

About the planning of the apartments of the pyramids

Abstract

Drawing on the data established by archaeologists, this analysis of major pyramidal apartments has revealed a common modular design of modern conception, based on the repetition of square modules of identical dimensions, which makes it possible to assume the existence of planning archives. On the basis of such research, we learn that the main point of the design and of its application on the building yard was represented by the intersection of the entry corridor with the ground line. An even more exact correspondence between the abacus and all the measures of the apartments in the Pyramid of Chefren is a definitive confirm of this hypothesis, which demonstrates that the actual structure is the result of incidental necessity. As such modularity of design exists in all the pyramids having apartments in the external structure, while it is vague in those with the apartments under the ground level, we conclude that only in the first case it was essential to have an extremely exact design.

Riccardo Manzini

During the preparation phase for the volumes related to Giza and Dahshur necropolis in my updating and completion of the work by Rinaldi and Maragioglio, I have noticed that in all the most important pyramids there is a recurrence in the measurements taken by the archeologists for some of the data, which is so frequent that it cannot be casual, and is clearly referring to the grid already in use for the harmonic creation of drawings and hieroglyphic writings.

Therefore, re-examining the data and the measurements of the pyramids of the Ancient Kingdom provided by the archeologists, and bearing in mind this observation, I realized that some apparent abnormalities, such as the presence of the otherwise inexplicable step placed at the top of the Grand Gallery of the Cheops pyramid, seem to be understandable.

From this comparison, I hypothetically deduced that there was an identical plan of modular design (abacus), through which it was possible to proceed quickly and easily with the final design, by simply adapting it to the desired composition. Having defined this theoretical scheme, I reversed the point of view, trying to re-design these apartments starting from the abacus, and I surprisingly obtained measurements so close to the ones identified by the archeologists, that they could be resulting from minimal construction errors, unless they are not due to survey errors.

The fact that the few detected contrasting measures are the result of plausible building errors, seems to be indicated by the possibility to express the data obtained from the supposed theoretical project through simple and total angular dimensions and ratios according to the Egyptian system, different from the ones reported by the authors, which are not always univocal.

As I said, I came to this surprising conclusion by analysing several canonical pyramids, but even if the general results were pretty impressive, in the pyramids of Cheops and Chephren they are so evocative that they suggest the existence of an identical extendible architectural module, already present, although in a more uneven form, in the pyramids of Snefru.

Standard Module

What emerged from this analysis is that the planners for the major stone pyramids used a pattern similar to our graph-paper, but based on square modules with a side of 42 cubits or their sub-multiples.

This planning system, which reached its perfection in the Cheops and Chephren pyramids, is obviously the fruit of progressive refinement which can already be noticed in the pyramidal Complexes of Snefru, although with an understandably lesser concordance.

An example [figure 1] is the rationalization of the measures obtained in the Southern Complex

of Snefru according to the suggested scheme, which are exactly coinciding with 14 cubits modules (whole submultiples of the 42 cubits module), while in the articulated apartments of both pyramids of this king these concordances are present, but less frequent, although progressively improved in the Northern building.

