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RELIEF OF THE SPOILS ON THE ARCH OF TITUS
A PHOTOGRAMMETRIC SURVEY

ABSTRACT

Inside the Arch of Titus, above the Forum in Rome, there are two reliefs. On the south wall the relief shows the Jewish seven-branched lampstand or menorah and the "shewbread" table, receptacles and trumpets. Two metric cameras, the Zeiss Jena UMK 10/1318 and the Hasselblad MK70 were used in this project. The objects are plotted in scale 1:1 with an estimated depth accuracy of 0.2 to 0.6 mm. Samples of photographs for stereoscopical viewing are shown.

INTRODUCTION

In Rome, above the Forum, inside the Arch of Titus, you can today see two reliefs, depicting the Roman triumph after the conquest of Jerusalem in the year 70 A. D. On the south wall the relief shows the triumphal procession carrying the sacred vessels of the Jewish people, the seven-branched lampstand or menorah, the "shewbread" table, receptacles and trumpets.

Since the vessels depicted have long since vanished and it may be assumed that the sculptor worked from the actual objects, their representation on the relief is probably closest to the originals.

Inside the Arch, the two reliefs are about three meters above the ground, see figure 1. One is not allowed to measure directly on them or take a cast of them. Photogrammetry is obviously an ideal measuring method here. The reliefs are about 1900 years old, air pollution has severely damaged them, especially during the latter years, which further emphasizes the need for a highly accurate metric recording.

PLANNING THE PHOTOGRAMMETRIC WORK

Taken as a whole, the relief measures 3.82 x 1.94 m or about 7.4 m², while each group of objects which we are interested in is almost 1 m high or wide.

The two metric cameras, used in this project, were the Zeiss Jena UMK 10/1318, figure 3, and the Swedish Hasselblad MK70, figure 4.

The UMK 10/1318 camera has a Lamegon lens with focal length of 99 mm. The camera has been calibrated for an object distance of 2 m. The Hasselblad MK70 has a Biogon lens with focal length of 60 mm.

The UMK 10/1318 was used to take a horizontal sequence of photographs with the horizontal axis of the camera pointing toward the central line of the relief. The Hasselblad MK70 was used to take detailed photographs over special areas to supplement those taken with the UMK 10/1318.

THE FIELD WORK

Inside the Arch, figure 1, a scaffold was built by the staff of the Forum Romanum. Electric lights were installed and one of the men assisted during all the photographic work.

The UMK 10/1318 camera station points were marked on the scaffold and the bases, each 0.62 m, gave 7 photographs with 80% overlap. The projection centre of the UMK 10/1318 lens was placed over these marks and scale control was provided by a levelling rod placed horizontally below the relief.

At least two exposures were made at each photo station. The plates were developed the same day in order to check each glass plate and if necessary rephotograph from the station. Using a spirit level in both directions ϕ and ω the camera was always made horizontal. Thus each stereo model was close to the photogrammetric normal case. See figure 2.

The photographic materials used in this work were for the UMK 10/1318 Agfa Gevaert Aviphot pan 30, glass plates 3 mm thick, and for the Hasselblad MK70 Kodak Plus-X pan 70 mm perforations type II, film.

THE ESTIMATED ACCURACY

The scale of the photography is approximately 1:22 and assuming an image co-ordinate accuracy of $dp = 0.01$ mm we obtain an estimated planimetric accuracy of 0.22 mm in the object scale. To determine the accuracy in depth the formula used was

$$dy = \frac{y^2 \cdot dp}{B \cdot c} \text{ where } y = \text{the photography distance in mm;}$$

dp = the accuracy in the photographs and measurement;
 B = the base in mm; and c = focal length in mm, 104.86 mm for the UMK 10/1318.

Using the different overlaps we obtain the following estimates for depth accuracy:

overlap	base	mm	depth precision	base/photography distance
80%	1	620	$dy = 0.615$ mm	1:3.2
60%	2	1240	$dy = 0.308$ mm	1:1.6
20%	3	1860	$dy = 0.205$ mm	1:1.1

Samples of the stereoscopic UMK 10/1318 photographs are shown in figure 5. Some special photographs from the Hasselblad MK70 are shown in figures 6 and 7.

