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THE VIRTUAL RESTITUTION OF THE MESOAMERICAN SITE OF CACAXTLA: A METHODOLOGICAL POINT OF VIEW

1. Description of the problem

The mesoamerican archaeological site of Cacaxtla is in such deteriorated state of conservation that figuring out its original conformation and the conceptual drive behind it is a rather difficult task. Furthermore, it is now clear the existence of several constructive periods as revealed by overlapped constructions exposed after partial deeper excavations. So, when observing the site as it is found now, structural elements that never coexisted in time conform a complex space that actually never existed. Thus, a methodology for the hypothetical restitution of mesoamerican architecture is necessary to improve our conception of the past real life to which constructions belong. In the recent past, using techniques such as maquettes or drawings, considerable contribution was made concerning the hypothetical reconstruction of mesoamerican archaeological sites, as can be appreciated in the work of Tatiana Proskouriakoff (1963), which stands as one of the most relevant in this respect for the mayan area.

In the present time, a new tool can be used for the purpose of obtaining a hypothetical restitution, that is tridimensional computing, which allows a level of precision not reached by maquettes or drawings and which can be complemented with animation techniques, translated into video, multimedia and virtual reality. Examples of the success of this approach can be seen in the computerized restitution of the Abbacy of Cluny, Karnak, the Frauenkirche of Dresden (Collins *et al.* 1995), Roman ruins, each done with distinct purpose.

Nevertheless, beyond the spectacular results obtained, the computerized restitutions demand the development of specific methodologies related to the object of study. Thereafter, a rigorous analytical work would normally be expected to yield a better understanding of the architectural space before its modeling with CAD systems. The results from the restitution may expand as a consequence, allowing previously the extraction of design rules and architectural composition, which will be used in the virtual reconstruction.

For the restitution of Cacaxtla, a complete study was carried out starting from the precise survey from which a computerized model could be elaborated. From this, the discussion concerning the role of the different structures for the definition of spaces, the way they were developed by the ancient architects and, finally, the possible conceptual drive underlying the construction, was made possible.

A rather important premise is that analysis should begin using all avail-

able real data, discarding as much as possible any preconceived idea. Our occidental cultural paradigm provides us with a frame of mind in relation to the use of space that has to be separated when studying a mesoamerican ancient site. It would be illegitimate to assign functions for each space, neither to pre-establish the existence of composition rules based on symmetries or modules. In several instances, it has been demonstrated that the mesoamerican spatial conception can be related to cosmic events or to geographical features such as mountains (Aveni, Gibbs 1976; Hartung 1986; Gendrop, Heyden 1994), while there is evidence of a geometrical knowledge used in sculptural elements (Chanfón 1978). On the other hand, the space-time widht of the mesoamerican cultures precludes the translation of composition rules from one site to another, since they appear as unique features associated to specific sites. Thus, the analysis should be based on the observation of local architectural elements to allow for the deduction of local specific rules used within the site.

2. The time-space location of Cacaxtla

The archaeological site of Cacaxtla is located in the Mexican highland. Its splendor time is estimated around 800-850 AD, which coincides with the fall of Teotihuacán and the rise of Cholula and Xochicalco. The oldest structures found in Cacaxtla belong to the beginning of our era; by the end of the millennium, the site was abandoned. This Olmeca-Xicalanca site, is found in the commercial route linking Teotihuacán with the Mayan world which might have been of great economical importance for its development and cultural influences. Due to the inclusion of elements reminiscent of sites such as Monte Albán, Tajín, the Mayan area and Teotihuacán, it has been classified as an eclectic site (Kubler 1978).

The outstanding feature of Cacaxtla is due to the richness and amount of mural paintings, together with their surprising state of conservation since they were carefully buried before initiating the latest constructions (Tavv. IX a and b). The artistic quality of the paintings in addition, give to the site a unique position among all mesoamerican archaeological ruins. It is important to recall that of all known studies, those related to the architectural aspects of Cacaxtla, are the less frequent ones.