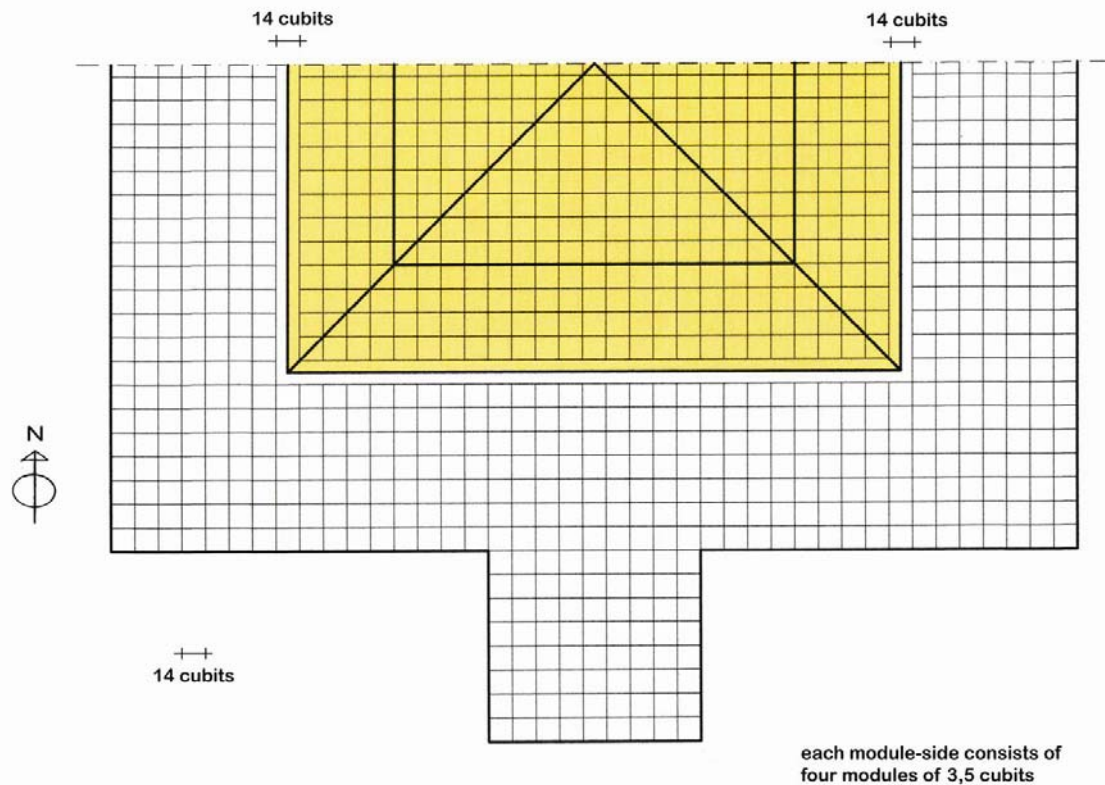


Figure 1 – Modularity deduced in the Southern Complex of Snefru

We can see that when we divide each module by whole square sub-multiples of 3,5 cubits per side, even the few details which are foreign to the main scheme find their place. It is quite significant that a modularity of 3,5 cubits is present in almost all the pyramidal Complexes of the Ancient Kingdom and has also been found by Arnold in the pyramid of Senwesert III in Dahshur¹ and Wegner in the Southern temple of the his Cenotaph in Abido².

A brief but significant first confirmation of this modularity [figure 2] can be found in the inclination of the non horizontal corridors of all the pyramids, which are referred to by the authors with variable data, but that are always included between 25°-27°, except for some usually understandable rare particular cases. I think that, using the suggested modularity, these components would result in being the diagonals of “perfect” rectangles, since the resulting inclination is 26°,56 equivalent to a simple Egyptian ratio of 1 every 2, while the suggested widths are solely expressable with approximate or fractional ratios.

¹ D. ARNOLD, *The pyramid Complex of Senwosret III at Dahshur*, Architectural Studies, New York 2002.

² J. WEGNER, *The mortuary temple of Senwosret III at Abydos*, New Haven and Philadelphia, 2007.

It's important to highlight that Dorner's recent tests regarding the descending corridor of Snefru's northern pyramid³ indicate a precise degree of slope of 26°,56, exactly the same as the one theoretically deduced.

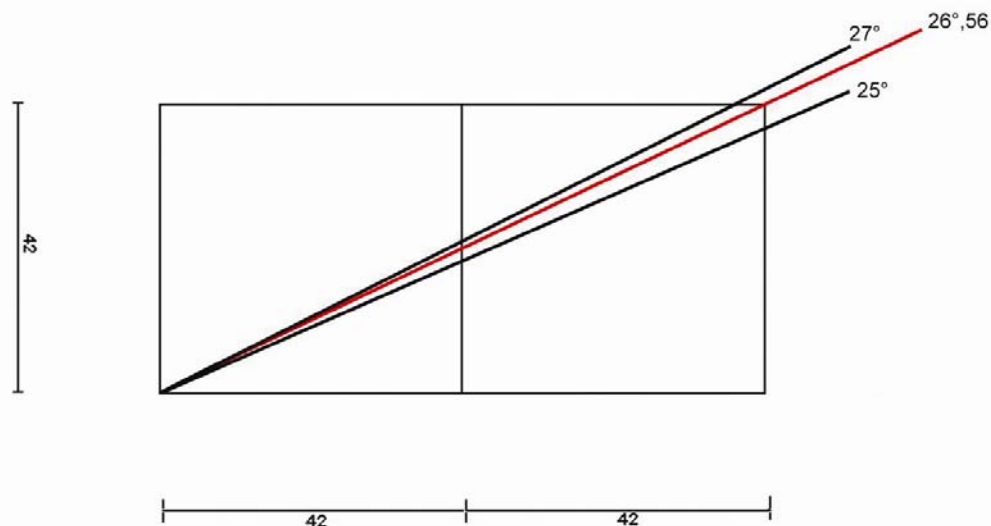


Figure 2 – Comparison between the slopes calculated and that theoretical of the descending passages of the pyramids

