IV. THE RECORDING OF MAYA SCULPTURE

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The beginnings of a useful recording of Maya sculpture may be said to date to the travels of John L. Stephens and Frederick Catherwood in the early 1840's. A number of earlier explorers undertook the drawing of Maya monuments, but the scope of their work was never so extensive and their renderings of sculptures were almost invariably Europeanized, as, for example, in the unfortunate neo-classic mannerisms of Waldeck in his drawings of Palenque stucco. But drawing upon the resources of the camera lucida and their own remarkable talents, Stephens and Catherwood succeeded in accumulating a record of extraordinary excellence which embraced an impressive sampling of Maya art from Copan to Chichen Itza. The wide circulation of Catherwood's drawings deriving from the success of Stephens' lively narratives was a major stimulus in the re-awakening of interest in the ancient civilizations of the New World and led eventually to the beginnings of scientific research. Although of outstanding importance for the age, Catherwood's drawings are by no means adequate for modern studies, and today they are to be valued mostly for their antiquarian charm and as works of art in their own right. The often repeated notion that "Catherwood's drawings are so accurate in their details that the hieroglyphs can be read" is true at times although much more accurate glyphic transcriptions are required for serious epigraphic investigations.

Four decades subsequent to the explorations of Stephens and Catherwood, and as a direct result of their stimulus, the beginnings of modern scientific field archaeology in Mesoamerica were initiated by A. P. Maudslay in the Maya area. The precise and detailed recording of Maya sculpture was at the forefront of Maudslay's plan of campaign, and the excellence with which he realized his goal has as yet not been surpassed in an endeavor of comparable magnitude. Relying upon photography and casting, already introduced into Maya field studies by Desire Charnay, Maudslay published in a lavish format magnificent photographic plates accompanied by line drawings of the sculptures. The drawings were prepared on the basis of photographs, casts, and field notes, and then were often checked against the originals in the field. It is difficult to be overly generous in the praise of Maudslay's contributions which laid the foundations for modern studies of Maya art and epigraphy. It is therefore in no way depreciative of his outstanding accomplishments to remark that it is surely inevitable in any great project involving such extensive drawing that despite every precaution some errors occur in Maudslay's renderings. However, since Maudslay's drawings are ordinarily paired with excellent photographic illustrations, it is often possible to correct the errors by reference to the photographic plates.

The investigations of Teobert Maler largely overlap the period of Maudslay's field studies in the Maya area. Maler was not the scientist that Maudslay was, but with often meager resources and under frequently most difficult field conditions, he produced a photographic record of Maya sculpture that is of inestimable value. His drawings made little pretention to be beyond the level of field sketches.

Regretably, the superlative standards of Maudslay were not emulated in subsequent recording of Maya sculpture. The great contributions to Maya art and epigraphy of Sylvanus G. Morley and Herbert J. Spinden, while adding enormously to the corpus--above all in the case of Morley, seldom achieved the photographic level of excellence set by Maudslay and rarely even distantly approached the level of reliability of his drawings. Fortunately, however, recent years witness a renewed effort at careful and painstaking photography and drawing of Maya monuments, as in the work of the University Museum's Tikal project and the Maya text recording project of Ian Graham under auspices of Peabody Museum, Harvard.

The accurate drawing of Maya texts and sculptures is an extraordinarily difficult task, partly since few pieces exist in their pristine condition. While various scientific techniques have been developed to further the accuracy of drawings, such as tracing from enlargements or projections of various negatives made under varying lighting controls, the intangible property of artistic insight is required to interpret line in such a manner as to successfully evoke the artistic qualities of the original. Thus literal line drawings, even when attaining a high and commendable level of accuracy and thus being invaluable for iconographic and similar inquiries, are seldom useful or even usable for purposes of critical or esthetic studies. The problem of sensitive and effective translation from the three dimensions of relief or sculpture to the two of drawing are almost insurrmountable in simple, direct line drawing, and thus there is the necessity of primary documentation by photographic and other means.

