# INSTANT PLANS BY POLAROID INSTANT PHOTOGRAPHY FOR ARCHAEOLOGY AND ARCHITECTURE

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Surveying and documentation of the excavations are essential tasks of the archaeologists. Their surveys are bound up with a common local coordinate system, in order to find out about connections and relations between the various parts of the excavations or the different soil-layers. Especially tiresome is the measuring and the drawing of the many soil and wall sections, which however are of great importance for the dating of the finds.

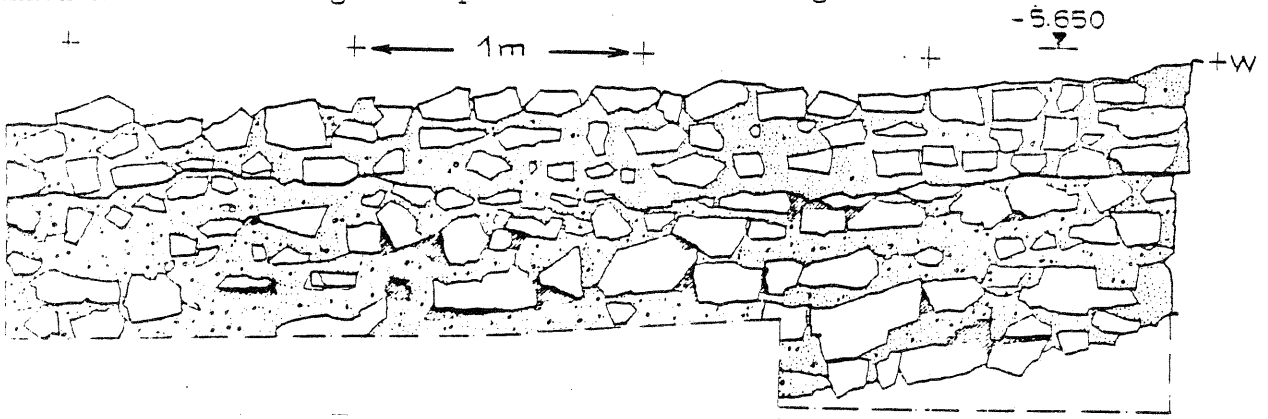



Fig. 1. Survey of a wall section, measured and drawn by hand.

Usually these mostly plane sections are drawn at a scale of 1:20. If rod, plummet and measure are used the time needed per $m^2$ is approximately one hour. The completeness, however, as well as the reliability of the drawings depend on a person which is only human, "errare humanum est", thus the value of documentation is reduced compared with a complete photogrammetric survey. Photogrammetry is quicker, reliably complete and correct, but expensive, if the fixed base stereocameras or the large format precision measuring cameras are used each time. Furthermore, archaeologists need immediately available results, as excavations and archaeological research work should not be interrupted for too long. And: The many kinds of plane objects can really be photo-documented with less effort. Examples are walls, soil-sections, inscriptions on monuments, mosaics, paintings etc.

It suggested itself to look for some instant photographic large format camera and to add everything practical and necessary, so that the archaeologist himself can handle it under excavation conditions. The resulting photographs have to be free of tilt displacements and correct to working scale. One must be able therefore to orient the camera axis orthogonal to the object plane to be photographed and measured. The image plane has to be parallel to the object plane and at a precalculated distance. With such correct-to-scale instant photographs one might then do some simple mosaiking on mm-graph-paper what results in an instant photoplan. Onto this photoplan itself or onto a transparent overlay the archaeologist can write down his notes or symbols about the interpretation of the visible, exact in place and correct to scale. He mainly has time now to be archaeologist and not any more up to 50 % his own surveyor.

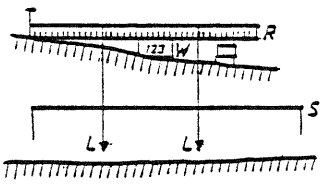
This idea has been followed up within a larger research project "Archaeology and Photogrammetry" of the authors, sponsored by the Austrian Fonds for the Promotion of Scientific Research, and well assisted by Polaroid Austria. At the same time this part was the diploma thesis of the second author. The result was an instant photogrammetric survey set for plane objects, the "Polaroid Archaeology Set".

Fig. 2. Adjusting the camera's object-distance in order to get the photo-scale correct to working scale 1:20. Soil section in the Carnuntum area.

Fig. 3. The polaroid instant camera in position for the monophotogrammetric documentation of inscriptions.

