control, which would have been particularly evident in the conglomeration of smaller units.

In the presence of such meticulous urban organization, it might be expected that towns such as el-Lahun would be oriented towards important features such as royal palaces or religious places of worship. Possibly the pyramid of Senwosret II was the most important monument in the area, but this was hardly visible from the town due to the great enclosure walls. The eastern ends of the longer blocks were nearly closed at the entrances to the north-south main road, indicating the possible use of a system of admittance for individuals arriving and leaving. The entire western suburb was a closed environment. Its prominent axiality, the symmetrical arrangement of houses, the walled areas with limited access and a strict system of gates or entrances to pathways was perhaps required so that a few watchmen could effectively control it, perhaps even day and night, a circumstance already suggested by Petrie.[27] The only preserved gateway into the city was found at the north east. It gave access to an east-west running street. The gate appears unfortified and unusually narrow for the primary entrance into the town. Perhaps the surveillance of the entrance was under the control of an *jmy-r ꜣ ḫnrt* ('door-keeper of a Prison').[28] With the width of the main streets and of the minor lanes reduced to a minimum, *Sekhem* seemed to have been a walled town with restricted circulation and a large population, and so it would have felt overcrowded (Fig. 4).[29]

The internal wall dividing *Hetep* from *Sekhem* has the same characteristics as the northern and eastern boundary walls of the settlement site. It excluded any direct communication between the

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25 Stele Cairo JdE 47261 published in Wainwright (1925) and Fisher (1980) is one of the most enigmatic objects recovered. This round topped stele of limestone is said to come from the sebakh of el-Lahun. On the front there is a single column which reads: *pryt 4 nt 20ḫ30*, 'Four houses (apartments) of 20x30 (cubits)' (measures are here expressed in cubits *mḥw*, corresponding to four apartments of circa 10,5 x 15.75 = 165 sqm, based on the standard cubit of 0.525 m). The stele, written in exceptionally large and well-formed hieroglyphs, was probably intended for public display. It was located at one of the intersections of the main road with one of the alleys. It is possible that all alleyways of the ghetto suburbs had similar stelae somehow recessed in wall corners, presumably to mark the entrances of specific dwellings in one of the most crowded areas of the settlement. Stelae like this one in the town were perhaps used to mark the dwelling distribution/zoning based on social groupings. The position of the 'four houses apartments of 20x30' can be tentatively localized in in the quarter EB 1 to 3N/S (see architectural plan in Doyen (2010), pp. 87, fig. 5).

26 A curious feature of this road system is the existence of a provision for the disposal of water and liquids (?) typical of a small sewer/drain in the centre of the street. Although not sufficiently investigated in this context, this feature is already attested in several cases in other urban settlements of the Ancient Near East. The disposal of solid waste on the other hand does not seem to have been of concern and was probably left to personal/household behaviours, and most probably was disposed of as refuse which accumulated around the city wall.

27 Petrie (1890), p. 23.

28 Ward (1982), no. 504.

29 Contra Quirke (2005), pp. 48-49. With sometimes less than 5 cubits (c. 2.6 m) of width, lanes in ancient Egyptian urban contexts were hardly generous for circulation of donkeys and large crowds at the same time and this can be interpreted as a sign of a low-level of quality of life. This applies also to the street of Tell el-Dab'a (Bietak *et al.* (2010), p. 17).

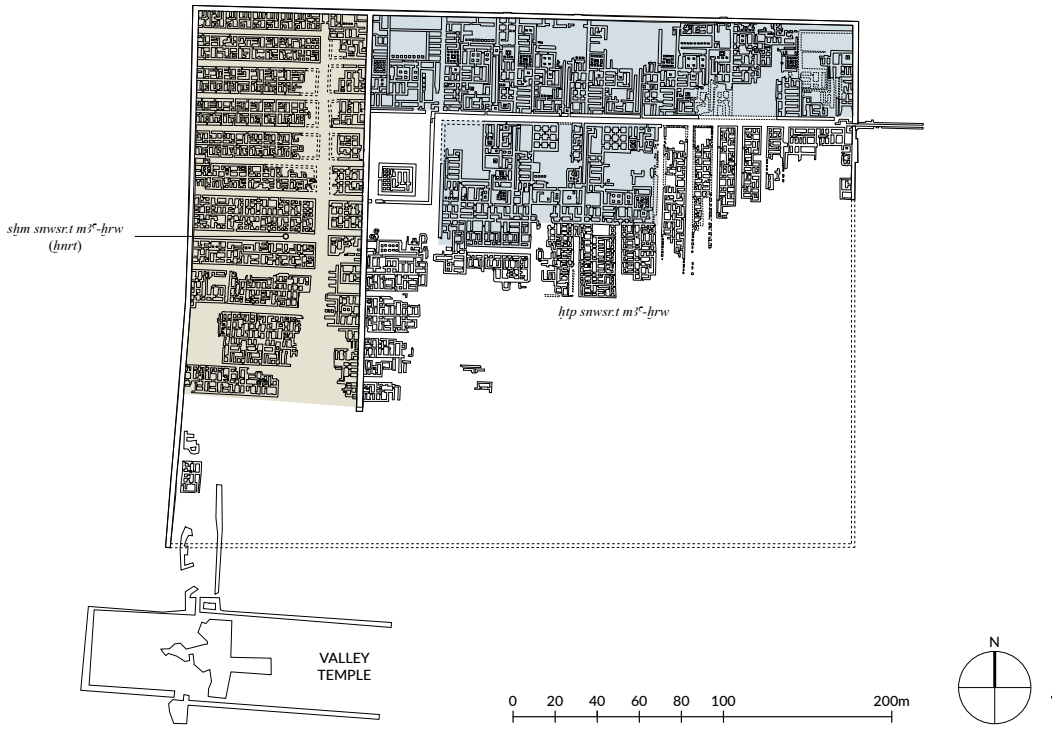

Fig. 4. The plan of el-Lahun reproduced from Petrie's reports, on a satellite image. In yellow is the workers' quarters at el-Lahun, the 'ghetto' *sḫm snwrt mꜣʿ-ḫrw*. In blue are the 'élite residences' of the eastern suburb *ḥtp snwsrt mꜣʿ-ḫrw*.

two main sectors and it also indicates an intentional, strict, administrative and social separation.[30] The width of the west enclosure wall dividing *Hetep* from *Sekhem* (c. 3.2 m wide), its sloping sides and, more significantly, the impressive elevation of more than 6 m when complete, imply that no view was allowed over the enclosure walls, surely inducing a sense of restriction and seclusion. The monumentally sized enclosure walls would have been impressive to the inhabitants of el-Lahun, and certainly represented a very significant investment of resources.

At the southern end, the regular north-south direction of the western boundary wall bends slightly, but significantly, to become aligned with the pharaoh's funerary temple which is located directly to the south. The slightly different alignment of the southernmost house-blocks adjoining this boundary wall, in comparison to the rest of blocks at *Sekhem*, could be the result of a later phase of construction associated with the cult temple to provide services dedicated to its distinctive function.[31]

Monumentality, conformity and organization according to architectural rules at el-Lahun seems to have conveyed important social messages to the town's inhabitants. The consistent pattern, imposed by the state, restricted and shaped the dwelling forms and limited personal choices. Social

30 Horváth (2010), p. 174.

31 This fact discussed by O'Connor seems to acquire symbolic or cosmological meaning (Horváth (2010), p. 195; O'Connor (1997), p. 389).

rules, physical constraints, and imposed directives from above determined how people carried out and arranged their domestic activities, within and outside their houses. The power and supremacy of the institutions were first used to mobilize the resources to build these vast projects. This demonstrated their authority to divert a large number of people and force them to conform to set rules. The structures then reinforced this idealized vision for the society and its individuals, and maintained the social differentiation necessary to transform 'chaos' into 'order'.

From farms to townhouses: The emergence of state planned towns

The transition that took place from rural villages to state planned settlements, often referred to as the 'urban revolution' in the Nile valley, is a poorly documented and little understood developmental phase.[32] Our knowledge of the social and ideological context in which the evolution from village life to the 'civilization' of planned towns took place, is inadequate given the complexity of the phenomenon.[33] In Egypt, the layouts of prehistoric settlements like Merimde Beni-Salame[34] and el-Maʿadi[35] provide evidence of primitive urban planning and community organization, with rows of huts positioned along what look like roughly-formed roads, as early as the Fayum Neolithic (c. 4000 B.C.). The archaic remains reveal a series of dwellings organized in approximately rectangular blocks, along straight streets, evidence of the initial stages of a planning strategy, in sharp contrast to the more spontaneous organic developments of the majority of farming villages.[36]

Although the lexicon used to describe these developments remains unclear, terms such as *ḥwt, mḏt* ('walled, rectangular (?) settlement', sometimes also used for 'royal funerary domain'), *njwt* ('walled, round (?) settlement'), *dmjt* ('town', 'quarter' or 'sanctuary'), *wḥyt* ('village'), *dmj* ('farming village'), for example, are used in Egyptology, but they tend to cover a rather large and often vague range of meanings.[37] Clearly, clusters of small dwellings at the back of a sanctuary cannot be considered a 'town' by even the broadest definition.[38] More securely, some of the earliest evidence for an urban community is recorded in the annals of the Palermo Stone under the pharaoh Horus-Nebmaat Snefru (c. 2600-2450 B.C.). Several foundation ceremonies are recorded for the first two dynasties, and also the 'making of thirty-five houses', almost certainly a new settlement for funerary personnel and priests.[39] The emergence of these earliest 'planned settlements' in Egypt, but also across the entire Fertile Crescent, contrast with the more familiar organic developments.[40]

Examples of towns with a certain degree of standardization between sites are well attested in the

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32 For this concept, and more generally for ancient urbanism in pre-industrial societies see Childe (1950), pp. 3-17; Smith (2009), pp. 3-29; Wilson (1963), pp. 33-36; and more recently Bietak, Czerny, Forstner-Müller (2010); Mellaart (1979), pp. 22-34. A list of dynastic settlements in ancient Egypt can be found in Butzer (1976), pp. 60-70.

33 For discussions and critique of Wilson's statements in 'Egypt-civilization without cities' see Kemp (1977), pp. 185-200. Urbanism in ancient Egypt is discussed in O'Connor (1972; 1993); Bietak (1979), pp. 105-106.

34 Junker (1928), pp. 14-33; Eiwanger (1999), pp. 501-505.

35 Menghin and Amer (1932; 1936); Menghin (1934), pp. 111-118.

36 The term 'organic' town is here intended to be an urban aggregation which developed naturally in contrast to the 'planned' town conceived as a single concept and organized in a structured layout, although in some cases the two situations can be combined. As a general rule, urban planning was typically focused on alignments over a long distance, perhaps oriented towards a symbolic feature, often ignoring topography, and also on the repetition of modular building units.

37 Egyptian terminology for settlement categories is purely functional (Faulkner (1962), pp. 66, 125, 313).

38 Kemp (1989), p. 141; Redford (1997), pp. 210-220.

39 Roccati (1982), pp. 36-38; Breasted (1906-7), p. 147. Similar quarters for funerary personnel and priests at Giza are discussed in Arnold (1998).

40 Bietak (1979), pp. 128-133. Of particular importance is the site of Hierakonpolis, probably one of the first organized communities as can be seen from the town plan (Hoffman, Hamroush and Allen (1986), pp. 175-187; Hoffman (1980), pp. 119-137; Hoffman (1984), pp. 235-245). An analysis of spatial organisation in mortuary context is in Roth (1993), pp. 33-55.

Old Kingdom. Several urban centers emerged[41] characterized by a combination of organic layouts and closely packed streets, often thought to represent the typical Egyptian town.[42] Most likely, this arrangement was representative of the majority of the ancient urban settlements in early Egypt.[43] The ancient urban settlements of Elephantine,[44] Dahshur,[45] and Memphis[46] are examples of ancient towns which evolved organically.[47] They are characterized by a lack of noticeable overall direction of growth, and contained a compact community with a variety of trade specializations, which were organized and developed into different quarters. In these settings, most likely one house was added to an earlier one along narrow streets, according to arbitrary alignments.

From the beginning of the 4th Dynasty, the transformation from farming villages to urban agglomerates and, in a similar way, the shift from 'farms' to 'town houses' was doubtless triggered by the emergence of strong centralized government, an increasingly military attitude, the concentration of resources, and social control of the wider population.[48] The Decree of Dahshur of pharaoh Merytawy Pepi I (c. 2300-2181 B.C.) mentions two early pyramid towns built near the pyramids of Sneferu.[49] Another town, currently under investigation, is Heit el-Ghurab at Giza. Its inhabitants would have supported the mortuary cults. It extends over an area of c. 0.65 ha to the east of the main pyramids, in the vicinity of the causeway of the monument of Queen Khentkawes (late 4th Dynasty, c. 2529-2471 B.C.).[50] Such settlements seem to have had a series of dedicated quarters in a similar manner to el-Lahun. There were quarters for bureaucratic officials, priests and overseers employed in the temples, on one side, and a more congested sector for larger number of workmen involved in the heavy toil at the pyramids and sanctuaries, on the other. An early stage of urbanism can be recognized in these state planned developments of the Old Kingdom. They are physical manifestations of an ideology inspired and controlled by a dominant élite group, who were intent on building institutionalized mechanisms enforcing community integration.[51]

The natural, original, form of Egyptian society in Antiquity was rural village life, and it was inherently conservative. It was characterized by a society in which the majority of its members lived

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41 Kemp (1989), pp. 144-145, fig. 50. In terms of town sizes, the best guess for Mit-Rahina in the Old / Middle Kingdom is between 120 to 150 ha, probably the largest settlement in Egypt. Abydos, c. 2 ha, was enlarged to c. 3.7 ha; Elephantine was between 2 and 2.5 ha in early Old Kingdom, growing in Middle Kingdom to over 8 ha; Edfu approximately 8–9 ha at around the same time; Hierakonpolis c. 8.5 ha; El-Kab c. 8.5 ha; Dendera in the Old Kingdom c. 2 ha; Abu Ghalib in early Middle Kingdom c. 3.4-4.2 ha; Kahun c. 14 ha; Tell el-Yahudiya in the 2nd Intermediate Period, 21 ha (according to Bietak (1979), pp. 108-128).

42 See for instance Seidlmayer (1996), p. 108. Rectangular house construction is more favourable for a rectangular settlement pattern. For example see the case of Mahasna (Site S2-M2) in Garstang (1902), pp. 6-8, pl. 4. A rare model in clay of a rectangular Predynastic house from el-Amrah is discussed in Randall-MacIver and Mace (1902), pl. 10.

43 Kemp (1972), p. 675. For planned versus organic cities in Antiquity see Smith (2007), pp. 5-6. Planning in Ancient Egypt is exclusively referring to a group of contemporaneous urban centres within a single cultural area. It is possible that the sample in this investigation could be biased by an uncertain number of disappeared but nonetheless important urban centres in the valley.

44 Von Pilgrim *et al.* (2004), pp. 119-148; von Pilgrim (1996); Kaiser *et al.* (1999), p. 234; Dreyer (2002), pp. 157-225.

45 Arnold (1980), pp. 15-16, fig. 1; Arnold (1989), No. 4, figs. 1-4.

46 Jeffreys (1985); Jeffreys *et al.* (1983), pp. 30-42; Jeffreys and Málek (1988), pp. 15-29; Kemp (1976), pp. 25-28.

47 Dwellings in these settlements have been discussed also in Shaw (1992), p. 150.

48 Seidlmayer (1996a; 1996b).

49 Moret (1917), pp. 359-447, II, pp. 387-427, pls. 5-6. For the hieroglyphic text see Sethe (1906-1933), pp. 209-213; Goedicke (1967), pp. 55-77; Borchardt (1905), pp. 1-11.

50 Lehner suggests the possibility that the galleries served as 'barracks' and the whole Heit el-Ghurab site has been described as a 'workers' camp'. The settlement went through a series of developmental phases and was most likely inhabited until the end of the Old Kingdom (Lehner and Tavares (2010), pp. 171-216; Lehner (2002), pp. 27-74; Tavares (2011)). The Giza Plateau Mapping Project is available at http://oi.uchicago.edu/research/projects/giza-plateau-mapping-project-gpmp-0#Introduction.

51 De Marrais *et al.* (1996), p. 15; Hassan (1993), pp. 551-569; Kemp (1989), p. 151. The Middle Kingdom is defined as 'intensely structured and bureaucratic with a dominant tendency for regulations and correspondingly structured views of the society', and this is reflected in the ordered, rigid, rectangular building models used for its settlements.

in relatively small homogeneous groups, based on closely knit primary relations, usually involving immediate family, and a neighborhood that was inter-related.

There are good reasons for inferring that the subsequent establishment of state control over the built environment was characterized by the dissolution of the model of *civitas* prevalent in the Predynastic and Old Kingdom periods, and the intensification of social complexity and social control. Ancient Egyptian society progressed through a profound socio-cultural change as a result of the diffusion of new planned settlements. With the abandonment of the conservative thinking typical of traditional rural life, the cultural evolution undoubtedly had consequences for social relations.[52] As well as state planning, state architecture was closely related to the governmental system. State authority enabled control over both the physical environment and its inhabitants.[53] Ideology, as an active force within the society of the Middle Kingdom, was communicated via both material and symbolic elements, and was undoubtedly influential in shaping the urban architectural forms of the new planned settlements.

Where the symbolism of architecture emerged, it was very closely linked to royal ideology and was used as a form of 'monumental propaganda'.[54] Urban planning in Egypt first became systematic within defended forts and work camps built by the royal establishment. In these developments, orthogonal planning was widely used to establish the urban layout and the housing arrangements, using an architectural language of rigid grids, straight lines and square corners; clearly the manifestation in the built environment of strict norms and rigid social rules.[55]

State planned pyramid towns had common elements on which the royal establishment depended in order to control and organize people and resources. Bottlenecks at doorways and entrances and exits to pathways facilitated guarding and controlling the flow of people and materials, while the impressive monumental walls enforced the social differentiation, concealing and separating individuals of different status. Over time, via the width of the streets, the materials used and, the comparative sizes of residential dwellings, the state bureaucrats were able to assert complete control over the population and their *modus vivendi*.

The bureaucratic and rigid organization of the Middle Kingdom produced planned settlement schemes that were easily duplicated, but which gave the ancient architects less autonomy, and preventing them from incorporating variation or modernization over time. The typical new settlement of the Middle Kingdom was the end product of a planning process that had a precise purpose. It was an artificial construct rather than a natural or spontaneous development. The monumental aspects of the architecture were visible on a large scale to the population. They were an effective way to convey a sense of mind control or indoctrination, and they provided a means of disseminating that propaganda.

The physical environment: urban order, housing and lifestyle

At el-Lahun, the largest concentration of houses in the west compound *Sekhem-Senwosret* is distributed along eleven parallel east-west lanes extending off a main north-south running street (Fig. 5). For Petrie, it was evident that the west block was a 'barrack-like camp' or a sort of 'dormi-

52 Wenke (1989), pp. 129-155; Seidlmayer (1996b), p. 108. However, it is rather difficult to infer the specifics of ancient religious beliefs, sacred symbolism, and cosmology from the socio-cultural changes. The absence of textual data have made the attempts largely speculative (Wenke (1991), pp. 279-329; Rapoport (1969), p. 7).

53 Fairman, (1949), p. 49.

54 De Marrais *et al.* (1996), p. 15.

55 Kemp (1989), pp. 149-179; Czerny (1999), pp. 17-29.

tory for confined people'.[56] The majority of blocks are of similar size and have the same internal layout, with a prevalence of rectangular rooms of two or three standard size variants.[57] Its design was repetitive in room arrangement and in allocation of space. The use of an integrated orthogonal interior plan suggests a higher level of planning than simply common alignments or semi-orthogonal urban blocks. Even though only the lower courses of their walls survive, we can conclude that this repetition reflects a precise vision of society in the town. This man-made environment is the expression of social division, made by a ruling élite class to separate themselves from those located at the bottom of the social ladder.[58] The house units in the sample at el-Lahun range in ground floor area from about 44 to about 170 square meters for the most generous units.[59]

In contrast to this regularity, the nature of mud-brick generally encouraged development of the houses by gradual enlargement. In the Fayum mud was much cheaper and easier to obtain than stone, and as a result, all of the structures, whether private houses or royal palaces, were built of sun dried mud brick. Studies of mud brick architecture have shown that when a house collapsed or was pulled down, the mass of debris was not necessarily removed but sufficiently levelled before another house was erected on top of it. The rectangular ground plans of houses at el-Lahun indeed show that rooms were added or subtracted when family groups extended, using the most common building material available. The simplicity with which additions could be built allowed houses to 'grow' as required, and as opportunities for expansion occurred such as through the destruction or abandonment of adjacent proprieties.[60]

Even with the excellent survey conducted by Petrie, we do not possess a reliable source of information regarding these changes.[61] The extensive re-use of material mixed-up traces of structural alterations corresponding to different owners, which perhaps also indicate changes in the rank of the inhabitants.[62] Looking at the pattern of altered structural walls it is possible to infer that, originally, all blocks of the houses were extended as a standard scheme for the full extent of the west precinct, and perhaps extended into the unexcavated area at south.[63] After the initial flourishing of the settlement during the Middle Kingdom, the division of the residential quarters into elongated strips was maintained into the New Kingdom era, however, larger dwellings in the south-west area may have been part of a subsequent re-construction, aligning houses with the temple. They may have accommodated the priests and lay personnel responsible for the perpetual cult of the deceased king, during this later phase[64]. Suggestions have been put forward that they provided

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56 Petrie (1891), p. 8.

57 The architectural aspects of dwellings are vividly reported in Petrie (1890), pp. 21-32. Mud brick architecture in Antiquity is dealt with in Spencer (1979).

58 Mud brick houses are undoubtedly the reflection of a dynamic social system, in contrast with the more static stone built constructions of royal and administrative palaces (Shaw (1992), pp. 147-166). For the reasons for the diffusion of rectangular construction see Steadman (2006), pp. 119-130.

59 Discussion can be found in Quirke (2005), pp. 74-87; Doyen (2010), pp. 81-87, Figs. 3, 4 and 5. Gross floor areas range from 44.1 sqm (16 c x 10 c = 8.4 m × 5.25 m) for types 1 in the east sectors ED a,b,c,d, E; ED b,c,d, W and EB w,x,y,z,E and for the largest ones 297.6 sqm (36 c × 30 c = 18.9 m × 15.75 m) for types 22 in sectors Wd 1,2. The types 3a, 3b (15 c x 15 c = 7.875 m x 7.875 m = 62 sqm) is the most frequent dwelling, although not the smallest one which is of about 44 sqm with 2 or 3 rooms. See also Roik (1988).

60 Shaw (1992), p. 150. This applies also to administrative buildings (Kemp (1987), pp. 120-136).

61 Gallorini (2008). The plan of the town, with its units and doorways, is still approximate (see Frey and Knudstad (2008), p. 73, fig. 51).

62 In early settlement types, circular dwellings tend to be characteristic of nomadic and semi-nomadic societies, while rectangular dwellings are characteristic of fully sedentary societies. Rectangular structures are easier to construct in bricks and it is much easier to add one to another (Flannery (1972), pp. 23-53. See also Flannery (1993), pp. 109-117; Flannery (2002), pp. 417-433; see also Shaw (1992), p. 150).