The main constructive part known as "The Great Basement" (Fig. 1) has overlapped constructive elements showing the multiple modifications of the site. Complete areas and rooms were buried to allow for construction of upper layers, in some cases preserving their height; roofs were removed and reinforcing walls constructed before filling the cavities. In other instances the height of the walls was reduced to match the needs of new buildings. Although for descriptive purposes it is generally accepted the use of constructive time periods, the site appears to have been submitted to a constant trans-

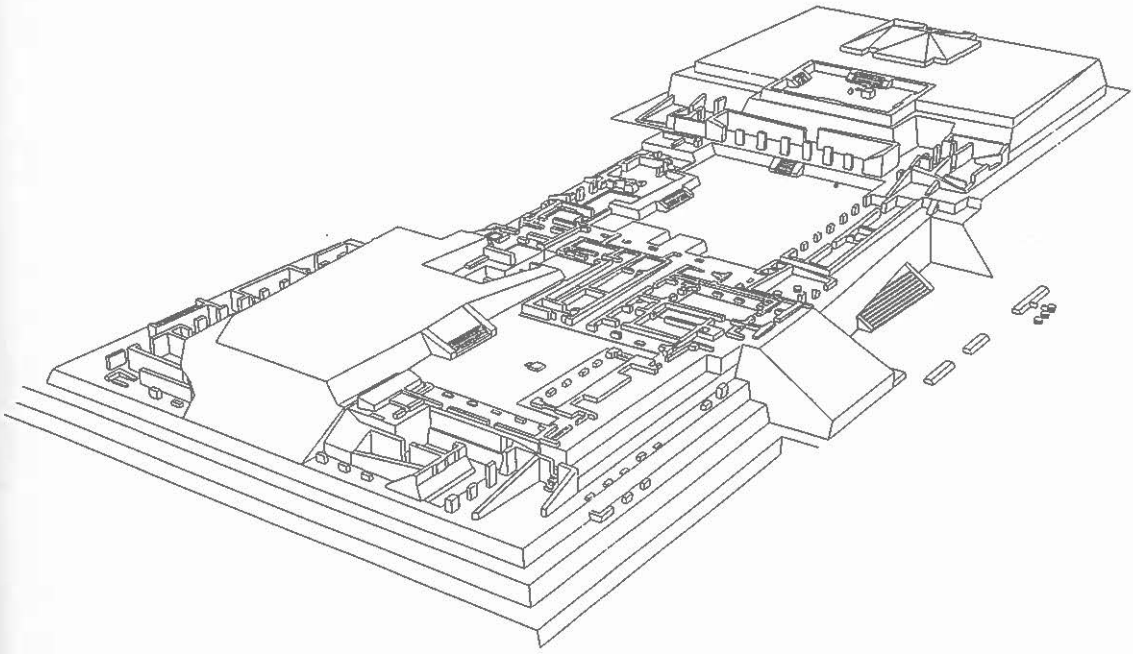

Fig. 1 – Actual state, 3D model (Lucet, Lupone).

formation. For the new construction, some of the previous elements were reused, while others were buried or destroyed. Modifications had magnitudes going from minor changes to massive reconstructions.

3. Methodology

Nowadays, the only source available for a computerized reconstruction of Cacaxtla is the site itself using the physical remaining elements.

3.1 *The survey*

In the first step of the work, the preparation of a digitized version of the available drawing (a 1:250 map) was considered. It was self evident then, that this would not satisfy the requirements of the work, since the precision of the drawings drastically affects the validity of assumptions which will be derived from the analysis of measurements. For example, with the available drawing, a wall of 40 cm. width appears as a 1.6 mm. element, while a 60 cm. wall is represented with 2.4 mm. assuming an extremely careful drawing. This minimal difference is critical considering that such measurements might differentiate walls with structural or separation functions. In addition, size differences may be indicative of the evolution of the techniques applied along

the different constructive periods. Variations in the dimensions of columns might be regarded as indicative of distinctive building style through the evolution of the site, which provides a basis for correlating historical periods with constructive features.

Therefore, a new, more precise survey seemed necessary and this was done in several measuring sessions during 1993 and 1994, involving the necessary precision to improve the outcome of analytical procedures.

The survey with the purpose of carrying out a computerized restitution involves different steps respect to the typical archaeological one since a key objective is an architectural "original" representation.

For example, elements that originally did not defined the architectural space, such as reinforcing walls created when filling or burying spaces, can be eliminated.