Cheops

I'll now give you a brief illustration of the relationship between the apartments of the Cheops pyramid and the deduced scheme [figure 3], setting aside the application of the modular scheme to the apartments of the Snefru pyramids, which is present but not so meaningful in the light of the new perspectives that appeared after the correction of the measures made by Dorner⁴.

Cheops pyramid is the maximum expression of Egyptian architecture of the time, but it also represents the most sophisticated evolution of the modular planning project found in the two previous pyramids, since it has a nearly perfect correspondence to the module with a side of 42 cubits.

Starting as usual from the data supplied by scholars⁵, in this building almost all the measures reported appear to be very close to the ones obtained using a grid of 42 cubits and most of the characteristic points correspond to the ones of the theoretical squares.

So, simply considering that the inclinations of both corridors **AB** and **ΣC** were the same, namely 26°,56 equivalent to the 1 every 2 ratio, we could obtain an almost total coincidence between most of the parameters calculated by the authors and the ones derived from my theoretical analysis. However it should be noticed that Rinaldi and Maragioglio indicate⁶ an inclination for

³ Detailed excavation report currently in the author's archive (unpublished).

⁴ op.cit.

⁵ V. MARAGIOGLIO, C. RINALDI, *L'architettura delle piramidi menfite, parte IV: La piramide di Cheope*, Rapallo 1965.

⁶ op. cit.

these corridors respectively of $26^{\circ},41$ and of $26^{\circ},30$, values which are slightly different from the theoretical one ($26^{\circ},56$) but not expressible with the Egyptian system.

Figure 3 – Modular scheme of the apartments of the pyramid of Cheops

The "Great Gallery" represents the diagonal of a "perfect" rectangle of 1 every 2, the Queen's corridor **DE** is the common part between the Southern rectangles, since it is equidistant from the end of the "Great Gallery" and the ground-line, and the point **D** of origin of the Queen's corridor coincides with the node common to the three "perfect" rectangles.

The comparison [table 1] between the data given by Rinaldi and Maragioglio and the ones I deduced from my theoretical reconstruction show slight differences which are summarized in the following table, where it is evident that all the theoretical measures, if transformed into Egyptian units of measure, are multiples or entire fractions of the supposed recurring modular-datum of 42 cubits.

⁸ J.S. PERRING, *The Pyramids of Gizeh*, London 1839-40.

DETAIL	RINALDI AND MARAGIOGLIO'S SURVEY	OUR THEORETICAL DATA	DIFFERENCE	THEORETICAL DATA IN EGYPTIAN VALUES
Descending corridor entry (A) level	17,50 m	17,77 m	0,22 m	-
Pyramid round level	+ 0,53 m	0	- 0,53 m	0 c
Descending corridor (AB) inclination	26°,41	26°,56	0°,15	1 / 2
Corridors intersection (Σ) level	5,06 m	5,50 m	0,44 m	10,5 c
Distance pyramid axis / ground level intersection	67,20 m	66,00 m	1,20 m	126 c
Descending corridor end level [1]	- 33,15 m	- 33,00 m	0,15 m	63 c
Ascending corridor (ΣC) inclination	26°,30	26°,56	0°,26	1 / 2
King's crypt level	43,70 m	44,00 m	0,30 m	84 c
Queen's corridor (DE) length	41,32 m	44,00 m	2,68 m	84 c
Queen's corridor (DE) level	22,34 m	22,00 m	0,34 m	42 c
Relative level between Queen's corridor and King's crypt	21,36 m	22,00 m	0,64 m	42 c

[1] Virtual data obtained by projecting the corridor to meet the axis of the pyramid

Table 1 – Comparison between the dimensions of the apartments of the pyramid of Cheops revealed by Rinaldi and Maragioglio and those theoretical

It is evident that the only significantly discordant data are some of those referring to the Queen's corridor, but, since it is not credible that errors have been made in measuring the length of a corridor, I deduced that, as we'll see later, while building this apartment errors were made in comparison with the theoretical project.