63 Kemp (1989), p. 151.

64 Quirke (1990), p. 178; O'Connor (1997), p. 389; Doyen (2010), p. 81; Bietak (1979), p. 115.

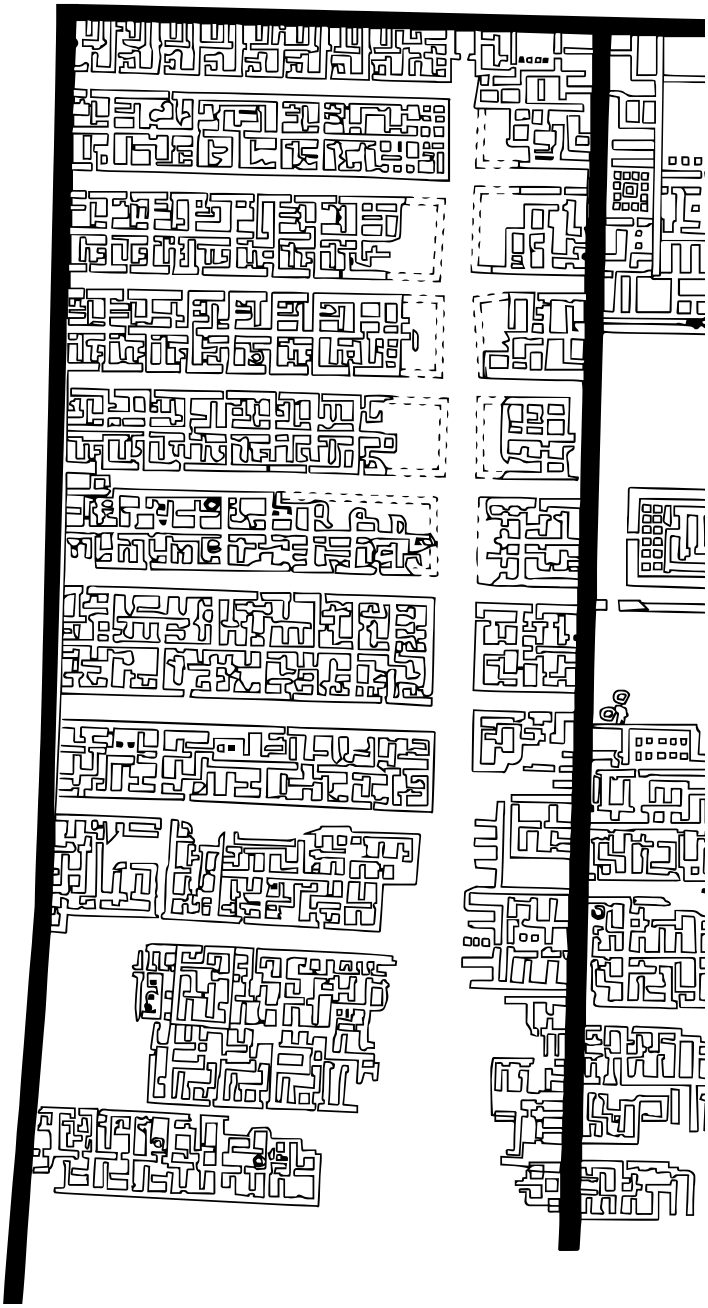

Fig. 5. Detailed plan of the workmen quarters 'ghetto' *sḫm snwsrt mꜣʿ-ḫrw* (after Petrie's reports).

temporary accommodation and offices for the high-status temple functionaries and the temple staff, in direct proximity to the place of the cult. These larger dwellings may have been the result of a longer-term commitment to maintaining rituals and the ritual purity of cult attendants and temple functionaries.[65]

65 David (1991), p. 36. Hygiene, water supply and sewage could have been serious problems at el-Lahun. We learn for example from Petrie that '...rats were as great a plague in the XII dynasty as they are at present in Egypt. Nearly every room has its corners tunnelled by the rats; and the holes are stuffed up with stones and rubbish to keep them back...' (Petrie (1891), p. 8). The Petrie Museum preserves a pottery rat trap (UC 16773) originally identified as a coop for small chickens or incubator (available at http://petriecat.museums.ucl.ac.uk).

Reconstructing and characterizing site use through time

Understanding the chronological sequences and site stratification at el-Lahun is challenging. After the death of its founder, Senwosret II, el-Lahun went through a series of occupational phases that spanned many decades. These are evident in the archaeological record, especially in the southern part of the west suburb, however, alterations made during the later history of the settlement, mainly during the New Kingdom, also appear in Petrie's survey plans.

In places, the houses of the earliest strata of the settlement are badly destroyed by the more recent building activities of the late Middle Kingdom, but in the case of the layout of Rank B, the sequence of dwellings of medium size, identical shape, and uniform appearance is remarkable.[66]

Reconstructing the overall architectural form of a *ḫnrt* is not easy. There is no documentary or pictorial evidence for what a 'special work camp' looked like. Quirke has argued that *ḫnrwt* were initially defense related but 'impermanent edifices of loose stone or organic materials' which roughly resembled a well-planned, regularly constructed and well-organized 'district'. Hence, *ḫnrwt* seem to have been *ḳd* ('assembled') but were not necessarily intended to endure, at least in the face of offensive military action.[67]

How much can be said about the feelings of those who lived in these type of dwellings? This is difficult to answer due to the concept's multi-dimensional nature. Any hypothesis must be related to the local environment as well as to the design and functionality of the dwellings. Central to understanding peoples' feelings and quality of life in this environment is the ability to evaluate the various factors in play.

Households cannot be studied in isolation, but need to be contextualized within their wider social setting. In the west block of *Sekhem-Senwosret*, there does not seem to have been any significant natural or man-made elements within sight or in the surrounding environment, meaning that it was a largely barren landscape. There were neither distant nor varied views nor additional spaces such as public areas or meeting places within the urban scheme. In fact, el-Lahun did not include communal or shared gardens, courtyards or private open spaces. In 'work camps' such as el-Lahun, it seems that there was no opportunity for public interaction within a social space, which could have contributed to a better quality of living.

The multiple dwellings were arranged in ranks with no traces of communal property within the complex. The buildings shared a common orientation aligned with the rectangular compound wall, and this rectilinear form may have been particularly susceptible to prevailing winds.[68] Government control and enforced standardization can also be manifested by the use of standard units of length, but at el-Lahun the hypothesis put forward by Doyen, for an urban scheme based on a unique unit of length for the construction of the whole settlement, appears weak.[69]

At el-Lahun, only one outer door opens to the street from each property. The level of privacy this provided is unclear, but it should be expected that the entrances provided a degree of privacy for

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66 Petrie applied, after excavating and exposing the walls, a lettering system to specific rows of terrace housing. The first, most southern row of terraces, has been called Rank A.

67 Quirke (1988), p. 86. There are no indications of what a *ḫnrt* could look like, since no pictorial representation or architectural model have ever been recovered. See also the case of Qasr el-Saga (Herbich (2001)).

68 Doyen (2010), p. 98, fig. 14.

69 It is here considered that 1 cubit (c.) = 7 palms (p.) = 52.5 cm (Doyen (2010), pp. 98-99; Carlotti (1995), pp. 127-139). In reality, a variety of royal cubit rods have been recovered at el-Lahun, varying from 64.5 to 68.275 cm in length. See Petrie Museum catalogue at http://petriecat.museums.ucl.ac.uk. For their unusual size, away from the canonical 52.5 cm, Petrie suggested Asiatic origins (Petrie (1926), pl. 6 and successive, nos. 646, 652, 3453, 4149, 4354).

the interior even when the door was open. All households forming part of a group were positioned next to each other in a patterned arrangement. It is not clear if discrete groups of inhabitants occupied each separate structure. Many of the houses seem excessively small, with only four small rooms that can be considered 'living spaces' each, arranged back to front in rows in most cases. Doyen defines them as 'pièce d'accès' (a),'annexe' (b),'circulation' (c),'antichambre' (d),'pièces terminales' (e).[70] When interpreting the differences between rooms it is easy to fall in the trap of assuming that a single room was allocated a single function, whereas the reality in ancient times was usually more complicated. In the majority of buildings there was a predominance of rectangular rooms with widths of 2 or 3 multiples of standard vault spans, indicated by the positions of structural walls of the appropriate thickness. This arrangement is characteristic of mud-brick vaulting which was probably similar in form to better preserved examples from the Middle Kingdom, such as the cenotaphs at Abydos. It is likely that the interiors of the chambers were roofed with barrel vaults in mudbrick in the so called 'Nubian' or 'skewed construction' style,[71] unlike other domestic examples from the New Kingdom at Deir el-Medina or Tell el-Amarna.

The whole settlement was surrounded with a six-meter high monumental wall on its four sides. Kemp, Uphill and Smith, and others, concord with the idea that the settlement was closed to the south by a fourth side consisting of a 'dike-like' wall, as Petrie anticipated. The only ancient entrance to the settlement so far identified is in the eastern enclosure wall, with a width of less than two meters (c. 2.8 cubits). It is still unclear if any other town gates existed to provide access to traffic routes linking this community to other contemporary urban centers, to the north, such as the towns of el-Lisht,[72] Medinet el-Madi,[73] Memphis, Dahshur, or perhaps towards the south, as far as Abydos and Elephantine.

The separation walls and enclosure fortifications are often assumed to have been built for defensive purposes, but despite their magnitude, more careful analysis suggests that they may have been erected primarily in order to segregate and control the work-force. Their primary purpose may in fact have been symbolic, to dwarf and dominate the surrounded individuals with their monumental proportions,[74] and as such they articulated a form of monumental propaganda.

This conclusion can be justified in part by considering that Egypt, at the time the work-camp was constructed, was not at risk of attack or raids during the late Middle Kingdom. Structural aspects and symbolic elements imply that ideology was an active force in shaping the earliest state-planned settlements. Massive elements of architecture were ideal for population mind control and indoctrination and for the dissemination of propaganda.[75] The thick wall dividing the two parts of the settlement seems to support this logical explanation. The two blocks *Hetep-Senwosret* and *Sekhem-Senwosret* co-existed at el-Lahun within a system of separate but 'contained communities' in which enclosure walls, rather than active force, impressed and intimidated the population, imposing differentiated status, and standing for power, influence and social control.[76]

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70 Doyen (2000), p. 72.

71 Fathy (1973).

72 Arnold (1996); Arnold (1989), pp. 75-93.

73 Medinet el-Madi, ancient *Dja*, a locality at about 30 km southwest of the town of Medinet el-Fayum, near the village of Abu Gandir, was the site of a 12th Dynasty Middle Kingdom settlement connected with the cobra goddess Renenutet and the crocodile god 'Sobek of Shedet' temple. Ptolemaic and Roman urban schemes seemed to follow, like many of the other towns in the Fayum, the original orthogonal layout of the Middle Kingdom town (http://www.medinetmadi.org and excavation reports in Vogliano (1936; 1937); Bresciani and Giammarusti (2012); Bresciani *et al.* (2006)).

74 Kemp (2000), pp. 335-346.

75 De Marrais *et al.* (1996), p. 16.

76 Moeller (2004), p. 265.

Evidence from the First Intermediate Period demonstrates that local families in power frequently decided to build enclosure walls.[77] Town walls in antiquity, according to several authors, invite a functionalist explanation rather than a structural one.[78] The form of the walls at el-Lahun suggests limitations on mobility and intimidation were the design criteria, rather than protection from external threat. As an extension of this logic, we should consider the possibility that in the Ancient Near East, walls were not only constructed as defenses against an external enemy, but perhaps more often as protection against possible internal state disorder and turmoil.[79] Upon deeper examination, the arrangement of the town at el-Lahun is more complicated than originally assumed.

Apart from uncovering the major architectural elements, investigations of the town have produced other informative archaeological discoveries. The re-flooring of some of the big 'mansions' over burials in the eastern part of the town suggest that the town was occupied for many generations, and that it was abandoned at least twice.[80] As often happened in the dynastic history of Egypt, once the maintenance of the mortuary cult of a pharaoh ceased, the funerary establishment and related town were mostly deserted, and parts of it were subsequently used as burial areas. A significant number of Asiatics were found in the burials at el-Lahun, but it is difficult to conclude if they were slaves brought into Egypt following conflicts abroad, as war prisoners, or as merchandise to be traded in exchange with others, or possibly both of the above.[81]

One of the important aspects that Petrie noted was the introduction of the custom of burying infants within the interior of several houses at el-Lahun, a practice that was not originally part of traditional Egyptian culture or rituals.[82] Several wooden boxes were found *in-situ* containing infant burials, which scholars have interpreted as indicative of high childbirth mortality:

'…beneath the brick floors of the rooms were, however, the best place to search; not only for hidden things, such as a statuette of a dancer and pair of ivory castanets, but also for numerous burials of babies in wooden boxes.[83] These boxes had been made for clothes and household use, but were used to bury infants, often accompanied by necklaces and other things…'.[84]

Artefacts in bronze, such as a mirror tang, weights, and large amounts of pottery were discovered by Petrie and identified as imported goods from their morphological styles and compositions.[85]

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77 Moeller (2004), p. 265.

78 Kemp (2000), pp. 335-346; Kemp (2004), pp. 250-260; Moeller (2004), pp. 261-265; Spence (2004), pp. 259-288.

79 Trigger (1972), p. 589.

80 The town was again occupied, although sparsely, during the 18th Dynasty under pharaoh Nebmaatre Amenhotep III (c. 1402-1364 B.C.), as is confirmed by the occurrence of numerous scarabs produced during this renewed occupation.

81 Posener (1957), p. 158.

82 Petrie (1890), p. 12. Intramural burials for infants have been recovered in contemporary settlements such as Elephantine, Abydos, Tell el-Dab'a and Lisht. This custom began with the earliest settled communities in the Near East and continued through the Bronze Age, predominantly in sites with South Levantine connections (el-Omari, Merimde Beni Salame). Initially thought of as a custom of foreign origins, (it has been suggested it was introduced by immigrant, Asiatic workers) it was widespread and attested as native in Egypt as well, although the topic is still debated. We can speculate that the number of infant burials at el-Lahun is indicative of a high mortality rate for babies at birth. For the foreign origins of this practice see Sparks (2004), pp. 25-54; David (1991), p. 37. At the Abydos town site, burials of small children were found in pots or shallows under the house floor (Richards (2005), pp. 66, 169-170; Wegner (2001), p. 303). This practice does not have a single interpretation for all cultural contexts, although it implies a religious belief in rebirth and hope for an afterlife (McGeorge (2011) available at http://halshs.archives-ouvertes.fr/halshs-00808172). In the case of Elephantine island, the custom of in-settlement burials of foetuses and infants that is seen in later periods is attested as early as the 6th Dynasty (Kaiser *et al.* (1993), p. 182; Raue (2004)).

83 These boxes were originally fabricated for other purpose and later re-used a coffins (Manchester Museum Catalogue available at http://harbour.man.ac.uk/emuweb/pages/common/imagedisplay.php?irn=815&reftable=ecatalogue&refirn=102925).

84 Petrie (1892), p. 116.

85 See discussion in Petrik (2011), pp. 215-217; Posener (1957), p. 161. The well-known torque or necklace was the distinctive ornament of the western Asiatic area and a typical product of Byblos. Kamares pottery entered Egypt and was imitated and

Burials attested across the whole settlement and, more intriguingly, within domestic contexts, have shown that after a first occupational phase, the town was inhabited during a second phase of intense activity in the New Kingdom, during the reign of Nebmaatre Amenhotep III (c. 1391-1353 B.C.). Petrie was certainly right in classifying the site of el-Lahun as the workers' town related to the construction of the pyramid of Senwosret II. Only in the second season did he recognize the sparser evidence for occupation during the 18th Dynasty, in particular during the reign of Amenhotep III. The presence of later burials in the south-eastern part of the site indicate that el-Lahun was uninhabited and partially in ruins by the late 18th Dynasty.[86]

Characterizing the inhabitants of the *ḫnrt wrt*, the 'Great Prison'

The minority of officials and élite people in Ancient Egyptian society have received a disproportionate amount of scholarly attention, and this misrepresents the realities of the past. The workers that lived in the high-density town suburbs of el-Lahun are a good example. They would hardly have been noticed were it not for the recovery of documents recording information about their everyday lives from the town and elsewhere in Egypt. These have provided information about the large population in the lower social strata who would otherwise have left few traces of their existence.[87]

The formation of a social class system and the origins of inequality and social stratification in Ancient Egypt are matters of some scholarly debate. El-Lahun offers the opportunity to explore to what extent differences between social groups and diverse backgrounds can transform a view of Ancient Egyptian society from one of an orderly and reverential culture into one of an environment rich with confrontational situations.[88]

There is certainly evidence of abundant cultic activity at *Sekhem-Senwosret*.[89] From the highest offices down to the household level, participation in the royal cults was enforced. There were at least four temples[90] in *Sekhem-Senwosret*, and there is also evidence of other cults, such as for Hathor.[91] Hieratic documents attest to other institutions involved with the cults such as the ***šnwt nt ḥtpw-nṯr*** ('granary of divine offering') and ***šnʿ n ḥtpw-nṯr sḫm snwsrt*** ('food production area of divine offering of *Sekhem-Senwosret*'),[92] but the majority of the documents recovered provide anecdotal evidence of a much harsher daily life. The administrative texts are pre-occupied with keeping track of prisoners and making sure they complete their allocated work.

The majority of the papyri recovered from domestic and religious settings at el-Lahun consist of records of the daily interactions of the inhabitants. These activities were conducted through and

produced locally (Hughes and Quirke (1998), pp. 112-140). Minoan sherds and imitations at el-Lahun were not luxury items for it appears that none of them were discovered in the vicinity of the north rows of mansions, rather it seems to have been domestic ware used by some ordinary people.

86 A burial ground for the inhabitants of this ancient town is located at 8 km east of el-Lahun in the locality of Qaryat el-Harajah, south of the modern village. It contained poor graves as well as a few scattered burial (Engelbach (1923); Grajetzki (2004)). No forensic investigations have been carried out so far.

87 Broadly speaking, with 'lower status' categories such as *tšj.w* ('defectors'), *mry.t* ('employed'), *ḥsbw* ('conscripted workers'), *bꜣk.w* ('workers'), *sḳrw-ꜥnḫ* ('bound for life' or foreign 'prisoners of war'), and so on are intended here.

88 The formation of social class systems and the origins of inequality and social stratification connected to the 'urban revolution', are subjects still inadequately explored in Egyptology. For an overview see Bard (1992), pp. 16-21.

89 Horváth (2010), p.179. See also Kemp (1989), pp. 149-166.

90 *jnpw tpj-ḏw.f* ('Anubis who is upon his hill'), *sbk nb rꜣ-sḥ.wj* ('Sobek lord of Ra-sehui') and the most important cult-temple for Senwosret II, the *ḥwt-nṯr n.t nsw.t-biti ḫꜥ-ḫpr-rꜥ mꜣꜥ-ḫrw* ('temple of the king of Upper and Lower Egypt, Khakheperra true of voice') (Horváth (2010), p. 183; Quirke (1997), p. 28).

91 Horváth (2015), pp. 125-144.

92 P. Berlin 10048+10319 and 10055 (Quirke (1997), p. 29).

recorded in a large number of administrative texts.[93] Many of them manifest personal or social disputes, and reveal a rigid system of rules operating in the community. The central context of the discussion at el-Lahun is the term *ḫnrt wr* ('great prison'), often mentioned in connection with the community of *Sekhem-Senwosret*.[94] For some scholars the translation of the term *ḫnrt* remains ambiguous, but this masculine noun may originate from the verb stem *ḫnr* ('to imprison', 'to restrain', and 'to confine').[95] Faulkner[96] related the term to the word *ḫnrj* ('criminal, prisoner'), implying an institution equivalent to a prison. Gardiner[97] also considered the meaning to be connected to the root *ḫn(r)j* to 'restrain'. The *Wörterbuch* defined the term *ḫnrt* as 'prison', 'fortress', or a kind of 'barrier'.[98] The translation and interpretation of this term was amply discussed by Hayes,[99] and more recently reviewed by Quirke.[100] Hayes saw a link between institutions such as the *ḫnrt* and concepts such as 'prison', or in the case of *ḫnrt wrt* (the 'great prison'). Roccati[101] followed this interpretation, finding that the *ḫnrt wrt* of Thebes denoted a '*campo di concentramento*' (a concentrations camp) that provided forced labor for a series of state projects. Quirke's work provided a very thorough survey and analysis of the relevant textual data, and he raised some objections against Hayes' interpretation, concluding that for these terms a softer rendition such as 'compound' or 'enclosure' would be more appropriate.[102] Despite the ambiguities of Egyptian terminology in the documents of the Old and Middle Kingdoms, and several alternative interpretations, in the majority of cases this term refers to *ḥsb.w* ('conscripted' or 'confined men/women' or similar). One of the best known examples of the use of the word is in a tale from the Westcar Papyrus. It describes an event that took place in the court of king Khufu[103] involving a *ḫnrt*, who is clearly considered to be a *ḫnrj* ('criminal' or 'confined man'):[104]

> *ḏd.jn ḥm.f jn jw mꜣꜥt pw pꜣ ḏd iw.k rḫ.tj ṯs tp ḥsḳ ḏd.jn Ḏdj tjw jw.j rḫ.kwj jtj ꜥnḫ wḏꜣ snb nb.j ḏd.jn ḥm.f jmj jn.tw n.j ḫnrj nty m ḫnr.t wd nkn.f*
>
> '…then his majesty (Khufu) said: is it the truth what they say that you know how to tie a severed head? And Djedi said: yes, I know how to, sovereign my lord, life-prosperity-health. Then his majesty said: let me be brought a criminal who is in prison and inflict the injuries on him'.[105]

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93 The discovery of a number of unpublished Lahun fragments led several authors to produce the followings works addressing the town's papyri: Collier and Quirke (2002; 2004; 2006); Quirke (2009). For the temple's archive in the Berlin Museum see Luft (1992; 2006); Luft, (1998), pp. 185-200; Quirke (1988), pp. 86-106. This work relies heavily upon these publications for extracts and later translations.

94 For the occurrence of this term (P. Brooklyn 35.1446, dating to the reign of Amenemhat III) see Hayes (1955), pp. 36-42. For a recent discussion on this term see also Eyre (2013), pp. 72-73. Two variants in spelling exist, due to the similarity in the hieratic sign M91 with M90 (Quirke (1988), pp. 83-84).

95 *Wb* III, pp. 295-296.

96 Faulkner (1962), p. 193.

97 Gardiner (1957), p. 519.

98 *Wb* III, p. 296.

99 Hayes (1955), pp. 16, 36-42, 49, 53-54 65-66. See also Eyre (2013), pp. 72-74, 196.

100 Quirke (1988), p. 86 and the bibliography cited there. More recently also reviewed in Eyre (2013), pp. 72-74.

101 '...*ḫnrt* designa il 'campo di concentramento' destinato a provvedere manodopera coatta per le varie imprese statali…' (Roccati (1982), pp. 16-19 and also Lorton (1977), p. 17). For the great prison of Thebes see Lacau (1984), p. 24 and Ilin-Tomich (2015), pp. 127-128.

102 Quirke (1988), pp. 95-96. For the completeness of possible reconstructions, it should also be mentioned that the term *ḫnrt* has been proposed also as 'the official institution of the ancient Egyptian royal harem'. For this hypothesis see Reiser-Haslauer (1972), briefly discussed also in Hayes (1955), p. 41. The terms is attested for example in several documents (see above Eyre (2013)).

103 Circa. 2589-2566 B.C.

104 For the P. Westcar, col. VIII, 15-6, dated to 16th or 17th Dynasty, but composed probably in the 12th Dynasty, see Blackman (1988); Lichtheim (1973), p. 216; Quirke (2004), p. 85.

105 In this account, the sage Djedi confirmed in front of king Khufu that he could reattach a severed head to a body. But when the king ordered him to apply his magical abilities on 'a captive taken from the *ḫnrt*', Djedi refused and ended up to demonstrating

Similarly, when describing the tragic events that took place during the First Intermediate Period, the *Admonitions of Ipuwer* recorded in the P. Leiden 334, refer to the widespread deterioration of the institutions. A significant episode concerns the escape of a number of individuals from a *ḫnrt*, who were found walking freely in the streets:

jw ms hpw nw ḫnrt djw r ḫnty šm.tw m ms ḥr.s m jwwyt

'…indeed, the laws of the *ḫnrt* are thrown out and men walk on them in public places'.

In another passage a similar situation of scandal is described as follows:

jw ms ḫnrt wrt m pr-ꜣ.f ḥwrw ḥr šmt jyt m ḥwwt wrwt

'…indeed, the great *ḫnrt* is a popular resort, and poor men come and go to the Great Mansions'.[106]

Here again textual evidence conveys the sense of undesirable freedom of movement of individuals outside what should have been a place of incarceration. This episode could only have happened if those individuals had previously been detained in the establishment. Clearly they had been released or had left their restricted condition during a period of political instability and uprisings, when social control was evidently more relaxed.[107] 'Similarly, texts from the end of the Middle Kingdom, and the New Kingdom *Duties of a Vizier* included a specific task associated with a  *šfd n ḫbnty* ('criminal register')[108] which indicates a list of individuals, certainly a group, who were kept in the *ḫnrt wrt* ('great prison'):

> 'Now as for every act of the vizier when hearing cases in his bureau. As regards anyone who is not efficient in every duty concerning which he (the vizier) questions him, namely the one who will be unable to exculpate himself in a hearing instituted on the matter, he shall be entered into the criminal register which is in the Great Prison. The same goes for the one who will be unable to exculpate his messenger, and if their wrongdoings will occur for the second time, then it shall be reported and passed on to the vizier that they are registered on the criminal register, with a statement of the case for which they were previously entered on the register in accordance with their offences'.[109]

These criminal registers were surely necessary for controlling such institutions, and they indicate the complexity of organizing them, particularly with respect to the number of people involved and the level of activity described. A state workforce could potentially have been concentrated in the *ḫnrwt*, the ghettos of the *njwt mꜣwt* ('new towns'). Those institutions may have served as the basis of the state's corvée labor workforce.[110] It seems likely that the main purpose of the *ḫnrwt* was to amass and control, on a considerable scale, a workforce of convicts, criminals and captives, either prisoners of war and/or natives. This restricted the social status of the convicts, while making them available as required for cult activities, private household work, quarrying, mining, and large-scale construction works. It is also possible that people could have been forcibly relocated from the countryside in order to construct and populate new forts and planned towns.

