

PHOTOGRAMMETRIC RECORDING
OF
THE ADIVINO PYRAMID, UXMAL, YUCATAN, MEXICO:
FIELD EVALUATIONS 1990
(English version)

by

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Abstract

This report describes photogrammetric documentation carried out at Uxmal, Yucatan, Mexico in 1990. The purpose of the study was to evaluate architectural photogrammetry as a technique for documenting important cultural heritage resources. The west and north facades of the Adivino Pyramid at Uxmal, were recorded photogrammetrically from the ground and the air, and the resulting photographs and survey data provide a permanent record from which changes in the structure can be measured and drawings made. The results of our fieldwork clearly indicate that photogrammetric documentation of important cultural heritage resources in Mexico can be carried out by non-specialists with great precision and minimum cost.

I. Photogrammetry for archaeological documentation

Background

Generally, in the United States photogrammetry has been used for the production of topographic maps by governmental agencies such as the Geological Survey and commercial organizations, and only a handful of photogrammetrists, here, have learned the techniques required to record architecture. In Europe a number of nations fund the photogrammetric recording of their heritage resources, and the International Committee for Architectural Photogrammetry (CIPA) in Europe is part of the International Council on Monuments and Sites (ICOMOS) which is funded by UNESCO.

One person in the United States who has been working to develop simple systems to photogrammetrically record architecture is H. Dell Foster. Foster, president of American Measuring Instruments (AMI), a photogrammetry company in San Antonio, Texas, offered to act as technical consultant for recording of the Adivino Pyramid to test the feasibility of using photogrammetry to document Maya architecture, and his associate, John Garcia, acted as field consultant.

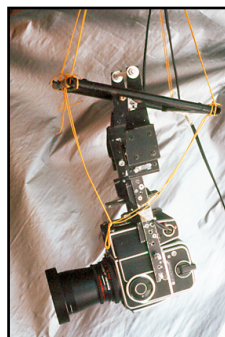
Architectural photogrammetry, a well developed technique, had not been applied by archaeologists to the Maya area, as far as could be determined, and so Foster's and Garcia's help in carrying out field tests was welcomed. It seemed that photogrammetry would make an excellent tool for documentation of Maya architecture since precise architectural drawings and measurements could be made from stereo photographs now or any time in the future.

An important part of architectural photographic documentation is the ability to take measurements and make drawings from the documentary image. For example, once a structure has been recorded photogrammetrically its condition at the moment of photograph is fixed on film, and one can make quantitative studies of the building at any time. The accuracy of any measurement made from a pair of stereo photographs is directly related to the distance separating each image of a pair, the distance of the subject to the camera, and the accuracy of target surveys. Additional factors that affect the precision of measurement are the quality of the lens, film, accuracy of exposure and the equipment (stereoplotter, software and hardware) used take measurements and to plot a drawing.

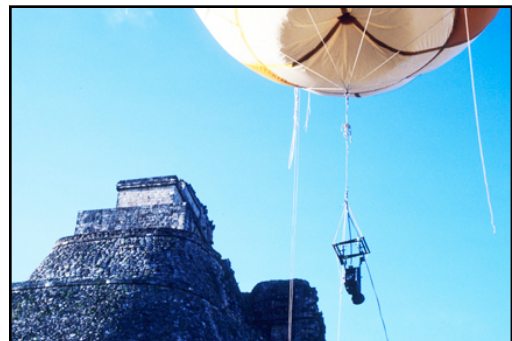
Fieldwork at Uxmal--1990



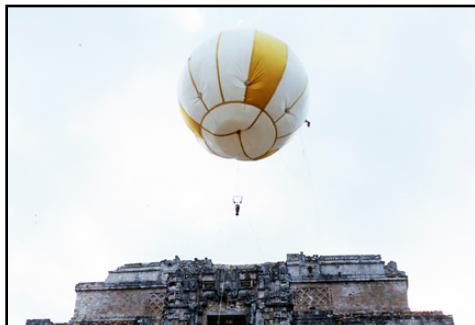
West facade, Adivino Pyramid, Uxmal. Pic: Desmond 1989.