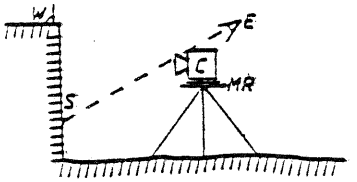
In the instructions for use the following technical details and practical recommandations can be read: A Polaroid instant camera 600SE with objectives f = 75 mm, 127 mm or 150 mm and an image format of 83 x 108 mm, with tripod and macro rail (for shifting of the camera orthogonal to the object plane) has to be positioned in proper height and distance in front of the object plane. The interior orientation is known by calibration. The distortion of the lenses is smaller than drawing accuracy at photoscale. The levelling of the camera can be done by means of a specially adapted cross level. The main "difficulty" for a non-surveyor is how to find the correct direction of the camera axis. Therefore some of the corresponding photogrammetric tricks shall be described here:

Fig.4



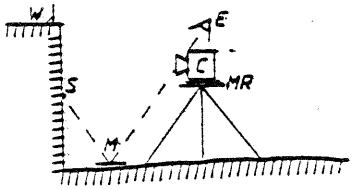

A string spanned horizontally at known height in the object plane and some crossing plummet strings at known coordinates (which can easily be found by means of a surveyors rod at natural ground level) present some orthogonal object grid lines which must be seen in the viewfinder - at correct azimuth - without tilt displacements. (Fig. 4).

Fig.5



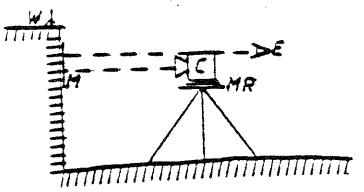

Or, if the horizontally spanned string is not at the same height as the camera but rather at a largely different height, then the horizontal front edge of the camera body can be turned until it appears parallel to the string. (Fig. 5).

Fig.6



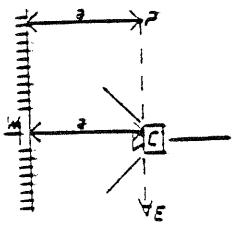

The same principle can be followed with the mirror image of a horizontal line close to the height of the camera, but therefore a rather large mirror, which is part of the kit, has to be placed horizontally (water level !) on the ground half the way between camera and object. Viewing now over the camera's horizontal front edge towards the mirror one can observe the mirror image of the horizontal string. The camera has to be turned now until both are parallel. (Fig. 6).

Fig.7




A further "method" is to orient the camera towards its own mirror image, if the mirror is well placed within the object plane. (Fig. 7).

Fig.8




Another method recommends: Measure the distance between the object plane and the upper front edge of the camera; create a new point at the same distance from the object plane but some meters left or right; rotate the camera unless the front edge straight line view passes this new point. (Fig. 8).

C ... Camera on tripod, levelled
E ... Eye and viewing direction
M ... Mirror placed in plane or horizontally
MR... Macrorail oriented towards object
R ... Surveyors rod as coordinate guide
S ... String spanned horizontally
W ... Writing bord or slate for section numbers etc.