THE STEREOGRAMMETRIC DRAWINGS

The plotting of the objects was done in a Wild stereoautograph A7 at the Department of Photogrammetry in Stockholm, using the following scales: negative scale about 1:22, model scale in the instrument 1:5 or 1:6, and the scale of the drawing itself 1:1.

The seven-branched lampstand. Figure 8.

The absolute orientation of the lampstand was done in such a way that its centre and outermost pair of branches were plotted in the same plane.

The angle around the axis parallel to the long side of the relief, common ω , is about 8 gon or $7^{\circ}12'$, relative to the relief frame. The angle around the axis parallel to the short side of the relief, common ϕ , is about 0.5 gon or $0^{\circ}30'$.

The contour lines are plotted with a 1 mm interval. The photogrammetric stereo model has in this case a stereo base of 1164.34 mm which gives a depth accuracy of 0.43 mm.

The "shewbread" table, receptacles and trumpets. Figure 9.

The absolute orientation is here defined by a plane through three points, two at the table-top corners and one at the erected left-leg side.

The angles are: common $\omega = 2.73$ gon or $2^{\circ}32'$, and common $\phi = -0.79$ gon or $-0^{\circ}47'$.

The contour lines are plotted with a 1 mm interval. The stereo model has a base of 1817.76 mm which gives an accuracy of 0.28 mm in depth.

Cross sections of the objects were also plotted.

ACKNOWLEDGEMENTS

The work was, from its inception, planned and executed in close co-operation with Dr. Leon Yarden, the historical expert and initiator of the project.*

In Rome, Professor Gianfilippo Carettoni, Soprintendente of the Forum Romanum until 1976, and his staff were exceedingly obliging towards Dr. Yarden and the Department of Photogrammetry in Stockholm.

The Swedish Institute of Classical Studies at Rome, through the then director Professor Carl Eric Östenberg, kindly put its photographic development equipment at our disposal.

The UMK 10/1318 Zeiss Jena camera was placed at our disposal by the Swedish firm Nord-Optik, Järfälla, and the Swedish Hasselblad MK70 by the Hasselblad company, Gothenburg.

The ink redrawing of figures 8 and 9 was made by Miss Monica Holst of VIAK AB, Consulting Engineers and Surveyors, Vällingby.

*A comprehensive historical study of the vessels by Dr. Yarden, based on the present survey, is to appear shortly.