Hasselblad medium format camera rigged to hang from balloon. Pic: Desmond 1990.



Radio controlled Hasselblad camera attached to balloon. Pic: Desmond, 1990.



Radio controlled Hasselblad camera attached to balloon near top of Adivino Pyramid. Pic: Desmond, 1990.

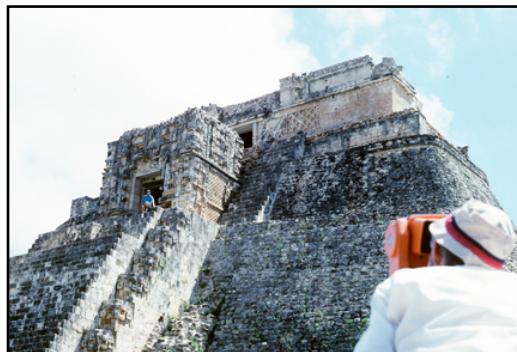
Our field work had as its purpose to record the west and north sides of the Adivino Pyramid from the ground, and, using a small, four meter diameter hydrogen filled balloon with a camera attached, record the upper part of the facade from the air. Gerald Johnson, associate professor of surveying



John Garcia (L) and James Callaghan plan placement of survey targets on the pyramid. Pic: Desmond, 1990.



Placing survey targets on the pyramid. Left David Farquhar, right James Callaghan. Pic: Desmond, 1990.



Professor Gerald Johnson making measurements of the targets on the pyramid using a total station theodolite. Pic: Desmond, 1990.

and photogrammetry for the Department of Civil and Mineral Engineering at the University of Minnesota-Twin Cities, surveyed the pyramid, and provided a university owned hydrogen balloon, and directed its use to photograph the upper facade. The balloon acted as a camera platform to photograph the upper temples using a horizontally attached Hasselblad camera with a radio controlled shutter and film advance.

Our procedure was to place targets on the pyramid and then survey the elevation and angle, and distance of each target from each station. On the west side we placed 29 targets and surveyed them from three stations (A, B, C). On the north side



West facade of the Adivino Pyramid, Uxmal. 3D stereo used for photogrammetric processing. Pic: Desmond, 1990.

we surveyed 28 targets from two stations (D, E).

The next step, carried out while the targets were being surveyed, was to photograph the pyramid from the ground. Photos of all sides of the pyramid were taken approximately 20 meters from the structure, 4 meters apart and parallel to each other. The camera lens was set at infinity.

Balloon photography was carried out, very early, on two mornings when there was almost no wind, 20 meters in height and 15 to 20 meters from the facades. The sensitivity of the balloon to even a slight breeze prevented us from taking photographs in the afternoon when the light on the west facade was bright enough for a high shutter speed that would prevent blurring from camera movement.



Hydrogen balloon with camera hanging below photographing the west facade of the Adivino Pyramid. Right photo shows balloon being walked to north and east sides for additional photos. Pic: Desmond, 1990.

Aerial photos of the Adivino Pyramid, Uxmal taken from a balloon. 1990



West facade of the Adivino Pyramid. 1990



North side of pyramid with profile of Chenes Temple. 1990



North side of pyramid with profile of east stairway.



East facade of pyramid with stairway, and shadow of balloon, 1990



East facade of pyramid with stairway, and shadow of balloon. 1990.

The Hasselblad camera was fitted with a wide angle 50mm, F4 lens. Using Kodachrome 64 film, the maximum shutter speed could not be set faster than 1/125 second even with a maximum aperture of F4 when photographing the early morning shaded west facade. We decided to use very fine grain Kodachrome 64 so that the stereo photos could be viewed clearly under magnification in the stereoplotter. Every

effort was made to make exposures when the camera was still, but virtually all photos of the west facade have some blurring. More testing is recommended to see whether Ektachrome 200 or 400, or other high speed transparency films have a grain size acceptable for operation in a stereoplotter.

