Assessing the historical value of investigating ancient monuments by means of an intelligent digital model: The case of the temple of Karnak in Egypt.

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Abstract: This article deals with the way epigraphic surveys are currently carried out by Egyptologists investigating pharaonic temples, on the one hand, and the theoretical as well as practical knowledge that can be gained by making greater use of CG-aided tools, on the other.

Keywords: architecture – CG-aided tool – epigraphy – temple.

1. Introduction

Egyptologists have increasingly made use of computer modeling in order for the general public to get a better picture of the way Egyptian temples appeared during the different phases of their history (cf. Albouy & al., 1989). By and large, little attention has been paid however in accurately reproducing the actual stonework of the temples and the scenes and the inscriptions engraved on their walls (*contra*, Brocard, 1996; Vergnieux, 1999), features which are either rendered by wireframing or texture mapping.

In this paper, we wish to introduce the approach proposed by the Groupe de Recherche en Conception Assistée par Ordinateur (GRCAO) of the Université de Montréal, in order to modelise both the elaborate stonework and the decoration of ancient monuments, so that professionals may use this tool in architectural and epigraphic surveying. The research group has signed a contract of collaboration with the permanent French Centre National de la Recherche Scientifique (CNRS)-mission UPR 1002 in Egypt in order to test its methods by using the temple of Karnak, the biggest and most complex of its kind, as a digital model. In the first part of our paper, a short account will be given of the current methods used by Egyptologists to carry out surveys. In the second part, we will present the avenues presently explored by the GRCAO to help Egyptologists restitute the temple on the architectural plane as well as the epigraphic one, and show how Computer Graphics (CG)-aided tools may improve on more conventional ways of analyzing ancient Egyptian architecture.

2. Methods currently used in epigraphic work

Let us first give a brief outlook of the methods currently used to carry out epigraphic work in Egypt by two venerable egyptological institutions, the American Epigraphic Survey and the Centre Franco-Egyptien d'Etude des Temples de Karnak. Both approaches will then be evaluated in order to draw a later comparison between these methods and the one put forward by the GRCAO.

a) The Epigraphic Survey.

The so-called Chicago House method, named after the residence built by the University of Chicago in Luxor to house the Egyptologists working in and around the old capital of Thebes, has hardly changed since its inception in the 1920s. Series of pictures of an inscribed wall are first taken at right angle in order to eliminate distortions as much as possible. The pictures are then developed and enlarged to fit a 20' x 24' frame. A professional artist goes to the site and draws the contour lines directly on the picture, checking and double-checking his/her work with the inscription carved on the wall. The picture is later immersed in an iodine bath which makes the photographic image disappear, leaving behind only the pencil drawing. An epigrapher compares the drawing of the artist with the original and adds in modifications. The artist and epigrapher, and then the field director all agree on the final version of the drawing before it is inked for good (L. Bell, 1987; The Epigraphic Survey, 2001).

What are the pros and cons of this method? On the plus side, meticulous work and numerous checks undeniably make for very fine execution, accuracy and trustworthiness, qualities which the Epigraphic Survey is doubtless and justifiably well-known for. On the other hand, the process may prove time-consuming and costly for less fortunate institutions which can not afford to have teams stay in Egypt on a quasi-permanent basis.

b) The Centre Franco-Egyptien d'Etude des Temples de Karnak has also developed its own method of epigraphic surveying. Epigraphers use large transparent plastic sheets which they apply against the surface of the wall to be drawn. They use a felt pen to draw the contour lines of the scene. Back at the office, they redraw and correct the lines to make it fit better to reality. They then draw the whole scene on tracing paper again, using a Rotring rapidograph. The drawing is then photographed and reduced to one tenth of its original size. Drawings and pictures are then assembled for publicaton.