Special care should be taken when searching for information about dimensions of objects in their original state. Thus, the extremity of a destroyed wall should not be registered; instead, evidences of its real limits will be sought from surrounding elements.

The measurements should include the finish of the elements. In the case of Cacaxtla, all structures were covered by one or more layers of stucco; in several cases, corners appeared very deteriorated or missing. In such cases, footprints on the floor were sought or their known width was added to the measurement.

A detailed search for elements that are indicative of modifications in the constructions should be carried out. These are:

- the presence of several layers of finish and, sometimes, their partial removal *v. gr.* the polished dust-keepers at the lower parts of walls that appear covered by further rough stucco;
- crashes on the floors. While some of them can be attributed to ulterior settlings, sliding or collapse of the construction, others may reflect superposition of structures, the presence of buried walls or the presence of important modifications of the platforms located at different heights;
- stucco finish covered by another wall. When walls were extended or inter-column spaces were refilled to conform a new wall, the finish of stucco was not removed. Instead, adobe was used for refilling and a layer of stucco applied on the exteriors to cover the overall new structure. Such elements remain under the new structure and are of key importance when analyzing transformations.

The survey should not be just a description of the actual state but should be submitted to constant analysis, keeping in mind that the final objective is a virtual reconstruction of the site. The search for explanations for the found elements during the field work allows to consider new hypothesis about the

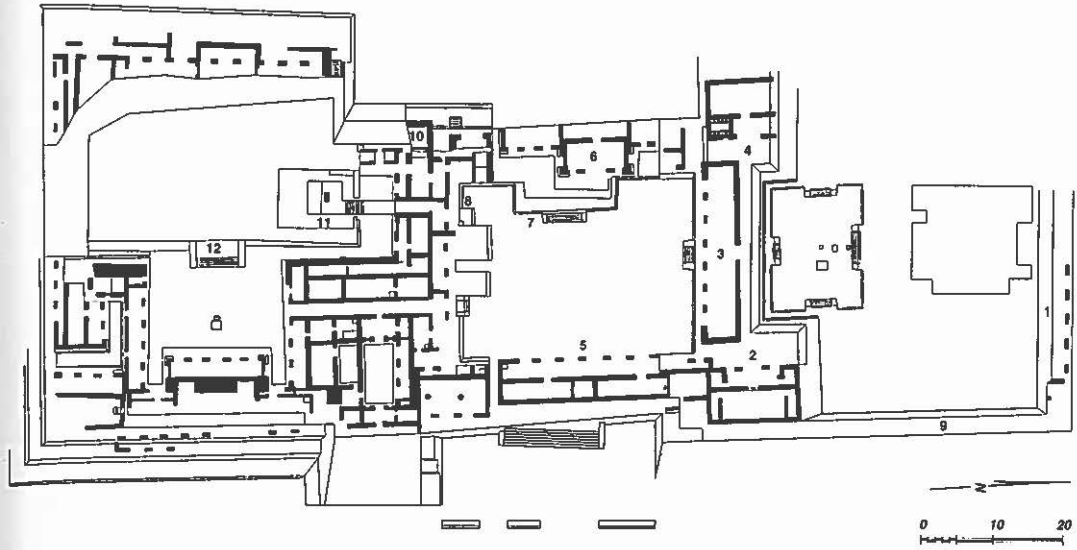

Fig. 2 – Ground plane. 1 North side portico; 2 Portico A; 3 Portico B; 4 Portico C; 5 Portico D; 6 Portico E; 7 Pyramidal platform; 8 Buried columns; 9 Peripheral wall; 10 "Hollowed Wall"; 11 "Red Temple"; 12 South pyramid.

original state and in some cases, to search for elements in order to corroborate such hypothesis, which lead to findings that hardly could be obtained otherwise.

3.2 *The methodology for analysis*

Due to the complexity and large size of the "Great Basement", the site was divided into smaller units amenable of independent analysis. Thus, the site was divided into groups called buildings or sets (north side of the site) (Fig. 2). For each group, measurements were taken, the state of conservation registered and elements were searched to evaluate for possible transformations in time. In cases as that of building E (number 6 in Fig. 2) and the pyramidal element (number 7 in Fig. 2), it can be seen that the latter completely buried the former, therefore allowing the assumption that they did not existed simultaneously and consequently, their study can be carried out independently.