Since it is clear from the abacus [figure 3] that the intersection point Ω between the corridor and the ground-line is the fulcrum of the project⁹, we can infer that its definition on the ground had to be the first action in building the pyramid, as it was the most easily definable point on the ground, but, above all, because both the placing of the axis of the pyramid and of the base of the North side of the building depended on it.

It appears to be confirmed by the unfinished so-called "Great Pit" of Zawiet el-Aryan [figure 4] where the only parts built in masonry¹⁰ are the foundations of the crypt and the paving section of the descending corridor placed near the ground-line, and not in the deepest part as could be expected.

⁹ R.MANZINI, "Sulla progettazione degli appartamenti piramidali", MATur 30 (2006), p.91-126.

¹⁰ V. MARAGIOGLIO, C. RINALDI, *L'architettura delle piramidi menfite, parte VI: La Grande Fossa di Zawiet el-Aryan*, Rapallo 1967.

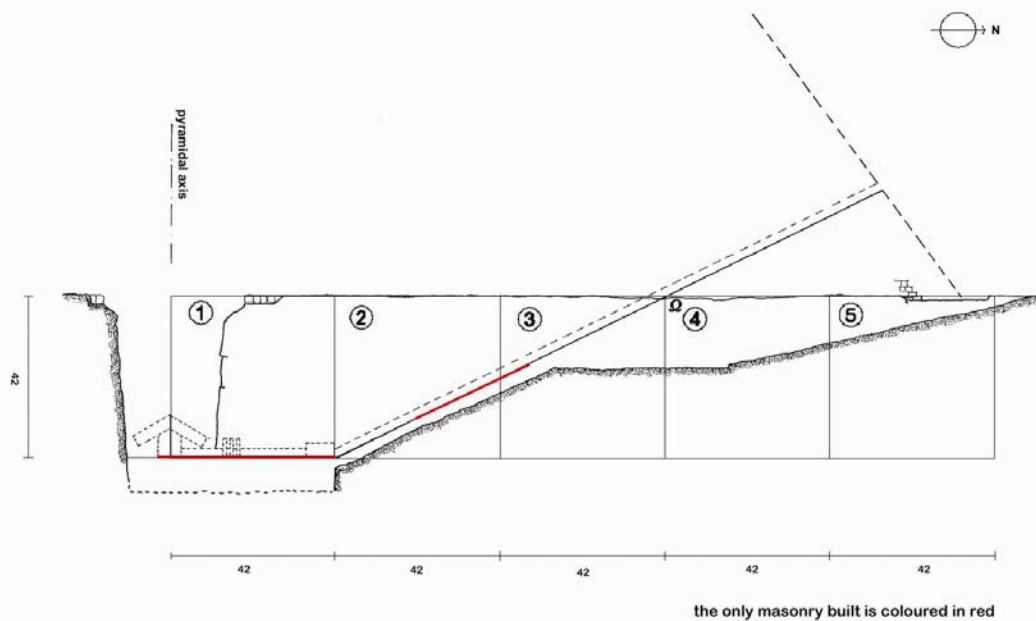


Figure 4 – Modularity and reconstructive theory of the apartments of the "Great Pit" considering their remains

Chephren

A substantial test of the existence of a planning abacus with a 42 cubits modularity emerges from the analysis of the Chephren pyramid [figure 5], which presents some characteristics differing from the other pyramids of the Ancient Kingdom, such as the axis of the apartments significantly decentralized towards East if compared to the North/South one of the building or the crypt that is the only one to be placed North of the East/West axis¹¹.