Balloon photographs of the north, east, and south facades of the pyramid were sharper because we were able to set the shutter speed at 1/250 for most photos, and 1/500 second for a few of the east facade where there was bright sunlight.

Where winds do not present a problem, a small hydrogen balloon is excellent for architectural photographs of difficult to reach locations, and would also be useful for vertical photos of structures. A bipod is simpler to use and not affected by wind so it is suggested that it be employed for horizontal photography up to about 15 meters. For aerial photographs up to 200 meters from the ground, a 35mm camera mounted in an inexpensive radio controlled airplane with a two meter wing span has been used successfully for several years for aerial photography by the United States National Park Service.



Photogrammetrist John Garcia with American Measuring Instruments 35/70 stereoplotter at AMI offices in San Antonio, Texas. Pic: Desmond, 1990.

John Garcia, a photogrammetrist with American Measuring Instruments, has reported that he has made measurements from the balloon photos using a stereoplotter and that his results are within 3 centimeters of field measurements of the pyramid. We consider these results very acceptable for photos taken 20 meters from the subject.

II. Conclusions

The results of our fieldwork clearly indicate that photogrammetric documentation of important cultural heritage resources in Mexico can be carried out with great precision and minimum cost. It is important to note that while project personnel had little prior experience with architectural photogrammetric recording, the results of this project are equal to those of highly trained photogrammetrists. This indicates that archaeologists can easily attain a high level of expertise in photogrammetric recording in a relatively short amount of time, and in turn record cultural heritage resources to a level of precision previously thought impossible.

Most archaeologists would agree that our cultural heritage is being destroyed by environmental and human causes in spite of the efforts of our dedicated colleagues, so it is imperative that we record and monitor our heritage. A high quality medium format camera and a surveying instrument accurate to 10 seconds of arc is available to most archaeologists. With those tools and a little training archaeological subjects can be documented with precision, measurements taken, the condition of buildings monitored, and architectural drawings made from the photographs when needed--tomorrow or 100 years from now.

III. Volunteer Project Personnel

Field Work--1990

Principal Investigator:

Lawrence G. Desmond, Assistant Professor of Anthropology, University of Minnesota-Morris, and Foundation for the Advancement of Archaeology through Collaboration in Technology.

Surveying and balloon operations:

Gerald W. Johnson, Assistant Professor of Civil Engineering, University of Minnesota-Twin Cities.

Logistics and field assistance:

James W. Callaghan, Archaeologist, Director of the Institute of Maya Culture, University of Mayab, Merida, Yucatan.

Photogrammetric consulting:

John Garcia, American Measuring Instruments, San Antonio, Texas.

Assistants:

Alys Culhane, Assistant Professor of English, University of Minnesota.

Patricia Anderson, Graduate Student in Anthropology and Archaeology, University of Chicago.

Roger Farquhar, San Francisco, California.

David Farquhar, Santa Cruz, California.

Giselle ten Hompel, Boulder, Colorado.

IV. Acknowledgements

In addition to the persons mentioned above who volunteered their time to help make this project a success, I would also like to thank the Consejo de Arqueología por la Dirección General del Instituto Nacional de Antropología e Historia for authorizing the project. In Yucatan great thanks are due to our archaeologist colleagues at INAH's Centro Regional de Yucatan who facilitated governmental arrangements, and provided important consultations prior to our field work. Director of Centro Regional de Yucatan, Alfredo Barrera Rubio, early on saw the importance of photogrammetry for architectural documentation and supported our work at Uxmal. Finally, mention should be made of Pedro Casanova at Uxmal and his staff who were most kind and helpful during our on site work.

V. Bibliographic reference to paper

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