GRAPHICAL REPRESENTATION OF AN ARMENIAN CASTLE WITH AUTOCAD

M. Kempa, M. Schlüter

Institute of Photogrammetry and Cartography, TH Darmstadt, FRG

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ABSTRACT

In order to preserve and restore an Armenian monument - at the moment a ruin and heavily demaged by earthquakes - a measurement campaign was done in Armenia/USSR initiated and supported by German and Armenian curators of monuments . Caused by the specific locality photogrammetric and geodetic (tachymetric) maesurements had to be combined for the task: graphical maps (plan-, side views etc.) for following static calculations. In order to enable the processing of both types of raw-data AutoCAD was chosen as graphic tool. This resulted in a more flexible handling of the input. Data processing, results and the advantages of the chosen procedure are presented.

KEYWORDS

Architectural, CAD/CAM, Terrestrial, Visualization

THE ARCHITECTURAL MONUMENT

The Castle Amberd is situated on the southersn hillside of the extinct volcano Aragaz about 2100 m above sea level and about one hour apart from Eriwan by car. It was built on a rock-tongue between the rivers Amberd and Arkashian and in a precipitous terrain. It means that the topography was optimally chosen for the construction of a citadel and an adjoining town. The origins extend to the middle of the 10^{th} century when Amberd served as summer residence of the Armenian sovereigns. During the following centuries it had an eventful history and it is supposed that it was destroyed for the last time in the 14^{th} century. Since then castle and town have been deserted and dilapidated (s. fig. 1)

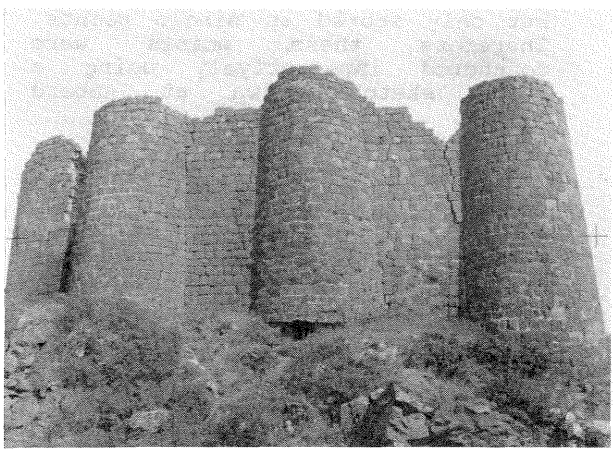

figure 1: northern wall of Amberd castle

INITIATIVE, PARTICIPANTS AND CLAIMS

Although the castle went to ruin it is a national symbol for many Armenian people. Therefore it was chosen for a common project to be realised by Armenian and German curators of monuments. The initiative to restore and preserve this monument is supported by the "Landesamt für Denkmalpflege" (office for preservation of monuments) of the German state Hessen. To enable a concept for the restoration at first static examinations were necessary to prevent the continuous dilapidation of the castle and to lay further work on a solid basis. Our institute was charged to evaluate the plans for the static studies. Besides that a complete documentation of the castle for art-historical and building-historical examinations should be provided *Burg Amberd in Armenien 1990, Kempa 1991.*

EQUIPMENT AND OUTDOOR WORK

To enable a very flexible data collection outside and having regard to the mountainous topography the following strategy was developed: a combination of geodetic and photogrammetric measuring techniques whereat the following data processing with AutoCAD had to be taken into consideration.

Therefore the following measuring instruments were used: an electronic tachymeter (ELTA 2) combined with an electronic interface (REC 500) and a small plotter, and a (non-metric) survey camera (ROLLEIFLEX SLX) with a 50 and 80 mm lens. The potential of this type of photogrammetric camera was often used for architectural tasks, e.g. *Stephani M., Eder K. 1987, Wester-Ebbinghaus W. 1983.* This equipment offered a high measurement comfort and considerably facilitated the outdoor work.

The determination of control points was carried out by polygons for the outside walls and the interior area of the the castle. The differences in elevation between these two parts (about 25 meters) and bad sights rendered this work rather difficult. In some parts also tachymetric measurements were carried out for further data processing in order to minimize the expense of raw-data collection.

The photogrammetric work can be divided into two parts: all walls were covered by terrestrial camera stations and in addition - especially for the interior area - aerial photographs were taken using a helicopter of Aeroflot.

PHOTOGRAMMETRIC TASKS AND DATA PROCESSING

The photogrammetric tasks were given either by the object and the desired result. Because a mapping of the borders of the stones principally had to be guaranteed, the image scale should not be less then 1:300, and for a better visibility color images were taken. The accuracy of the graphical representation should be in the range of 0.05-0.1 m. This was achieved for both mentioned types of photo coverage. It must be added that the calculations containing aerial photographs had worse accuracy because of movement blurs.

