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A computerised register of pre-Hispanic architecture

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20.1. Introduction

The researcher who wants to study meso-American cultures will be aided by the following sources of information:

- the pre-Hispanic codex
- the codex written after the conquest
- narration by monks during the early stages of the conquest
- archaeological sites

Unfortunately, few codex entries were written not long before or very shortly after the Spanish conquest. Relevant entries appear to be *c.* 800 AD, and their interpretation is complex as they have not been translated to a satisfactory level.

The stories from monks and soldiers are very important for obtaining data about habits and styles of meso-American civilisations at the time of the conquest. However, they are constrained by the cultural framework of the 15th. and 16th. centuries. The new culture portrayed in this narration is evidently partial, and the interpretation should be taken with caution.

On the other hand, the indigenous cultures left numerous remains that are now the best source of information. By studying them, we may gain a substantially better knowledge and understanding of the indigenous history, ways of life, economy, etc. Among such cultural legacies, the architecture of cities and isolated constructions carry an eloquent message of the culture.

If we define architecture as a deliberate human effort to build places for specific activities and purposes, we can derive from the styles of the buildings the habits and feelings of their constructors. Thus, a baroque construction is completely different from a classical one, and we can also distinguish between Teotihuacan architecture and the Puuc style in the Mayan area. In consequence, the value of an accurate register of the architectural legacy of a culture is obvious.

The process of registering has typically been carried out by means of drawings and photography. The arrival of computers has added new tools for this purpose, and has made more efficient and precise archiving and manipulation of extensive amounts of 2- and 3-dimensional descriptions of buildings.

The present project is the first attempt carried out in Mexico which aimed at developing the systematic use of computerised architectural descriptions of archaeological sites, making extensive use of the capabilities of computers for 2D and 3D representation. The project also includes a register of mural paintings and an advanced attempt to link databases and 3D models.

20.2. Cacaxtla

The archaeological site of Cacaxtla was chosen as the first case study for the computerised register because of a number of favourable circumstances. It is located east of Mexico City and is easily accessible within one hour. It is a recently-discovered site since it was uncovered only fifteen years ago, though its existence was known long before that. It was actually treasure-hunting that revealed the presence of high quality mural paintings. This roused the interest of the National Institute of Anthropology, which started excavations soon after the discoveries.

The site is surrounded by hills. On the west side is found Xochitecatl, another important site where the presence of numerous pyramidal structures has been confirmed. The peak of activities at Cacaxtla is placed from about 650 AD to about 900 AD, and the site was abandoned long before the Spanish conquest. The oldest records about Cacaxtla were written by Muñoz Camargo and are dated to the XVI century.

Cacaxtla was located on the commercial route between the Mayan and Teotihuacan areas. The economy depended on both commerce and a well-developed agricultural system. This economic background afforded economic surpluses to build a rich ceremonial centre, with original architectural techniques such as stuccos, the vast mural production, and the impressive side slopes in Teotihuacan style.

20.3. Computer system

20.3.1. Hardware, software and methodology

Architectural information about the site was collected using CAD systems such as AutoCAD and MicroStation on personal computers. At the beginning an IBM-60 (10 MHz) with 1Mb RAM was used, then a 386 (25 MHz) with 4Mb RAM, and finally a Macintosh fx (40 MHz) with 8Mb RAM.

The general drawing of the site was digitised using a grid of 1m squares with the same origin as that originally used by the archaeologists. Further, a precise 3-dimensional drawing was created to obtain a scaled model (Fig. 20.1). The 3-dimensional models incorporate the traditional advantages of multiple cross-section drawings, layers, perspectives and maquettes, possess a high degree of precision, and allow printing at any scale.

20.3.2. Layer separation

Up to the present, the work has been focused on the volumetric description of the buildings; however, a new description in layers is necessary to obtain a more precise registering

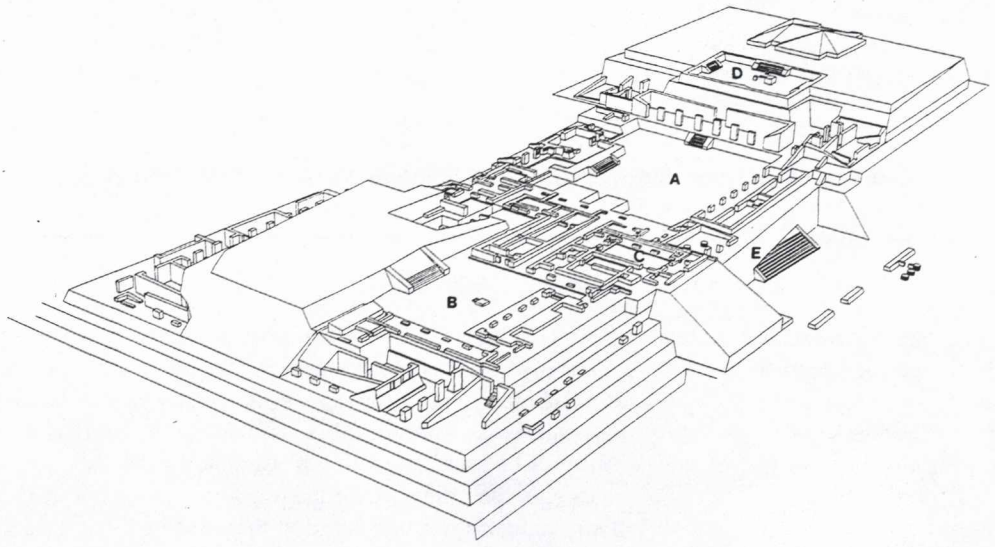

Figure 20.1: Perspective view from the south-east corner of the 3-dimensional model. A) Plaza of The Battle; B) Patio of the Altars; C) Patio of the Rhomboids; D) Swollen Patio; E) Main Stair.