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his talent on a goose. The cruelty of this tyrant was also noted by the Greek historian Herodotus in *Historiae*, Book II, chapter 124-126.

106 P. Leiden 334, col. VI, 9-10. Ipuwer described the difficult situation around the towns of Egypt during the First Intermediate Period in detail (Lichtheim (1973), p. 150; Quirke (1988), p. 97, note 41).

107 P. Leiden 344, col. VI, 9-11 (commentary in Quirke (1988), pp. 94-95). See Gardiner for a slightly different translation: 'forsooth, the laws of the judgment hall are cast forth. Men walk upon them in the public places. Poor men break them up (?) in the streets' (Gardiner (1909), p. 49).

108 Hayes (1955), p. 40.

109 Quirke (1988), p. 98. See also Quirke (1986), p. 115 (in particular note 37) and Hayes (1955), p. 40.

110 Within the *ḫnrwt* each member was expected to execute some *ḥn.t* ('task') (see below).

During the Middle Kingdom, a large number of captives, Asiatic/Western Asiatic (Levantine) and Nubian, were taken by force to Egypt after successful campaigns as a result of the expansion of the Egyptian state over that time.[111] Many of these non-acculturated groups, especially those mentioned in papyri with the ethnic label *ꜥꜣm.w/ꜥꜣm.t* ('male/female Asiatic'),[112] were transported to Egypt, organized into gangs and sent to work in ghetto camps or on estates,[113] while others ended up in private ownership.[114] This movement of people must have had a significant effect on the Egyptian demographic, and in particular on the urban communities which were established during the Middle Kingdom.

Obliged to work: Anecdotes from the hieratic documents

It is still a challenge for Egyptologists to explain the huge volumes of construction work achieved in pharaonic Egypt, but it is probably safe to assume that the work could only have been achieved under some form of pressure, and that consequently, it depended on some levels of coercion and conscription. Collective 'religious enthusiasm', 'devotion to the sovereign', and 'social obligations' could have represented the less forceful motivations to work,[115] but the administrative documents attest to a legally codified system of slavery or servitude at el-Lahun. It should be noted that the concept of 'slave' is essentially derived from later Roman law, but there is evidence for the organization of labor into divisions or 'phyles' spanning all of Ancient Egyptian history. It was the system put in place to organize workers employed in quarries. Stone masons were typically designated as members of teams involved in construction works or in tomb preparations, and in a few instances also in military projects.[116] Similarly, people of foreign origin who lived in Egypt must have been obliged to adapt to the social and cultural systems of their host country and were probably subjected to restrictions on their freedom.[117] It is, however, not always clear from texts attesting to slavery in the late Middle Kingdom which mention the sale of labor, whether they are referring to the person or to his/her labor.[118]

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111 Larkman (2007), pp. 107-113.

112 The term is related to the occurrence of the Egyptian *ꜥꜣm* (sign T14), Gardiner, Grammar, 513, for 'boomerang' or 'throwing stick', the person using this weapon was a 'boomerang thrower'. The Egyptians labelled foreigners according to their weapons. Later on this sign was used as a determinative to mark barbarian people of any sort. The term *ꜥꜣmw*, attested from the 6th Dynasty onwards, seems to derive from the Semitic word alm, a Semitic stem used to indicate a 'slave' in Ugaritic, or a 'young man' in Hebrew. Probably used by Semitic people in Ancient Egypt to address each other within a homogeneous or socially related group, the Egyptians might have adopted this term from the population to which they refer. For a more recent discussion of the term see Luft (1993), p. 291.

113 The title *jrj-ḫꜣswt* ('responsible for supplying of the court with foreign products') is clearly associated with this task. Expeditions where Medjay and Aamu were captured as prisoners are amply documented (Posener (1957), pp. 145-163; Petrik (2011), pp. 211-226; Posener (1957), p. 159; Redford (2004); David (1986), p. 190). A discussion on foreign populations is in Schneider (1998; 2003; 2010).

114 Quirke (1991), pp. 141-149; Luft (1993), p. 292.

115 For the long-standing discussion on the production of monumental construction and the existence of slave labour in Ancient Egypt see Loprieno (2012). On the topic of possible connection of Egypt and the history of Israelites enslaved see Hoffmeier (1997), pp. 52-76.

116 Rosters and name lists for workers were used extensively in Ancient Egypt. Papyrus Reisner I, (reign of Senwosret I) is one of the most cited (Eyre (1987)). The phyle system in the Old Kingdom is discussed in Roth (1991). For the Middle Kingdom phyles see Kees (1948), pp. 71-90, 314-325; Kóthay (2007), pp. 138-150; Kóthay (2016), pp. 763-771. Stone worker gangs are widely attested at el-Lahun (Di Teodoro (2013), pp. 64-80).

117 That Egypt was a multicultural society is probably related to the fact that it is surrounded by one of the harshest environments of the planet. Egyptians saw the world consisting only of four races: Egyptians, Tjehenu, Meshwesh and Libu tribes (Booth (2005)).

118 Bakir (1952), p. 38. On a case of the sale of a slave-girl see Smither (1948), pp. 31-34; Eyre (1987), pp. 18-20; Lorton (1977), pp. 2-64. For the list of seventy-nine slaves appearing in P. Brooklyn 35.1446 (reign of Sekhemre' Sewadjtawi Sebekhotpe III, circa 1740 B.C.) the verso contains a list (partial) of slaves with statements of transaction of property.

At el-Lahun, the term ***mrjt*** ('dependent') is frequently used to refer to foreign captives brought to Egypt, primarily as property of the king, and assigned to temple workshops, granaries and to the fields. According to Bakir, ***n-ḏt*** refers to subjugated foreigners and people who contributed service to religious institutions. The population of el-Lahun, composed mainly of confined men and women, often of Syrian-Palestinian origins and scarcely motivated by religious devotion to the sovereign, were most likely subject to a certain amount of coercion.[119] Seclusion and beatings were probably common, and were most likely aimed toward subduing the foreigners.[120] There is evidence documenting this in the historical record, in literature and in iconography. The role of foreigners within Egyptian society, a society considered by some to have been liberal in some respects, was clearly one of total subjugation:

> *js ꜥ3m ḫsy ḳsn pw n bw ntf 3hw mw št3 m ḫt ꜥš3 w3wt jry ḳsn m-ꜥ ḏww n ḥms.f m st wꜥt stšw ꜥḳw rdwy.fy jw.f ḥr ꜥḥ3 ḏr rk Ḥr*
>
> '…the miserable Asiatic! He is wretched because of the place he is in, lacking of water, scarce in wood, many are its roads and painful because of mountains. He has not settled in one place. Food forces his legs forward, he has been fighting since the time of Horus'.[121]

Based on the evidence, the living conditions of these confined men and women must have been low due to poverty, cramped quarters and general overcrowding in the town.[122] While a controlled level of hostility and forced assimilation of social groups into the social system were essential in this setting, at el-Lahun there were all the components of a violent society in which social cohesion was achieved by the use of physical force.[123]

A high concentration of different ethnic groups in such a relatively small area must have produced social problems typical of small districts, rather than of larger urban contexts.[124] Maintaining social cohesion, perhaps in conjunction with the corvée system of manual labor, a type of tax system in the form of manual work, must have required a strict regime controlling behavior, attendance, and monitoring progress. From the institutional point of view, the intent seemed to have been to remove the personal cultural traditions of the rural individuals and force them to conform to the patterns of urban behavior required for state labor projects. It is likely, therefore, that the society was susceptible to class-based, racial, and ethnic disputes between different groups, and between those in charge and the subordinates. Although ideas and beliefs are only indirectly preserved in the archaeological record, it is possible to interpret the walls around the houses and the districts as instruments for regulating social stresses.[125] The architecture manifested social divisions and

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119 Kadish (1996), pp. 439-449.

120 Szpakowska (2008), pp. 150-151. Although we do not have information on skeletal remains from el-Lahun townspeople, individuals buried at Abydos in similar context and contemporaneously have shown fractures from intentional violence (fractures on the forearm are typical of a defensive posture). Forensic analysis indicates violence, and this is reported in Baker (2001), p. 47. Human remains reveal trauma caused by the accumulation of years of hard labour and repetitive motions, for example vertebra had depressions caused by lifting/carrying heavy loads, some joints in lower back and neck showed stress osteoarthritis, nutritional deficiencies, infections and tuberculosis (Baker (2001), pp. 42-49). Diseases such as tuberculosis are typical for people living in settlements with a high population density and in close proximity to animals harbouring diseases or parasites. Common in the Old Kingdom are scenes of workers being beaten, sometimes with sticks that are shaped to look like a man's hand, often while tied to a post (Beaux (1991), pp. 33-53; Muhlestein (2015)).

121 For the Instruction addressed to King Merikare see Lichtheim (1973), pp. 103-104.

122 Quantifying overcrowding is a difficult tasks. Generally, experts define overcrowding as the presence of an exaggerated number of people within the available space, but of course, the theories and definitions vary in different contexts and countries and depend on sociocultural, economic, and geographical dynamics (Clauson-Kaas *et al.* (1996), pp. 349-363).

123 Vila (1973), p. 159. For example, this is clear from the historical background of the period in the Instruction for King Merikare, which record events which took place during the First Intermediate Period during the reign of king Achotoes III (c. 2130-2140 B.C.) (Lichtheim (1973), pp. 103-104; Quack (1992)).

124 On this topic see also Walmsley (1988).

125 Rowlands (1972), p. 448.

distinctions as a form of 'institutionalized racism'.

From the 4th Dynasty onwards, the pharaohs obtained the necessary workforce of *ḥmw/ḥmwt* ('male/female slave') from Asia and Nubia. Often the foreigners were brought to Egypt via trade or as prisoners of war, and were assigned to local temples or to prominent officials.[126] It appears that inside *ḫnrwt*-quarters, every captive was forced as an individual to execute the required *hꜣw* ('manual labor') as demanded by the institutions, or find a *jwꜣw/jwꜣyt* ('male/female substitute').[127]

A document of the time of Amenemhat III (c. 1844-1797 B.C.) recovered in a similar urban context seems to depict the control of food supplies and relief from 'deprivation' and 'starvation' as another aspect of the labor system during the Middle Kingdom Egypt. Individuals from the desert seeking refuge in Egyptian towns and volunteering to work are attested in several places.[128] The papyri P. BM10752 contains on its *recto* a military dispatch from Elephantine, one of the so-called 'Semna dispatches', a series of reports on Egyptian border activities from the fortress of Semna West:

> 'Copy of a document which was brought to him as something brought from the fortress of Elephantine as something sent by a fortress to another fortress. For the gladdening of your heart, may you be healthy and living. To the effect two Medjay-men three Medjay-women and two infants came down from the desert hills in year 3 third month of the winter season day 27(?). They said, we have come to serve the Palace (i.e. the Pharaoh) life-prosperity-health. It was asked about the condition of the desert. They said we did not hear anything, except that the desert population is starving to death so they said. Then the servant there caused them to be dismissed to their desert on this day'.[129]

Based on sources such as the one above, it is reasonable to think that many individuals were forced to live in state-planned towns because they had little choice over their lifestyle.

Although largely conjectural, scholars have estimated that the population of el-Lahun was up to 9000 individuals.[130] This is based on the capacity of the granaries,[131] and taking into account Butzer's hypothesis of a total Egyptian population of 1.1 million during the Middle Kingdom.[132] Estimates of the town's population vary considerably based on estimates of housing density, the possibility

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126 Bakir (1952), pp. 30-32. Military activity in Nubia is attested throughout the Middle Kingdom (Altenmüller (1991), pp. 1-48; Marcus (2007), pp. 137-90). The Amenemhat inscription mentions that one of the aims is the capture of a workforce for the king's pyramid city (see also Yeivin (1967), pp. 119-128).

127 Quirke (1988), p. 90.

128 Famine in Ancient Egypt is amply documented. Although perhaps biased by its use as an ideological motif, the scene from the causeway of the pyramid of Unas depicting emaciated Bedouins is an example. Famine in Antiquity is attested in the book of Genesis (12:10): '...now there was famine in the land. So Abraham went down to Egypt to sojourn there for the famine was severe in the land (Canaan)...'. See also Vandier (1936).

129 P. BM10752, P. Ramesseum C, recovered from a tomb of a magician of the 13th Dynasty who reused its verso. Despatch no. 5 (page 4, lines 6-12) was issued during year 3 of the reign of Amenemhat III (c.1840 B.C.) (see Smither (1945), pp. 3-10; Spanel (1984), pp. 844-847. Wente and Meltzer (1990), no. 82; also discussed in Quirke (1990), pp. 187-188, 191-193; more recently also see Porten (2011); Vogel (2004), pp. 82-83). For an overview of the identity of *mḏꜣw* Medjay people see Liszka (2011), pp. 149-171. Egyptians seem to have thought of the Medjay as a foreign ethnic group (Negroid) of a non-specific location in the region of the Eastern Desert around the First and Second Cataracts.

130 According to Naroll, a rough estimation of settlement population is in the order of one-tenth of the floor area in square meters occupied by its roofed dwellings (Naroll (1962), pp. 578-589). For the debate see also Helck (1957), pp. 9-11; Stadelmann (1981), pp. 67-77; Stadelmann (1984), pp. 10-14.

131 A vast majority of the population was dependent on the larger houses for their rations. Kemp has suggested that much of the population, especially in the western town, was dependent upon the mansions for their rations. Kemp estimates that the granaries in the five large houses could have held enough grain to support a population of 5,000 people, or 9,000 people on minimum rations. Whatever the total population figure, the el-Lahun granaries could have sustained the entire town. It should be noted that this figure is based upon the granaries from 8 of the possible 10 large houses; so it is possible that even more people could have been fed by the granaries (6,000 to 11,000 people) (Kemp (1989), pp. 153-155; Kemp (1987), pp. 133-134; Badawy (1967)).

132 The hypothesis of a population of 1.1 million during the Middle Kingdom in Egypt was advanced by Butzer (1976), pp. 82-84. For an overview of demography in Ancient Egypt see Kraus (2004).

that the dwellings had an upper story, and estimates of the storage capacity of the granaries in large houses, pushing the upper limit up to as many as 11,000 inhabitants.[133] A consistent number of documents mention Asiatics who were permanent residents in the town. Generic ethnonyms such as *ꜥꜣm.w/ꜥꜣm.t* ('male/female Asiatic') or *nḥsy* ('Nubian'), were used by the ancient Egyptians to refer to both foreigners living outside of Egypt, and 'adapted members' living in the Egyptian social system, i.e. assimilated members of Egyptian society.[134] The terms remained vague and did not differentiate individuals according to their precise origins, as these were rarely of importance to the Egyptians. Nevertheless, residents came from numerous areas comprising the Levant, Syria, and Mesopotamia. As discussed above, it appears that the individuals also included Egyptians who, due to famine, debt and the like gave up their legal freedoms voluntarily. They were usually referred to as *bꜣk.w* ('servants') but generally not as *ḥm.w* ('slaves'). The generic word for *ꜥꜣm.w* ('male Asiatic'), became synonymous with 'slave' to indicate those condemned to live on the fringes of Egyptian society, in awful conditions, occupied in heavy labor in the mines and in the quarries of the eastern desert. The term *ẖsy* ('miserable', 'wretched' or 'vile') is often associated with it.[135] Lorton noted that in the context of the *Instruction for King Merikare* this emphasizes the misery of their daily life and their hopeless situation.[136]

Members of workforces engaged in heavy labor, especially during the unbearably hot months of the summer, would have had little or no autonomy. Furthermore, if they were held in isolated town-communities with all of their relatives, they would have had little reason to escape. The individual's relationship with the state was one governed by an ideology centered on the king and the subjugation of non-Egyptians. The longevity of the state[137] depended on this ideology. It drove the workforce to feel obliged to perform corvée on major royal projects, such as pyramid building, and to work effectively within a disciplined but effective construction system. The majority of the time spent awake for most Egyptians seems to have been devoted to work, or, in the case of the bureaucrats and/or officials, to the organization and inspection of work.[138]

The west suburb of el-Lahun also accommodated the priests and the personnel associated with the temples in the town and the royal mortuary cult of the pharaoh.[139] Temple personnel included doorkeepers, musicians and dancers, mostly women, as well as ritual celebrants.[140] Inhabitants of el-Lahun were perhaps sorted into different suburbs or zones according to their socio-economic status, their ethnic affiliation, their seniority by age, religious beliefs, family and clan structures, trades or craft specializations. This type of arrangement may have been imposed via official zoning

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133 Petrie's floor plan covers only about half of the homes enclosed. The possibility of a living spaces on rooftop of small dwellings needs to be considered, based on several flight of stairs documented in situ.

134 Asiatics are mentioned in the temple's archive in the following documents: P.Berlin10002; 10004/1 and 10004/2; 10021; 10033; 10034; 10046; 10047; 10050; 10055; 10071; 10081C; 10082; 10104; 10127b,c,d,+10129a; 10287. In UCL London, the followings town's papyri: P.UC32058; 32098; 32101; 32124; 32127; 32130; 32143E; 32147G; 32151B; 32167; 32168+269; 32191; 32201; 32286; 32294; 32295.

135 The *Prophecy of Neferti*, composed during the early part of Amenemhat I describes the troubles that plagued Egypt '...with Asiatics roaming in their strength, frightening those about to harvest and seizing cattle from the plough...the chaos of the land, and all happiness has vanished. The land is bowed down in distress, owing to those feeders, Asiatics who roam the land. Foes have arisen in the East; Asiatics have come down to Egypt...' (Lichtheim (1973), p. 141).

136 Lorton (1973), pp. 65-70. Herodotus (*Histories*, II, in De Selincourt (1954), pp. 102-3, 106-108) mentions the king Senwosret capturing a series of prisoners who were brought to Egypt to work on building projects. See also Posener (1957), p. 161.

137 Leahy (2000), pp. 225-234.

138 Another important question is how far élite and non-élite shared the same ideology. The complexity of this reality has been discussed in Baines (1990), pp. 1-23.

139 Quirke (1990), p. 178; O'Connor (1997), p. 389; Doyen (2010), p. 81; Bietak (1979), p. 115.

140 As mentioned in the case of P. UC32147G in Collier and Quirke (2006), p. 259: '...Deliveries of temple of Sobek Lord of Djedu [...] of Sobek Lord of Geregbaf [...] of Sobek Lord of Resehwy [...]...Asiatic women 12(?)'.

regulations. El-Lahun, Abydos and also Thebes are good examples of late Middle Kingdom royal establishments containing this type of prison-like camp within their boundaries.

The *ḫnrt* in el-Lahun is mentioned in several daily reports which attest to the careful management of camp populations, in this case the relocation of an individual by force in the great *ḫnrt* of el-Lahun:

> 'I speak so that I let you know regarding having him in the great enclosure camp…saying…'.[141]

In another case an Asiatic called Jarw is to be transferred from the special Asiatic camp together with his son and other individuals.[142] Registers and letters[143] mentioning the *nḥsyw/nḥsyw.t* (Nubians) and *mḏꜣyw/mḏꜣyw.t* (Medjay) include their occupations and titles. The textual records agree with the archaeological record in indicating that foreign slave workers were almost as numerous as the native Egyptians.[144] Several individuals were grouped together and labelled as *hb.w* ('dancers') and *hs.w* ('singers'), designations that should be regarded as their title and profession, while others were designated as *mḏꜣyw* guards.[145]

Some Aamu and Medjay men mentioned[146] refer to more privileged foreigners among the temple workforce, using Egyptian names for the most part, and in some cases outnumbering the Egyptians.[147] Some names had Egyptian aspects but were Asiatic in origins[148] and it appears that Asiatics who had another title were no longer obliged to use the term aAm before their name.[149] Undoubtedly, after extended contact with the Egyptians, Asiatics and Nubians became settlers, and so a steady influx of new imported workers could have been necessary for the state to maintain the working population of towns and estates.[150] Despite assimilation in some respects, the settled immigrants retained a lower status than native Egyptians.

Immigrants were required to leave behind their own countries and cultures, which were regarded as disgraceful and hostile, and adapt to the Egyptian ethic of servitude to the reigning king. They would eventually no longer be referred to as *ḫꜣs.tyw* ('foreigners'), an adjective reserved for people living in lands outside of Egypt.[151]

Immigrant people who lived and worked in *Hetep-Senwosret* and *Sekhem-Senwosret* and the surrounding area were subordinate to several officials such as the *jmy-r ḫnrw* ('overseer of prisoners'),[152] the *jmy-r ḫnrt* ('overseer of a prison')[153] or the *jmy-r ḫnrt n r-ꜥꜣ-wr* ('overseer of the prison of the Great Doorway').[154] Their lives were under the scrutiny of the *sš n ḫnrt wrt* ('scribe-secretary

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141 P. UC32109E, Collier and Quirke (2002), pp. 20-21.
142 P. Berlin 10021 in Luft (1993), p. 296; Scharff (1924), pp. 45-47.
143 See Collier and Quirke (2006), p. 4-5, fig. 1 and Collier (2009), pp. 205-259.
144 Quirke (1988), p. 90.
145 Luft (1993), p. 296.
146 The term *mḏꜣy/mḏꜣy.t* ('Medjay') appears for instance in P. Berlin10160+10162, P. Cairo JdE 71580, P. UC32143A, 32191, 32143A and 32191. In few cases they record the names of musicians and dancers (attendance sheet) and the day they served in festivals (Liszka (2011), pp. 149-171). See also Collier and Quirke (2006), pp. 92-93.
147 Luft (1993), p. 293. Asiatic names were rendered by the Egyptians in their hieroglyphic script, which are not always easy to read, especially when the consonants differ from the Egyptian ones.
148 It is highly probable that this could have played some role in the process of assimilation by giving Egyptian names to foreign children and adults, perhaps because of the difficulty that Egyptians found in pronouncing the foreign names (David (1986), p. 190).
149 Luft (1993), p. 292.
150 Trigger (1972), pp. 581-582.
151 Schneider (2010), pp. 143-163.
152 Ward (1982), p. 40, no. 298.
153 Ward (1982), p. 40, no. 302.
154 Ward (1982), p. 40, no. 303.

of the great enclosure')[155] who controlled their movement within the special camp, and the *sꜣ ḫnrt* ('prison guard').

A significant number of families lived permanently in the vicinity of the main administrative block.[156] Every member of those low status families[157] was expected to contribute labor. They were represented by the head of the household who was responsible for the group and when communicating with officials. Those called up to work could be, and were often, replaced by other family members or other substitutes,[158] sometimes for brief periods on tasks such as temple duties. There are even examples of replacements working for a month at a time.[159]

In one such typical situation a man declares that:

> *jwꜣ.kwj ḥr sꜣ.j kꜣwty n ḥw.t-nṯr jm r ḏd jw.f m nhw n hꜣw*
>
> 'I was seized on account of my son the workman of the temple there (by my district officers who said) that he is in deficit for state-labor'.[160]

The administration registered individuals that belonging to households and enrolled them in the monthly staff allocated to temples or work groups.[161] Massive construction projects and state planned work in stone quarries seem to have been particularly in need of *ḥsbw* ('the counted', 'enlistees' and 'conscripted workers'). Low status workers like the 'stone-pullers of *Hetep-Senwosret*' and 'men of *Sekhem-Senwosret*' are mentioned in temple archives.[162]

Egyptians *rmṯ*[163] often appear in Middle Kingdom documents in parallel with terms such as *tšj.w* ('defectors'), *mry.t* ('employed'), *bꜣk.w* ('workers'), *sḳr.w-ꜥnḫ* ('bound for life'), usually foreign prisoners of war or *nfr.w* ('low status young')[164] often recruited for heavy work in quarry expeditions. The evidence from the papyri indicates that sooner or later everyone at el-Lahun had to respond to roll-calls from the authorities, although it seems that protesting against work was not rare, especially among people involved in the more arduous labor in the stone quarries and building sites.[165] A fragment of a papyrus[166] indicates that such protest could be substantial: *m…n…m wṯs ḫrw* ('…in…not…in raising rebellion').

The local administration kept an up-to-date list of all the residents in a series of name lists[167] with

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155 Ward (1982), p. 163, no. 1412; David (1986), pp. 190-191; Lacau (1984). Among the el-Lahun accounts, labour control is one of the duties of the *jmy-r pr ḥsb rmṯ* ('accountant of people'), as well as the *ḫꜣ n dd rmṯ* ('bureau for issue of people') (Collier and Quirke (2006), p. 4; see also Petrik (2011), p. 214 and Ilin-Tomich (2015), pp. 127-153).