Here again, the quality of work is doubtless not to be questioned. The fact that epigraphers, like those of the Epigraphic Survey, work almost year round in the field, allows temple scenes to be directly scrutinized by well-seasoned eyes, a great advantage when it comes to reading badly damaged reliefs, a situation not altogether rare. On the minus side, reducing large size sheets into handy pictures requires costly material, which is on top of that not readily available (Traunecker, 1987). Flying back home at the end of a season with large size plastic sheets may not always be very practical. The method used by the French is reliable when the scene to be drawn is in sunken relief (cf. fig. 1), but proves to be less adequate when the relief is raised (cf. fig. 2), the surface on which the plastic sheet is applied not being leveled. Last but not least, here as with the Epigraphic Survey, manual drawing does not allow for automatic recording and data processing, as computerization is not used.

Fig. 1

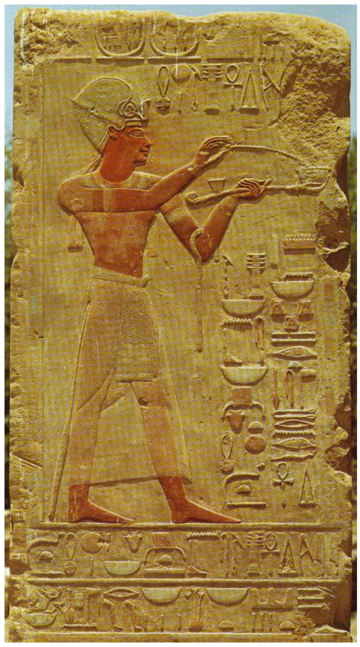

Fig. 2

3. The method developed by the GRCAO

Developed by means of the Autolisp function in Autocad, the GRCAO's user-friendly system allows lines, curves and splines to be traced by computer, requiring only two points to be recorded along every single line or Bézier curve to be drawn over the contours of figures shown on the picture which serves as a backdrop (figs. 3 & 4).

Fig. 3

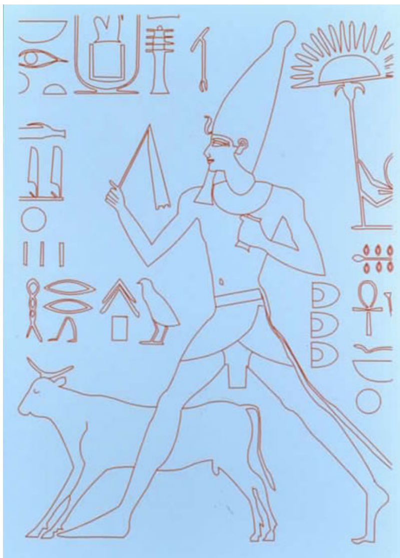

Fig. 4 (drawing by J. Revez)

The classical way of defining splines calls for the curve to be tangent at the mid-point of a polygone segment. Here this point can be located anywhere along the segment, allowing greater flexibility in the tracing of curves, a necessary requirement when drawing complex geometric forms such as hieroglyphs (C. Parisel, 2001). A broader aim of the project is to develop a system that will allow not only the representation of figures and hieroglyphic signs, but also to render these signs intelligent. By intelligent, we mean a system that can record and recognise each sign not only according to its geometric form, but also by means of its phonetic value. Systematic recording of signs is convenient when one has to restore a damaged inscription in which many signs are mutilated and difficult to read. The program would record what is left of a sign and then propose a list of signs which fit its geometrical shape. It would then be up to the Egyptologist to choose among the selection of hieroglyphs the one that suits him/her best.

The advantages of using CG-aided tools over the traditional manual method are manifold for other reasons: Computer Aided Architectural Design (CAAD) allows the researchers to keep track of their thought processes and know-how as they unfold: diagrams, sketches, graphics and the like are stored along the way and contribute to develop suggestions, new ideas and heuristic points of view during the design process (Gero, 1994).

Research carried out by the GRCAO in 1997, on the methods of work in architecture and computer simulation, clearly showed an important limit to the use of CAAD: the impossibility of transmitting to the computer the properties that the architectural model must have in order to extract a figural representation (De Paoli, 1999). A figural representation expresses the process of genesis, of constructive logic and allows for non geometric information to be dealt with. This approach insures the possibility of designing some scenes (models) starting from a partial description of its properties.