Another method of recording Maya sculpture is through rubbings. The first application of this technique in Maya field studies may have been undertaken by John H. Denison. At the suggestion of A. M. Tozzer, Denison undertook in 1932 to make rubbings of some of the sculptures at Chichen Itza and subsequently at sites visited by the Carnegie Institution of Washington's Campeche expeditions of 1933, 1934, and 1938 (Ruppert and Denison 1943:1-2, 99). We have not had the opportunity to examine any of these rubbings at first hand, but to judge from the published reproductions, there were significant limitations in Denison's techniques that prevented a fully adequate exploitation of the method. Although various students have subsequently utilized the technique of rubbing, it is only in recent years that a significant and large scale effort to record Maya sculpture with an advanced rubbing process has been initiated by Merle Greene Robertson (1). Although time consuming and clearly depending in no small degree upon the artistic sensitivity of Mrs. Robertson, an invaluable and accurate record of Maya sculpture is now emerging which provides an amazingly successful evocation of the original qualities of the sculpture. This record is invaluable to the study of Maya sculpture, and the enthusiastic reception of exhibitions of her rubbings at leading museums of the country testifies to the success of her efforts (2).

While the casting of Maya sculptures is clearly next best to having the original at hand for study, this method of reproduction is time consuming and is usually expensive. The introduction of liquid latex for mold making was a great advance, but latex has more recently been eclipsed by the vastly superior silastic materials which can be designed with a remarkably extensive range of qualities and potentialities. Unfortunately, silastic continues to be very expensive although no doubt more economical techniques of its use can be devised while the cost of the material will decrease with its wider use in industry. A major remaining problem with casts and molds is the museum space required for their storage. There exists, however, still another method of easily recording Maya sculpture in such a manner that casts can always be made when needed and which has negligible requirements of space for storage--namely, photogrammetry.

Some years ago the photogrammetric recording and replication of some Egyptian sculptures was undertaken in Aswan Dam salvage archaeology, and the potentialities and capabilities of photogrammetry are being rapidly and increasingly realized and expanded today in such projects as NASA's program of lunar mapping and recording. Since photogrammetry is still not very familiar to many archaeologists, we venture here to sketch briefly the method as it might be applied to the recording of Maya sculpture (3). It is not our intention to propose or design a detailed program; thus far, we have carried out minimal field experimentation, and we assume that colleagues considering employing photogrammetry will carry out their own experiments as to equipment and procedures most suited to their own project requirements.

Basically, the process of photogrammetry involves simultaneously making two photographs from two cameras separated by a small distance. From this stereoscopic pair of photographs all the three dimensional information of the subject can be obtained. The principle is identical to the way in which the human eyes operate. In order to successfully record Maya sculpture photogrammetrically, minimal equipment additional to the usual field photographic inventory is required, and only two measurements need be made.

Although special and often prohibitively expensive camera apparatuses are manufactured for making a stereoscopic pair of photographs, the considerations of portability, as well as economy, suggest the use of a single camera probably to be best suited to Maya field work. In order to employ a single camera, a specially designed base must be used which consists of a precisely calibrated bar or tract which is mounted horizontally upon a sturdy, professional quality tripod. The base can be cheaply machined from a material such as aluminum and should probably calibrated in half centimeters. The camera is mounted upon the base and is moved along the calibrated track to make the two pictures. The base serves to keep the camera back in exactly the same plane while the photographs are taken, and the calibrated track allows a simple reading of the distance between the two camera positions of the two photographs.

The base distance separating the positions from which the two photographs are made is one of the crucial measurements that must be recorded in the photogrammetric process. The second and final measurement that must be made in the field at the time of making the photogrammetric record is the focal length of the camera lens at the moment the photographs are taken. If the camera is focused upon infinity, the focal length is the given focal length of the lens. If the lens is focused at less than infinity, a table can be prepared, or obtained from the manufacturer of the camera, which will convert the focused distance (say 7 feet or 2 meters) into the corresponding focal length of the lens (in millimeters).

The camera employed for making the photographs should have a larger format than 35mm. The 2 1/4" x 2 1/4" format may be adequate since Maruyasu and Oshima (1964:11) report an accuracy of .3mm to 1.5mm attained in the recording of giant Buddha sculptures using the techniques described here with their 2 1/4" x 2 1/4" format stereo photography. If this format is adopted, then the Hasselblad 500C with an 80mm planar lens would seem to be an excellent choice for the camera.

Unfortunately, however, the square format is not an entirely efficient utilization of space. Partly for this reason, serious consideration should be given to employing the 4" x 5" format. The still larger negative area, of course, means greater detail and resolution and consequently more accuracy in the final construction of a contour map or replica of the sculpture. Naturally, to further guarantee high resolution in the negatives, whatever the size employed, a fine grain film such as Kodak Panatomic-X and fine grain developer such as Edwal's FG7 should be used. Similarly, film should be stored in a can or similar air-tight cannister with a supply of desiccated silica gel to protect it from the tropical moisture (Life Library 1971:9-42).