156 Luft (1992), p. 296.

157 Larkman (2007), pp. 107-113.

158 P. Berlin10023 Ar(1)-(2) in Luft (1998a), p. 7, note 50; P. Berlin10081B in Luft (1992), pp. 103-104, 162; P. Berlin10081 in Luft (1992), pp. 101-102, 161; P. Berlin10020rt unpublished. A 'roll-call', where a substitute has been called to attend is common as in P. UC32174 and P. UC32168+32269.

159 P. Berlin10065A and P. Berlin10104 (Quirke (1991), pp. 144-145).

160 P. Berlin10023A (Horváth (2010), p. 173; Wente (1990), p. 74; Luft (1992), no. 10023; Quirke (1990), p. 163). To these titles *hꜣw* and *iwꜣw* seem to be associated a sense of constraint and obligation within the setting of *Sekhem-Senwosret*.

161 For example as can be found in a list of an unspecified numbers of male temple attendants in *Sekhem-Senwosret*, as well as in several others texts where the Asiatics were documented as dancers in P. Berlin10046.9 (David (1986), p. 190; Luft (1993), p. 93).

162 Loprieno (1996), pp. 197-233. Hauling stone mentioned in P. UC32201 (Collier and Quirke, Letters, (2002), p. 107).

163 P. Berlin10104 in Quirke (1991), pp. 144-145.

164 Loprieno (1996), pp. 197-233.

165 P. Berlin10023A, 12th Dynasty, reign of Amenemhat III, in Wente and Meltzer (1990), p. 74, no. 88; Luft (1992), pp. 103-104, and 162.

166 P. UC32107E+H perhaps a literary composition?

167 P. UC32174 and P. UC32352 and P. UC32168+32269.

headings *jmy-rn.f ḥsbw jtḥw-jnrw* ('name-list of conscripts stone haulers') or simply *jmy-rn.f mnyw* ('name-list of conscripts'). Several documents,[168] not surprisingly, suggest that several individuals were able to vanish in the middle of the crowded suburb.

An *ꜥ3m* worker called *Sn-wsr.t* is included in a dispatch reporting five individuals '…who did not come to work...'.[169]

Punishment, however, could be harsh. The *Nauri Decree*[170], a much later text of the 19th Dynasty, records the 'discipline' of the government included the '…beating with two hundred blows' together with exacting the work *b3k.w* of the person belonging to the foundation from him, for every day that he shall spend with him, and give them to the foundation…while also …punishment shall be done to him by cutting off his nose and his ears he being put as a cultivator in the foundation…and as previous plus…and putting his wife and his children as serfs(?) of the steward of his estate…'.

The written evidence consistently records cases of fugitives from the *ḫnrt*. A list of corvée-fugitives of the reign of Amenemhat III[171] includes a report on absences from duties. A certain man called *Sn-wsr.t*, who apparently had been hiding in *Sekhem-Senwosret*, came to be the concern of a certain steward *Hrw-ms3.f*:

> 'this is a communication about the man of *Tp-jhw Nmtj-nhtw*'s son *Snwsrt* saying he is guardian in *sḫm Snwsrt mꜣꜥ-hrw* there are no duties of his since many years… behold he is the son of the retainer Jmnj the son of Jjkj'.[172]

In a dispatch a servant called *Ḥm-nsw.t* is caught before an attempts to run away:

> *swḏ3-jb pw n nb ꜥnḫ wḏ3 snb ḥr rdjt djt.tw jb ḫnt p3y.k Hm-nsw W3ḏ-h3w m rdjt sšw.f nn rdjt bt3.f mj bw nb nfr jrrw nb ꜥnḫ wḏ snb*
>
> '…this is a communication to the lord life, health and prosperity, about having attention given to your servant *Wꜥdj-hꜥw*, in assigning his documentation without allowing him to evade, in accordance with everything suiting which the lord, life-prosperity-health, can do if he pleases'.[173]

Another example concerning fugitives is even more illuminating:

> '…as for any persons whom you may find missing among them, you are to write to the steward Horemsaf about them…I your humble servant, have sent a list of missing persons in writing to the pyramid town *ḥtp snwsr.t mꜣꜥ-ḫr.w* satisfied is Senwosret true of voice'.[174]

A letter found on a fragmented sheet of papyrus describes the fate of someone who tried to escape from the *ḫnrt*:[175]

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168 Luft (1993), p. 24.

169 Luft (1993), p. 296.

170 For the Inscription on the cliff of Nauri, a stele carved on the face of the hill at c. 35 km north of the Third Cataract, in the time of king Seti I (c. 1300 B.C.), see Edgerton (1947).

171 P. Brooklyn35.14446 (Quirke (1991), p. 146).

172 P. Berlin10065b, a 'register' for the inhabitants (Collier (2009), p. 208).

173 P. UC32210, Lot VIII.1 in Griffith (1898), p. I, 79, II, pl. XXXV; Collier and Quirke (2002), p. 133. This situation is also dealt with in the P. Brooklyn 35.1446 (year 36 of Amenemhat III): *3w(.)n ḫnr.t wr m* (date) *r wh hr.f m d3d3t m 3wy r jrt hp r.f n wꜥrw ḫnrt*, 'It was issued to the *ḫnr.t wr* (or the *ḫnr.t wr* issued) on (date) to release his dependents from the board being(?) (the document) issued to execute the regulation against him for one who flees the *ḫnr.t*' (Quirke (1988), p. 90, note 22; Hayes (1955) pl. 1-7, pp. 19-66).

174 P. Berlin10073, 19th year, under Amenemhat III (Wente and Meltzer (1990), p. 76, no. 91, Luft (1992), no. 10073).

175 P. UC32209 (f)+(b) (see Collier and Quirke (2002), pp. 128-129, lines 1 and 6; Wente and Meltzer (1990), p. 83, no. 102; Petrie (1891), pp. 1-2, pls. 34, no.12.1; Griffith (1898), pl. 34, lines 17-20). 'Egyptian law courts' are known with the term *ḏ3ḏ3t*

mt wj ꜣbꜣb.kw gm.n.j ḥm-nsw Sbk-m-ḥb mt wnn.f wꜥr mt rdj.n.j sw n ḫnr.t n sḏm mt grt pw m-ꜥ.t kꜣ dj.t mwt.f m ḫꜣ n wḥmw jmj spr.tw r.f m tꜣ ꜣt

'…look I am delighted! I have found the king's servant Sobekemheb. Look he had indeed fled. Look, I have handed him over to the prison for judgment. Look, moreover this means it is in your hands, so you seem to be letting him die/languish (?) in the office of the reporter. Have someone to go to him right away!'.[176]

Each worker's presence and absence were clearly noted and addressed, thus making it possible for administrators to monitor work attendance across time and space. Fleeing from work on state projects was classified as a criminal offence against the state and punished severely, possibly including capital punishment.[177]

Another piece of correspondence, in this case between the pharaoh and the temple scribe *Hrw-msꜣ.f*, refers to an individual taken by force: '…you should know that the door-keeper of the temple *Snt*'s son *Jmnj* appealed to me saying, I was deprived of my son …'.[178]

A papyrus recovered from Thebes, now in Brooklyn, contains a list of 76 residents of Upper Egypt who were held in the 'great prison of Thebes' '…because they avoided performing the compulsory services required by state administrators…'. This list comprises Egyptians of humble origins, amongst whom were 'those not certain who their fathers were'.[179] The same papyrus includes instructions to the 'Great Prison' to deal with these individuals in accordance with the relevant sections of the criminal law. A section records the sentences given and the conclusion of nearly all the cases, such as the following:[180]

'…the daughter of Sianhur Teti the scribe of the *Fields of This* a woman an order was issued to the Great Prison in regnal year 31, month 3 of Shomu, day 9 to release her people in the law-court being an order issued in order to execute against her the law pertaining to one who runs away without performing his service here (check mark) statement by the scribe of the vizier, Deduamun it is completed, case closed'.[181]

The papyri also indicate that many individuals who lived in *Sekhem-Senwosret*[182] belonged to some-

during the Old and Middle Kingdoms, and Qnbt from the Middle Kingdom until the beginning of the Late Period. Translated often with the term 'council', 'committee' they dealt with ordinary cases which were punished with beatings, and crimes entailing heavier punishments such as mutilations or death penalty. The 'action of the judges' was referred as *wḏꜥ* or *wḏꜥ-mdw* the last as a noun can also designate 'judge' and 'judgment' thus it appears related to the existence of a *ḫnrt n sḏm* ('judgement enclosure'). For example the stele of Simontu of year 3 of Amenemhat II (BM828) describes his career as *sš n ḫnrt n sḏm* ('scribe of the enclosure of hearing') (Quirke (1988), pp. 100-101; Lippert (2012)).

176 Although difficult to demonstrate, this could be a case of 'forced' suicide. Egyptian attitude to criminal punishment is still poorly understood but evidence from dynastic Egypt is quite convincing, such as in the Turin Judicial Papyrus: *jw.w wꜣḥ.f ḥr st.f jw.f mt n.f ḏs.f*, '...they left him in his place and he killed himself...' (Loktionov (2015), p. 107). For an overall picture of law and legal practice in Ancient Egypt see Mota (2010), pp. 6-26.

177 P. UC32126 (Collier and Quirke (2002), p. 63; Collier (2009), p. 214). The town of *Ges-iab* ('the left side') is an undefined settlement in the vicinity in existence since the time of Senwosret I (Quirke (1997), p. 26).

178 P. Berlin 10023Ar (1)-(2), year 11th, reign of Amenemhat III, from the temple archive (Sharff (1924), pp. 27-30; Quirke (1988), p. 89, note 18; Luft (1998a), p. 7, note 50; Luft (1992), P. Berlin10023). In P. Berlin10021 a collection of people from the *ḫnrt* at the mouth of the Fayum is attested, and in few cases a *jwꜣw*, i.e. a person taken by the state to replace someone listed for work (Quirke (1988), p. 88, note 17; Scharff (1924), pp. 45-47).

179 P. Brooklyn 35.1466. For the list of fugitives see Hayes (1955), p. 25, (lines 1-24, 25-54, 55-80). Its verso contains a long list of slaves from the first and second regnal years of Sekhemre-Sewadjtawi Sebekhotep III (c. 1749-1742 B.C.), with 95 slave names, 37 of whom are labelled as Semitic with names preceded by the Egyptian *ꜥꜣmw* ('male Asiatic') or *ꜥꜣmwt* ('female Asiatic'). They are always followed in a second column by an Egyptian name. See also Albright (1954), pp. 222-233.

180 Hayes (1955), p. 64.

181 Ezzamel (2004), p. 515. Field of This still remains an unknown locality.

182 P. Berlin 10004. See also P. UC32168+32269. A small fragment has a headline: '...conscript of the *ꜥꜣmw* who are in

body. This is demonstrated by the name of a person or the name of an institution written behind the name of the enrolled individual.[183] A document of year 29 of the reign of Amenemhet III deals with the sale of slaves. It is a *swn.t* ('deed of cession') for a female Asiatic made for an official called Ihysoneb. The text reads:

> '…regnal year 29, month 3, inundation, autumn, day 7 drawn up in the office of the vizier … a cession deed of the assistant to the treasurer Shepset's son Ihysoneb of the northern sector…the female Asiatics Akhiatef Kemeteni, Keme[t]eni Sopduemmeru, Mashy 2 years and 3 months […]am Benwy(?)'.[184]

Foreign manual workers were in demand as workforce all over Egypt in the second half of the 12th Dynasty in Egypt. Bietak's excavations[185] at Tell el-Dab'a uncovered a special Aamu quarter that was still in use during the Second Intermediate Period, but there is evidence of Egyptian intolerance towards the easterners as can be found in the letter of the official Senwosret's son Khakheperre Sonbe to the steward Horemsaef in the year 37 of Amenemes III. An 'overseer of the sealers' called *Snbtj.fj* addressed his concerns towards the nomarch saying: '…from the overseer of treasurers and judges *Snbtj.fj*…saying, send 30 corvée-workers to follow the lord-life-prosperity, do not send these Asiatics!'.[186] Another document referring to the delivery of poultry is particularly revealing when it mentions two Asiatic men *ꜥꜣm.w* among the delivery goods.[187] According to the documents from the archive, the Asiatic and Nubian population slowly increased, in particular during the second half of the reign of Ammenhat III.[188] Fragments recovered from the *ḫnrt wrt* ('great prison') of Thebes[189] give detailed glimpses of life in these burgeoning communities:

> *ꜣw n ḫnrt wrt m* (date?) *r wḥꜥ ḫr.w.f m ḏꜣḏꜣt m ꜣwy r jrt hp r.f n wꜥrw ḫnrt*
>
> 'It was issued to the *ḫnrt wrt* (or the *ḫnrt wrt* issued) on (date?) to release his dependents from the board, being the document issued to execute the regulation against him for one who flees the *ḫnrt*'.

Less serious infringements recorded include a petty theft:

> *jr pꜣ bjt hnw 1 rdy n bꜣk-jm gm.n bꜣk-jm sw(r)j.n sw pꜣ ꜥꜣm ḏd.f smj n bꜣk-jm m-ḏd mk jn bnrt rdj jry.j st*
>
> '…as for the hin of honey (already) assigned to the servant-there, the servant-there has discovered that the Asiatic has drunk/used it up, saying quote: look, it was the sweetness which made me do it…'.[190]

A final unfortunate individual exclaims dramatically *mwt.kwj mjn jḫ tm.j mꜣꜣ ḫpr.tj.sj*, 'I am dead today, rather than see what may happen…'.

Conclusion

Studies of the earliest urban settlements in the Nile Valley often neglect the social organization and built environments of the 'poor'. Studies of ancient settlements, including at el-Lahun, have had

Sekhem-Senwosret'. The rest of the line is lost (Luft (1993), p. 297).

183 Luft (1993), p. 296; P. Berlin10021 and 10047.

184 P. UC32167 (Collier (2009), p. 210).

185 Bietak (1991; 2001).

186 P. Berlin10111 Aa r II (2)-(5), originally P. Berlin10228e+10323a+10111Aa rt II (3)-(5) (Luft (1993), p. 297).

187 In a series of documents from year 1 to year 19 of the reign of Amenemhat III (Luft (1993), p. 297).

188 P. Berlin10050, year 6 of Senwosret III. P. Berlin10050r I (Borchardt (1899), pp. 98-99).

189 Hayes (1955), p. 64, discussed also in Ezzamel (2004), pp. 514-515.

190 P. UC32124 (Collier and Quirke (2002), p. 59). This rather curious episode is significant in showing that at el-Lahun there was evidently marked variation in diet and food consumption among the inhabitants.

a tendency to focus on the minority of 'élite' people and their living conditions. They use the traditional top-down approach to the subject, overlooking the people of lower status and their social and living conditions. This article and the associated study were intended to advance the discussion by addressing the daily lives of the majority of the population in these highly-structured communities.

For the western community of el-Lahun, the textual and architectural data demonstrate a built environment reflecting strong social boundaries; a community regulated by way of impressively regimented settlement forms. Moving from a spatial scale of individual building to the urban settlement as a whole, the architectural aspects discussed appear to be particular relevant for social interpretations. Information about the lives of the inhabitants of el-Lahun is scarce, and so the architecture is a valuable resource, but analysis at the single household level is not easy because of the difficulties in understanding architectural variations in structures with no clear-cut functional distinction between rooms. The structuring of space within households and the degree of internal and individual variations between living spaces was undoubtedly of cultural and functional significance to the inhabitants, but a full understanding of this, based on the archaeology alone seems irremediably lost. In addition, the daily lives of those living in that environment were surely different to those of the officials who designed and constructed it.

Nevertheless, general cultural patterns can be inferred from investigations of the structural remains. The intended organization of daily life, the physical limits on movement and social interaction, were rooted in social rules, rituals and relations of power intended to control the community and subject it to centralized coordination. It seems that the city enclosure walls, often thought to be erected for defensive purposes, were largely symbolic. They were primary intended to dwarf the individuals with their monumental dimensions and to segregate the low status workers from the ruling group, into what were essentially prison-like conditions. Nevertheless, or perhaps as a result of those efforts to control the population, the textual evidence shows that el-Lahun experienced more social turmoil than equivalently sized traditional rural villages. In such an overcrowded environment, social discrimination and injustices caused by ethnic differences and inequality often led to disputes and conflicts.

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An elegant vault design principle identified in Old and New Kingdom architecture

David Ian Lightbody & Franck Monnier

Excavations[1] in Egypt have occasionally brought to light markings and inscriptions relating to the 'intrados' (the lower or inner curve of an arch or vault). Although poorly preserved, these few surviving texts have preserved valuable information regarding the preparation and construction of certain types of vaults (fig. 1).

Researchers have tended to approach the analysis of these fragments by linking the forms traced on them to precise geometric constructions, without first establishing the legitimacy of such an approach. Elliptical arches are often referenced, without first demonstrating that the ancient Egyptians were able to generate such complex forms. Even if they were not aware of abstract concepts such as ellipses and catenary arcs, the ancient Egyptians may nevertheless have been able to apply them using rudimentary processes intended to produce shapes with the approximate form of an oval, or with the inherent strength of a catenary arch. There are a number of different plausible scenarios, but certain hypotheses, without ever having been proven, seem to have acquired the status of established fact.

Studies of the design of mudbrick barrel vaults and inclined-layer Nubian arches have lead researchers to investigate how the forms of vaults were first calculated and how their profiles were traced out, either using geometric rules or empirical, practical processes. In one of the earliest publications dealing exclusively with questions of construction in ancient Egypt, Auguste Choisy proposed a simple design method which could have been used for making Nubian vaults.[2] The profiles of Nubian vaults resemble the raised handles of baskets, and he proposed a method of defining a circular arc which can be used to create this type of vault. He called this the Egyptian basket-handle type,[3] a name subsequently adopted by others.[4]

El-Naggar subsequently noted that while vault forms can often be shown to be close to certain theoretical vault types, as Choisy had done in this case, they can only rarely be shown to be precisely comparable.[5] This disconnect between theoretical models and surviving vaults does not, of course, mean that no precise rules were used for their construction, and herein lies the difficulty of determining what geometric rules and methods were employed by the ancient Egyptians.

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1 The authors would like to thank Andrew Conner for sharing his research into the Saqqara ostracon. An archived version of his website, which was devoted to the Saqqara ostracon and his analysis, is currently available at the time of writing at: http://web.archive.org/web/20070708153336/http://goldenlot.us/ADC/ostrakon.htm [date accessed: 15 June 2017]. We gratefully acknowledge Alain Guilleux for providing the photos for the article.

2 Choisy (1904), pp. 46-48.

3 Choisy (1904), p. 46.

4 El-Naggar (1999), p. 363.

5 El-Naggar (1999), p. 363.

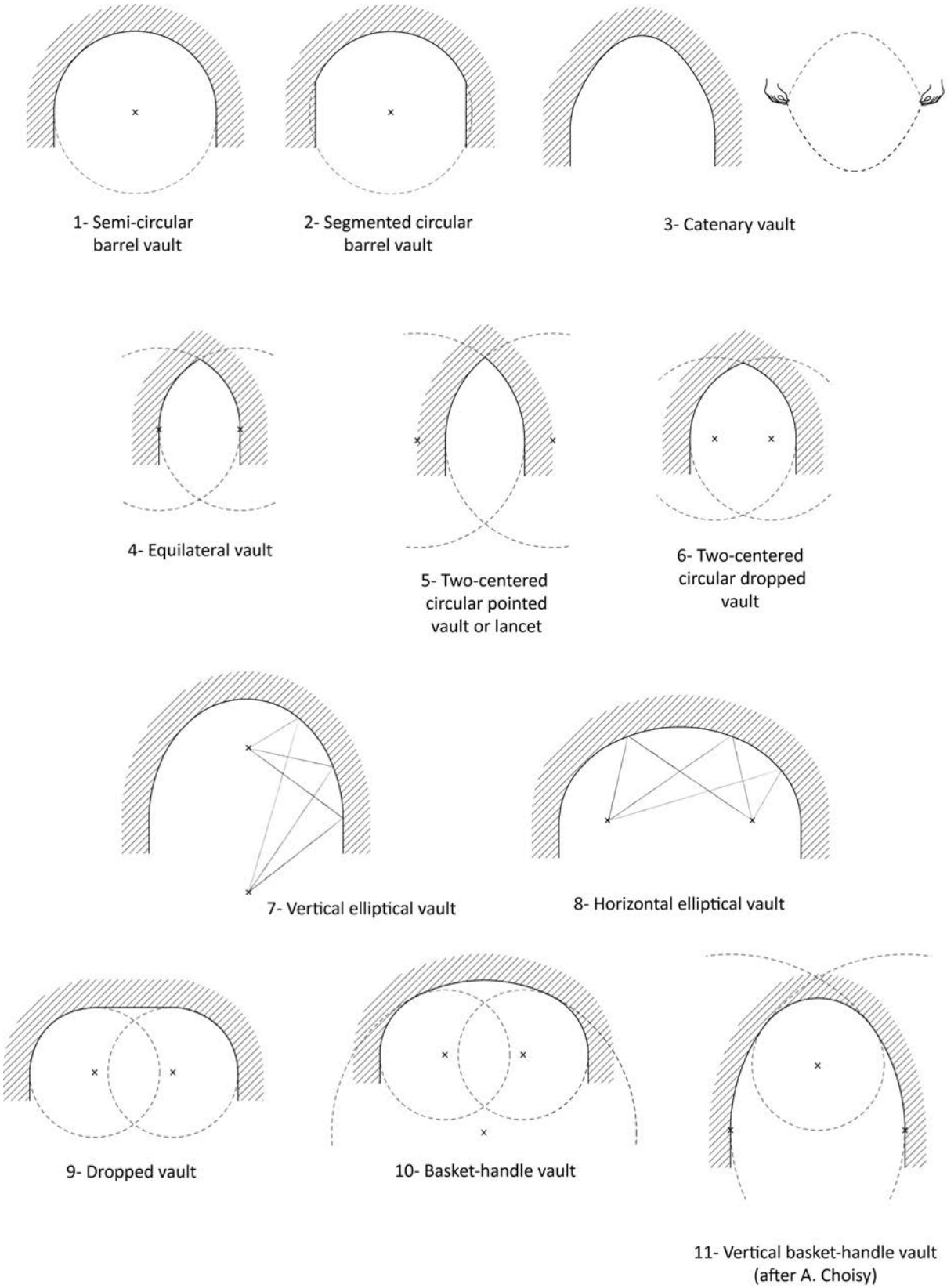

Fig. 1. Diagrams depicting types of vaults relevant to the current analysis.

Excavation reports, for the most part, record vault forms with appropriate precision, but not of a level that would allow researchers to draw clear geometric lessons from the evidence. In some cases, the degree of similarity between barrel vaults, catenary vaults, and elliptical vaults means that only a few centimeters of difference separate the theoretical forms, so that the small details can be significant.

Moreover, less well-defined vault profiles suggest that the Egyptians often worked by habit. The construction of mud-brick vaults became so familiar that they eventually produced them free hand, further complicating the analytical process.[6]

In the case of stone built structures, however, more care and accuracy would be required, given the effort involved in the initial construction and the difficulty of altering the form after it had been made. In the case of rock-cut chambers the curved form of a vault could not simply be traced out in advance as no end walls would be available on which to draw the form, before the vault had been cut. The curve would therefore have been drawn out nearby and the vertical heights at each horizontal position across the vault marked out in order to guide rock cutting into the ceiling to appropriate depths.

With these caveats in mind, in this article we present and compare two analyses of important ancient Egyptian geometric profiles. The first analysis is of a sketched profile found beside KV9. This was first published by Franck Monnier in French.[7] The second analysis is of an arch sketched on a limestone ostracon from Saqqara, which was first completed by Andrew Conner, a naval architect and chartered engineer. He previously published the analysis on a website dedicated to the ostracon.[8]

The reason for bringing these two analyses together is that the same, distinctive, geometric method, based on a 3-4-5 triangle, may have been used to create both profiles. As well as describing the geometry of the method, we also demonstrate that the method fits both architectural contexts very well. This reinforces the strength of the conclusions that can be drawn from the evidence.

