

The altar in detail

In Reporter edition 35, we published a contribution on the subject 'Archaeological clearance of the Frauenkirche in Dresden', which greatly interested our readers. This spurred us to devote another report on what is globally, a unique work of reconstruction of a cultural and historic structure. Dr Hans-Ulrich Schulz now describes the photogrammetric documentation and reconstruction of the altar at the Frauenkirche.

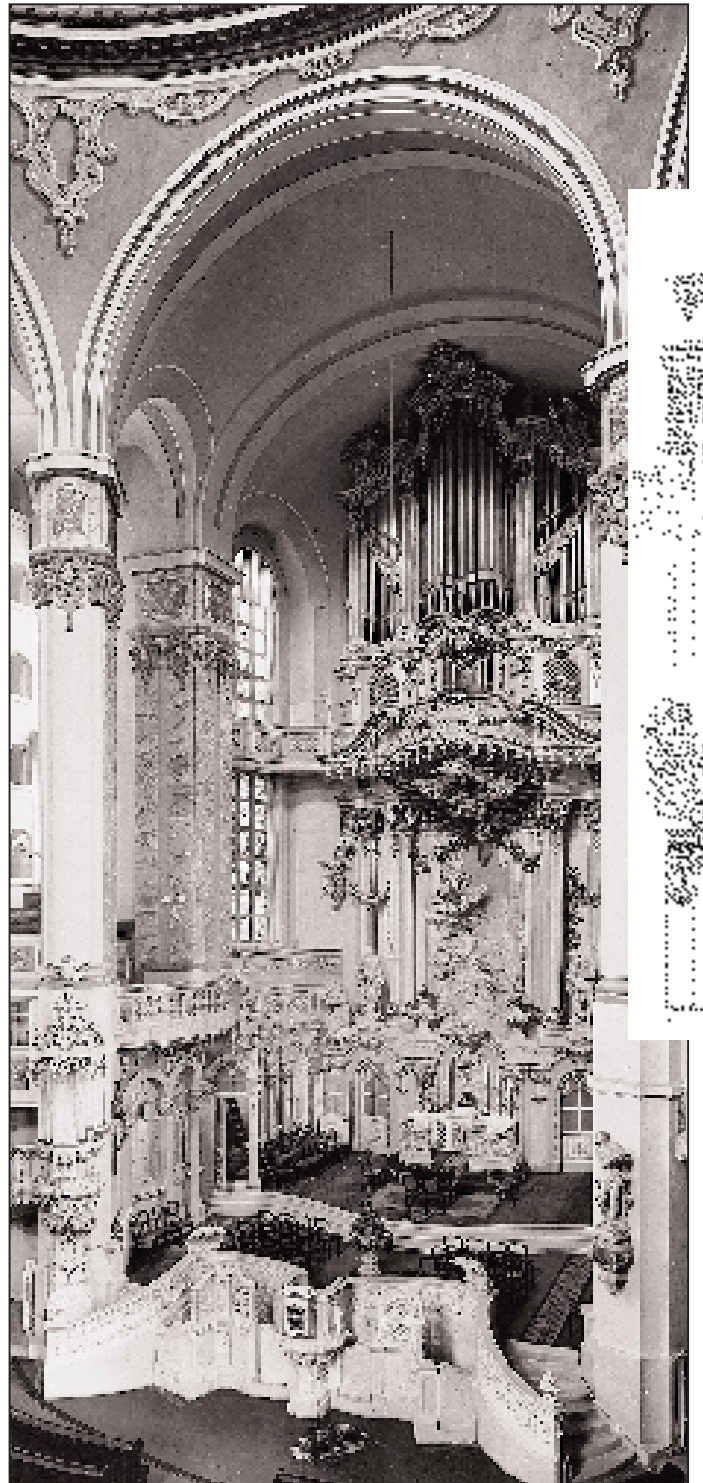
Over the past years within the framework of archaeological recording, the extent of the ruin's sub-terranean catacombs was surveyed, both before and after clearing the mountain of rubble. The mountain of rubble with its thousands of stones and recovered pieces, was itself photographically, geodetically, photogrammetrically and alphanumerically recorded. On behalf of the Frauenkirche in Dresden charity, the remaining ruined parts including the altar ruins were photogrammetrically recorded by 'MESSBILDSTELLE GmbH' and documented in 3D and 2D form.

Because a large quantity of historical pictures of the church interior exist, the charity engaged 'MESSBILDSTELLE GmbH' to test and execute a photogrammetric reconstruction of the altar and organ back-drop. In this article the particular specialist demands and the results achieved (which are from our point of view the first time stereo evaluation of historic amateur photographs has been realised) will be presented.

Photo triangulation of selected historical photographs

For the assignments to be undertaken, it was necessary to select suitable photographs from the Saxony State Library (German Fotothek) and the Ministry of State Monuments, Saxony. The main criteria in selection were the photographic quality and the scale of the picture, so that it could be guaranteed that details could be readily identified. Because a pinpoint reconstruction of a linear evaluation of the Baroque elements was desired, the selection of pictures had to be made with reference to the requirements of stereo evaluation. Pictures with a similar scale and parallel photographic axis were checked for availability.