Once the pair of photographs have been made and processed, the two prints are dry mounted onto cardboard separated by a distance somewhat less than between the human eyes (Manual 1960:106). The stereo pair can now be viewed through a stereoscope to give a three dimensional image.

While our concern here has been merely to illustrate the ease with which a photogrammetric record of Maya sculpture can be made at the time of regular photographic recording, it may be of interest to briefly indicate the use of the stereoscopic pair for the making of a contour map or a replica of the sculpture, and for this purpose the reader is referred to the appendix of this paper.

Since a stereoscopic pair of photographs carries so much more information than an ordinary single photograph, it seems urgent to develop techniques of photogrammetric recording especially in this age in which we witness the apalling destruction of Maya sculpture on a ghastly scale. Although it may not be necessary or feasible for archaeological projects or museums at present to realize all the potentials inherent in photogrammetry, the essential record can easily and inexpensively be made and will be available for future exploitation (4).

Appendix

In order to make a contour map of a photogrammetrically recorded sculpture an autograph machine is employed. With the autograph the contours of the three dimensional image seen while viewing the stereo pair through the stereoscope are traced.

To understand the basic geometry of the operation and why a stereoscopic pair contains three dimensional information, the procedure is outlined for finding the three coordinates (X, Y, and Z) of a chosen point on the image. On the pair of prints the x and y coordinate axis are drawn and the point A is located on each print. The x_a', y_a',, x_a and y_a measurements of point A are taken from the stereoscopic pair, the parallax, p, is computed, and the three formulae listed are used to compute X_a, Y_a, and Z_a. In these three formulae B and f were measured when the photograph was taken; the other measurements were made directly from the two prints. It is the parallax, or shifting of the position of a on the two negatives, that gives the three dimensional property to stereoscopic photogrammetry (Moffitt 1967).

Thus the final measurements theoretically required are the coordinates of a point A on each of the two photographs of a stereo pair. Without the autograph, it would be necessary to plot these measurements for a very large number of points in order to construct an accurate contour map. With the autograph the operator traces contours directly without having to plot each point and to interpolate between them with connecting lines. Thus the actual numerical determination by hand of these last measurements is unnecessary, and the only measurements actually made are the initial ones of camera position separation and focal length made at the time the photographs are taken.

In order to obtain a numerically contoured plaster replica of a photographed sculpture, a somewhat different machine is employed. The stereo pair is again viewed through a stereoscope and the various contours are followed. However, instead of actually drawing a contour map the operator punches a button at regular intervals as he follows the different contours of the sculpture's image. Depressing the button automatically results in a computer card recording the X, Y, and Z coordinates for each of the points selected. Thus, a set of data cards is obtained recording a very large number of points on the sculpture; the greater the accuracy desired, the more points are digitalized. The data obtained is transferred to tape in accordance with an appropriate computer program, and the tape is fed into a milling machine to carve the replica in any material from plastic to plaster.

While milling machines exist capable of carving an actual size replica of a large Maya sculpture (such as are used in the automotive industry), common university mechanical engineering shops will probably possess the resources for carving replicas at about 50% actual scale. Although it may neither be feasible or desirable in the near future to produce any replicas of Maya sculpture by these means, having the properly made and recorded stereoscopic pair of photographs means that all the information necessary to produce an accurate copy of a Maya sculpture is on record for potential future needs. And simply having the stereo pair allows the scholar the very substantial advantage of being able to view the sculpture three dimensionally.