Tracing of a vault in proximity to the tomb of Ramses VI (KV9, 20th Dynasty)

Following the clearance of the tomb of Ramses VI in the Valley of the Kings, Georges Daressy uncovered a large sketched profile of a vault drawn out on a wall close to the entrance of the tomb in black ink (fig. 2-[1]).[9] He found that it was executed after dressing and lime-whitening of the wall surface. At the time it was discovered the diagram had already suffered from erosion and was incomplete. Today it has almost completely disappeared.[10] After studying the sketch, Daressy noted that the width of the horizontal line at the base of the diagram (6.334 m) was almost identical to the width of the vault which formed the hypogeum in the adjacent tomb of Ramses VI (6.35 m).[11] It was a logical step to propose that the diagram was intended to guide the construction of the excavated vault in that tomb. However, if that was intention, the final height of the chamber deviates from the described form, despite the fact that the walls were finished and decorated.[12] The final

6 The various forms of Nubian vaults at the Ramesseum are discussed in Goyon *et al.* (2004), p. 128, fig. 132-d and Monnier (2015b).
7 Monnier (2015a).
8 http://web.archive.org/web/20070708153336/http://goldenlot.us/ADC/ostrakon.htm [date accessed: 15 June 2017].
9 Daressy (1907), pp. 237-241.
10 El-Naggar, (1999), p. 333, no. 1494.
11 Daressy (1907), p. 238.
12 Theban Mapping Project tomb KV9 http://www.thebanmappingproject.com/sites/pdfs/kv09.pdf.

form of the tomb's vault is significantly flattened and is more reminiscent of a dropped vault, a type of chamber roofing form that is seen elsewhere, including in the majority of the tombs in the Valley of the Kings. Only the funerary chamber of the more ancient tomb of Ramses III (KV11), situated not far from the sketch's location, at around 50 m distant, contains a vault that very closely approaches[13] the form of the curve described by the profile and the dimensions of the diagram (fig. 2-[3]). The horizontal line on the diagram is marked approximately every 0.146 m.

Daressy assumed a standard cubit *mḥ nswt* of 0.5277 m was used in the design, and he then devised a method (fig. 2-[2]) whereby an elliptical profile resembling the sketch could have been obtained.[14] Here is the (rather complex) procedure:

1. Trace out a horizontal center line AB of 13 1/3 cubits.
2. From the mid-point of AB, at O, trace out a perpendicular vertical line with a height of 5 1/3 cubits.
3. From point C at the top of the vertical, make a semi-circle with a radius of 6 2/3 cubits, cutting AB at points E and D.[15]
4. Make an ellipse using E and D as the two foci and C as the vertex. Employ the 'gardener's method' to create the ellipse. The curve should start at A and end at B.
5. Draw out the horizontal 'spring line' for the vault 3 cubits below point C. The width of this line will be 12 cubits and will equal the span of the vault.

With his procedure Daressy also seems to have employed triangles having the same proportions as a 3-4-5 triangle; the triangles COD and COE, each having dimensions 4, 5 1/3, and 6 2/3 cubits.[16] These measures correspond to values 3-4-5 increased by a factor of 1 and 1/3, thus maintaining the notable proportions.

On this basis, Daressy hypothesized that the workers applied the so-called gardener's method, which consists of planting two sticks on flat and level ground at foci E and D, attaching a rope (in this case of 13 1/3 cubits) between them, and sliding a third stake along inside it while keeping the rope sufficiently taut on either side, in order to obtain the desired ellipse.

Daressy's hypothesis and the conclusions he drew are often accepted without reservation, to the extent that certain elements of his analysis are now considered to be established fact.[17] The reality is that Daressy demonstrated nothing concrete, and proposed a method of construction which was not founded on proofs. The form of the upper section of Daressy's ellipse very closely approximates the form of the drawing traced out near the entrance to the tomb of Ramses VI, however, and as Daressy also noted, the ellipse and the drawing sketched out on the wall diverge at several points. In conclusion, there is no clear evidence that Daressy's method was known to the ancient Egyptians.

The current authors attempted to establish if the curve could have been created using a more straightforward method based on a circular arc. Elementary rules of geometry were first employed to determine the radius of the circle passing through three points: the two end points of the horizontal line of 12 cubits, and the top of the arc at C. It turned out that the radius of a circle passing

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13 Theban Mapping Project tomb KV11 http://www.thebanmappingproject.com/sites/pdfs/kv11.pdf.

14 We doubt the basis of such levels of precision (to a tenth of a millimeter) attributed to the cubit, however, the value does fall within a range that is historically appropriate for the period. See Carlotti (1995), p. 138.

15 In step 3 described above, the value of 6 1/3 cubits provided in the article by Daressy has been corrected to 6 2/3 cubits, which corresponds to the 3.5182 m stated. The analysis in the remainder of his article seems to support this correction.

16 The final pair of values were erroneously recorded again by Daressy as 6 1/3 cubits. See Daressy (1907), p. 238.

17 Arnold (1991), p. 22; El-Naggar (1999), p. 333; Rossi (2003), pp. 114-115.

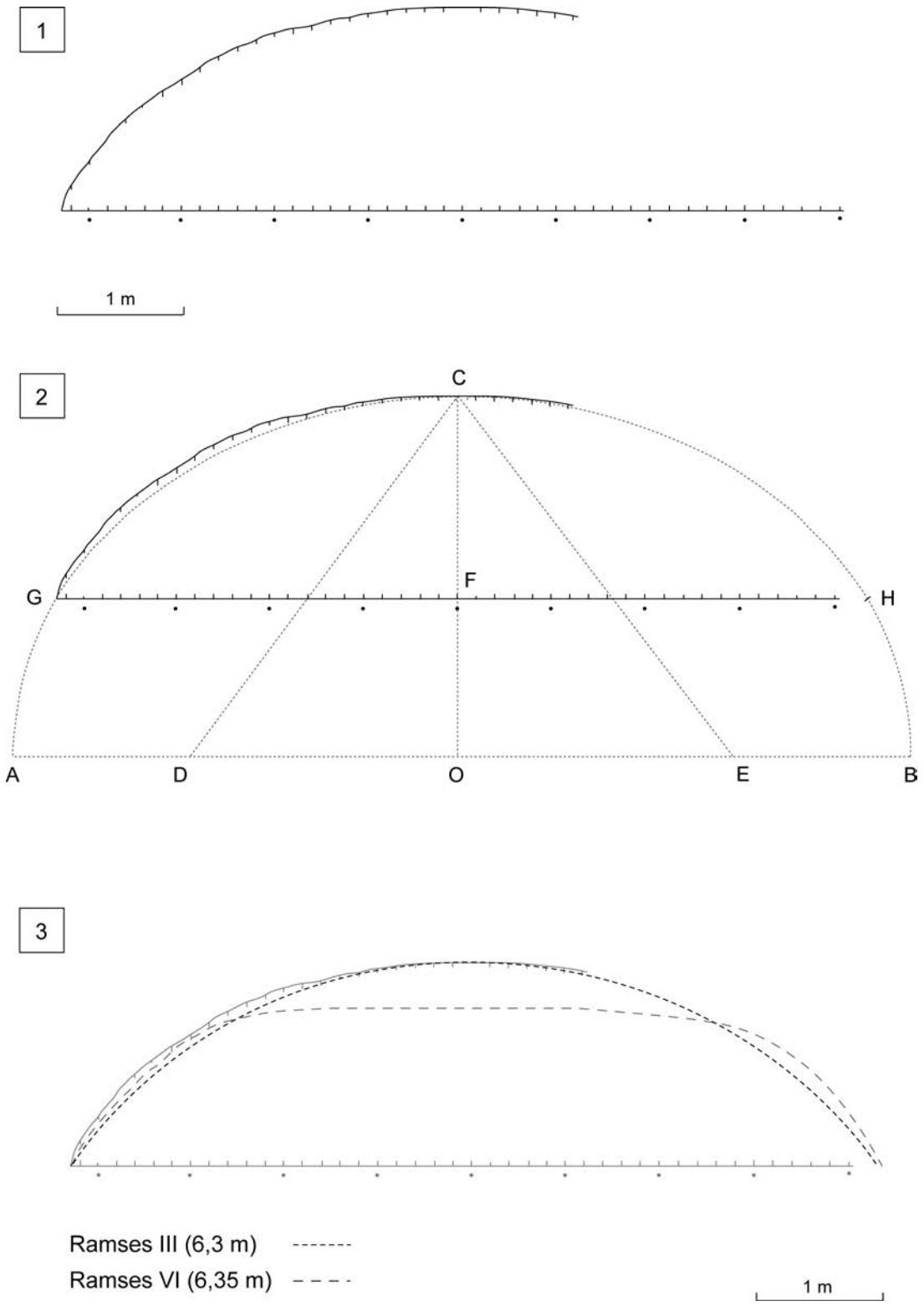

Fig. 2.
1. Diagram of a curve represented on the wall of the excavated trench near tomb KV9 of Ramses VI (Daressy 1907, p. 241, fig. 1).
2. Daressy's method to draw the curve of tomb KV9.
3. Comparison of the drawing at the tomb of Ramses VI with the profile of vaults surmounting the funerary chambers of Ramses VI (tomb KV9) and Ramses III (tomb KV11). Widths of the vaults are given.

through these points is very precisely equal to 7 ½ cubits. This is a remarkable value, and all the more remarkable because it implies that the triangle on which the arc is based has sides measuring 4 ½, 6, and 7 ½ cubits, and a hypotenuse which is the radius of the circle. This triangle, again, possesses exactly the same proportions as a 3-4-5 triangle.

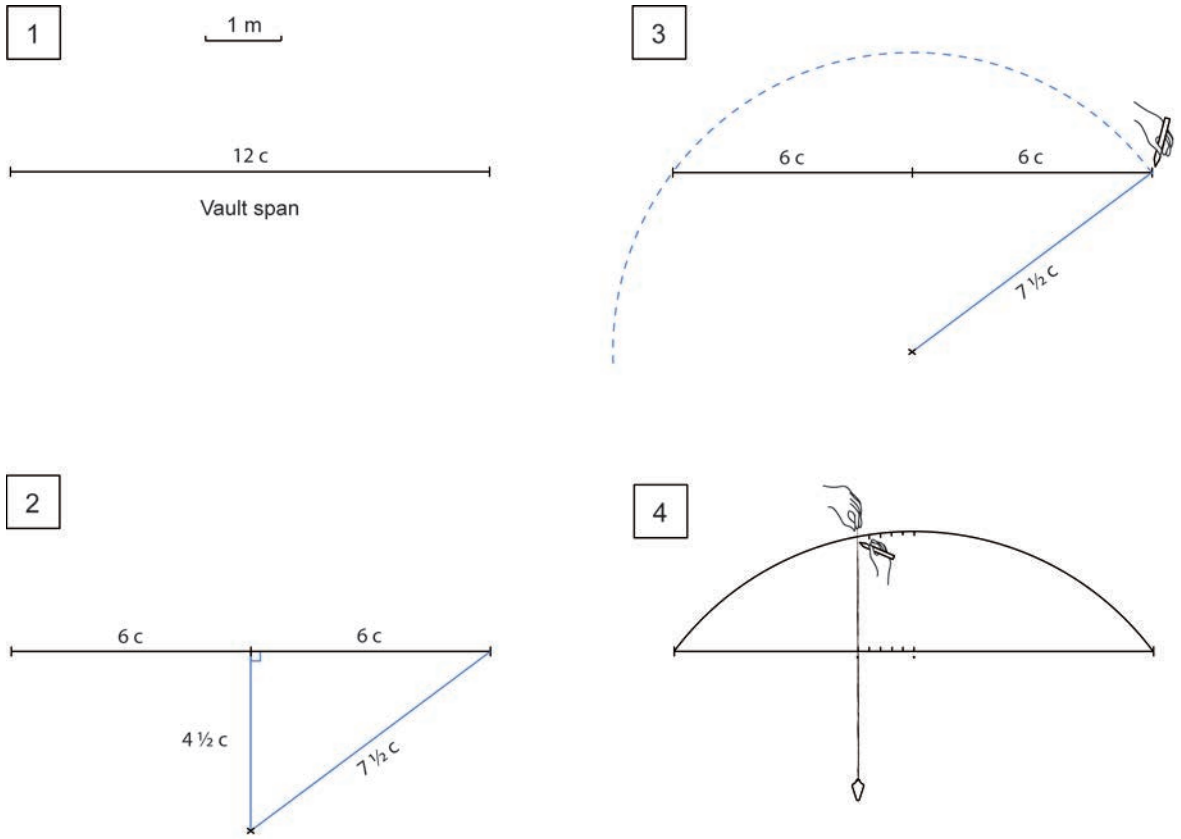

Fig. 3. Method devised by F. Monnier to construct the profile of a vault which matches that discovered during the excavation of the tomb of Ramses VI, and also the vault over the burial chamber in the tomb of Ramses III.

The circular arc obtained in this way also corresponds precisely with the form of the vaulted roof which covers the funerary chamber of Ramses III (fig. 2-[3]).

With this circle and this method of curve construction we have discovered an alternative, and much simpler, procedure to that proposed by Daressy. From a technical point of view our method has the advantage of being based on measurements which are easily obtained within the ancient Egyptian system of linear measurement. Its most interesting geometric characteristic is that it employs a triangle having the same proportions as a 3-4-5 triangle, for which the hypotenuse is also the radius of the circle.

The workers who carried out the construction of vaults on-site built structures according to instructions provided by their master of works. In turn, the master of works would have followed a vault design process that was determined by the internal characteristics of the architectural space to be covered, in this case the burial chamber of the tomb. The vault was therefore dimensioned according to the spatial characteristics of the tomb. The first parameter required to define the vault profile was, therefore, the width of the space to be covered, in other words the span of the vault.

In this case the width is equal to a whole 12 cubits. The first parameter used in Daressy's method is, contrastingly, the major axis of the ellipse, which is 13 1/3 cubits. With the mathematical tools at their disposal, it is difficult to imagine how the ancient Egyptians could subsequently have established the length of rope or cord required to produce an ellipse that would accurately run through points G, C, and H, and for which the distance between G and H was 12 cubits. This is an extremely complex problem, even more so when attempted within the context of ancient Egyptian mathematics.

The method of construction based on a circular arc is much simpler in this respect. First, the half width of the vault would be easily calculated, in this case 6 cubits. The engineer would then determine the sides of a triangle with proportions 3-4-5, where the side 4 would equate to the 6 cubits. The multiplication factor is therefore 1 ½, and so they would subsequently find that the other side lengths to have values of 4 ½ and 7 ½ cubits respectively (fig. 3). At that stage it only remained to trace out a circle with radius of 7 ½ cubits, running from the end points of the so called 'spring line'.

With respect to other possible techniques employed, the catenary method provides a fairly simple practical way to trace out the requisite profile, avoiding all mathematics in the process. If we suspend a cord or chain between two points at the same vertical height, with the ends separated by 12 cubits, the shape of the hanging mass will, due to its own regularly distributed weight, describe a catenary curve.

For vaults of this approximate form, the profiles of a catenary curve, a vault with a circular arc, and an elliptical vault can be remarkably similar. No document describes the actual process or processes used, so the diagrams could indeed represent catenary curves produced using a manual process. It is therefore not necessary to resort to using a complex mathematical method involving an ellipse, constructed using the gardener's method, to explain the profile. Neither the gardener's method nor a form which is indisputably an ellipse is attested in the ancient Egyptian culture.

Daressy claimed that the portion of the ellipse he described is so similar to the curve traced at the entrance to the tomb that we can assume that any differences are due to construction errors.[18] In this article, however, the current authors have proposed that an arc of a circle also closely matches the profile of the curve traced out at the entrance to the tomb, and that there is therefore no reason to prefer a hypothesis based on an ellipse. It is more complicated and is not attested elsewhere in the ancient Egyptian cultural material. A hypothesis based on a catenary curve should not be ruled out, even if its form deviates rather more from the curve drawn at the tomb entrance than do the forms produced by the other methods.

In conclusion, the characteristics of the circular arc which has been described in the first half of this article seem so noteworthy that it would be remarkable if they had occurred by accident. The current authors consider that the circular arc is very likely the geometric form used in the construction of the sketched curve at KV9.

The Third Dynasty traced vault profile on ostracon JE 50036

The second major piece of evidence referenced in this article is a limestone ostracon with a delineated profile of a vault illustrated on it that was discovered in the complex of pharaoh Djoser, beside the north pavilion. It is currently on display in the Imhotep museum at Saqqara (JE 50036).[19]

18 Daressy (1907), p. 238.
19 Firth (1924), p. 122.

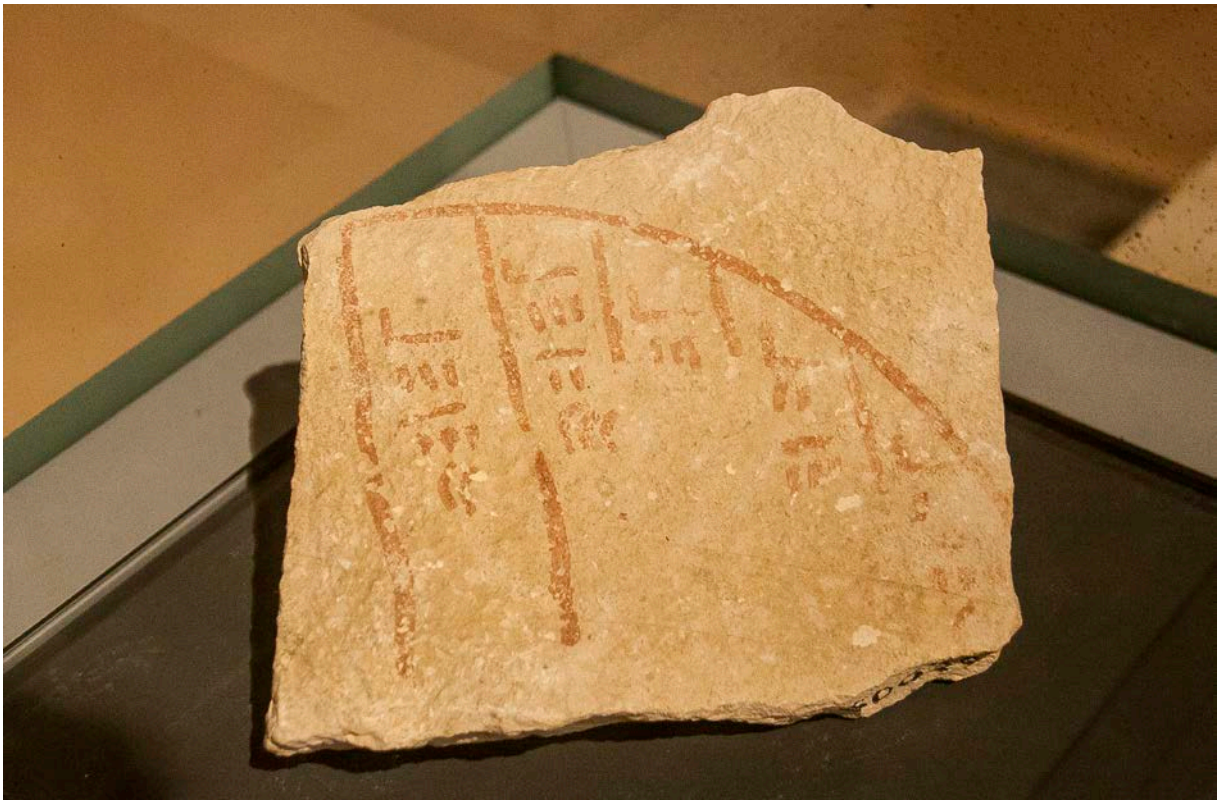

Fig. 4. Ostracon dating to the 3rd dynasty
(JE 50036, previously in the Cairo Museum, now housed in the Imhotep Museum at Saqqara)
(Photograph courtesy of Alain Guilleux).

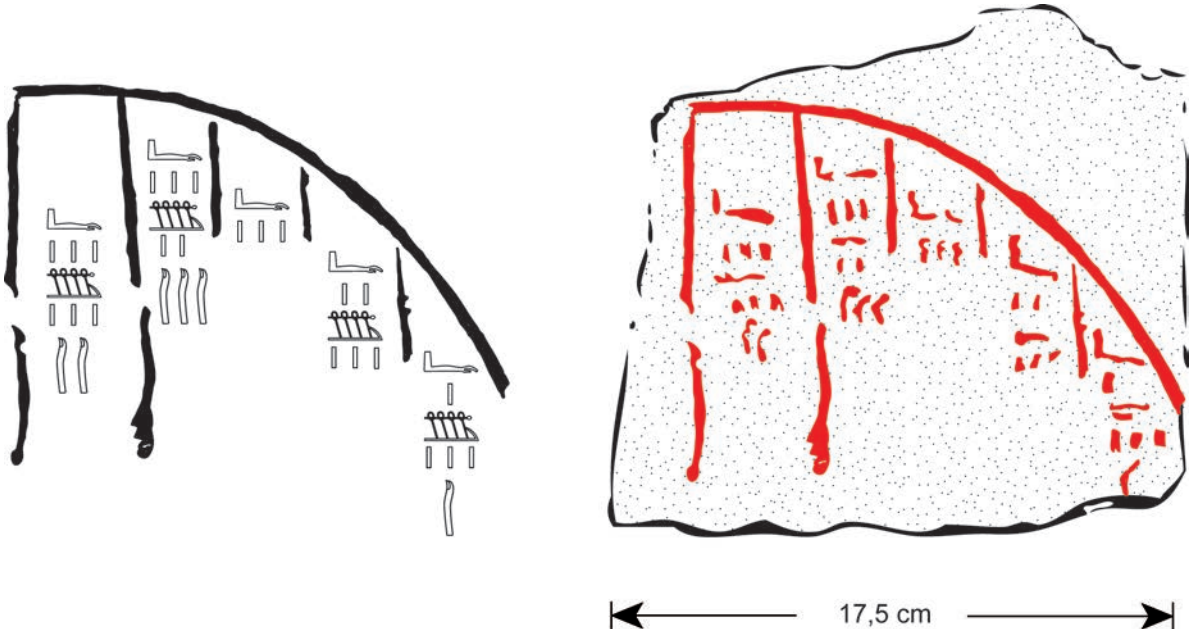

Fig. 5. Profile of a half vault or half arch represented on a limestone ostracon dating to the 3rd dynasty (JE 50036, previously in the Cairo Museum, now housed in the Imhotep Museum at Saqqara) and a hieroglyphic transcription of the annotations. The numbers inscribed in the object indicate that the sketch probably served as a construction guide for a vault, or arched decoration, and as such both sides would have been symmetrical so that only one side had to be depicted.

The curve drawn on it in red ink was accompanied by a number of inscriptions in hieratic which were regularly spaced by vertical lines (fig. 4). The drawing and the annotations beside it were addressed many decades ago by Battiscombe Gunn,[20] Georges Daressy,[21] Somers Clarke and Reginald Engelbach,[22] and subsequently by Jean-Philippe Lauer.[23] The numerals appearing on the diagram are expressed in cubits, palms, and digits, which Gunn reformulated into digits to facilitate mathematical analysis of the sequence of values found there (see table and figs. 5 and 6).

Translation of the dimensions listed	The same dimensions expressed only in digits
3 cubits, 3 palms, and 2 digits	98
3 cubits, 2 palms, and 3 digits	95
3 cubits	84
2 cubits, 3 palms	68
1 cubit, 3 palms, and 1 digit	41

Table. Dimensions recorded on ostracon JE 50036.

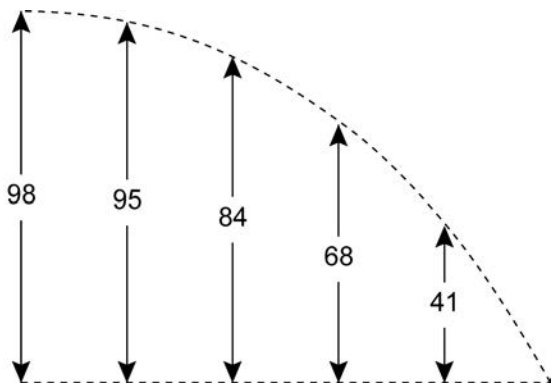

Fig. 6. Dimensions recorded on ostracon JE 50036.

Gunn interpreted the numbers as dimensions of a vault seen in profile.[24] The numerals would therefore indicate the height of the curve at the top of equidistant vertical 'ribs' or 'ordinates' located along its span.

The horizontal distance between the vertical values is not specified on the ostracon, but logic would suggest that they were separated by a constant value, which Gunn decided to set as 28 digits, or one cubit. He then sought to relate this design to the remains of a mound-like structure 'E' situated within the Djoser complex.[25] This relationship was rejected by Lauer based on later measurements.[26] In the present study, and in the absence of accurate data for the size of the structure

20 Gunn (1926).
21 Daressy (1927), pp. 157-160.
22 Clarke and Engelbach (1930), pp. 52-56.
23 Lauer (1936), pp. 174-175; Rossi (2003), pp. 115-117; El-Naggar (1999), pp. 331-332 described these artefacts simply by re-iterating the analyses and conclusions of their predecessors.
24 Gunn (1926), pp. 197-202.
25 Gunn (1926), pp. 200-202, fig. 5.
26 Lauer (1936), pp. 174-175, fig. 199.

'E', no attempt is made to compare the information on the ostracon with the monument, of which only a small part of the original material remains.

George Daressy re-opened the discussion shortly thereafter and provided his own analysis of the fragment.[27] He attempted to establish how the precise values recorded on the object were originally generated. Like Gunn he postulated that the values represented the heights of several points to be used to trace out the profile of the arc. He also concluded that the curve was a circular arc that had originally been traced out on the ground.