Figure 1

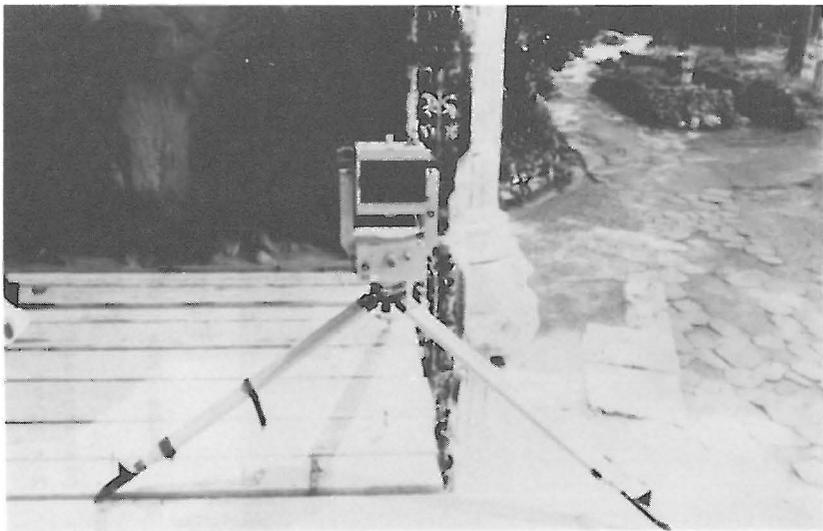


Figure 2

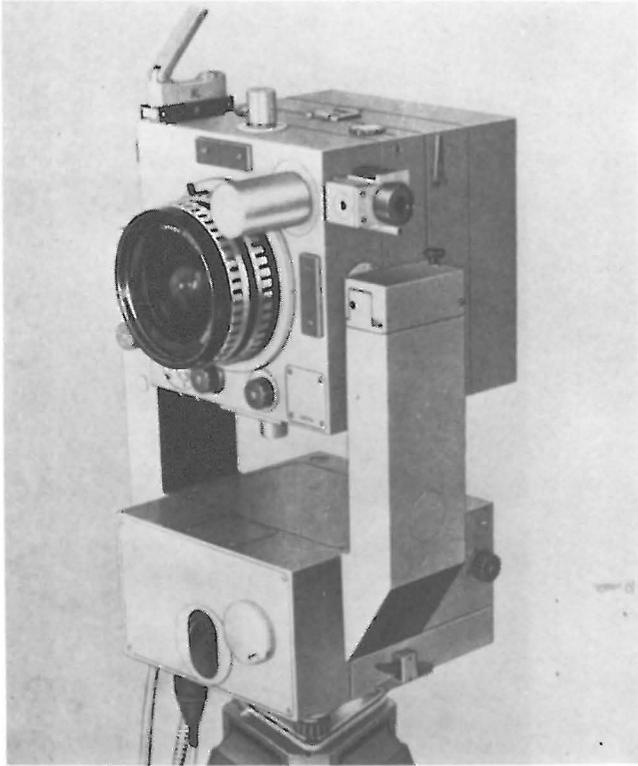
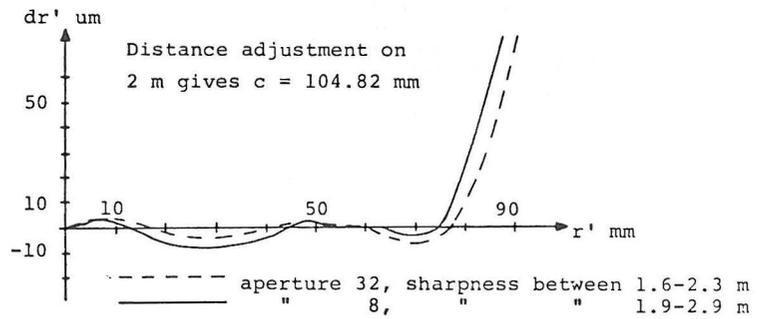