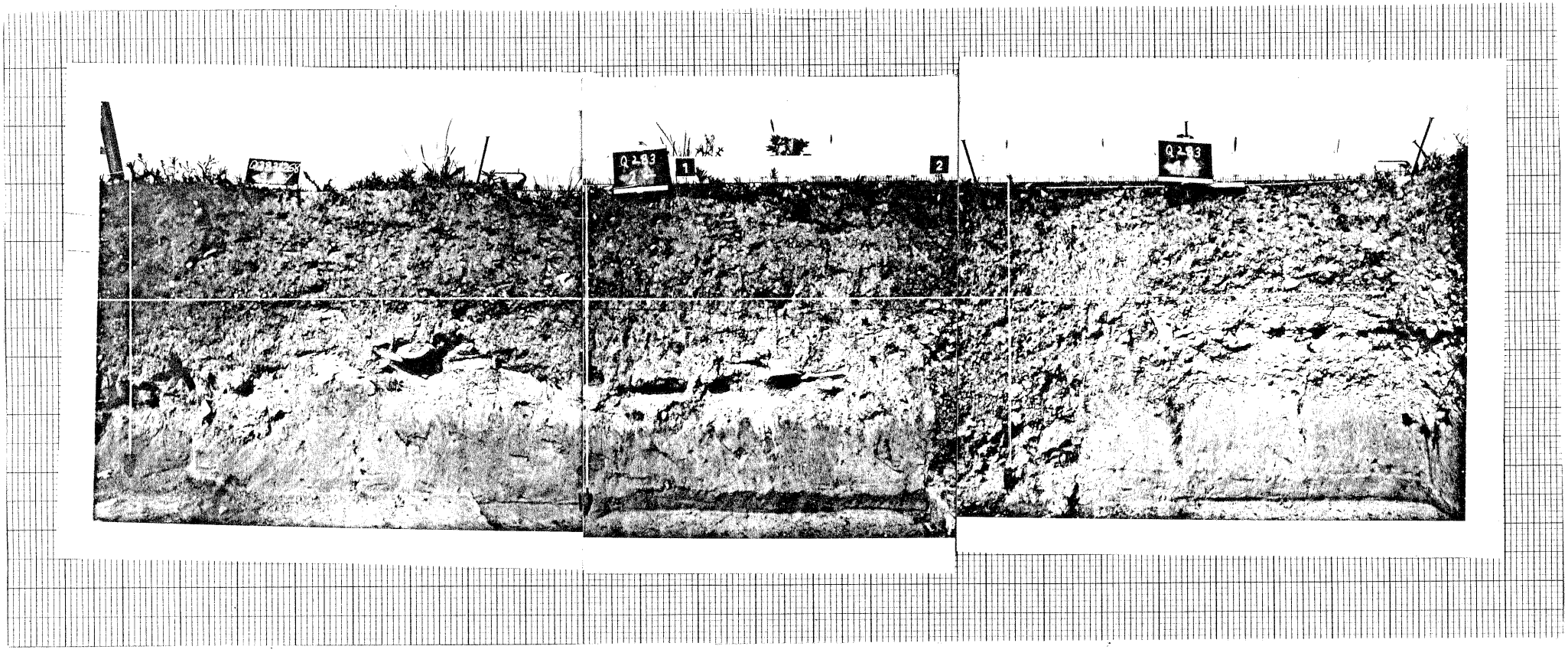


Fig. 9. A controlled mosaik of instant photography true to scale 1:20. Soil section in Carnuntum.

Finally the camera-object-distance has to be corrected in order to obtain a well scaled photograph. Let us define:

s = object distance from the first principal plane of the lens
s'= image distance from the second principal plane of the lens
d = distance between the two principal planes
E = s + d + s' = object distance from zero point at image plane
f = focal length of the lens
m = s/s' = photo scale factor

The well known image equation reads then

$$\frac{1}{s'} + \frac{1}{s} = \frac{1}{f}$$

For close range photography it is normal practice to write:

$$s = (m + 1)\, f$$

$$s' = \frac{(m + 1)^2}{m}\, f$$

Thus: $$E = \frac{(m + 1)^2}{m}\, f + d$$

E.g.: For the 75 mm-lens and the scale 1:m = 1:20 we get E = 1,66 m.

The working distance for the wanted scale of photography is precalculated and fix. The actual distance $\overline{E}$ might be measured now and compared with E. The camera can be shifted for the difference $\Delta E = E - \overline{E}$ using the mm-scale on the macro rail.

After final overall check the shutter can be released. The simple developing process doesn't need any description here.

Such simple photogrammetry makes the life easier for the archaeologist, because he himself can produce photographs of plane objects true to his working scale. After controlled mosaiking on mm-graph-paper the archaeologist has a complete plan of his wall, mosaik or soil section, whereon the coordinate system is indicated by the images of the plummet strings, by horizontal strings or rods. Such a mosaik is now a basic document showing everything, correctly positioned, correct to scale and connected to the coordinate system of the excavation.(Fig. 9).

This simple photogrammetric survey takes only some minutes per photograph and each photograph 1:20 covers 3,5 $m^2$ ! Other scales or other lenses can be used, but each disposition of scale and lens needs its own calibration data which can be determined by a photogrammetrist if not found in the instruction booklet. It goes without saying that the Polaroid archaeological kit, developed for and together with archaeologists, is also well suited for many tasks of the architects. It is hoped that archaeologists and architects will make use of this simple, reliable and time saving proposal for surveys of plane objects as e.g. soil sections, walls, inscriptions, mosaiks and paintings etc.

The Polaroid Archaeological Survey Kit is available from
Polaroid Austria, Eitnergasse 13, A-1233 Vienna.

ABSTRACT

Based on a Polaroid Instant Imaging Camera 600 SE (with lenses f = 75 mm, 127 mm or 150 mm for 83 x 108 mm format) a simple instant plan production system has been developed for archaeologists and architects. The basic idea was to take instant photographs of plane objects with the photoplane parallel and from precalculated distances. A constant scale mosaic is quickly done, time and costs for tiresome detail surveys can be saved, time and money remain for the own work of the archaeologist or architect. The practical standard cases are vertical stone walls, painted walls and vertical earth profiles. The system can also be adopted for not vertical objects as for example floor stone mosaics. The system has been developed and tested in cooperation with the Austrian Archaeological Institute and is now available from Polaroid Austria, Vienna.

ZUSAMMENFASSUNG

Auf der Basis einer Polaroid Sofortbildkamera 600 SE (mit Objektiven f = 75, 127 oder 150 mm für das Format 83 x 108 mm) wurde ein einfaches Sofortplan-Produktionssystem für Archäologen und Architekten entwickelt. Die Grundidee bestand darin, Sofortbilder mit der Bildebene parallel zur Objektebene und aus vorausberechneter Entfernung herzustellen, sodaß rasch ein maßstäbliches Bildmosaik zusammengesetzt werden kann, das Zeit und Kosten für ermüdende Detailvermessungen erspart. Zeit und Geld verbleiben dann für die eigentlichen Arbeiten des Archäologen bzw. Architekten. Die praktischen Standardfälle sind senkrechte Steinmauern, Wandgemälde und Erdquerschnitte. Das System kann für nicht vertikale Objekte, wie Steinmosaikfußböden, leicht adaptiert werden. Es ist in Zusammenarbeit mit dem Österreichischen Archäologischen Institut entwickelt und erprobt worden und nun bei Polaroid Österreich erhältlich.