Daressy's diagram illustrating this method seems convincing, but when the current authors tried to verify its accuracy it was found that the arc did not match all of the recorded dimensions satisfactorily. In fact, according to the current authors' measurements the differences were not negligible, and this made us doubt that the ostracon represented a circular arc made in this way.

One of the main problems with Daressy's analysis is that he assumed that the gap between the vertical ribs at the far right hand side of the curve was in fact less than for the others. It is quite understandable if the scribe did not record the distances between each vertical rib because the distances were all effectively the same, but on the other hand, if one of the intervals were significantly less than for the rest then we would expect that this distance would have been recorded by necessity. In fact there is no such value recorded on the ostracon (at point 0 on the diagram). Daressy noted this discrepancy, but was content to explain it away by concluding that it was a detail which would have been known to the workers due to routine practices, and therefore did not need to be recorded.[28] However, this would only be the case if we assume that every vault constructed during that era (or perhaps just on this construction site) had an identical span, something that seems highly unlikely.

Both the circular arc proposed by Daressy and a catenary curve reveal small differences compared to the heights of the vertical ribs recorded on the ostracon.

Once again, the width of the vault was not the initial value used in Daressy's process, something that seems counter-intuitive. If the ancient Egyptian mason was dealing with a vault designed to span a space, then the width of the space was the initial dimension that had to be specified. In Daressy's method the width of the space is only derived at the end of the whole process.

Since a vault is designed to cover or protect a space it can only be designed and dimensioned once the space itself has been defined. It is, therefore, more likely that the vertical rises which defined the curve of the vault were derived from the horizontal base implied by the diagram, and in particular, from the width of this base.

We can now introduce and describe the new method which more accurately explains the data-set found on the ostracon from Saqqara. The method was first derived by chartered engineer Andrew Conner in 2004, and was subsequently published on his personal website which was devoted to the subject. Conner proposed that the arc described on the ostracon was half of a circular segment, but he suggested that the chord of the circular arc was based on a 3-4-5 triangle, for which the value 4 corresponded to half the width of the vault space to be covered, and the value 5 corresponded to the radius of the describing circle. The full width of the vault or arc would equate to a full chord of the circle.

27 Daressy (1927), pp. 157-160.
28 Daressy (1927), p. 158.

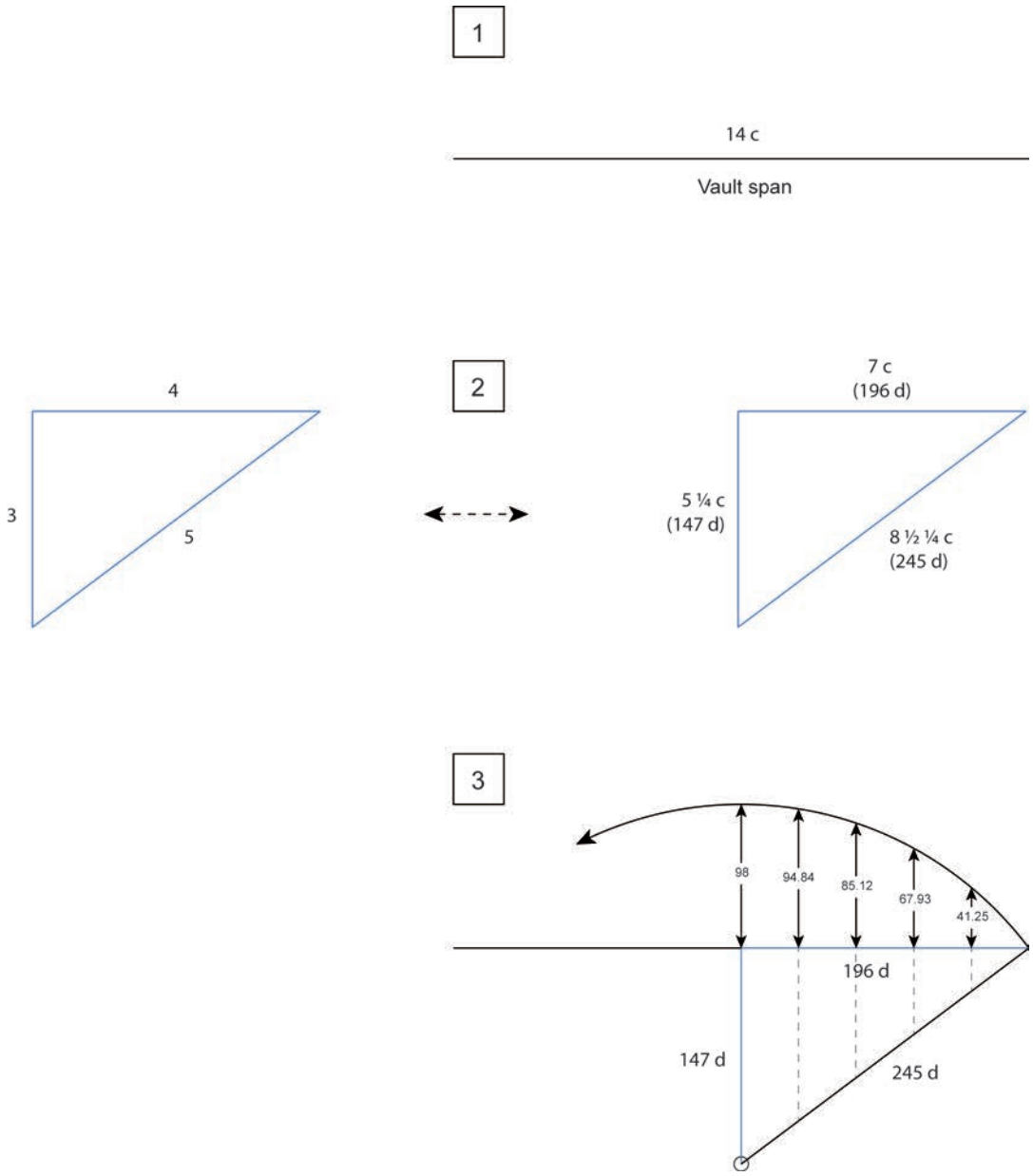

Fig. 7. Conner's method for obtaining the Saqqara Ostracon data.
(98, 95, 84/**85**, 68, 41, 0).

The strength of Conner's proposed method is that the curve described using this method matches the data described on the ostracon very closely, with only a single digit of discrepancy on one of the ordinates. Additionally, the width of the vault described would be a whole 14 cubits, something that agrees well with a theory where the width of the vault defined the dimensions of the vault's curvature.[29]

29 There is one apparent weakness to this theory in that the resulting distance between each of the five subdivisions (assuming they were all equal) is a non-integer value, i.e. 1.4 cubits. This distance is particularly difficult to measure out using a seven-part cubit. In fact, the 14 cubit width to be covered was particularly challenging in this respect, as its half-width is a prime number; seven cubits. This cannot be subdivided into a whole integer value, or a fractional value that can be easily measured using cubits and palms, unless it is subdivided into seven parts or more. One possibility is that the positions of the subdivisions were measured using the radius below as a guide, as it was constructed as 5 parts (in the 3-4-5 triangle) when making the curve (245/5=49 digits).

With respect to the one digit of discrepancy, Conner suggested that the third ordinate had flaked off or had accidently been omitted, in which case the value should be 85. The data produced by the geometric method would then provide an exact match to the data on the ostracon.

The method is simple and can be produced using basic practical instruments, readily available to the Egyptians of that era, and it does not require a background knowledge of more complex geometry.

Conner concluded that the method was equivalent to that used in constructing the data presented on the Saqqara ostracon, and he therefore proposed that the 3-4-5 triangle was known to the Old Kingdom Egyptians. The method is also identical to that proposed earlier in this article for the diagram depicted outside KV9.

Discussion

The curves studied in this article were most likely intended to guide the construction of curved vaults. Both examples describe arcs of similar magnitudes and almost identical proportions, and according to our analysis both were constructed based on 3-4-5 triangles. In the example from KV9 the vault has a width of 12 cubits and an internal height of 3 cubits, while in the second example on the ostracon from Saqqara the vault has a width of 14 cubits and an internal height of 3 ½ cubits. Both have the same form and proportions. The long side of the 3-4-5 triangle which determined those proportions would have been used as the radius of the describing circle. One of the strengths of this hypothesis is that the circular chords describe the width of the vaults. Chamber widths were the dimension of primary importance with respect to covering architectural spaces. Both spans are also whole numbers of cubits.

Fig. 8. Tiled faïence relief from the subterranean chambers beneath the Djoser Complex (JE 68921 Cairo Museum). (photo courtesy of Alain Guilleux)

This evidence indicates that the ancient Egyptians were already able to carry out relatively systematic and sophisticated geometric research and architectural construction during the 3rd dynasty. The 3rd and 4th dynasties were highly creative periods in pharaonic history. Many new construction techniques and fundamental new concepts first appeared at that time. In the decades during which the Djoser complex was built the scribes and architects attained unprecedented levels of technical ability, notable even within the wider context of the Old Kingdom. It is worth recalling that the architect Imhotep (c. 2650-2600 B.C.), who reputedly designed and constructed the Saqqara complex, was revered by later Egyptians for his exceptional skills and as a pioneer in building with stone.

During his research into the Saqqara ostracon, Conner also identified decorative features at Saqqara which are perhaps related to the vault structures and methods discussed here. Several faïence

ceramic tiled reliefs discovered in the subterranean tunnels beneath the Saqqara step pyramid include designs incorporating circular segments, or arcs surmounting chords of circles.[30] Djed columns support the arcs over the chords, in positions comparable to those of the ordinates on the ostracon. In turn the arcs sit on large rectangles made up of many smaller rectangular ceramic tiles.[31] One of these reliefs, JE 68921, is now on display in the Cairo Museum. The close similarity between these decorative forms and the geometry described above leads us to consider if the ostracon is related to these reliefs in some more significant way. While the dimensions and proportions do not match in this case, it is worth considering if these reliefs resemble designs and elements that would have been familiar to the artisans and scribes of the period. If the ancient Egyptians were studying basic concepts of rectilinear and circular geometry, including arches and circular segments, at the time the Djoser complex was under construction, then it is possible that these tiles were based on elements that had a metrical function, and which could have facilitated experimental geometric research. Rather than being purely decorative, these reliefs may even have reused and preserved materials that also had a practical, and perhaps educational, function, or they may be durable skeuomorphs of more perishable wooden precursors.

The small tiles resemble what would result if a cubit were cut into pieces, for example if the parts were to be used to measure individually. Analysis of the dimensions of the tiles indicates that they were a fairly regular half-palm/2 digits in width (approximately 3.74 cm), so that 14 of them aligned side-by-side in a row would form a cubit.[32] Subdivision of rules into units of half-palms/2-digits would have been particularly useful for measurement. It would have allowed half cubits (3 ½ palms) and multiples of half cubits to be measured, something that could not be done using the basic 7-palm measure, or using individual whole palm units.

Setting out half-palm/2-digit tiles along circumferences of circles or arcs could have provided a simple means of measuring curved forms. If such a system existed, however, then it remains unclear from the reliefs if the tiles could be used to measure end-on-end, in the way that they are oriented around the curve on the relief (Fig. 8), or if that arrangement is purely a decorative form. The mortar separating the tiles in these arrangements also requires explanation if a metrical function was intended.

Despite being incapable of measuring half cubits accurately without further subdivision, the basic 7 part cubit was well suited to circular geometry. A circle with a 1 cubit diameter, being 7 palms, would have a circumference of precisely 22 palms. A quarter circle circumference would then be precisely 5 1/2 palms. These key values could easily have been measured by using small half-palm tiles placed around the circumferences of circles, perhaps set out on a horizontal surface.

Additional evidence from later Egyptian texts indicates possible continuity of these methods and concepts over longer periods of time. For example, demotic mathematical papyri from the Late Period include calculations involving circular segments and chords of circles.[33] The fundamental mathematical concepts were also understood by the neighboring complex ancient civilizations that

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30 Kuraszkiewicz (2015) discusses the significance of 64 different hieroglyphic marks recorded as inscribed on the reverse of the ceramic tiles. The marks include several numerals. It remains unclear what function these characters served, but Kuraszkewicz concluded that these were makers marks applied during the manufacturing process.

31 Sourouzian and Saleh (1986), p. 267; Lauer (1936), pp. 34-37. Excavations by the Egyptian Antiquities Service, 1928. The 'Panel with Mats Decoration from Faience Tiles' is a reconstruction of an unfinished wall found in the underground chambers. It is now on display in the Cairo Museum upper floor corridor 42. The height of the relief including the base rectangle is 181 cm, the width is 203 cm.

32 The width of the row of 20 upright tiles from the Djoser complex in Saqqara now in the NY Met (48.160.1) is 73.7 cm, giving an average width of 3.695 mm. This deviates by less than 1.2% from 2 digits, if the Old Kingdom cubit is taken as 0.5235 m (20.61"). A survey of several different tiles on sale for private collectors showed a width range varying from 36-38 mm.

33 See Parker (1972), pp. 44-50, plates 12-14, P. Cairo J.E. 89140, 89141, 89143.

developed in the Fertile Crescent. Cuneiform tablet MS3049, now[34] in Schoyen collection includes two diagrams and two examples demonstrating algorithms for calculating the lengths of chords of circles. The tablet was written in Old Babylonian, in cuneiform script on clay, and dates to the 17th century B.C.[35] Similarly, Euclid's Elements and Claudius Ptolemy's tables of chords later contained problems that demonstrated how to deal with circular chords.[36]

But why would the ancient Egyptians have employed a 3-4-5 triangle in this construction method? There are several plausible reasons. It generates a curve that can be produced consistently and in proportion for any given architectural span. It is an extremely strong form structurally, because the circular segment described is remarkably close in form to a catenary curve, which provides optimum structural strength. Lauer suggested that the 3-4-5 proportions were used in Egyptian architecture for reasons of architectural harmony of proportion,[37] but it is also possible that the form was originally chosen for the practical reasons noted above. It was inherently strong and could be generated quickly and precisely with rudimentary methods and tools. The ancient Egyptians may even have perceived that the 3-4-5 numerical sequence lent symbolic strength to the finished structure. Whatever the determining factors, the end result was an elegant and practical solution to a complex architectural problem.

Conclusion

In conclusion, the circular arc which has been described in this article was apparently used in two disparate architectural contexts separated by more than 1400 years. The characteristics of the curve and its applications are so noteworthy that it would be remarkable if they occurred by accident. The correspondence between the geometric form described and the numerical and dimensional data recovered is very close. The current authors consider that this special circular arc is very likely to be an archetypal geometric form, first devised, used, and then passed down by the ingenious scribes and engineers of Old Kingdom Egypt.

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34 Friberg (2007), pp. 295-304. The tablet was written in Old Babylonian cuneiform on clay and dates to the 17th century B.C. It was recovered from Uruk, now in modern day Iraq.

35 Friberg (2007), p. 298. See also Old Babylonian tablet BM85194, ##21-22 from Sippar.

36 Euclid, Prop. III.35, and Ptolemy's tables of chords 'On the Size of Chords Inscribed in a Circle', part of the Syntaxis Mathematica of the Almagest,from the 2nd century A.D.

37 Lauer (1968).

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An interactive tool for the recording, analysis and interpretation of ancient Egyptian domestic mudbrick architecture

Maria Correas-Amador

Archaeologists regularly carry out site surveys which include observation and recording of visible features, drawing of site plans, and production of standing building surveys. After description and classification, the next phase of the archaeological process is interpreting and understanding what is observed and/or excavated. However, in the case of mudbrick structures, there is a lack of a standardised system for their recording and interpretation amongst archaeologists working in Egypt.

This article outlines the practical way in which an ethnoarchaeological study of Egyptian domestic architecture, initially designed as part of a doctoral research project[1], has been translated into the development of a digital tool for the recording, analysis and interpretation of ancient Egyptian houses.

The aim of the tool is to guide the study and thought processes involved in the recording, analysis and interpretation of ancient Egyptian domestic remains. The methodological framework could nevertheless be used as a basis on which to develop similar tools for the study of any class of site, in any location.

Theoretical foundations of the research

Architectural historians and archaeologists understand that human beings model characteristics of the landscapes in which they settle to suit their needs, through the modification of natural resources, and the development of human-made structures, chiefly buildings. There is, however, disagreement concerning the specifics of the roles that humans, on one hand, and buildings, on the other, play in that adaptation process. This article is founded on the principle that, although buildings are clearly and deliberately inserted into the environment by human agency, there are also reciprocal influences between buildings, humans, and their wider sociocultural landscape context. Relationships develop in this context which deserve to be studied individually. The sociocultural dimensions are particularly evident in domestic architecture. In order to understand houses properly, cultural signs and meanings on the one hand and functional and practical requirements on the other must be considered integral to the individual's experience of space.[2] The relationships between these meanings and requirements can best be understood through analysis of the various related contextual factors.

1 Correas-Amador (2013).
2 Moore (1986), p. 191.

The study of context is an essential concept in archaeology.[3] Although 'context' can have several meanings, it always implies the connection of objects with their surroundings.[4] The context in which archaeological remains are deposited is vital to reconstructing past human activity,[5] and it allows us to develop understanding of how these remains were used in the past.[6] The context in which a house is embedded is formed by a series of variables which were identified in this research project as environmental, sociocultural, community-related, and individually significant factors.

Environmental factors refer to the ways in which the local climatic and physical landscape conditions influence the specifics of how houses are built. Geography, climate, and the particular topography of a site all contribute to the appearance and distribution of the houses within it. In addition, the environment is also subject to human alteration, such as through the construction of canals, which substantially modify the surroundings and can therefore have an indirect effect on local building characteristics.

Sociocultural aspects are amongst the most important contextual factors involved in housing. Social interaction is in part construed by means of the built environment, and consequently, by houses.[7] Status, class, and gender, for example, can all be expressed through architecture, and are in turn expressions of tradition.

Whether a settlement was pre-planned or developed organically is also significant. A deliberate urban plan might result in particular types of buildings being present throughout. The particularities of the community, for example towns which were designed specifically for a certain groups of workers, will affect the number of examples of particular types of buildings.

Finally, individual preferences based on particular social circumstances, tastes and perceptions are also part of the context in which houses are immersed.

Material and context influence each other, and that influence is particularly visible in relation to environmental and sociocultural variables. Building materials are linked to the environment, given that the surroundings determine material availability and climate suitability. In addition, material choices are also influenced by practical choices related to cost, flexibility and durability. Social and cultural factors unrelated to practical suitability can also be significant reasons for certain choices of material. Consequently, all of these aspects must be taken into account if we are to achieve a holistic understanding of domestic architecture.

Ethnoarchaeology and domestic mudbrick architecture

Ancient Egyptian domestic architecture is, for a number of reasons, comparatively less well known than funerary or religious architecture. Traditionally, the discourse regarding ancient Egyptian houses has been built upon the study of the limited archaeological remains available, and some artistic sources including tomb wall representations and models representing typical architectural forms recovered both from domestic and mortuary contexts[8]. These sources have contextual limitations in as far as they are the products of specific social groups and chronological periods. Information regarding domestic architecture is remarkably scarce in ancient Egyptian literature. In addition, archaeological

3 Cameron (2006), p. 22.
4 Hodder and Hutson (2003), p. 171.
5 Renfrew and Bahn (2000), p. 50.
6 Last (2006), p. 120; Barrett (2006), p. 194.
7 Rapoport (1976); Kamp (1993); Last (2006), p. 120.
8 For a critical analysis of contributions to the study of ancient Egyptian domestic architecture and main points of discussion, see Correas-Amador (2013), pp. 29-42.

studies of architectural remains in Egypt have generally not focused on domestic architectural material; mudbrick in the vast majority of cases. Nevertheless, in recent years, there has been more academic focus on discussions concerning ancient Egyptian domestic architecture, mostly associated with urbanism studies[9], building on the tradition of the pioneering work carried out from the 1970s at sites such as Amarna, Elephantine, and Tell el-Daba.[10] There have also been more recent publications which, like the research presented here, point at the usefulness of the study of modern mudbrick materials and techniques in order to understand ancient Egyptian domestic architecture more fully.[11]

Current discussions of ancient Egyptian domestic architecture and urbanism could benefit greatly from incorporating a broader understanding of the techniques, possibilities and limitations of using mud and mudbrick as a building material. In this respect, ethnoarchaeology offers a source of information which is largely missing or incomplete in the archaeological record. Its value has been proven by its successful application to the study of ancient Egyptian pottery and basketry, as exemplified by the works of Nicholson and Patterson[12] and Wendrich[13] respectively. However, it had hitherto never been applied to the study of ancient Egyptian houses, despite traditional Egyptian mud houses providing useful data for the interpretation of cultural and geographical contexts and material factors; precisely the information that we lack from ancient sources.

Ethnoarchaeology is suitable for the study of domestic architecture as its main aim is to re-establish the link between material culture - which also includes buildings[14] - and cultural context as a whole.[15] It allows for the development of analogies[16] which can help us understand the reciprocal relationships between humans and buildings. It acknowledges that buildings, as material culture, reflect human activities and intentions, but that these activities and intentions are also shaped, restricted or promoted by the buildings in which they take place and develop.[17]

Therefore, the use of ethnoarchaeology facilitates, on the one hand, a theorized analysis of the influence of contextual aspects in house materiality; and on the other hand, it informs us about practical concerns involving the building material in question, its properties, and the construction methods developed for utilizing it. Finally, it illuminates the relationship between the two, which is a fundamental link for understanding domestic architecture, and one which is most often lost in the archaeological record. It also facilitates the reconstruction of the context – the importance of which was discussed in the previous section.

The study was carried out by analysing the environmental, sociocultural, community, and individually related factors, through study of the available textual sources, architectural surveys, interviews with current inhabitants, and observation of contemporary mudbrick structures.

Research and tool development methodology

All of the theoretical factors discussed above must be taken into account during an ethnoarchaeological study of domestic architecture. The physical properties of the material should also be evaluated; a consideration of building techniques is also crucial to understanding houses.

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9 E.g. Bietak *et al.* (2010), Moeller (2016), forthcoming 'Across Borders' conference 2017 (1st-3rd Sept 2017, Munich).
10 For a summary of work to date, see www.amarnaproject.org, ww.dainst.org (Elephantine Project), http://www.auaris.at, respectively.
11 Karmowski (2014, 2014b).
12 Nicholson and Patterson (1985).
13 Wendrich (1999).
14 Tilley *et al.* (2006), p. 1, p. 4.
15 David and Kramer (2001), p. 2.
16 Lane (2006), p. 402.
17 Lane (2006), p. 404.

In order to develop the methodology the first step was to test the theoretical principles identified as relevant to research on domestic architecture, in particular the interactive, contextual, and material factors involved. To achieve this, information regarding processes which might have influenced Egyptian mudbrick house architecture was gathered by studying construction carried out in the last century, by way of interviews with local people and observation on the ground in Egypt.

Data collected concerning processes affecting houses in the late 19th and throughout the 20th century included studies regarding land ownership, rural life and agriculture, economic geography, local geologies, and the more general history of Egypt over that period of time. The time frame was chosen due to the fact that the most substantial corpus of information about mudbrick houses in rural Egypt comes from this most recent era.

Through the analysis of these studies a combination of contextual factors which might have impacted on the layout and physical appearance of mudbrick houses in the more distant past was identified: environmental factors, most significantly the importance of the river Nile and human modifications made to it through the construction of dams and irrigation improvements; sociocultural factors, through the identification of certain construction materials with prestige and status (just as red brick and concrete have related to more traditional materials since their introduction at the beginning of the 20th century); whole community-related factors, such as communities having to abandon their houses due to the building of dams; lastly, individual factors, such as individual household compositions changing through time. This data and the associated analysis served, therefore, to validate the various issues proposed as constituting influential contextual factors. The research showed that these factors did indeed influence domestic architectural choices, and it also facilitated the development of a theoretical understanding of the manner in which those issues affect the physical form of the houses.

In addition to the theoretical aspects it was necessary to develop knowledge of construction processes, architectural characteristics, and the development of modern mudbrick houses in order to gain better understanding of the physical aspects which might have impacted on archaeological remains. This was achieved through architectural surveys and observations carried out across three main geographical areas; Lower Egypt (Garbheya, Kafr el Sheikh, Menoufiya, Dakahliya, Sharquiya, Beheira, Qalyubiya), Upper Egypt (Luxor, Qena) and the Dakhleh Oasis. Information was collected by means of individual fieldwork surveys and with reference to a limited number of published[18] and unpublished sources, notably those within Hassan Fathy's personal collection in the Rare Books and Special Collections Library of the American University in Cairo. Checklists, surveys and drawings were used to record materials, construction techniques, and structural elements consistently, as well as house layouts and room distributions.

This knowledge regarding contextual factors and material properties was then used to develop a comprehensive understanding of modern mudbrick house architecture in each one of the chosen areas. To achieve this, the impact of particular contextual and material factors in relation to architectural features was recorded and described, as well as ground plans and information about the use of space in the modern houses.