The number of control points was restricted to 6 points per wall, because after sorting and ordering all pictures at first for almost each sight of wall the number of control points was increased by bundle block adjustment *Düppe R. D. 1984.* Afterwards stereosscopic models were evaluated with an analytical plotter (Wild AC1). The data collection was carried out due to required entities containing different types of lines which were supplied with different keys due to their information (e.g. profile, detail, contour). It was attached importance to get all relevant information (line) simultaneously evaluating a model. After having finished this the raw-data for the following processing with AutoCAD were given in a homogeneous coordinate system.

DATA PROCESSING WITH AUTOCAD

A brief look at the literature shows that AutoCAD is more and more used for the graphical representation of photogrammetrically derived data, e.g. *Belli A. 1990, Heine E. et al. 1990, Stevens D., Mc Kay W. M. 1990.* The advantage of this procedure is that data sets of different origin can be combined. The user has also a lot of utilities for visualisation available and the exploitations were done on a graphic monitor.

Before transfering and integrating the data into AutoCAD a preprocessing had to be carried out with regard to the following aspects:

connection of line segments belonging together derived from different models

combination of data sets which belong to one plot

transformation of the lines into the right projection plane

cleaning of the data

This steps were finished with the conversion of the data into the DXF-format which means a "data exchange format" for in- and output data for AutoCAD (s. *AutoCAD User Guide*). The tachymetric data were already given in the DXF-format, but only stored as single points. Therefore these points were connected interactively using a rough sketch drawn at Amberd castle.

For the postprocessing different information was put into varying layers to enable to fade data in or out due to the respective task. Thus the input could be controlled by e.g. superimposing a front view with the vertical profiles of a wall. The graphical representation could be varied by signature, colour or area filling if necessary. The result should be an easily readable representaion of the entire information (in fig. 2 an overview of all plans is depicted).

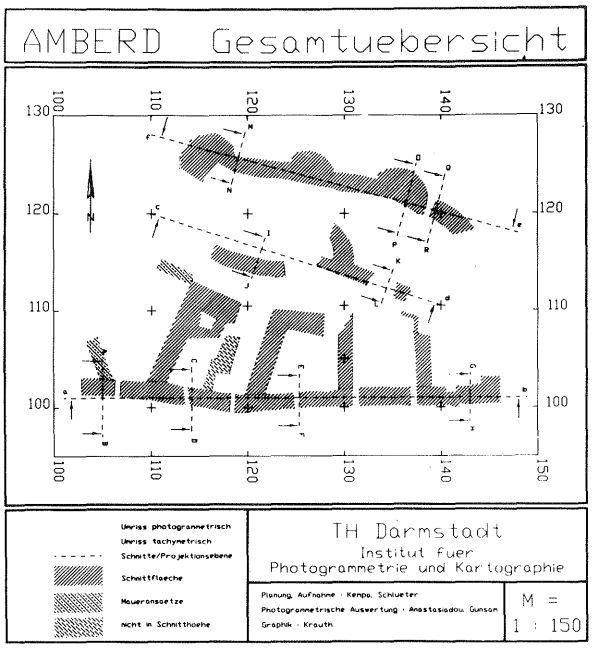

figure 2: ground section and overview of evaluated plans

RESULTS, CONCLUSIONS AND OUTLOOK

For the southern wall of the castle all plans are exemplarily performed in fig. 3-5. In the front view one can see that in some parts evaluation of details (e.g. the window embrasures) were carried out.

The chosen procedure offers the advantage the that after collection and preprocessing in principal any desired kind of representaion or combination of the data is possible. This is very important if one has to cooperate with experts with different professional background (e.g. architects, statical engineers): in that cases the aimed density of information and its representation not always are a priori definitely fixed. In addition one has to take into account the amount of data.

A further aspect is given by the fact that in the area of architecture the application of AutoCAD is now rather widely spread. An exchange of graphical data and their further procesing under more art-historical or building-historical approaches is thus very easily possible.

Looking at the costs for hard- and software it can be remarked that compared with analytical plotters with a (rather) low cost equipment (in principle: a coordinate-measuring machine, personal computer and a graphic tool) the evaluation of plans - using photogrammetric techniques and restricting to a less accuracy - for architects can be enabled.

As mentioned above perhaps further exploitation of the existing data (i.e. photos, more detailed information extraction) will be done, because for carrying out the restoration an inventory of stones is needed. To get such an inventory varying procedures are possible: supply of the existing plans with orthophotos or mapping of the borders of stones of all walls using stereo models again. The first strategy is problematic, because for an opto-mechanical rectification the inclination of almost all photos is too strong and could be only achieved step by step. On the other hand a detailed mapping of the borders of stones is very time consuming. Therefore another solution seems to be more attractive: digitization of those parts of the images which are needed and then digital rectification with control points. The digital orthophotos now can be used to extract edges (of stones) applying methods of digital image processing. First experiments were carried out within the framework of practical studies for students last year and yielded good results.