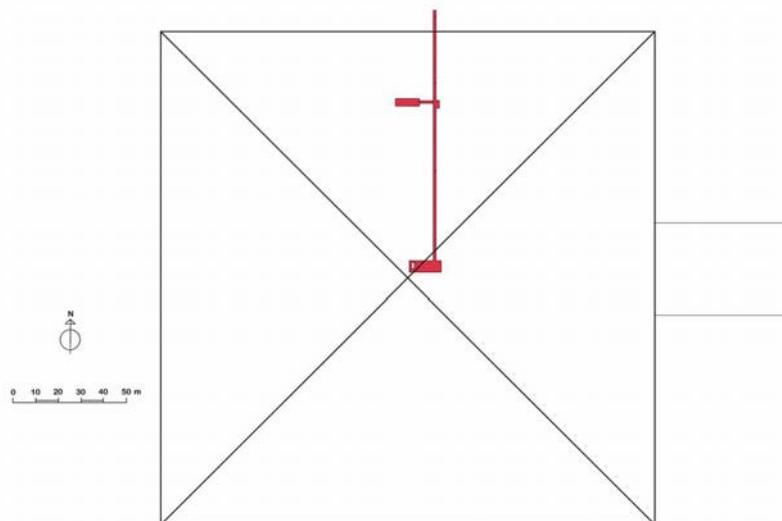


Figure 5 – Plant of the current pyramid of Chephren

Such characteristics and many other clues made the scholars presume the existence of an origi-

¹¹ V. MARAGIOGLIO, C. RINALDI, *L'architettura delle piramidi menfite, parte V: La piramide di Chephren*, Rapallo 1966.

nal pyramid which was planned and started but never completed, and is larger by “about thirty meters” to the North and East than the present one.

Trying to understand the dimensions of this hypothetical monument, I assumed [figure 6] that the entrance to the funerary apartments and consequently their axis, as is evident in most pyramids, was at the centre line of the north side of this pyramid.

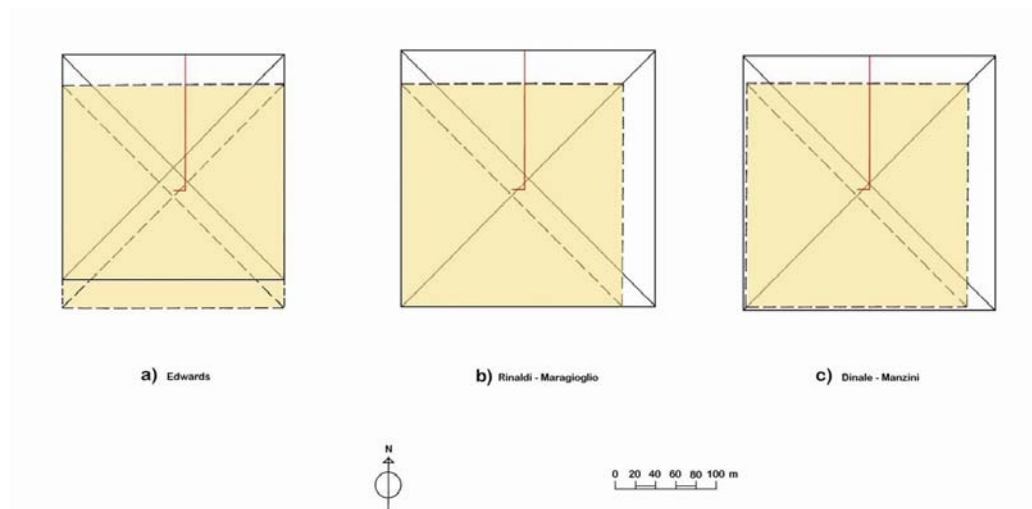


Figure 6 – Comparison among the reconstructive theories regarding the planning of the original pyramid of Chephren

Making the axis of the apartments coincide with the North/South one of the supposed pyramid, there should have been a building greater than the existing one¹² located 49 cubits towards North and East (25,6 m), in line with what has been presumed by scholars (“about thirty meters”).

