Using the latest research in computer modelling to carry out epigraphic work at Karnak : a new way of apprehending Egyptian temples.

by Jean Revez

Introduction.

The GRCAO, the Groupe de Recherche en Conception Assistée par Ordinateur of the Université de Montréal, is currently exploring new avenues that will define novel ways of modeling monuments. This research group, led by Prof. Tidafi and which I am part of thanks to a two year post-doctoral scholarship granted by the FCAR, a Quebec government research agency, has signed a contract of collaboration with the permanent CNRS-mission of the Centre Franco-Egyptien in Karnak. The main object of this association is to determine the historical and archaeological parameters that goes into the development of a new tool that will restitute the temple on the architectural plane as well as the epigraphic one, and to integrate these considerations in such a way as to help the egyptologist apprehend the temple as a whole.

Egyptologists have increasingly made use of computer modelling in order to reconstitute Egyptian temples, and Karnak is no exception to the rule. During the late 1980s, the Fondation Electricité de France used a software called PDMS to show the temple at different phases of its history. This system was very practical towards visualizing how the temple looked under the reign of a given king. (**diapo 1**) This slide, for instance, shows the temple under the rule of Thoutmosis II, where the new constructions added by this pharaoh are marked in red. Whereas this and more recent softwares have proven useful in forming a mental image of a monumental structure at a specific point in history, little attention has been paid up to now in the

computer world to temple scenes and inscriptions. In the case illustrated above, for example, wireframing is used to distinguish between the architectonic features; the walls are simply left in blank.

In this paper, I wish to introduce you to the approach proposed by the GRCAO in order to modelise epigraphy, and then show how the project will lead to a better understanding of the socalled 'grammaire du temple'.

1) Methods currently used in epigraphic work.

Before dealing with the GRCAO proper, I would like first of all to 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.

(**diapo 1**) The so-called Chicago House method, named after the residence built by the University Chicago in Luxor to house the american Egyptologists working in and around the old capital of Thebes, has hardly changed since its inception in the 1920s. (**diapo 1**) 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. **(diapo 1)** 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.

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 to be 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. (**diapo 1**) 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 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. Flying back home at the end of a season with large size plastic sheets may not be very practical. (**diapo 1**) The method used by the French is reliable when the scene to be drawn is in sunken relief, (**diapo 1**) but proves to be less adequate when the relief is raised, 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.

2) The method developed by the GRCAO: data processing.

(diapo 1) **(diapo 2)** Claude Parisel, a now retired professor at l'École d'Architecture de l'Université de Montréal who founded the GRCAO, has developed an original and ingenuous method which allows lines, curves and splines to be drawn by computer. **(diapo 1) (diapo 2)** His user-friendly system requires only two points to be recorded along every single line or curve to be drawn over the contours of figures shown on the picture which serves as a backdrop. The advantages of this method are manifold: work is stored numerically, a process which makes it possible to memorize the program using a low number of megabytes. The storage of information is invaluable when it comes to setting up a data base made up of hieroglyphic signs or figures in a relief scene. **(diapo 1) (diapo 2)** Secondly, as shown on the slides, one can enlarge a picture at will so as to work individually on successive sections of a wall. Thirdly, 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. **(diapo 1) (diapo 2)** Fourthly, when one sign comes up more than once, as it is the case with the topographical lists of conquered towns or the procession of Nile genies, it is possible to draw a sign, copy it and paste it, and then simply rework each sign or figure separately. By avoiding drawing all the signs from scratch, one saves a great deal of time.

I would like to stress that I am not implying that work done by hand or on the site can altogether be replaced by computer modelling. **(diapo 1)** Damaged areas of a wall still need to be checked on the spot and intricate patterns, such as the motifs of a crown or the feathers of a bird are still best rendered by hand. **(diapo 1)** A solution also has to be found as to how to represent in a computer drawing the thicker lines that can artificially recreate the shadow emanating from a direct source of light. This is not only important for aesthetic reasons, but also for conventional ones, since the direction of light makes it possible for the reader to determine whether a given scene is carved in sunken or raised relief. For example, the relief

drawn by hand and shown on the screen is raised, since the thicker lines are drawn on the right side of the figures. I am confident that the technicians at the GRCAO will solve this matter.

(diapo 1) (diapo 2) With another program developed by the GRCAO called photo-2D 2D-photo, it is possible to take a wide angle shot of a wall segment, then to draw its scenes using the picture as background, and finally to have the drawing automatically straightened up in a two dimensional frontal view . One must at first use a theodolite to measure four points on the surface of a wall. These reference points are then recorded on the picture (**here on the left**), and are transferred into the 2-D two-dimensional frame (**here on the right**). This operation allows the drawings to appear in its exact original location, when they are restored at right angle, as shown with the representation of the cartouche of Ramesses II in the 2-D box.