The information collected regarding material factors (descriptions of materiality of architectural features) was then 'reduced' by restructuring it to fit standard categories used for architectural description, such as the general conceptual division between external and internal finishes, with external finishes being subdivided into: roofs, walls, doors, windows and other features; and internal

18 Castel (1984), Hivernel (1996), Henein (1988), Schijns (2008), Simpson (2008), de Filippi (2006), Lozach (1930), Hug (1930), Eigner (1984).

finishes into ceilings, walls, doors, windows and others. The way of presenting the information was, for each one of these elements, designed to include descriptions of the materials used and then to explain any variations found. This process of data analysis was repeated for each one of the three areas studied (in Lower Egypt, Upper Egypt and the Dakhleh Oasis) in order to facilitate comparison between regions. Once each one of the three geographical areas was described, the information was synthesised and presented as a general summary for each area to allow comparison between houses featuring each one of the external and internal finishes described.

Concerning ground plans and the distribution and use of spaces, the synthesis of the data included the identification of the main activities commonly taking place within each type of space, across the sample sites, and within the literature examined. Activities included storage areas, animal housing areas, cooking areas, sleeping areas, social interaction areas, and others. The first three are of particular archaeological relevance. These activity areas were recorded and described in each of the three geographical regions, Lower Egypt, Upper Egypt and the Dakhleh Oasis.

Afterwards, in a similar process to that undertaken for the architectural features, the similarities and differences between the three regions for each type of activity area were analysed. The study included examinations of area access and room position relative to the rest of the structure. One

Site	Period	Area	Phase/ Level	Dynasty	Houses	Main sources
Giza	Old Kingdom	Kenthkawes Town (KKT)		4th	Houses A-K	Hassan (1943); Lehner et al (2006, 2009); Tavares (2008); AERA (2011)
Kahun	Middle Kingdom	Western town - workmen's houses		12th-13th	all (general descriptions)	Petrie (1890, 1891); David (1996); Quirke (2005)
		N wall: 5 large properties				
Elephantine	Middle Kingdom	South city of Chnum temple	XVb	Late 11th	H25b	Von Pilgrim (1996)
		South city of Chnum temple	XVa	Early 12th	H25a	
		North City	XIV	12th	H86	
		South city of Chnum temple	XIII	12th	H10, H12	
Lisht	Middle Kingdom/ SIP	North - Cemetery	IIa	13th	A.13, A.33	Arnold (1996)
Tell el-Daba	Middle Kingdom	F/I	stratum e	Early 12th/ late 13th	I/20: 5, 6, 7, 8	Czerny (1999)
	SIP	A/V	stratum E/1, D/3, D/2	15th	032-33, 056-59, 056-60, 081-83, 092-093, 173-176	Hein and Jánosi (2004)
Deir el Ballas	Late SIP	Houses by North Palace		Late SIP	House E	Lacovara (1990, 1996)
Memphis	New Kingdom	Kom Rabia: RAT	Level IV	Early NK	rooms 7/23, 8/9/22, 3/21, 2/7/14, 19/20/5/26/27, 24/6	Jeffreys (2006)
			Level III	18th		
			Level II	19th		
Amarna	New Kingdom	Main City		18th	Q47.23, N50.19, O49.14, N49.6, O47.8, N51.4, P47.6, Q46.2, Ranefer I and II	Borchardt and Ricke (1980); Kemp and Stevens (2010)
el-Ashmunein	TIP	Site W	level 1b, 2a, 2b, 3	22nd-25th	j.10 and k.10	Spencer (1993)
			levels 1c, 3	22nd, 24th, 25th	j.11 and k.11	
Karnak	TIP	East of Amon´s temple sacred lake	phase 1	21st	Houses I to VI	Anus and Saad (1971); Masson (2008); Millet and Masson (2011)

Table 1. Houses included in the ancient sample. This shows the sites, settlements, and specific houses included in the study, together with their bibliographical references.

of the aims of the analysis was to identify potentially recurrent associations between room types, and as these relationships could have included rooms on a second floor, the roofing of spaces was also studied, in order to learn how to identify areas that could have supported another storey above. These variations and relationships are both relevant from an archaeological point of view.

The analysis of the distribution and use of space included other aspects that are difficult to understand through the archaeological record, such as the use of open spaces.

Analysis of the surveys was made through the production of elevations and ground plans (AutoCAD drawings). Once all of the drawings were in the same format it was possible to analyse any possible variations and similarities in floor plans.

In order to evaluate and demonstrate the potential of the methodology developed, the next step was to examine a series of archaeological sites (Table 1), in light of the results of the study of modern mudbrick houses. This was achieved through the application of the method developed to the analysis of mudbrick house remains from a wide selection of dynastic era archaeological sites, from several different periods and areas, in order to maximize the number of variable combinations observable.

The interpretation of the compiled results drew on a synthesis of all the analyses made throughout the research. The main analytical processes can be summarised as follows: identifying the main contextual factors and their variations, extrapolating how those factors translate into specific material features, and analysing their influence on the distribution and use of spaces. This process resulted in the production of the accompanying interpretative tool which presents likely correlations between contextual factors and materiality, and which can aid survey and analysis standardisation in future excavations. It can be used as a reference tool and can aid with the interpretations of archaeological remains. Whilst the finished tool is yet to be systematically implemented across a full site, the application of the methodology on the aforementioned published sites has achieved some promising results[19] which support its future testing across full settlements and sites.

The analysis of the archaeological data in this way suggested that establishing general conclusions regarding the relations between houses in the sample, through time and across periods, is difficult, most likely because of the large number of factors involved and the degree of individuality expressed. For that reason, it is suggested that if we are to achieve a meaningful discourse, the necessary approach is first, to contextualize the site and settlement in question within its own period and location, secondly, to analyse the specifics of the settlement and the particularities of the community, and finally, and only once relative conclusions for each settlement have been established, will it be possible to compare settlements across different sites. Consequently, this approach combines, on the one hand, the exploration of cultural and individual diversity brought forth by the study of individual settlements, and on the other hand, it allows for the synthesis of studies between settlements that is necessary in order to develop a general discourse about ancient Egyptian houses.

That understanding informed the design of the underlying structure of the tool, which is constructed in three sections as described in the next section of this article.

Key principles and variables included within the tool

As has been described, by way of survey and study of modern standing mudbrick houses across various locations in Egypt, a number of variables were identified which would appear to

19 See Correas-Amador (2013) pp. 192-238 for the practical application to the houses on table 1 and conclusions regarding materials and features, and the distribution and use of space within them.

have influenced the physical characteristics of traditional Egyptian domestic architecture. When considered with respect to the ancient archaeological remains it was found that some of these variables had a clear correlation with the archaeological record, while others pointed towards unproved relations. In a number of cases there was no observed correlation between ancient and modern samples. In some of those cases, however, other features were present which suggested that such a correlation might indeed exist. Those variables were then included in the analytical system, even if no direct association was found in the archaeological record. Where no primary or parallel evidence was available, any potential correlation was excluded from the rationale.

These observed and potential relationships between the architectural parameters/variables were then used to design a digital tool that would encourage consideration of these relationships and potential relationships when surveying other archaeological sites and built structures. This will help develop understanding of the technical factors and cultural meanings that shaped the architecture being surveyed, in the future.

The analysis is, therefore, divided into three sections, which were incorporated in the tool design.

Section 1. Introduces elements of the settlement/landscape context that should be considered prior to the analysis of specific houses.

Section 2. Forms the core of the tool and provides a method of analysis and interpretation for the most common domestic architectural features found across both modern and ancient samples.

Section 3. Develops Section 2 further by suggesting elements that may be reasons for variation both within the settlements and between houses across different settlements.

Section 1 - Site Considerations

Section 1 refers to site and settlement/landscape characteristics which might have had an indirect effect on some of the variables contained in section 2, despite them hardly ever being obvious from the archaeological material. In some instances, these aspects can be identified by studying other districts within the site aside from the settlement containing the main population (i.e. palaces and temples which incorporate iconographic, epigraphic or material information), which provide contextual background for section 2. Understanding different site characteristics can assist when comparing houses from different settlements. Although some of these aspects seem obvious, they have often been overlooked when interpreting, and in particularly when attempting to compare, ancient Egyptian domestic architecture.

Factors such as the degree of isolation of a site, as well as its planned or organic nature, influence the design of houses. The literature regarding ancient contexts suggests that different degrees of political and cultural dependence or independence existed at different sites within the same periods. Proximity to or distance from central powers affects local economics and material production and could have also have affected architecture.

The reasons behind the original foundation of settlements, where known, should be considered when analysing the architecture in order to be able to evaluate the influence of global and local politics, economics and traditions. The site's chronological history and relation to other settlements within the landscape must also be understood.

Section 2 - Building Analysis

Section 2 is the core of the interpretative method and the tool as it contains the range of factors that can directly influence architectural features, as well as detailing the different ways in which

this influence can materialise. Such relations are explained through tags 'related to', 'subject to', 'modified by', 'encouraged by', 'not encouraged by' and 'enables'.

'Related to' suggests a link between the feature and the variable which can be more or less obvious but can manifest itself with different degrees of strength. That can be the case for example for windows, which are clearly primarily related to ventilation and light. Similarly, the number of floors is usually related to land availability, with houses tending to have more floors if the building space is limited, though this relation is not sine qua non.

'Subject to' indicates that the feature is likely to be directly and substantially modified by a certain variable when this is in operation. For example, sturdy roofs are subject to deposit formation over time, eventually making them difficult to distinguish from upper floors.

'Modified by' means that the variable consistently has an effect on the feature, as in the case of maintenance and repairs to walls, which will substantially modify the color of the bricks.

'Encouraged by' and 'not encouraged by' refer mainly to environmental factors which may or may not prompt the need for a certain feature, as is the case of rain, which encourages sturdy beamed roofs as opposed to weak, straw-piled roofs.

Lastly, 'enables' recognises that relationships between variables and features are bi-directional and that, in some cases, the features may actually prompt some of the processes present in the variables as well as vice versa. For example, the presence of an oven enables the action of cooking.

This section also encourages reflection on the function that features can have, for example decorative, practical, adaptive or structural. Bricks and mortar are structural as there would be no wall without them; render is practical in as far as it protects the wall even though it is not essential, and paint mainly has a decorative role which can often carry cultural connotations.

The section also considers the environmental variables that were identified through the research, and takes into account the natural processes affecting the archaeological remains after deposition.

Environmental variables have a direct effect on both the building material choices and the appearance and distribution of houses as a whole. Organic material requires constant maintenance for its preservation, due to it being subject to environmental erosion, however, its organic nature also means that it can be easily recycled, re-used and modified.

The particular distribution and use of space within a house is subject to several inter-related influences and should also be considered carefully. These include the cultural characteristics of the community, the resources available to the community, and the productive activities of the community in which the house is embedded. Changes in the demographic composition of the house´s inhabitants, their occupations, their social positions and beliefs, all have the potential to change houses over time, however, the fact that vernacular architecture is deeply rooted in local tradition should not be forgotten.

One of the most important contributions of the study of space in modern mudbrick houses was the development of an understanding of the distinction between intended function and subsequent use. It is important to note that, despite the fact that rooms might originally be designed with a certain function, this function usually changes through time; not only over long periods, but also at different times of the day, and of the year. A consequence of this is that certain rooms can be transformed or demoted from their original functions, for example, bedrooms can be transformed into animal storage areas. During the research, common activity areas were identified across houses which did not always correspond to Western-style dedicated rooms. Similarly, it is worth noting that not all use-changes leave a trace, and that ephemeral

issues such as privacy and gender divisions might occur and indeed shift without the need for an architectural correlation.

In addition to all of the previous factors considered, deposit formation over time and the action of the elements should always be considered when evaluating the reasons for the presence or absence of architectural features.

It is clear that, given the organic nature of mudbrick houses, their excavation and interpretation can bring specific challenges; for example, thick layers of deposits created as the result of repetitive maintenance of buildings can be mistaken for signs of long occupation. Distinguishing between the contents of a room, its fallen roof and any structures that were located above is also problematic. Similar remains can sometimes belong to different features; for example, wall remnants can be mistaken for roof and ceiling fragments and vice versa; ceiling beams can be mistaken for wooden beams used in walls as structural reinforcement, as the original lengths and diameters of wooden elements are usually badly affected by rot.

These erosion processes can also alter the dimensions of certain features, such as bricks, or even cause their total disappearance in some cases. These processes do not only occur in the long term, but also in the medium term, which is why regular maintenance is essential.

Section 3 - Variation Analysis

Finally, section 3 revisits possible reasons for variability within the same settlement and between settlements, based on the information obtained for each house, through consideration of the parameters outlined in section 2. Variation within the internal analysis of a settlement can be due to economic differences between houses, varying traditions, different household structures, and individual factors, but the characteristics of a settlement as a whole can also vary in comparison to others. This variation may be influenced, for example, by differences in local material availability, or local climatic conditions. Land availability also influences the degree of spread and density of houses in settlements through time, and should be considered a factor that may help explain variation between sites.

Operation of the Tool

The various sections of the tool can be accessed as interconnected pages of a PDF document. The tool is interactive, allowing users to be guided through the documentation process by clicking on the various menus. When placing the mouse over words in the PDF a small hand appears over those menus which lead to other related sections and pages of the tool. By clicking once, the user will be re-directed to the relevant related section where associated variables are listed. This interactive document could potentially be used on-site, in the field, on portable tablets, and used alongside more traditional clipboards with paper forms for recording results and relationships.

Some of the feature pages include a camera icon; the user can click on it to see examples illustrating that type of feature, and then click back to return to the original text page.

Ideally, the sections should be worked through consecutively in order to create a standardised record and analysis. A sample form may be designed and provided with the digital tool that can be used to record observations, help develop understanding of the factors and variables involved, and eventually identify possible relationships. Users are also encouraged to adapt and design forms for their own practical use, and are only asked to acknowledge the original source of the conceptual design.

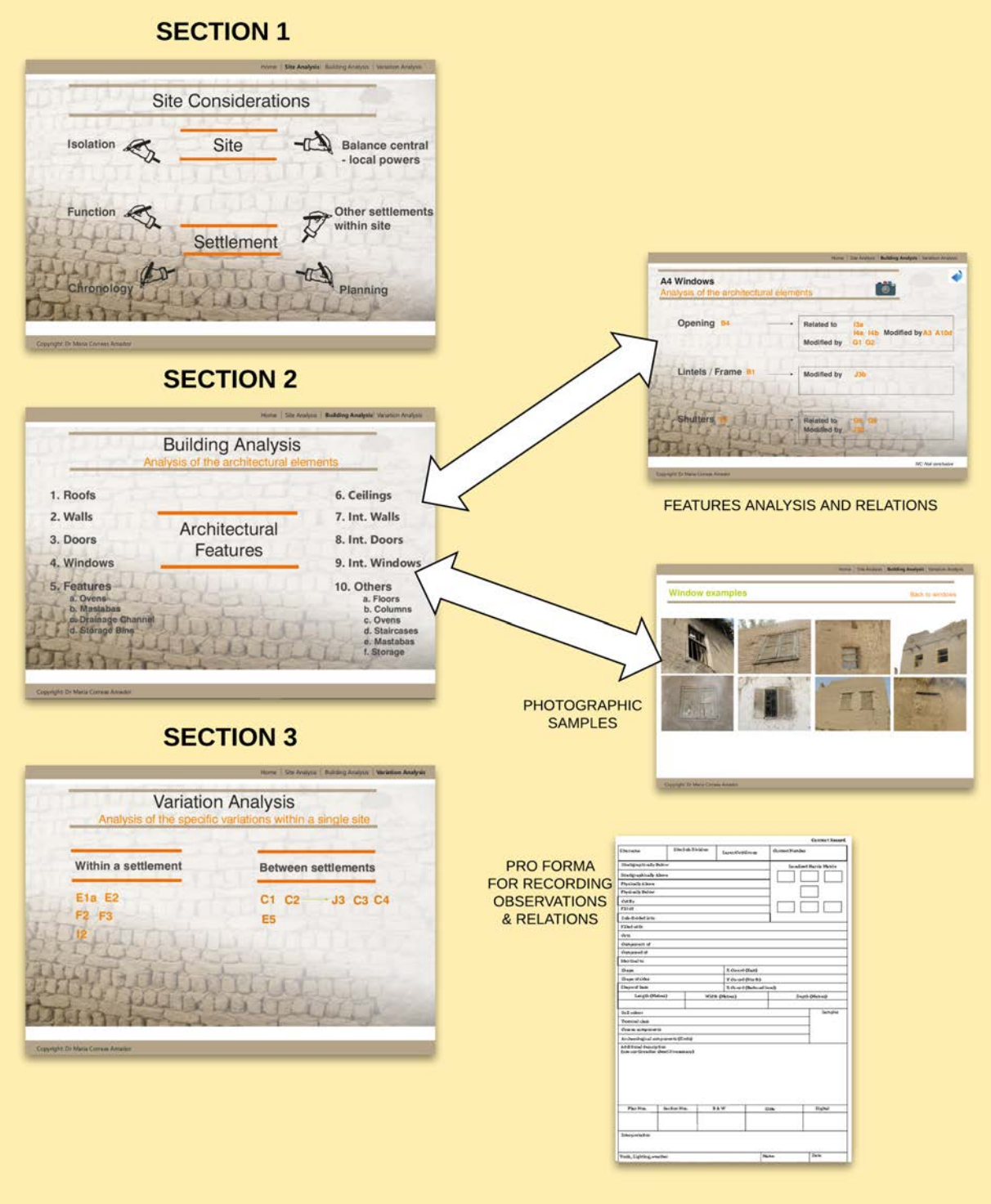

Fig. 1. Tool operation summary diagram.

Conclusion

Throughout the ethnoarchaeological study that preceded the creation of the tool, the complexity that characterises the manner in which humans modify their environment, and the material forms into which those modification translate, was revealed. The house, both in its ancient and modern forms, showed itself to be a canvas on which environmental, social, cultural, individual, and a myriad of other influences, are captured and displayed. When appropriately analysed, houses reveal the essences of the cultures that made them; precisely the insights that archaeologists want to gain from the study of ancient remains. Humans 'live' in caves, tents, and houses; and these capture everything that is to do with being alive. They embody relationships established with the world around and with other people in it.

This ethnoarchaeological study of mudbrick houses highlights the importance of a holistic approach to domestic architecture, and a change in focus from previous studies of domestic architecture is suggested. That change is articulated in the new theoretical and methodological approach described here, which has its practical manifestation in the accompanying tool.

In the first instance, it is hoped that this tool will provide a basic framework and become a starting point of reference for archaeologists involved in the excavation and study of ancient Egyptian domestic mudbrick remains. It cannot be emphasised enough that it is not designed as a static finished product, but rather as a system that should be expanded, modified, and developed as it is tested and tried by colleagues in the field, in a collaborative way. This will help promote a common methodological and conceptual workspace from which current and future researchers can benefit.

Moreover, the methodology upon which the tool has been built means that it can potentially be adapted to other Egyptian architectural environments, such as funerary or temple architecture. Furthermore, its consideration of environmental, sociocultural, community, and individual factors as universal variables influencing architectural development make it adaptable as an initial framework which can be applied to the study of architecture from other cultures and eras.

The realisation, no matter how problematic, that organic structures are dynamic entities which are subject to constant changes, is paramount for this type of archaeology. That the factors involved in such changes are manifold and often bi-directional is a natural corollary of such a realisation. Our research methods would be flawed if they did not attempt to mirror such a complex reality. In that respect, ethnoarchaeology has proved to be an essential tool in the process of achieving such a goal, as far as ancient Egyptian domestic architecture in concerned.

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Reviews

Gilles Dormion et Jean-Yves Verd'hurt, *La chambre de Snéfrou*, Actes Sud, 2016, 240 p., 72 fig., 17 ph., format: 24,5 x 1,4 x 14,5 cm, ISBN: 978-2330060909, 28 €.

Avec cet ouvrage, Gilles Dormion et Jean-Yves Verd'hurt entendent remanier et réformer l'ordre chronologique des trois grandes pyramides de Meïdoum et de Dahchour, ainsi que leur attribution traditionnelle au pharaon Snéfrou. Cette démarche les amène à réinterpréter les aménagements de la pyramide rhomboïdale de Dahchour-Sud et à tenter de démontrer l'existence insoupçonnée d'une troisième chambre.

Les auteurs dressent en avant-propos (pp. 17-19) le cadre de leur étude et définissent les quelques lignes qu'ils ont pris le parti de suivre dans leurs recherches. Ils expriment ici une réserve quant au symbolisme souvent invoqué par l'égyptologie pour expliquer telle ou telle fonction d'un édifice en tout ou partie. Il n'est selon eux 'souvent qu'incident'(p. 18) et prennent comme exemple le cas des voûtes en chevrons des 5e et 6e dynasties décorées d'étoiles dont la signification symbolique ne serait que secondaire.[1] Si la remarque peut se trouver occasionnellement justifiée, les Égyptiens ont en réalité cherché continuellement à concilier les aspects fonctionnel et symbolique, l'un ayant pu influer sur l'autre et inversement.

Dans ce préambule, les auteurs estiment que l'étude des pyramides ne requiert aucune connaissance épigraphiste savante (p. 19), laissant présager une démarche qui vise à minimiser à priori la documentation écrite.

En première partie (pp. 21-52), Dormion et Verd'hurt commencent par présenter brièvement le pharaon Snéfrou et la problématique que soulève un projet de construction de trois grandes pyramides durant son seul règne (Meïdoum, Dahchour-Sud et Dahchour-Nord).[2] Dès le premier paragraphe, ceux-ci évoquent une chronologie soi-disant 'officielle' quant à l'ordre dans lequel elles furent érigées. Ce prétendu consensus s'appuierait tout d'abord sur les nombreuses marques de chantier relevées à Meïdoum et à Dahchour et plus particulièrement sur celles comprenant des dates (en fait des numéros de compte du grand recensement annuel ou biannuel). À ce sujet, les auteurs n'évoquent que celles comprises entre les 12e et 23e comptes en ce qui concerne Meïdoum (p. 22). Or, une étude récente avait amené à réviser la lecture de certaines d'entre elles en ajoutant un 7e et un 8e compte au dossier.[3]

La disposition en assises horizontales ou inclinées est brièvement commentée pour chaque monument. Le tronc supérieur de la pyramide rhomboïdale est ainsi décrit comme étant disposé en assises horizontales, ce qui va à l'encontre de ce qu'a relevé Howard Vyse en cet endroit particulièrement difficile d'accès, c'est-à-dire des rangées inclinées de 3°30' en moyenne.[4]

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1 Si la fonction structurelle des ces organes est évidente, il serait toutefois excessif de dénigrer l'importance de leur aspect. Ce dernier a subi une évolution très marquée durant les règnes de Snéfrou et Khéops. Nous avons mis en évidence la valeur de leur signification et particulièrement celle des voûtes en chevrons qui, malgré l'efficacité mécanique et la qualité esthétique de la voûte en encorbellement, a fini par la supplanter définitivement après le règne de Khéops (Monnier (2011), pp. 84-89; Monnier (2017a), pp. 202-203; Monnier (2017b)).

2 La documentation et les témoignages archéologiques militent en faveur d'une attribution des trois pyramides à Snéfrou. Un courant attribue cependant la pyramide à degrés initiale de Meïdoum au pharaon Houni (on lira la synthèse : Monnier (2017), pp. 64-111).