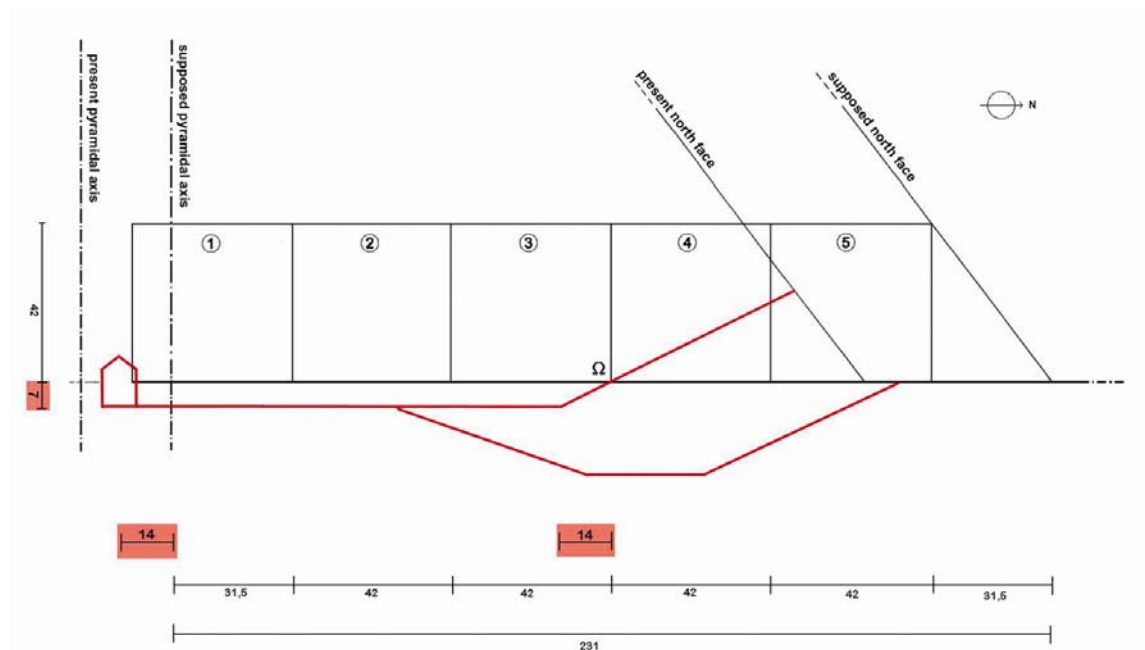


Figure 7 – Modularity of the extant apartments of the pyramid of Chephren

As I thought that the Ω point of the apartments had been the first to be defined on the ground

¹² R.MANZINI, *Complessi piramidali egizi, volume II: Necropoli di Giza*, Torino 2008.

during the construction of a pyramid, and as the existing apartments are the only sections originally planned, considering the measurements made by scholars we find [figure 7] an absolutely perfect coincidence with the points of the abacus, even though they are 14 cubits out of axis to the South.

Anyway the level reached by the present descending corridor (7 cubits) is quite unusual if compared to the abacus, and above all it also involves a southward shifting of 1/3 of a module (14 cubits) of the lower end of the same corridor as regards the Ω point. As a consequence, there is an equal shifting to the South of the East/West axis of the crypt, corresponding to the distance that separates it from the vertical one of the pyramid.

Considering that the horizontal corridor is hypogeum and covered only in its farthest external portion, I think we can refer all this to a contingent situation in which the workers might have been forced to continue the descending corridor past point Ω , perhaps owing to the friable soil they encountered.

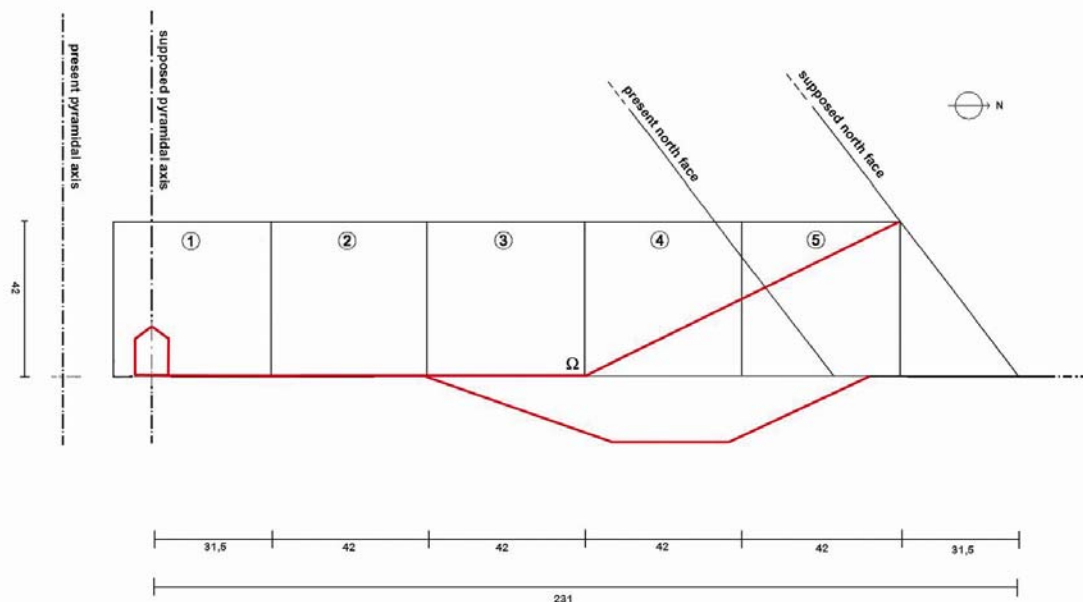


Figure 8 – Modularity in the reconstructive theory of the apartments of the pyramid of Chephren

