COMBINING A THEODOLITE - BASED MEASUREMENT SYSTEM AND STEREOPHOTOGRAMMETRY FOR THE RECORDING OF HERRENCHIEMSEE PALACE

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ABSTRACT

The measurement system CASOB consisting of electronic theodolites with electronic distance meter, a personal computer, some additional hardware tools and sophisticated software is applied to the recording of the palace *Herrenchiemsee* in Bavaria. CASOB yields 3-D coordinates of discrete object points and interfaces directly with common CAD systems. The measurement results can be displayed on site on the PC monitor and further processed in the CAD system.
Photogrammetrically determined information can be combined with the CASOB data. As an example, the upper part of the southern facade of *Herrenchiemsee* was recorded from a lifting platform with photogrammetric cameras.
In this paper, special attention is focused on the use of CAD in order to produce quickly, precisely and economically the entire 3-D model of a building and some follow-up products such as ground and elevation plans, and sections.

1. INTRODUCTION

The royal palace of *Herrenchiemsee* was built by the famous and fabulous Bavarian King Ludwig II. It is situated on an island called *Herreninsel* in the *Chiemsee* lake. Modelled after the palace of *Versailles* in France, its construction was largely completed around the year 1880. Today the *Chiemgau* region, the picturesque area around the lake, is an important centre of tourism in Bavaria. *Herrenchiemsee Palace* considerably contributes to the prosperity of the region, because all the castles and palaces of Ludwig II attract millions of visitors.

The King's architects, *von Dollmann* and *Hofmann*, built the palace of such an extraordinary quality that even over a 100 years later, it is still in an unusually good condition. Nevertheless, nowadays there is the necessity to do some preservation work in order to avert serious damages and to maintain the good general condition of the building substance.

Available plans date from the planning stage of the last century. As a result of many alterations during construction and the fact that the palace was never completed in total, drastic deviations from the original plans exist. Therefore, a survey was necessary for the purpose of preservation and, in general, for a complete documentation of the monument.