This situation enables the use of an intelligent design-assistance tool, based not only on the production of synthetic and realistic images of 3D scenes (i.e. drawings), but also on their development. In this process, the model is not the result of an analysis of solutions, or a simple list of functions, but the product of a cybernetic activity. The functions (activities) can be considered as a process of verification of the architectural (archeological) idea and the mental pre-conceptualization of a problem throughout the evolving representation of the model.

For exemple in a recent work, Iordanova (2000) explained that the semantic concept of the architect could be found either after a subjective interpretation of the available visual media produced by him, or by decrypting some verbal or written traces of the design process. In fact, the larger part of the design process takes place in the semantic world. Semantics serve as a source of analogy and inspiration for the creation of new architectural solutions. For this reason, we consider of fundamental importance to be able to keep trace of and to transfer the know-how of the design process (Tidafi, 1996). Figurations should therefore be generated on the basis of design knowledge and in the same time, they should be visually experienced. It thus becomes necessary to work with general concepts that can be specified for the purposes of their visual expression. This conforms well with the nature of perception and with the need for semantic meaning linked to the image: " The abstractness of the concepts is supposed to (somewhat) free them from their visual character and therefore make them suitable for intellectual operations. " (Arnheim, 1969)

In order to be able to evoke a concept more easily on the basis of visual perception, work at different levels of detail should be made possible. This will enable a top-down approach during the design process. This means that the details of an object could be specified after having defined the larger volumes or spaces, for example. Features difficult to conceptualize could be visualized by working with relations and features rather than with dimensions. By means of abstraction of the architectural-solution description, only the spatial or semantic out-frame of the object can be represented in cases where the specific solution is not yet available.

On a more practical plane, setting up a data base made up of hieroglyphic signs or figures drawn from relief scenes proves to be very useful, since stylistic features of these signs and figures vary considerably from reign to reign. As there are a great number of undated blocks scattered across the temple, it is much easier to look for common features when comparing the signs carved on these blocks with those already recorded into the computer, a fact that helps to determine the original location inside the temple of some of the dispersed blocks.

Thirdly, one can enlarge a picture at will so as to work each section of a wall individually over the computer, thus reducing the amount of time spent on the site.

Fourthly, when a line is incorrectly drawn, it is extremely easy to rectify it immediately; it is therefore not necessary to draw a whole scene two or three times over as is usually the case, but only to modify the parts of the drawing that actually need to be changed.

Finally, when one sign comes up more than once, as it is the case with the topographical lists of conquered towns (fig. 5), it is possible to draw a sign, copy it and paste it, and then simply rework each sign or figure separately. By avoiding to draw all the signs from scratch, one saves a great deal of time.

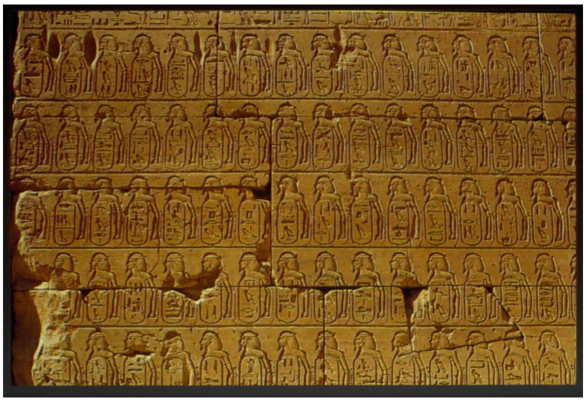

Fig. 5

In order to incorporate the drawn scenes within a threedimensional plane, the GRCAO uses photogrammetry (fig.6). One uses a theodolite to measure four points on the surface of a wall, record these points both on a picture taken at a wide angle shot (top part of window) and in a threedimensional vectorial plane (bottom part of window). As splines are drawn in the bottom section of the window, they are automatically being drawn over the picture, which thus serves as a guideline for contour lines (C. Parisel, 2001). This system is very useful when it is necessary to make the epigraphic survey of parts of monumental structures which are very difficult to reach by the epigrapher, even with the use of a scaffold, as for instance in the case of the top end of an obelisk.