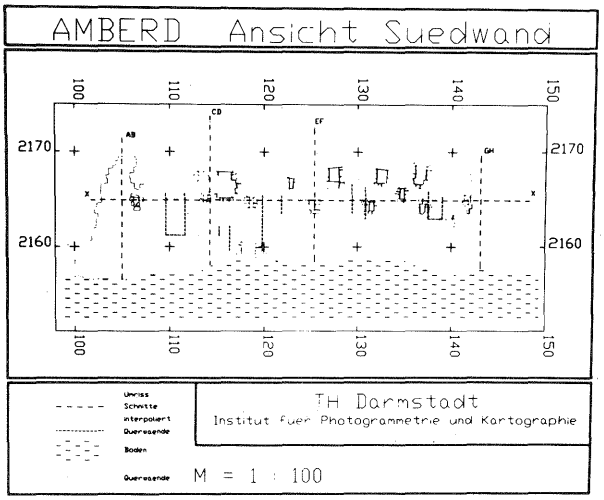

figure 3: front view of the southern wall (with additional information of the backside)

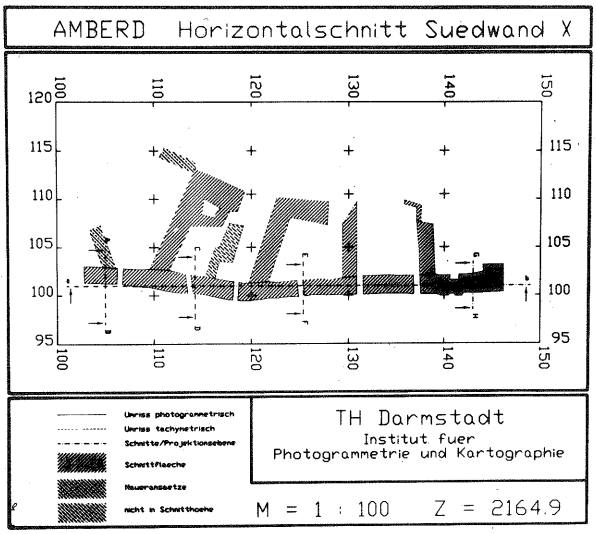

figure 4: ground section of the southern wall

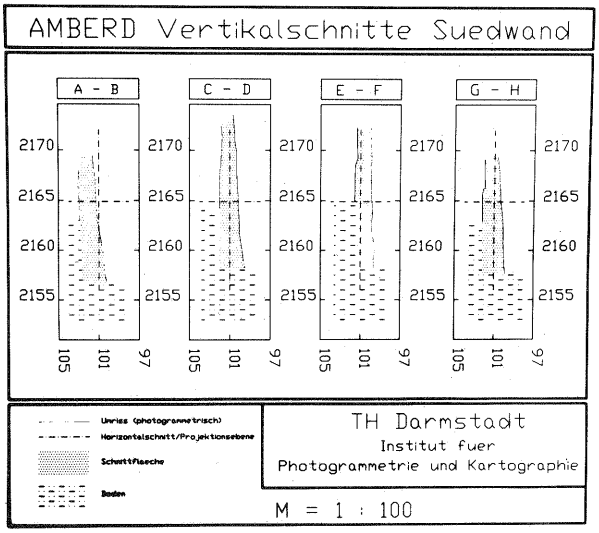

figure 5: vertical profiles of the southern wall

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REFERENCES

AutoCAD Release 11, 1990. Reference, Autodesk AG.

Belli A., 1990. Large-scale stereophotogrammetric survey and computer data processing on particular works of art. ISPRS Vol. 28, B 5/1, Zürich: 42-50.

Burg Amberd in Armenien, 1990. Sanierungskonzept. Sonderheft des Landesamts für Denkmalpflege (Hessen), Wiesbaden (unpublished).

Düppe R. D., 1984. Kombinierte Ausgleichung in der Photogrammetrie: Programmkonzeption und Beispiele. ISPRS Vol. 25, B 3a, Comm. III, Rio de Janeiro: 117-129.

Heine E., Kostka R., Reiter A., 1990. Main Palace of Santa Rosa: XTAMPAK a geodetic-photogrammetric documentation. ISPRS Vol. 28, B 5/1, Zürich: 67-76.

Kempa M., 1991. Photogrammetrische Aufnahme von Burg Amberd (Armenien, UdSSR). ZPF 59(3): 103-104.

Stephani M., Eder K., 1987. Leistungspotential einer Teilmeßkammer beim Einsatz in der Architekturphotogrammetrie. BuL 55(5): 204-213.

Stevens D., Mc Kay W. M., 1990. Combined use of photogrammetry and CAD in the reconstruction of fire-damaged buildings. ISPRS Vol. 28, B 5/1, Zürich: 77-85.

Wester-Ebbinghaus W., 1983. Ein photogrammetrisches System für Sonderanwendungen. BuL 51(1): 118-128.