Figure 3

Zeiss Jena UMK 10/1318



RADIAL DISTORTION

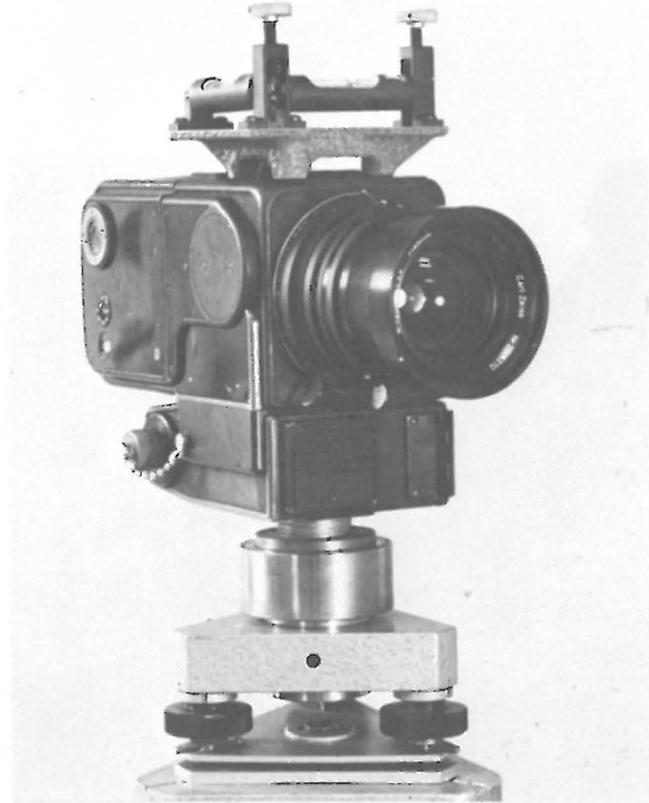


Figure 4

Hasselblad MK 70

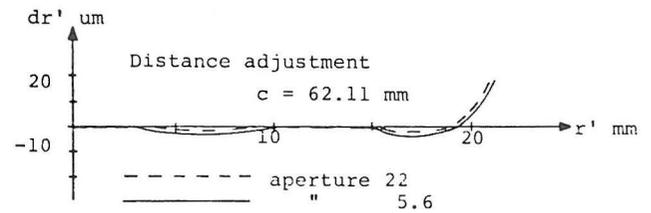




Figure 5



Figure 6



Figure 7



Figure 8

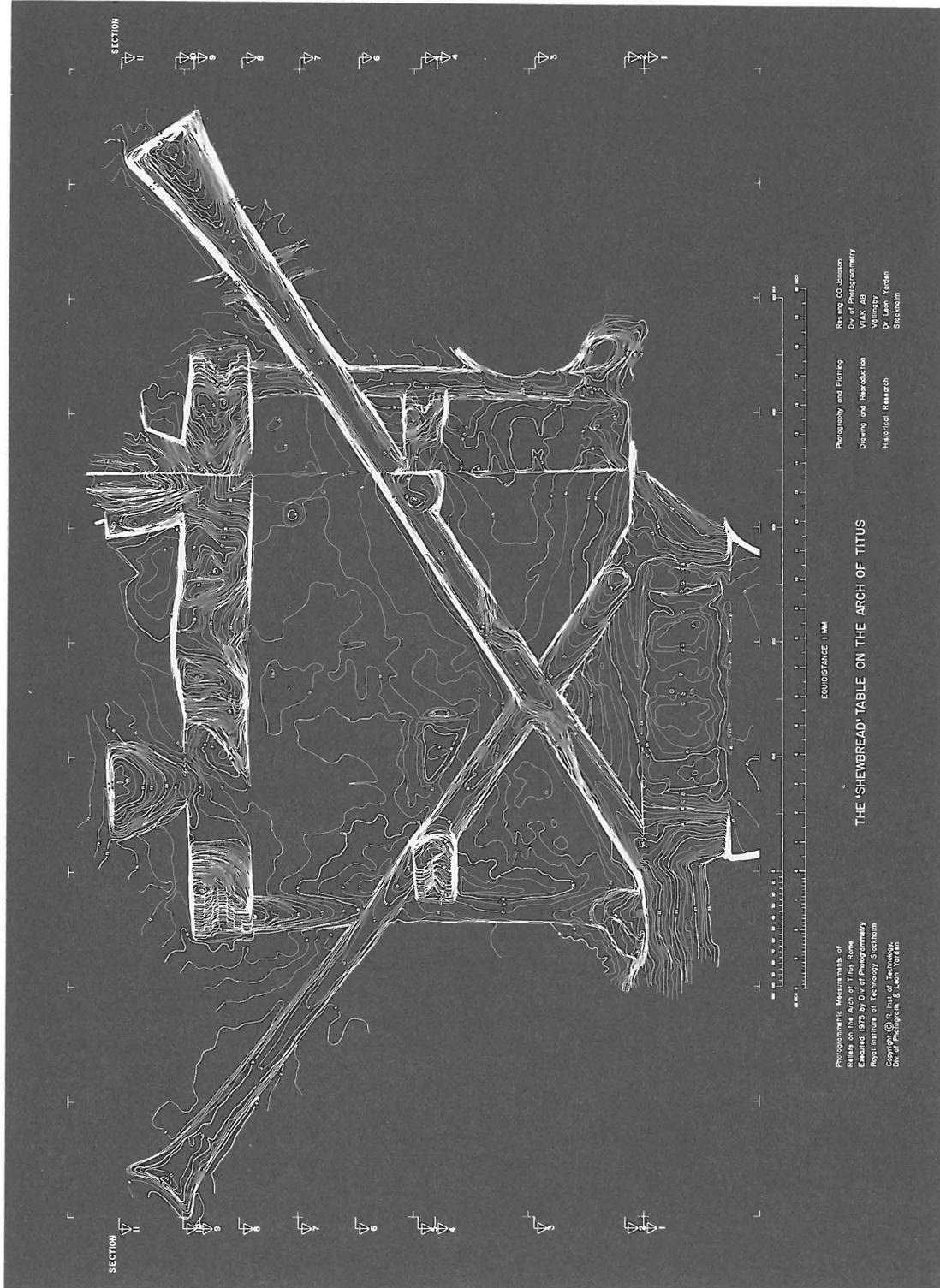


Figure 9