The restitution of buildings started with those which appeared as the simplest cases to analyze due to their good state of preservation and the reduced number of elements in their composition. Such cases were sets A, B, and C (numbers 2, 3 and 4 in Fig. 2). From these, it was possible to estimate the height of the buildings, to know the morphology of lateral walls and corners at the extremes of buildings and in general, the overall constructive schemes.

Each building chosen for study as an isolated element was compared with the surrounding constructions in order to establish possible time and morphological relationships among them. For this purpose, each building was considered as a different unit according to its particular historic configuration. Thus, building A turn out to be building A1 and A2 (first and second constructive stages respectively).

Between two constructions, the degree of time relationship was defined according to the following criteria:

- they coexisted in time;
- they did not coexisted in time.

When a possible coexistence of two was observed, further information was sought such as:

- whether they were built and buried in the same period (same "life span");
- one of them was built in a later period and buried before the other one (the life span of one construction falls completely within the life span of the other one);
- one construction occurred before and was buried before the other one was constructed (phased out times);
- both constructions were built at the same period but disappeared at different times;
- construction of the two buildings occurred at different times but they were buried in the same period.

Although in principle this classification would be expected to provide with very valuable data, this ideal level of precision was not reached in the majority of the cases.

Finally, the puzzle is amenable of reconstruction bringing together the elements that were studied in an isolated way. As mentioned before, if the site was subjected to constant modifications, those more important may be considered as constructive periods.

3.3 *The available data for analysis*

In addition to the elements mentioned before that can be used as signs of modifications of the site, the finishes of the structures are by themselves important sources that allow both, the extraction of building rules used by the mesoamerican constructor and a closer understanding of the architecture of the site.

In a simplified way, four types of finish can be distinguished in the site (Lucet, Casas, Lupone 1994):

- white rough stucco finish for vertical elements;
- white fine stucco finish for horizontal elements;
- red o white polish stucco in the lower parts of walls (dust-keepers).

The study of the location of the "dust-keepers" in walls showed that they never appear in the front façades but in interiors, and when placed in columns of the porticoes, they are always found in lateral or inner parts. This feature was important when investigating to which side of an isolated column was a room to be expected. This was applied with half-buried columns (number 8 in Fig. 2) and to find out if the peripheral wall of the north side-slope (number 9 in Fig. 2) was a limiting one or part of a portico. While the presence of red "dust-keepers" serves our purpose of distinguishing a building, so far no use beyond the decorative purpose can be ascribed to these elements in relation to white "dust-keepers".

3.4 *The making of a Virtual Model*

It was considered convenient that the restitution would be represented by an idealized model of the site, that is, no consideration was taken about the settling of the terrain or the inevitable errors that any construction process can have. Therefore, averaged measurements were taken where repetitive elements were found such as columns and inter-column spaces within the same façade or when the small variations between measures indicated a deliberate will to maintain regularity among the elements. For example, when structural walls showed a width of 57 cm, variations between 54 and 59 cm were rounded to the former value. However, in cases where rooms with rectangular shape show little departure from right angles (ca. 2°) so the restituted model was drawn with 90° angles.

Although the validity of such decisions is open to discussion, they were based taking in account the largest possible set of data, the judicious analysis of them and a will to match the apparent intention of the mesoamerican architect. It is clear that deformations with time and the traditional construction confront us with a site that departs from the ancient idea of space. Therefore, adhering to an ideal construction was part of the task. The study showed that the original will of the constructors seeks "perfection" as revealed by their careful planning. Furthermore, that search was accompanied by mathematical and technological knowledge seeking the fulfilment of this aim.

As an example, the study of the measures of 76 columns and 84 inter-column spaces grouped into 24 sets, show that 84.5% of the latter have values that fall near 1.198, 1.459 and 1.984 m, while 91.6% of the columns have values near 1.198 and 1.459 m (Lucet 1996). The selection of such values appears dictated by architectonic design, respecting symmetries in relation to axis and keeping relation among buildings located at their extremities; such will was present in the later constructions and standard measures prevailed in time.