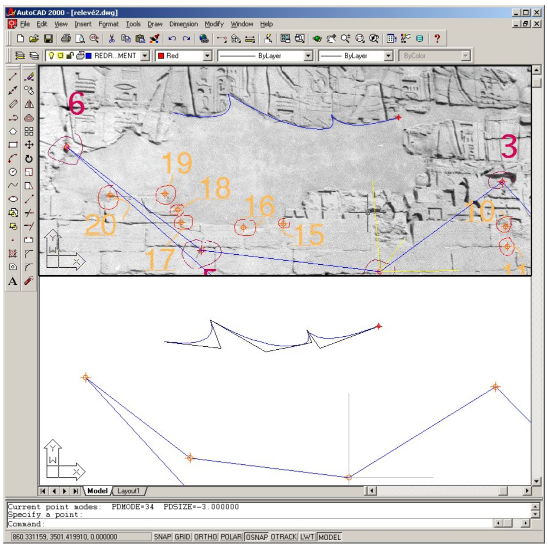

fig. 6 (graphics by C. Parisel)

The GRCAO also uses photogrammetry for courses of blocks to be drawn (fig. 7). One takes two pictures at different angles of a wall. As in the previous case, one starts by measuring with a theodolite a certain number of points, six in this case, before transferring them in both pictures and in the 3-D drawing model. The drawn blocks are by this means restored in their original position (C. Parisel, 2001). You see in fig. 7 the numbered reference points measured by theodolite (encircled in orange), as well as the drawn stones blocks drawn over two pictures taken at different angles (the two windows to the left) and then transposed in vertical view in the 3-D model (top window on the right).

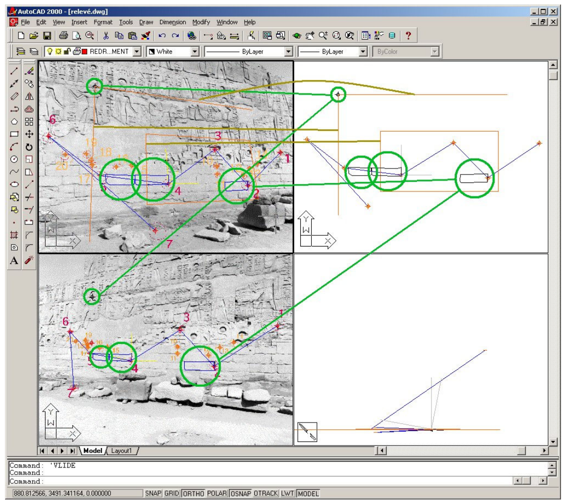

Fig. 7 (graphics by C. Parisel)

This system is very useful because it can not only give more information on how stone blocks were laid out (modes of construction differed sensibly from period to period, cf. Golvin & Goyon, 1987), but also on the way Ancient Egyptians reused blocks from dismantled monuments and incorporated them into new buildings they erected. For instance, what kind of architectural features were they included in (inner structure of pylons, foundations, etc.)? Within what geographical radius of their original position were these blocks reused?

4. Conclusion

We have attempted to plead in favor of a greater integration of computer modeling in the field of epigraphy and architeture, not only by producing images that will make the temple easier to visualise, but more importantly, by creating a functional language that will help to integrate all the considerations involved in the way the Ancient Egyptians conceived a temple. Far from us is the idea that computer programming will completely replace more traditional methods of surveying that have proven to be very effective in the past. We simply consider both approaches, old and new, to be complementary. Research carried out by the GRCAO leads to methods that can either speed up, ease or make the completion of certain tasks currently done by hand more cost- and time-effective. It can also execute operations that would otherwise be impossible to make. In all events, it definitely opens up avenues heretofore unexplored, simply due to the fact that the project involves scientists from different academic fields, may it be architecture, CAAD or egyptology, who work together in a spirit of collaborative design.

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