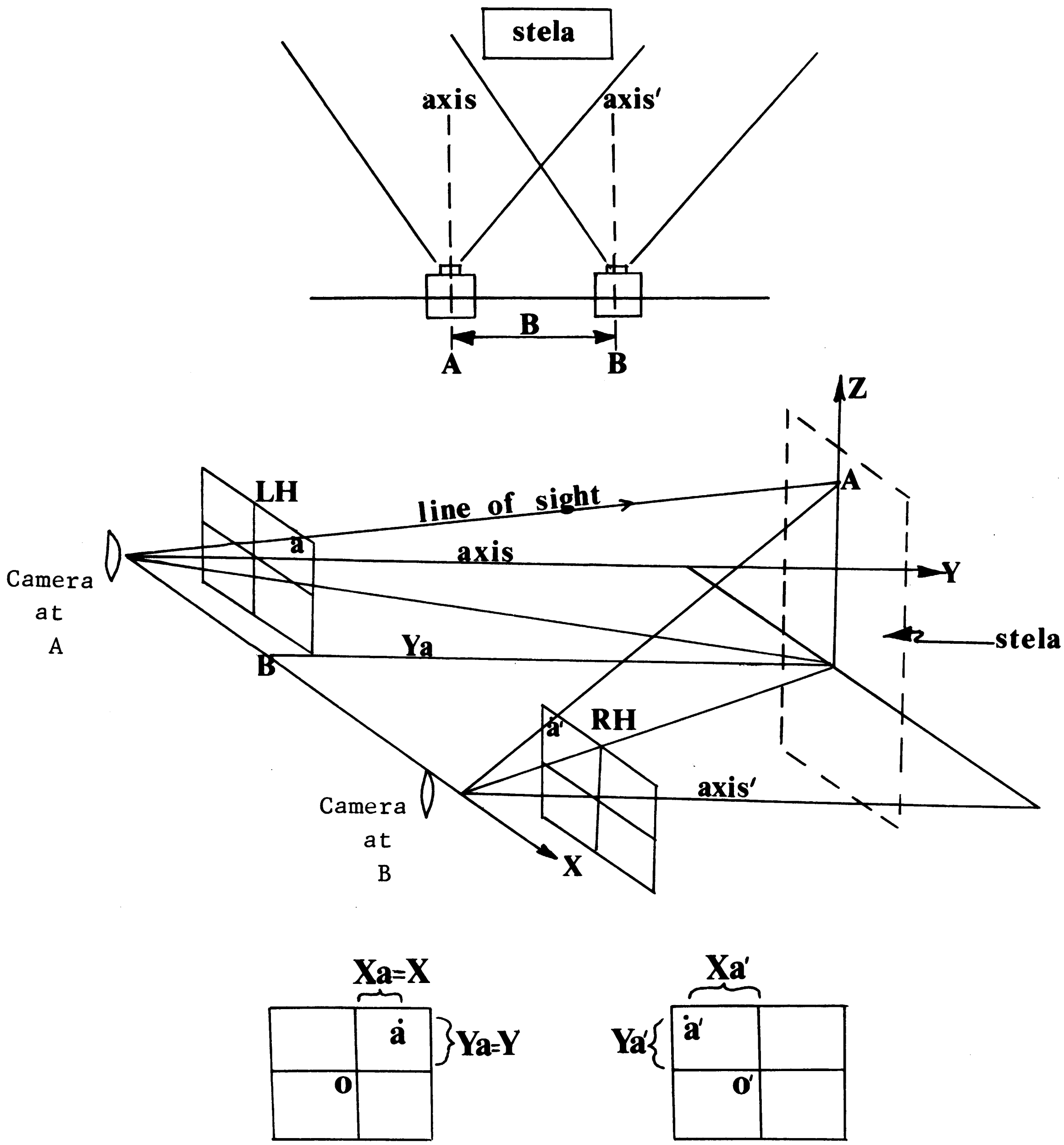
Notes

1. The first volume of rubbings resulting from Mrs. Robertson's work was published by the Museum of Primitive Art (1967) as Ancient Maya Relief Sculpture. A second and extensive collection of rubbings will be published shortly. Individual examples of Mrs. Robertson's work have appeared in numerous articles, including the present volume. The technique employed by Mrs. Robertson has been described fully (Robertson 1966).

2. The first public exhibition of Mrs. Robertson's rubbings of Maya monuments was held at the Lowie Museum of Anthropology, University of California, Berkeley, in 1965. Subsequent exhibitions include the following institutions: Chicago Natural History Museum, Museum of Primitive Art, University Museum (University of Pennsylvania), California Palace of the Legion of Honor, New Orleans Museum of Art.

3. The potentials of photogrammetry as applied to field archaeology are enormous, and it is surprising that so little use has thus far been made.

4. The Center for Latin American Studies, University of California, Berkeley, has supported this study.



$$X_a = \frac{B}{p} X$$

$$Y_a = \frac{B}{p} f$$

$$Z_a = \frac{B}{p} y$$

Where:
1) p (parallax) = $X_a - X_{a'}$
2) f (focal length) = 80 mm
3) X and Y are taken from LH negative
4) B = base

Figure 1. The basic geometry involved in photogrammetric recording of a stela.

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