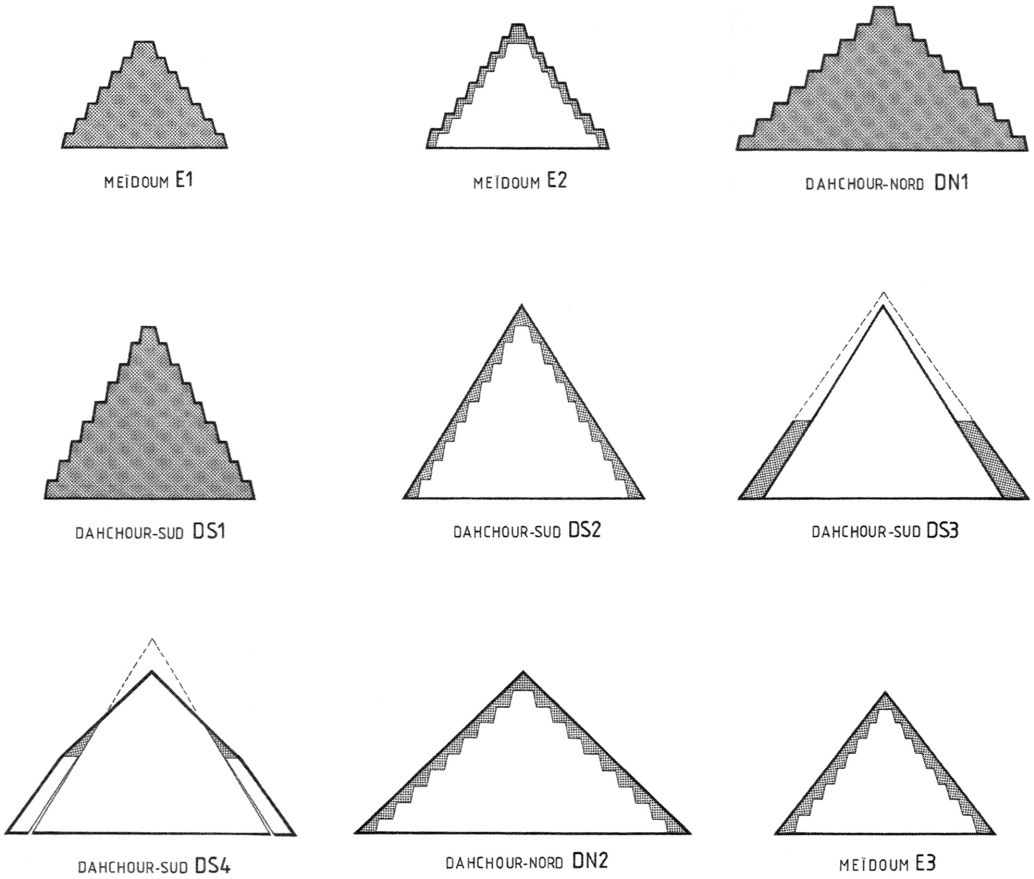
3 Verner (2008), pp. 25-26.

4 Vyse (1842), p. 66.

Les volumes des pyramides sont ensuite évoqués pour illustrer la chronologie 'officiellement' admise. On observe un accroissement selon un ordre Meïdoum/Dahchour-Sud/Dahchour-Nord/Khéops. Cet élément de comparaison comme argument pour justifier l'ordre des constructions est remis en cause. Ainsi, la hauteur pourrait être un facteur tout aussi (voire plus) déterminant en considérant tous les projets, achevés ou non (p. 26). Un autre argument invoqué par Dormion et Verd'hurt est celui de la portée des voûtes mises en œuvre qui, selon leurs termes, constituerait 'un critère indéniable de progrès' (p. 32). C'est tout particulièrement celui-ci qui contraindra les auteurs à refondre complètement au fil des pages l'attribution des pyramides discutées ici, ainsi que l'ordre de leur construction. Autre élément de progrès selon eux, et toujours en rapport avec les voûtes en encorbellement, serait la disposition en tas de charge sur les quatre pans des assises à Dahchour-Sud alors qu'elles ne figurent que sur deux pans à Meïdoum et Dahchour-Nord. Dahchour-Sud serait ainsi pour toutes ces raisons à repositionner chronologiquement entre Dahchour-Nord et la Grande pyramide de Khéops à Giza. Mais ils éludent sans la citer la voûte en encorbellement sur deux pans de la pyramide satellite de Dahchour-Sud qui, en ne s'inscrivant pas correctement dans ce schéma, entre en pleine contradiction avec leur conclusion (p. 35).

Le chapitre se poursuit par une synthèse incluant une petite discussion sur la manière dont ont pu être bâties les pyramides. Là encore, Dormion et Verd'hurt admettent comme une évidence qu'elles ont été érigées en deux phases consécutives : un noyau interne à degrés d'abord, un enrobage externe ensuite (p. 36), ce qu'aucune preuve ne permet toutefois d'imposer.

Les auteurs en arrivent ainsi à exposer le fruit de leur réflexion et renversent l'ordre classique des pyramides attribuées traditionnellement à Snéfrou : Meïdoum E1 (à degrés), Meïdoum E2 (à degrés), Dahchour-Nord 1 (à degrés), Dahchour-Sud 1 (à degrés), Dahchour-Sud 2, Dahchour-Sud 3, Dahchour-Sud 4, Dahchour-Nord 2, Meïdoum E3.



Chronologie de construction des pyramides attribuées traditionnellement à Snéfrou proposée par Gilles Dormion et Jean-Yves Verd'hurt (d'après la figure 15 de leur ouvrage).

Nous notons que les pyramides satellites de Meïdoum et Dahchour-Sud sont purement et simplement écartées de la réflexion. C'est dommageable en ce sens que la dernière d'entre elles au moins dispose de caractéristiques qui ne pèsent pas en faveur de la thèse développée dans ce livre, en l'occurrence une structure dépourvue de degrés internes et, ce qui importe pour la suite, une voûte à encorbellements disposés sur deux pans.

Pour soutenir leurs conclusions, Dormion et Verd'hurt prétendent que Snéfrou n'aurait pu accomplir l'exploit d'édifier durant son seul règne de 24 ans trois grandes pyramides dont le volume total représente 3 752 600 m^3, là où Khéops, dont l'œuvre est censée représenter un paroxysme, n'avait pu accomplir qu'une pyramide d'un volume de 2 590 000 m^3 en 23 ans (p. 40). L'argument serait sans doute recevable si les durées de règnes avancées étaient effectivement exactes. Sans entrer dans la complexité des débats touchant aux dates du règne de Snéfrou,[5] nous pouvons désormais tenir comme certain que ce roi régna en fait entre 29 ans et 48 ans[6] et Khéops, au moins 26 (sans doute 27).[7] Nous avons souligné par ailleurs qu'un simple calcul de proportionnalité sur la base des données apportées par l'œuvre de Khéops pouvait accorder à Snéfrou d'avoir élevé ces trois grandes pyramides en une quarantaine d'années.[8] La pyramide de Khéops ayant toutefois des spécificités techniques autrement plus contraignantes, ce chiffre pourrait certainement être encore revu à la baisse. Les durées de règne actuellement encore débattues mais relativement bien encadrées ne sauraient donc remettre en question la faisabilité d'un tel chantier sous Snéfrou. Malheureusement, ces graves erreurs entraînent les auteurs à réattribuer une partie de ces réalisations à un autre pharaon pour réévaluer à la baisse un volume bâti plus conforme à leur appréciation. La sépulture d'Houni n'ayant pas encore été à l'heure actuelle localisée, celle-ci est tout indiquée, selon eux, pour être l'une au moins des trois affectées traditionnellement à Snéfrou (p. 43). Ce seul élément d'information les mène à désigner Houni comme le responsable de, non seulement la pyramide à degrés initiale de Meïdoum, mais aussi d'une hypothétique pyramide à degrés initiale à Dahchour-Nord, tout cela pour ramener la production de Snéfrou 'à un niveau acceptable' au regard de celle de Khéops (p. 48).

Un tel chamboulement ne peut, convenons-en, que soulever un grand nombre de questions et la place manquerait ici pour discuter les réponses possibles que les auteurs tentent d'apporter, tant elles ont davantage à voir à des lignes d'un scénario compliqué qu'à une véritable réflexion scientifique (à titre d'exemple : 'Snéfrou avait réellement l'intention d'occuper un monument de son prédécesseur, mais Khéops refusant d'être l'exécutant d'un tel sacrilège serait passé outre les dernières volontés de son père en l'inhumant, comme il se devait, à Dahchour-Sud' (p. 52)).

Le second chapitre (pp. 53-74) s'attache à décrire et à comprendre la superstructure, c'est-à-dire la pyramide rhomboïdale proprement dite. Les appartements seront décrits aux chapitres suivants.

D'entrée de jeu, Dormion et Verd'hurt opposent les différents courants de point de vue qui tentent d'expliquer la forme en double pente très inhabituelle du monument, en critiquant avec raison l'approche symbolique que certains commentateurs invoquent trop facilement sans preuve dans ce cas précis. Pour les auteurs, la forme rhomboïdale est la conséquence d'incidents et de changements de projets durant la construction. La chronologie du chantier qu'ils proposent se démarque pourtant de celles que certains égyptologues avaient pu esquisser sur la constatation de fissures et de dégradations dans les deux chambres.[9] Ils remettent en question un supposé enchaînement d'évènements qui consiste à expliquer le brusque changement de pente par une volonté des Égyptiens de diminuer la masse pesant sur des appartements menaçant de s'effondrer (pp. 53-54). Même amenuisé, l'accroissement était en effet toujours réel. Et on ne peut admettre que les constructeurs aient continué sur cette voie après avoir évalué des risques d'effondrements ou de catastrophes au sein de l'édifice.

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5 Monnier (2017a), pp. 106-111.

6 *Ibidem.*

7 Notamment depuis la découverte d'une inscription au sud-ouest de Dakhla (Kuhlmann (2002), p. 138, fig. 10). On ajoutera à ce document les désormais célèbres papyrus découverts au Wadi el-Jarf en 2013 et sur lesquels on trouve cette même mention de l'année qui suit le 13e recensement (tous les articles parus depuis leur découverte sont référencés dans Tallet (2017)).

8 Monnier (2017a), p. 111.

9 Edwards (1992), p. 105; Vyse (1842), p. 68; Verner (2001), p. 177.

Les auteurs réitèrent ce qu'avaient pu établir les architectes italiens Vito Maragioglio et Celeste Rinaldi quant à l'ajout d'une épaisse enveloppe externe de maçonnerie appareillée en assises déversées,[10] expliquant ainsi l'existence de fractures et de joints-'ceintures' relevés dans les premiers tronçons des descenderies nord et ouest. Une première pyramide (les auteurs affirment qu'elle fut achevée) aurait donc été construite avec des faces fortement inclinées, puis agrandie en une pyramide avec des pentes plus douces (p. 62). Maragioglio et Rinaldi avaient pu reconstituer la première avec des faces inclinées de 60°.[11] Mais le géomètre Josef Dorner, après avoir effectué un nouveau survey des lieux dans les années 80,[12] avait mystérieusement décidé d'opter pour une pente de 57° à laquelle nous avons par ailleurs opposé des objections argumentées.[13] C'est cette dernière mesure que Dormion et Verd'hurt ont apparemment pris le parti de retenir (en fait 58°), tout en citant d'une manière contradictoire le raisonnement des architectes italiens. Les auteurs expliquent les fractures au droit des entrées originelles comme les traces et les conséquences d'un ripage de l'enveloppe dont les fondations ont été mal établies, une conclusion à laquelle nous sommes également parvenu. Avec quelques nuances cependant, puisque la pathologie du couloir issu de l'entrée ouest nous enseigne que le tronçon le plus en amont ne marque pas un affaissement comme dans la descenderie issue de l'entrée nord. C'est au contraire toute la partie en aval du couloir qui s'est affaissée de quelques centimètres.[14] Dormion l'avait bien noté étant donné que cette singularité, déjà relevée par Maragioglio et Rinaldi,[15] apparaît sur ses plans et coupes parus dans un ouvrage antérieur.[16] Ces mêmes plans sont aussi présents dans l'étude qui fait l'objet de ce compte-rendu, mais la particularité a curieusement été supprimée (fig. 21, p. 59). Les auteurs citent pourtant dans le texte ce léger différentiel (p. 66), mais sans en préciser le point de référence, ce qui laisse présumer qu'il s'agit simplement d'un tassement de l'enveloppe externe. Ce point d'une importance pourtant capitale nous a permis de déterminer que le premier projet n'avait pas été mené à son terme avant l'ajout de l'enveloppe de maçonnerie.[17] Ce comportement de la structure trouve en effet son explication dans l'adjonction ultérieure de la moitié supérieure du monument qui, en raison du déliaisonnement continu entre le massif et l'enveloppe externe, n'a pu propager ses charges de manière égale au travers de ces deux parties. Le massif interne s'est donc davantage tassé au fur et à mesure de l'élévation des assises. Par voie de conséquence, les plus hautes d'entre elles ne pouvaient encore exister au moment où le projet fut modifié, ce qui va à l'encontre des opinions et conclusions des auteurs.

La dernière partie du chapitre est une digression visant à expliquer l'existence des conduits dits 'de ventilation' dans la pyramide de Khéops.

L'ensemble des chapitres suivants, du troisième au neuvième (pp. 75-178), sert à décrire avec force détails les appartements de la pyramide rhomboïdale. Cette partie est assurément la plus approfondie. Et même si la majorité des informations sont à porter au crédit de Maragioglio et Rinaldi, on ne peut que saluer les talents de dessinateur de Gilles Dormion pour faciliter la compréhension de dispositifs pour le moins complexes et inhabituels. Les propos sont agrémentés de précisions et de constatations faites par les auteurs eux-mêmes, tant sur l'architecture que sur la pathologie.

Le réseau de couloirs et de pièces est bipartite : les appartements inférieurs et les appartements supérieurs reliés à un stade tardif par un boyau de liaison que Dormion et Verd'hurt supposent être un accès pour inspecter l'état de la chambre supérieure après la condamnation de la descenderie issue de l'ouest (p. 84).

La diversité des fractures et des mouvements de maçonnerie ponctuant la distribution mène les deux chercheurs à énoncer deux types de sinistres : le premier, endogène, est relatif à la qualité très hétérogène des matériaux employés et le second, exogène, est consécutif à la méthode de construction de l'enveloppe externe (p. 111).

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10 Maragioglio et Rinaldi (1964), pp. 98-100 (obs. 10).
11 *Ibidem.*
12 Dorner (1986), pp. 55-57, figs. 4-5.
13 Monnier et Puchkov (2016), p. 30 et n. 55; Monnier (2017a), pp. 94-95 (et n. 68).
14 Maragioglio et Rinaldi (1964), pp. 66-68, tav. 13; Monnier et Puchkov (2016), p. 19, figs. 11-12.
15 Maragioglio et Rinaldi (1964), pp. 66-68, tav. 13.
16 Dormion (2004), pp. 56, 58 (fig. 4).
17 Monnier et Puchkov (2016), p. 32, fig. 14.

C'est un point que nous partageons complètement.[18] Notre opinion diverge cependant quant aux détails des dégradations ayant affecté les chambres et les mesures mises en place pour les maîtriser. Nous y reviendrons.

Après s'être attardée sur l'appartement inférieur dont l'impasse de la cheminée trahit un premier projet abandonné, la description chemine ensuite de l'entrée occidentale au débouché du couloir horizontal. Les auteurs jugent la descenderie en bien meilleur état que celle issue du nord (p. 127), ce qui entre en contradiction avec nos propres constatations. Celle-ci s'avère en réalité gravement endommagée.[19]

De nombreuses interrogations sont posées au sujet du couloir horizontal dont certaines particularités échappent encore à la compréhension des auteurs (pp. 139-144).

Le boyau de liaison est ici pour la première fois décrit dans le détail avec des vues en plan et en coupe qui viendront compléter celles de Maragioglio et Rinaldi (pp. 145-156). Les passages aux herses sont traités de manière égale avec une proposition plausible de mise en œuvre (pp. 129-139).

La chambre supérieure recueille une attention toute particulière (pp. 157-178) et cela se comprend aisément au vu de sa complexité. Pour débuter, les auteurs notent que celle-ci s'avère beaucoup moins haute que ce qu'indiquent les anciens relevés. Selon eux, la pièce n'afficherait que quatorze encorbellements (p. 168) pour une hauteur de seulement 13,90 m au lieu des 16,50 m attendus[20] (p. 162). Nous avons nous-mêmes effectué des mesures qui divergent de celles prises par Ahmed Fakhry, mais d'une manière moins sensible. Nous ne saurions écarter qu'elles puissent être dues à des visées imprécises du télémètre laser. Il est en effet très difficile de discerner le faîte de la voûte, et un rondin disposé de travers à cet endroit peut fausser les mesures. Quoi qu'il en soit et bien que nous ayons comptabilisé quinze encorbellements,[21] ces divergences appellent à de nouveaux relevés complets et précis de cette chambre (photogrammétrie).

En ce qui concerne l'état déplorable de la voûte (pp. 167-169), les auteurs énoncent deux hypothèses : soit la dégradation s'est déroulée sur plusieurs millénaires, soit elle eut lieu juste après la construction ('les blocs commencèrent à pleuvoir'). Dans le premier cas, les débris auraient recouvert le massif. Que Fakhry n'en souffle mot signifierait selon eux qu'ils aient été ôtés par les constructeurs. S'il est vrai que Fakhry n'en dit rien, il est par contre faux d'en déduire qu'il trouva le sommet du massif vierge de toute blocaille. Une photo prise avant les dégagements entrepris par Abd Essalam el Hussein en 1946 montre très clairement un important tas de pierrailles issues de la voûte.[22]

La pièce avait été comblée jusqu'à un peu moins de la mi-hauteur par un massif appareillé en blocs de moyen appareil (pp. 165-167), noyant dès lors une structure charpentée en cèdre du Liban.

Les auteurs désapprouvent avec raison l'interprétation qu'ont pu exposer de nombreux égyptologues au sujet de cette ossature en bois.[23] Celle-ci ne pouvait servir à retenir les murs d'un édifice prétendument devenu instable, sous peine de céder et de se briser littéralement sous l'influence de forces considérables.[24] Nous ne saurions toutefois partager leur point de vue lorsqu'ils lui accordent une fonction utilitaire en tant qu'aménagement funéraire destiné à recevoir des plateformes (pp. 174-177). Comme les auteurs le signalent eux-mêmes, les madriers mis en traverse ne sont que littéralement coincés entre des montants verticaux. Aucun tenon, aucune mortaise ni aucune cheville ne viennent solidariser fermement cet ensemble comme il se devrait s'il était destiné à soutenir des charges. De plus, les pièces de cèdre du Liban affichent des sections très variables, tout en ne respectant pas l'horizontalité indispensable à un plancher. Cette reconstitution s'est imposée à eux en corrélant la chambre supérieure avec la chambre inférieure dans laquelle des indices tendent à montrer que des madriers y ont aussi été installés, puis ensuite démontés (pp. 106-109). Les caractéristiques que nous venons de souligner écartent l'éventualité de tels aménagements qui ne trouveraient

18 Monnier et Puchkov (2016).
19 Monnier et Puchkov (2016), p. 34, fig. 15.
20 D'après Fakhry (1959), p. 52.
21 Monnier et Puchkov (2017), p. 60 (n. 2).
22 Garnons Williams (1947), p. 305 [fig. 9]; Monnier (2017b), fig. 7.
23 Edwards (1992), p. 105; Verner (2001), p. 177.
24 Monnier (2017a), pp. 90-91.

aucun équivalent dans l'architecture funéraire. Tout indique plutôt qu'il s'agit d'éléments de construction visant à soutenir les blocs et les encorbellements lors de l'élévation des murs et des voûtes.[25] Les poutres se déclinent en deux types qui n'ont pas échappé aux auteurs : encastrées dans les parois opposées ou bien seulement coincées en étau. Les premières, typiques des espaces sous voûtes uniquement, devaient accueillir des plateformes de travail afin d'exécuter les opérations de finitions. Les secondes, que l'on trouve disposées dans le volume entier de la chambre, ne pouvaient agir qu'en tant qu'étrésillons lors de la pose des blocs.

L'ajout du massif de maçonnerie serait, selon eux et en suivant cette fois-ci l'opinion générale, consécutive à une faiblesse de la structure (p. 157).

La suite est pour le moins très conjecturale. Partant du principe que les chambres supérieure et inférieure possédaient toutes les deux des structures charpentées, les auteurs en déduisent qu'elles possédaient un rôle analogue et ôtent par voie de conséquence à la première d'entre elles son caractère funéraire (p. 177). Cette déduction semble être confortée par le fait que l'accès est resté libre jusqu'à nos jours, herse relevée (p. 180). C'est ce raisonnement qui les conduit à imaginer l'existence d'une chambre funéraire dissimulée.

La chambre supérieure aurait sans doute mérité une observation plus fine car les auteurs n'ont pas remarqué que les modifications subies avaient en réalité un autre but que de contrecarrer une faiblesse de la structure. Comme nous l'avons mis en lumière récemment, le sol a été surélevé par deux fois à l'aide d'un massif soigneusement appareillé et recouvert d'un dallage soigné.[26] À chaque modification, les encorbellements ont été retaillés afin d'offrir à la chambre des parois relativement planes. Ceci ne peut donc être la marque d'un abandon ni d'un défaut structurel grave.

Dormion et Verd'hurt, après analyse de plusieurs options, concluent à l'existence d'une grande pièce accessible par le sol au nord de l'actuelle chambre supérieure (pp. 179-195). À une accumulation d'hypothèses s'ajoute ainsi le paradoxe d'une chambre abritant toujours le corps de Snéfrou dont l'accès aurait été empêché – soulignons-le – par la présence du massif ajouté.

Des résultats de relevés micro gravimétriques sont exposés en fin d'ouvrage et semblent confirmer leurs conclusions (chap. XI, pp. 197-204).

Si ces résultats sont corrects, un important volume vide serait localisé entre la 'cheminée' et la chambre supérieure. Toutefois, il est important de noter que la détection par muographie réalisée par la mission *Scan Pyramids* en 2016 ne les a pas confirmés.[27] Ce type de mesures est tributaire des conditions imposées avant la modélisation et ces dernières sont fixées par nos connaissances limitées du milieu, c'est-à-dire les caractéristiques des matériaux (type de calcaire, taille et hétérogénéité des blocs) et de la construction (tranches, assises déversées ou non, présence de caissons possibles ?).[28] Dans ce contexte d'incertitude, ce type de résultats est loin d'être infaillible.

L'ouvrage se termine par un court chapitre consacré à la pyramide 'Rouge' et à certaines de ses particularités (chap. XIII, pp. 207-214).

Si de nombreux arguments sont exposés tout au long de l'ouvrage afin d'appuyer les propos, des conclusions sont formulées sur la base d'informations non exemptes d'approximations, voire d'erreurs. On remarquera la prise partiale de critères d'analyse que les auteurs ont trop tendance à considérer comme des preuves, en l'occurrence l'accroissement de la hauteur des monuments et de la portée des voûtes.

De notre point de vue, les auteurs s'égarent en voulant répondre à la nouvelle chronologie proposée et ne savent échapper à certaines contradictions. Sans aucun élément de preuve, Houni est supposé être le maître

25 Monnier (2017a), p. 92 (n. 60).

26 Monnier et Puchkov (2016), pp. 21-24.

27 Les premiers résultats ont été publiés en ligne sur http://www.sciencesetavenir.fr/archeo-paleo/archeologie/20160427.OBS9346/le-coeur-d-une-pyramide-scanne-grace-aux-muons.html [consulté le 20 mai 2016].

28 On peut admettre comme une hypothèse plausible que pour économiser du temps et du matériau de construction, la structure ne soit pas constituée uniquement de gros blocs appareillés.

d'œuvre de la pyramide 'Rouge', peu satisfait de la chambre de la pyramide de Meïdoum (p. 50),[29] en dépit des témoignages antiques désignant les deux pyramides de Dahchour comme faisant partie d'un seul et même complexe appartenant à Snéfrou : '[Les deux pyramides] Snéfrou apparaît'.[30]

La description architecturale que nous offre cette étude n'est pas sans intérêt, loin s'en faut. Mais elle ne peut s'imposer comme une référence en raison de ses lacunes et de ses faiblesses. La descenderie occidentale aurait mérité plus d'attention, mais surtout la chambre supérieure qui occupe pourtant une position déterminante dans l'argumentation.

La progression des idées repose pour ainsi dire sur une accumulation de conjectures que bien peu de faits viennent consolider pour la rendre réellement convaincante.

Cet ouvrage se veut disruptif par tout ce qu'il remet en question et par le bouleversement qu'il ambitionne. Mais des compétences architecturales seules ne peuvent suffire à refondre l'histoire et la chronologie du début de la IVe dynastie. Si nous admettons bien volontiers qu'elles tiennent une place primordiale, sous-estimer la documentation textuelle ou iconographique revient à se priver d'un lot d'informations historiques capitales pouvant valider ou non les hypothèses formulées. Cette approche pluridisciplinaire aurait permis aux auteurs de corriger des informations erronées qui, fort malheureusement, ont eu de fâcheuses conséquences sur leur raisonnement et leurs conclusions.

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29 Ils ont pourtant tenté de démontrer très récemment qu'une autre chambre (la véritable chambre funéraire) restait à découvrir dans cette même pyramide (Dormion et Verd'hurt (2013)).

30 Dont le fameux décret de l'an 21 du règne de Pépi Ier (Borchardt (1905), pp. 1-2).

Errata

in D. Mazzone, 'The Dark Side of a Model Community: The "Ghetto" of el-Lahun', bibliography:

Bussman – is Bussmann
De Marrais – is DeMarrais
Fisher, H.G. – is Fischer, H.G.
Griffiths, A. S. – is Griffith, A.S.
Hoffman, H. (1980) is Hoffman, M.A. (1980)
Hoffman, H. (1984) is Hoffman, M.A. (1980)
Hoffmann, M.A. *et al.* (1986) is Hoffman, M.A. *et al.* (1986)
Tuffnel – is Tuffnell