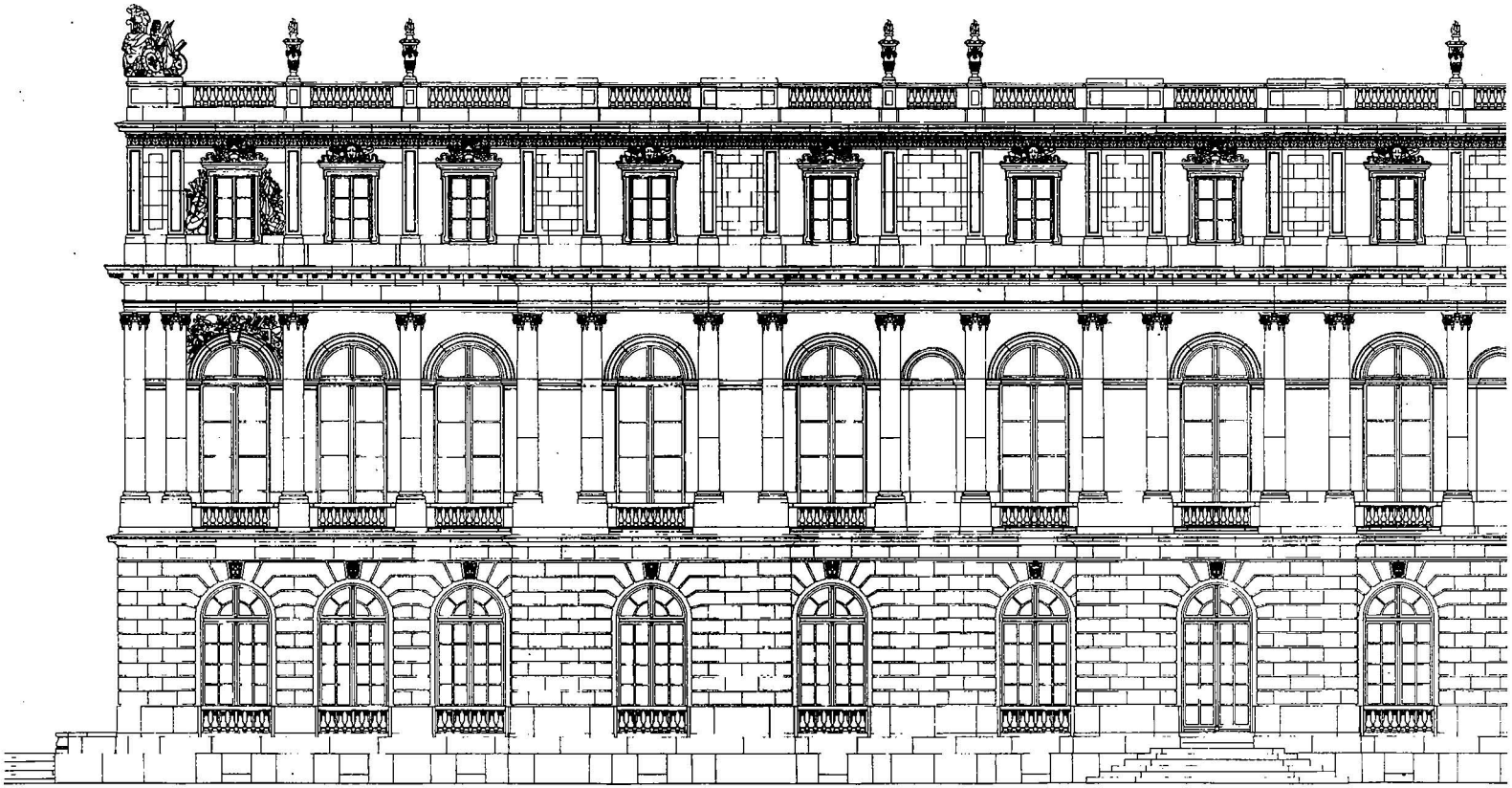


Fig. 1 Part of the southern facade of *Herrenchiemsee Palace.* The plan reduced from the original plotting scale of 1 : 50 was derived from the CAD model. The entire facade is approximately 100 m in length and 23 m in height.

A digital data base should be established as the result of the measurements. Plots at various scales should be produced. It was decided to carry out the survey by means of a theodolite-based system and, in addition, by stereophotogrammetry. Both methods result in spatial coordinates of object points which can be transfered to a CAD system. In this case, AutoCAD was used.

Todate, the survey of the southern facade of the palace is accomplished (Fig. 1). The remaining facades and the ground plans and sections of the interior are to follow later on.

2. Surveying concept

In order to survey the palace as quickly, precisely and economically as possible, some basic considerations and decisions were made:

- The facade can be devided into a number of elements of the same kind such as windows, balustrades, niches etc. (Figs. 2 and 3). By means of on site measurement, it was ascertained that the differences between the individual elements of the same kind are very small. The reason is that the palace was built in a prefabricated construction, i.e. the elements were uniformly prefabricated, delivered and precisely mounted on site. Small differences do not influence the documentation and the repair work. Therefore, the recurring details of the facade were measured once and then inserted in the CAD model as blocks using a lot of control points.

- It was decided to survey the lower half of the facade including the windows of the first floor (Fig. 1) by the theodolite-based system CASOB (KORTE 1991; see chapter 3), i.e. the virtually identical elements (blocks) mentioned above and the control points used for integrating all the elements within the CAD system were measured with CASOB.

- The upper part of the facade could not be measured from the ground by the theodolite system. It was recorded photogrammetrically using a lifting platform and a crane respectively (Fig. 4). Then only the control points required for combining the blocks were obtained from stereomodels (see chapter 4).

- Both measurement systems, CASOB and photogrammetry, yield an accuracy of the object restitution of about 1 cm.

- The facade is richly decorated with figurative elements and sculptures (Figs. 5 and 6). The precise shape of these elements is without any significance to the restoration. They were photographed using a camera with long focal length and then scetched by means of monoscopic digitization of enlarged paper prints on a digitizing tablet. Subsequently, the data were introduced in the CAD system.

- Finally, the CAD system plays the decisive role in combining and editing all the elements of the facade.

3. CASOB

The measurement system CASOB (Computer Aided Surveying of Buildings) is designed to provide quick and precise three-dimensional recording of the interior and exterior of buildings and monuments. Hardware components are electronic theodolites equipped with laser pointer and electronic distance meter, some special tools to observe inaccessible or hidden points, and a portable personal computer. CASOB offers several observation modes such as polar measurement with reflector, intersection by means of two theodolites etc.