From a stock of about 20 historic pictures from the years 1900 to 1933, nine pictures were first selected for picture triangulation. After various calculations of variants, only five pictures were selected for further evaluation. Because one picture of the altar area from each of the first, second and third galleries of the church all with about the same direction



Photograph of the organ gallery, altar and pulpit taken in 1933 (picture. State Library Saxony, State and University Library Dresden, Department German Fotothek / Möbius)

of exposure and distance were available, two stereo models with vertical bases in good quality could be made. A further stereo model illustrated the altar canopy in large scale. The two pictures indicate however a considerable difference in picture scale. The MAAS-CR program from Leica was used for the picture triangulation. This program was developed specially to

fulfil the demands made by close range photogrammetry. MAAS-CR allows direct picture co-ordination measuring in comparator mode on the Leica SD2000 analytical evaluation system with a comfortable user screen. The computer reconstruction of the picture situations by beam compensation integrated the cameras' simultaneous self-calibration and additional

Reconstruction of the view of the altar according to stereo evaluation of historic photographs



geometric references (eg., differences in height and evenness).

Because the pictures have no frame markings and the corners were not exact enough to measure, frame marks were simulated by point marking. Reproducibility of frame mark measuring is 20 mm and is considered to be adequate. Although presumably all photographs of the galleries were taken by the same camera, the inner orienteering for each picture was calculated individually. Here it was also taken into account that it was not known where the picture horizon was and whether the end material for the duplicates used was with any certainty the original negative.

Calculation of orientation data and the new point co-ordinates were made in the co-ordination system which was defined and made with reference to the main axes of the church. For this 14 control points were used. Four of these points exist on the remaining altar ruin and are defined with an accuracy of ± 1 cm. The position of these points shows however little depth in the exposure direction, which would lead to uncertain defining of orientation data. For this reason, further control points were included which were to be found on well spaced interior columns. The co-ordinates of these points come from the 3D reconstruction of the church made by the main planner, IPRO Dresden. Accuracy was also a priori assumed at ± 1 cm, since on one side the 3D reconstruction was based on the existing documentation of the ruins and on the other side, these co-ordinates represent the desired condition. Additionally further geometric references were taken into consideration in compensating, mainly the vertical position of the columns

In the result of the beam triangulation the following standard deviations were reached:

$$\begin{aligned}\sigma_0 &= \pm 23,5\mu\text{m} \\ \sigma_x &= \pm 2,5\text{ cm} \\ \sigma_y &= \pm 2,4\text{ cm} \\ \sigma_z &= \pm 3,2\text{ cm}.\end{aligned}$$

The results achieved met our expectations and are sufficient for a reconstruction of the altar and organ back-drop.

Stereo evaluation of historic photographs

In accordance with the previous survey for the inventory documentation the evaluation of the stereo model followed under two points of view:

- 3D evaluation of the main encompassing lines as basis for the 3D reconstruction
- detailed evaluation for a view of the altar including organ back-drop in scale 1:20

The evaluation was made with the Leica SD2000 analytical stereo evaluation system. On using MA AS-CR the orientation parameters of the stereo model result directly from the extreme orienteering of the beam compensation. Via a software interface the CAD system AUTOCAD at 'MESSBILDSTELLE GmbH' is connected directly with the evaluation device. Of special value for evaluation was the fact that the observation optics on the SD2000 offers the possibility to zoom individually the two parts of the pictures of the stereo model. In this way differences in scale are compensated whereby the stereoscopic impression and therefore accuracy of measurement are greatly improved.

The 3D evaluation includes all main altar encompassing lines and the organ back-drop as a 3D poly line. The measured lines were used directly for the 3D reconstruction or for testing. The results confirm the very good correspondence between the original inventory and the model reconstruction. The evaluation made of the altar ruin (Status 1993/94) by 'MESSBILDSTELLE GmbH' also served as the basis of the detailed reconstruction of the view of the altar, that is the evaluation was made directly in the already available CAD drawings. Because the view of

the altar ruin which accorded to the required scale of 1:10 was measured with a high degree of accuracy of ± 1 cm, during the stereo evaluation of the historic photographs an adjustment to the available material could be made. In this way it was also possible for residual mistakes in the stereo models of the historic photographs to be partially corrected by trial and error. Deviations between the stereo evaluations' 'current condition' and 'reconstruction' measured as a maximum but correctable against the available details, amounted to 5 cm.

To summarise, it can be established that through evaluating historic photographs a greater contribution to reconstructing the altar and organ in the Dresden Frauenkirche could be achieved. The pre-condition for this was the pure chance of having historic photographs, the availability of modern triangulation procedures and evaluation technology and the many years of experience of 'MESSBILDSTELLE GmbH' in surveying architecture and in inventory documentation of protected objects.

Dr Hans-Ulrich Schulz