of information about construction materials and surface renderings.

Surfaces that make up the 3-dimensional model are separated in layers according to their renderings. These are:

3D_STUCCO: which is the typical finish for all the external upper parts of the buildings;

3D_FILLING: which represents all earthy fillings used between structures for supporting upper constructions;

3D_MURAL_PAINTINGS: describing the finish used for mural paintings;

3D_DUST KEEPER: for the presence of a stripe of red paint on the lower part of the walls;

3D_ORNAMENTS: to describe decorative elements of stucco.

In general, the simultaneous handling of these elements slows down the overall editing work. Therefore, it was decided to group them into an independent layer so that they could be turned off at will.

3D_TEZONTLE: "tezontle" is a volcanic rock frequently used for building in the Mexican highlands

3D_STONE: is the finish for the big side slopes which are part of the great basement, made from a white limestone;

3D_EARTH_F: to indicate floors of compacted earth

3D_STUCCO_F: to indicate the corresponding materials when used as finish for the floor

Complementary information is contained in additional layers:

I_STUCCOS: describe those parts of the stuccos that have been repainted in following phases

I_TEPETATE: and I_ADOBE: for the constituent materials of the overall structure. Most of the building is indeed composed of "tepetate" and adobe.

Finally, there are layers that correspond to the descriptive layers of the construction phases

H_STAGE1, H_STAGE2, H_STAGE3, H_STAGE4, H_STAGE5.

Each is portrayed by a different colour to portray clearly the historical building sequence. The attempt at reconstructing the set of east porticos for the main Plaza is found in the layer H_PORTICO.

The layers that need to be turned on to work with the 3-dimensional model are labelled 3D; those corresponding to complementary information are labelled I and those for analysis, or which are hypothetical, with H. While layer separation is appropriate for the site and material that constitute Cacaxtla, similar logic can be applied to the description of other archaeological sites.

20.4. Description of the "Great Basement" and its construction phases

The hill that provides the base of the main structure of the archaeological site has been named the "Great Basement" and it has side slopes which support all the upper structures. During excavations it has been found that these slopes actually overlap, and represent several constructive phases. In order to build new rooms, the people removed the ceilings, lowered the walls, and refilled them carefully with earth, sometimes using the older structure as support. The "Great Basement" was probably built on top of a small hill, although excavations have not yet revealed where construction begins and what would have been part of an original prominence, since it is known that many structures remain buried. At least five construction phases have been proposed, but much work will have to be done before they can be proven.

The last phase possesses the familiar pyramidal topology. Since it corresponds to the last construction phase of Cacaxtla, it exhibits the highest degree of deterioration. On the west side of the "Plaza of the Battle", a pyramid covers a building which has much ornamental work using stuccos, and side slopes. Burials of about twenty-six children were found there.

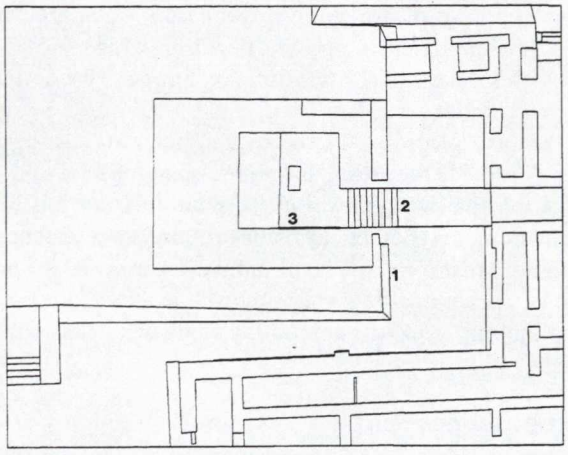

Figure 20.2: The Red Temple.

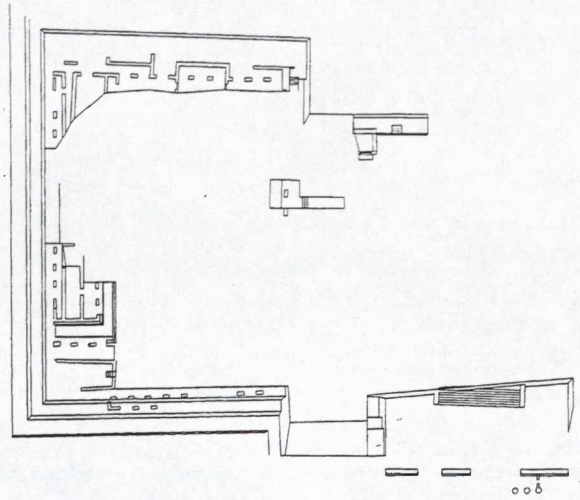

Figure 20.3: Cross-sectional view of the upper structure after clipping.