The symmetry of the façades is a remarkable feature along the site as well as their even number of columns. From this, the strong influence in the use of symmetry axis for the composition of plazas is evident.

3.5 *Results*

There are various degrees of certainty in the virtual restitution of the site. Some of the buildings could be reconstructed with a high degree of accuracy such as porticoes A, B and C (number 2, 3 and 4 in Fig. 2), while others were considered with a high degree of probability. This is the case of building D (number 5 in Fig. 2) which, despite the lack of available information, has a large resemblance with those in a much better state of preservation (A and B). Those of the former situation were reconstructed using the logic derived from those well preserved.

In cases such as the "Hollowed Wall" construction (number 10 in Fig. 2), where only one extremity of the building is exposed (part remains buried) the reconstruction should be considered as probable since the actual extension of the construction remains unknown (Tavv. VII a and b). In such case, the reconstruction is based upon the notion of global understanding of the object, without further pretensions for exactness.

In cases where the information is even more scarce or the observed configuration does not allow for valid comparisons, the architecture can only be understood in a limited way. A good example of this situation is the case of the "Red Temple" (number 11 in Fig. 2). The actual excavation shows a corridor that was later converted into stairs and further buried by a pyramidal basement (Lucet, Lupone 1995); the interpretation of the integration of these vestiges as a whole lies greatly on a purely hypothetical ground.

Finally, several wall corners have emerged from the ground revealing the presence of new sub-structures but their conceptual integration to the whole site is still premature due to the lack of information. Excavations are incomplete and the actual state of the site prevents a more accurate restitution (Fig. 1 and Tav. VIII, b). As can be appreciated in the restitution process of the southern plaza corresponding to the site *ca.* 800 AD (Tav. VIII, b), this is precluded by the pyramidal platform by which it was buried (number 12 in Fig. 2).

4. Conclusion

The virtual restitution work can be submitted to the restoration theory developed by Viollet-le-Duc. In XIX century, restoration defined in his words was «*Restaurer un édifice, ce n'est pas l'entretenir, le réparer ou le refaire, c'est le rétablir dans un état complet qui peut n'avoir jamais existé à un moment donné*» (Viollet-le-Duc 1854), where he postulates the importance of the architectural object as example of the creation of mankind which portrait specific historic moments (Lucet 1995).

He considers History as the study of evolutive processes from which we can extract knowledge about the way architects constructed as well as the general conception and conditions that defined such process. From these, it

is possible to deduct the rules that underlie the constructive process in the past and define the new rules for the contemporary architecture in the XIX century «*A quoi servirait l'histoire si elle n'était un enseignement*» (Viollet-le-Duc 1878). According to his postulates, the restoration should attempt to return the monument to and ideal state in relation to the historical moment and the prevailing conceptions of the society that influenced its creation.

This vision of restoration is difficult to apply when the monuments have experienced a number of transformations in time. When dealing with an archaeological site, its application would imply the sacrifice of choosing an historical time while ruling out the others. In Cacaxtla, modifications are found in a massive scale, burying complete buildings to construct new ones on top of the old ones. Furthermore, the excavation process can never be considered to be complete and indeed, numerous structures are known to be buried in Cacaxtla and their study is therefore prevented. Even more, it is unlikely that we will ever get to know the whole set since further study of underlying structures implies the destruction of the upper ones.

In this context, the computerized restitution appears as a suitable tool to apply the double objective of Viollet-le-Duc, *i.e.* to understand the rules applied to develop the architecture of the site and to present it in an idealized state.

Using the words of Viollet-le-Duc we can say that "virtual restitution is not just describing the building or repairing it, but to re-make it into a state of perfection that perhaps it never had".

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ABSTRACT

Besides allowing to visualize the architecture from the past by making use of images, either virtual or real, virtual restitution in architecture implies the use of analytical methodologies that serve the purpose of a better understanding of architectural space as well as its genesis. The restitution contributes both in the process of building an appropriate tridimensional model adequate for multiple uses, and in the output of new information as the restitution process develops. In the present work, the applied methodological approach is discussed in relation to a virtual restitution of the mesoamerican archaeological site of Cacaxtla leading to an idealized original state.