In fact, [figure 8] bringing the horizontal corridor to the ground-level, thus making it begin from point Ω , the East/West axis of the crypt would exactly coincide with the corresponding one of the pyramid (with a difference of 5 cm). In this case also the height of the entrance to the descending corridor seems to be coinciding exactly with one of the angles of the same module.

This reconstruction, which puts the apartments entirely above the ground-level, places this building among those, as we'll see in a short while, in which the presence of rooms in the super-structure would have required the existence of an abacus, which would otherwise be unexplicable.

Deductions

Since in all the pyramids we have taken into consideration a ratio with 42 cubits modules per side has emerged, I examined the schemes of the 5 ones which, in my opinion, are the essence of the planning. I refer in particular to point Ω because it seems to be the basis of the planning from which come not only the analogies in the project, but also the choice of the same ratios, which can not be attributed to mere coincidences.

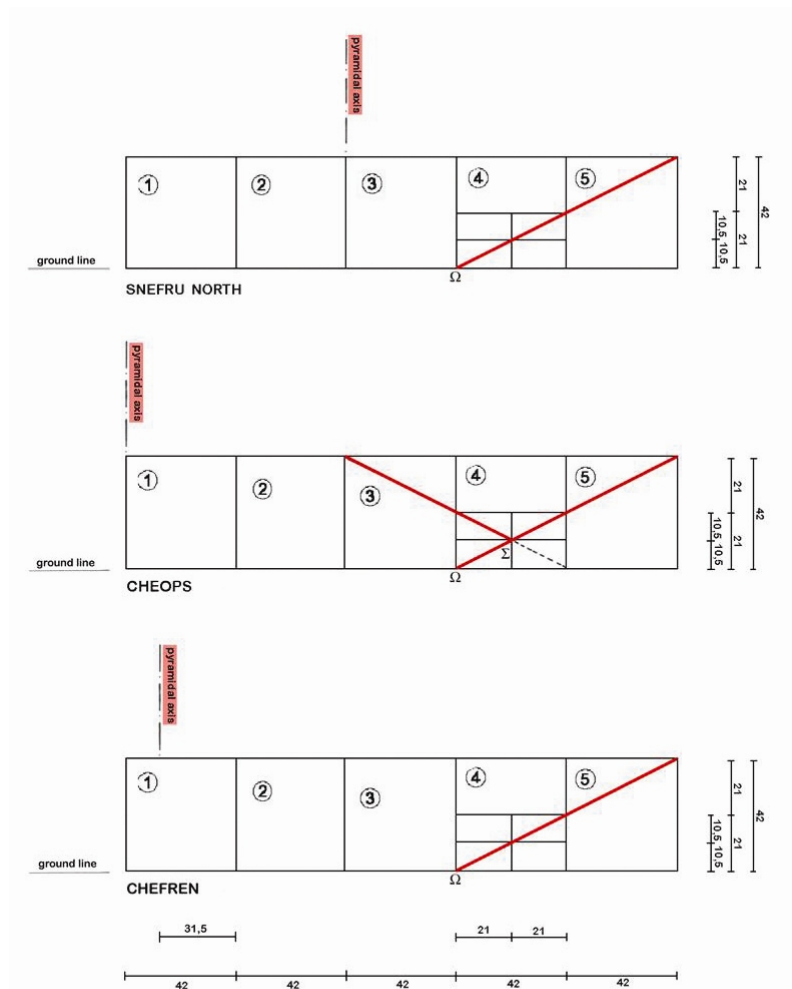


Figure 9 – Comparison among the 5 main modules of the apartments of the pyramids of Snefru North, Cheops, and Chephren

As a consequence [figure 9] overlapping intersection point Ω with the ground-line, and varying only the position of the abacus and the parameters of the buildings, we can reproduce an almost exact model of the apartments of all major pyramids and the entrance heights just like the ones indicated by archaeologists.