On the south, in the so-called "Patio of the Altars", forty-nine burials were found. Around the square are several constructions with porticos; and at the south-east corner there is a drain 40cm deep.

The "Patio of the Rhomboids" has a peripheral walk way and shows knowledge of handling various scales of exterior spaces, this one being small and rather private.

Offerings have been found in the "Swollen Patio" and in the "Patio of the Altars". These offerings consisted generally of shells, nails and obsidian objects.

On the peripheral side slopes, pilasters suggest a system of porticos around the periphery. There was no direct access to the upper part by a large stairway, but instead there were several small stairs that allowed indirect access; so activities on the upper level were perhaps reserved for people with privileges. The main stair gives access to a lower level. This possibly corresponds to a time when the ceremonial centre was more open to the population.

20.5. System tools to visualise construction phases

The Red Temple (Fig. 20.2) is a good example of the problems found when analysing meso-American architecture.

Originally there were vestiges of a pyramidal structure (1). While excavating, a stair was found (2), communicating the beginning of the pyramid to a lower level with a sidewalk and a column. Both sides of the stair have paintings of high quality. The other sides of the excavation are filled with earth and it is not possible to guess what there was on the front of the stair. Nevertheless, the cracks on the wall show that the east wall of the stair was different, and the column discovered at the lower part of the stair indicates the presence of a portico. A double painting layer on both sides of the stair and excavations at its back confirm the hypothesis of two construction phases.

Initially, there was a corridor between the portico and an unknown building; in a further phase, the corridor and the portico were closed, the stair was built, and finally a pyramid covered everything.

Some of the tools available in CAD can be useful to visualise constructive phases. For example, if we eliminate the upper parts of the 3-dimensional model using "clipping" and turn off the layer corresponding to the earth fillings, there can be observed (Figs. 20.3–4) an unknown area at the same level, several elements probably intercommunicating in an early phase. All these elements have porticos which demonstrate a relation to an interior plaza (the part that has not been excavated).

Many more excavations need to be done before we can be sure of the different phases within the site. Tunnelling seems to be a necessary approach, to avoid destruction of the upper layers. However, this task is difficult, given the earthy constitution of the materials and their dryness, which raise costs of exploration.

At the same level as the Red Temple is found an exceptional element of meso-American architecture: the hollowed wall (Fig. 20.4), whose function is unknown, since it is surrounded by earth and has more recent structures in its upper part. Several parts are decorated in relief. This is also the case for a side slope in the south west corner of the basement. It should be pointed out that the main stair starts at a level close to the floor of these elements. A common feature of this level is the high quality of the construction, a good state of preservation, and the fact that they were not mutilated for building the upper layers.

Clipping of the model does not give an elegant final look, since elements appear cut and incomplete. Nevertheless, this is a simple method for visualising elements at the same level, in this case probably contemporaneous, and for observing the 3D internal space.

20.6. Conclusion

There are in Cacaxtla multiple levels and overlaps of architectural structures that make the reading of orthogonal cross sections difficult. The generation of 3-dimensional models greatly simplifies the description of the site, making the reading and interpretation of drawings much easier.

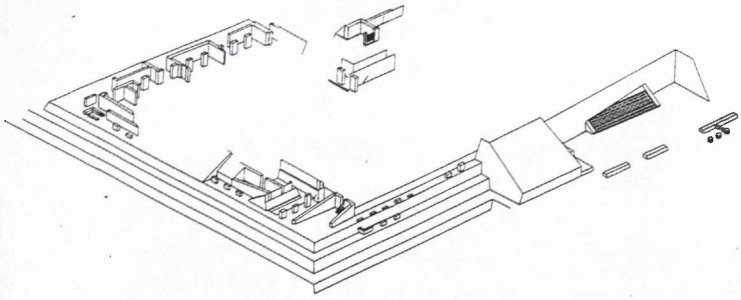

Figure 20.4: Isometric view after clipping.

The advantages of using the system can be summarised by the following features:

- a complete volumetric definition
- the possibility of selecting the desired information by turning off or on the layers which allow visualisation of zones and materials
- the possibility for visualising elements within a specified range of heights, making others temporarily invisible
- the possibility of visualising the model from any point of view, either in isometric or perspective mode
- the possibility of combining all the above mentioned options
- the ease of updating the model as excavation continues
- the ease of archiving information, compared with manual bookkeeping for paper drawings
- the ease of information exchange by computer diskettes.

The precise recording of meso-American archaeological sites by this 3D modelling is an important method of documentation that will allow and facilitate the analysis of its architecture. Hypothetical reconstruction, the production of photorealistic images, and animation may allow us to have an approximate vision of the site as it was in its time of splendour, and to communicate the result of our researches to visitors.

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