(diapo 1) This system is very useful when it is necessary to make the epigraphic survey of parts of a monumental structure 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 of an obelisk. This method is still in the process of being tested in order to reduce as much as possible the effect of distortion when pictures are taken at too wide of an angle.

The GRCAO has also developed a system which allows courses of blocks to be drawn on a set of two pictures, and then transposed into a 3-D model. **(diapo 1) (diapo 2)** 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 You see in both pictures the same numbered reference points measured by theodolite, on the one hand, and the drawn stones blocks, on the other. **(diapo 1)** Here is the transposition in the 3-D model of these elements.

This method is currently used to modelize architectural features such as blocks, but a similar approach is adopted to develop a system which will allow not only the representation of figures and hieroglyphic signs in 3-D by means of extrusion, but also to render these signs

intelligent. By intelligent, I mean a system which will record and recognise each sign according to its phonetic value as well as its geometric form. Because this part of the program is still in its early stage, it is important to ponder now over its future use and benefits, in order to determine in which directions research should be carried out to best meet the egyptologist's needs.

3) The historical and archaeological parameters involved in developing an integrative 3-D model of hieroglyphs .

a) Hieroglyphic signs.

A software that will modelize hieroglyphic texts carved on a wall will automatically have to record the size, depth and stylistic features of the signs, as well as the type of relief and the kind of stone used as support for the inscription. This is extremely useful, since these parameters vary considerably from reign to reign **(diapo 1) (diapo 2).** The slide on the left shows a sunken relief dating back to the time of Sesostris I of the 12th dynasty. The signs are broad, finely chiseled, but not deeply cut, while the inner surface of the signs bulge ever so slighty. Limestone is used, which comes to no surprise since most monuments before the mid-18th are made up of this material. The slide on the right shows the only *in situ* remains of the festival hall of the Tuthmosis IV which was once erected where the Hypostyle Hall is now standing. Many reused blocks found inside the 3rd pylon and now exhibited in the Open Museum at Karnak share the same characteristics as the raised-relief inscription in this picture, some of them actually matching the segment shown here. **(diapo 1)** As there are a great number of undated blocks scattered across the temple, it will be 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 will help to determine the original location inside the temple of some of the dispersed blocks.

Lexicography is another area where the modelling of epigraphy will be of great help. Spelling in Ancient Egypt did not follow strict rules as is the case in modern languages. For

instance, the Egyptian verb hb which means 'to substract' ends with the sign of the duck in flight (the gardiner sign list no. G40) from the ramesside period onwards. Egyptologists must currently browse through the computerized Worterbuch files of the University of Berlin or go through a great number of publications to find as many occurrences of a word as possible, and then determine how its spelling evolved in time. A system that will automatically record words from a wide chronological range of texts will allow the egyptologist to search for a word in the data base and then investigate its spelling.

Similarly, some words and expressions only appear in inscriptions at a certain time and then disappear altogether soon afterwards. For example, the expression hr-sa-dwaw which means 'after tomorrow' only occurs during the Third Intermediate Period. The epigrapher would once again have at his disposal lexicographical data which would allow him to date texts which are otherwise devoid of reliable chronological criteria.

Finally, on a more practical plane, systematic recording of signs will be convenient when one must restore a damaged inscription in which many signs are mutilated and difficult to read. The program will record what is left of a sign and then propose a list of signs which fit its geometrical shape. It will then be up to the Egyptologist to choose among the selection of hieroglyphs the one that suits him/her best. Furthermore, by recording all the inscriptions inside a temple, it will be easy to evaluate statistically how individual signs are associated, so that when a lacuna comes up in a text, it will be possible to determine in terms of probability which sign might have disappeared. This will help the Egyptologist in restoring the original inscription.

b) Scenes.

Relief scenes inside a temple are not disposed at random. **(diapo 1)** It is a well known fact for instance that battlerelief scenes are generally carved on the exterior walls of the temple, chaos having no place within the sacred precinct of the temple. A more thorough breakup of scenes by precise theme will shed greater light on the relationship that exists between epigraphy and architecture. Benoît Lurson has convincingly shown today that there is an

internal logic behind the relative positioning of scenes, on the one hand, and that such features inside an offering scene as the respective disposition and attitude of king and god, the type of rite they perfom, the way they are clad and the sort of crown they wear, all have an incidence on the interpretation of bas-reliefs. Recording such criteria will greatly increase the comprehension of temple iconography and its relation to religious and political ideology.

Conclusion

I have attempted today to plead in favor of a greater integration of computer modeling in the field of epigraphy. Far from me is the idea that computer programming will replace more traditional methods of surveying that have proven to be very effective in the past. I 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-effective. It can also execute operations that would otherwise be impossible to make. In all events, it definitely opens up avenues heretofore unexplored, simply by determining the parameters that go into the elaboration of a computer software which attempts to integrate all the considerations involved in the way the Ancient Egyptians conceived a temple.

I thank you for your attention.