I think that in some cases, above all in the pyramids built at later times, the changes in the inclination of these corridors were intentional, in order to restore established dimensions by correcting possible building errors. Considering that the apartments were built centrifugally, we have an ex-

ample in the greater and often variable inclination of the more external parts of some corridors in order to reach a clearly pre-established quota.

A more important example is [figure 10] the otherwise inexplicable step at the top of the Grand Gallery of Cheops, which seems to be built on purpose to compensate the minimum errors that occurred in the inclination of the corridors which led to a quota lower than the planned one where the floor of the crypt was already existing.

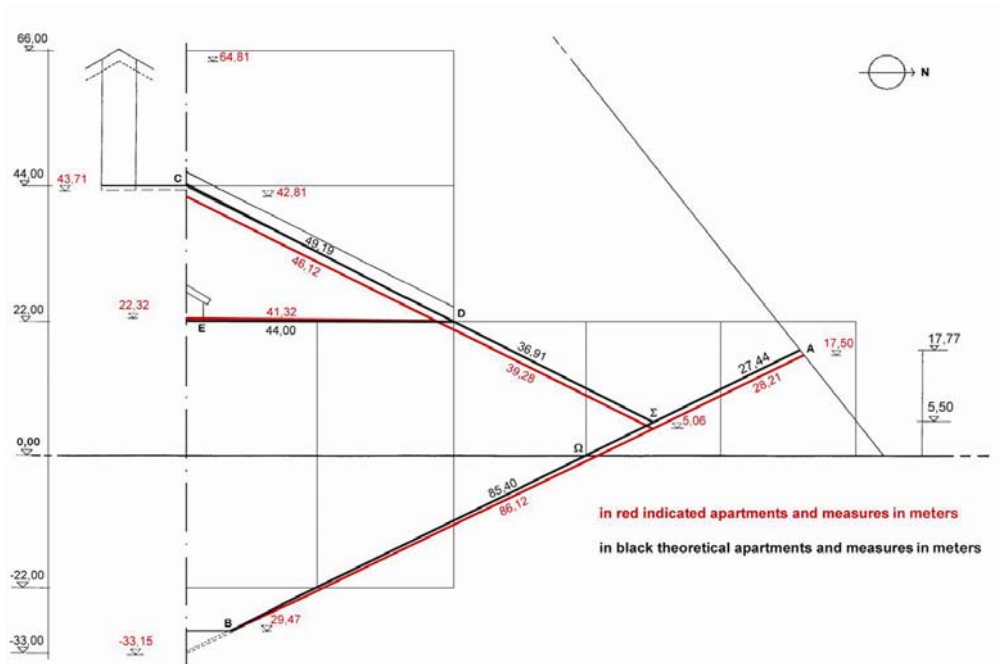


Figure 10 – Comparison between the extant apartments of the pyramid of Cheops and their theoretical plan

As a consequence of these errors, the "Queen's" corridor **DE** starts further South and at a higher level, which explains the minor length compared to the theoretically expected one.

From these comparisons it seems obvious that the pyramids of Cheops and Chephren are the "summa" of the previous projects, while the fact that this modular-project was abandoned, is due to a change in architectural choices.

In fact for the first canonical pyramids, which had a great number of apartments in the super-structure, an easy to read project was necessary from the beginning, as it was not possible to correct structural errors without intervening on the exterior building.

On the contrary, all the following pyramids have most of the apartments unrelated to the super-structure, so a precise design would no longer be needed as any changes in progress would have occurred only underground with wide margins of correction.

Final conderations

Considering that even nowadays during the construction of a building, discrepancies can take place between the design and its realization and that it is difficult to trace the exact intention of the de-

signers, we can conclude on the basis of the evaluated findings, that very advanced planning is possible. In fact the first four canonical pyramids are linked by a similar modular design, which shows constant evolution starting from the same scheme.

I have only tried to understand the intentions of the planning engineers, which at times can be slightly different from the actual construction, either due to contingent reasons or incorrect readings.

What matters is understanding that, in order to foresee building times and techniques, a plan and a scaled drawing according to the request of the customers must have existed, together with up-to-now unsuspected planning files.

Keywords: Pyramid – Planning – Cheops – Chefren – Modularity - Abacus

Riccardo Manzini
IAE professional member
Via Mombasiglio 111 10136 Torino, Italy
riccmanzini@gmail.com