Polar measurement is the standard procedure. An electronic theodolite is coupled with an electronic distance meter for determining the distance between the theodolite and the reflecting mirror positioned at the object point to be surveyed. A laser pointer mounted on the top of the theodolite produces a visible red beam to identify the point.

An essential advantage of CASOB is given by the fact that the measurement data are immediately processed in a personal computer (laptop). The result of the survey is prepared on site and can be displayed on the

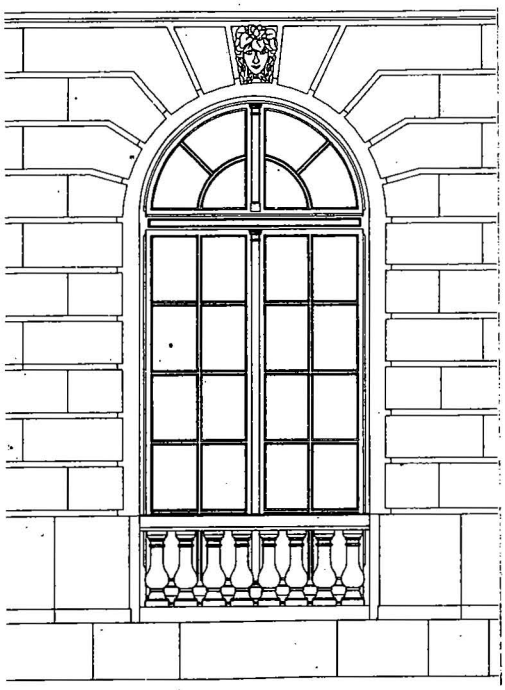


Fig. 2 Ground-floor window

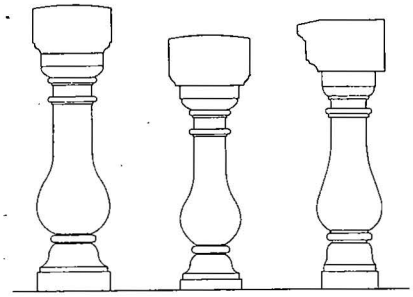


Fig. 3 Three types of balusters used in facade construction

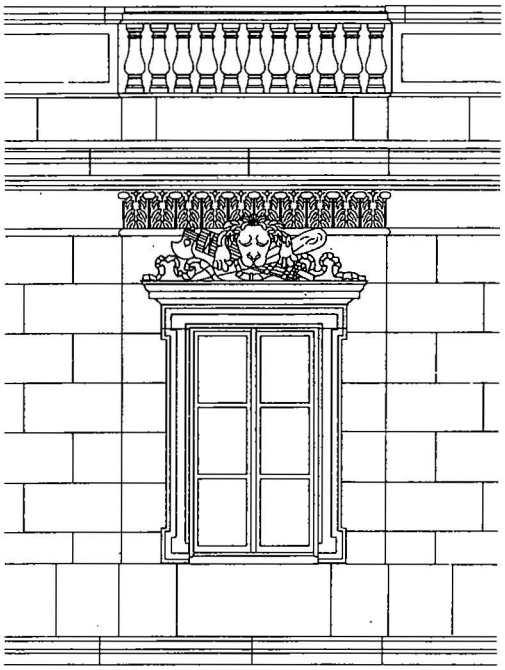


Fig. 5 Second floor window with figurative elements

Fig. 4 Taking the photographs from a crane

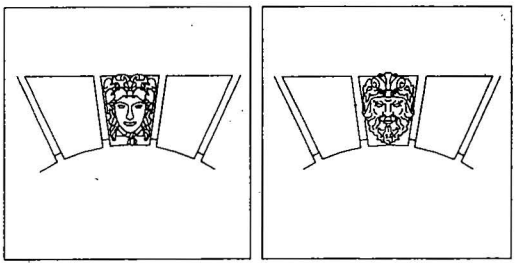


Fig. 6 Different types of sculptures

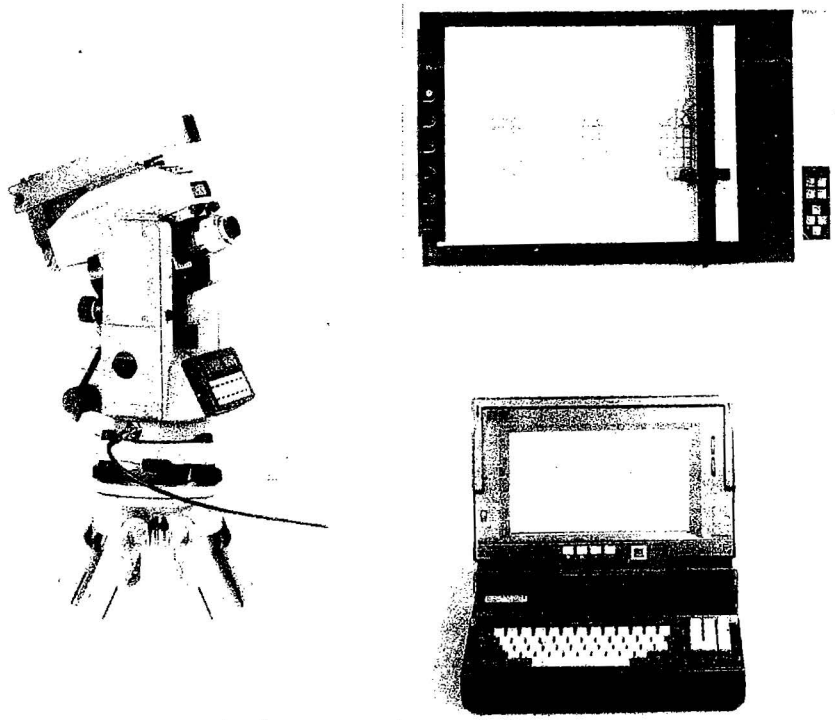


Fig. 7 CASOB for on site measuring and drawing: Electronic Theodolite with distance meter and target laser, laptop for on site calculation and data storage, and plotter

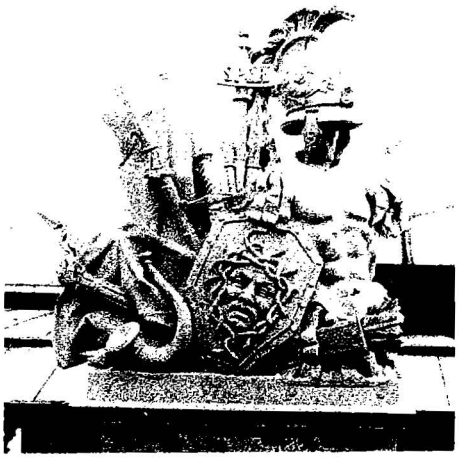
PC monitor or drawn with a draft plotter (Fig. 7). The calculation of 3-D coordinates of object points and the subsequent editing in the CAD system with the building in full view yield a true portrait of the object of interest.

The described point-by-point measurement mode allows for an arbitrarily dense scanning of an object. Up to 1500 points a day can be observed with two members of staff. The definitive result of the survey can be viewed, controlled and completed on site. Of course, the final CAD handling and the plotting of the finished plans take place at the office. In some cases, this procedure leads to a better and more economic solution than even stereophotogrammetry.

4. Photogrammetric survey

Photogrammetry was used very conventionally in the project *Herrenchiemsee*. A metric camera WILD P31 with 100 mm wide angle lens was applied to record the upper part of the southern facade. The photographs were taken from a lifting platform at a photo scale of approximately 1 : 150 (Fig. 8). 12 stereomodels were selected for the object restitution in an analytical plotter Zeiss Planicomp P2. Control points for the orientation of the stereomodels were determined by CASOB. In each stereomodel, about 100 object points were measured in order to combine the different elements of the facade in the CAD system.

Fig. 8 Metric photograph of the upper part of the facade



Figs. 9 and 10 Different types of sculptures of the facade

On the other hand, photographs of figurative elements were taken with a Rolleimetric 6006 equipped with a telephoto lens (Figs. 9 and 10). As mentioned above, enlarged paper prints of these photographs were digitized on a tablet.

5. Concluding remarks

In this project, stereophotogrammetry was applied in a rather curious way. A metric camera and normal case photography were used. But only a limited number of discrete object points was measured in the stereomodels in order to enable the CAD handling. This method proved to be very quick and cost-effective. The photographic recording of the southern facade of *Herrenchiemsee* required one day, the orientation of the 12 stereomodels and the determination of object points another two days.

However, the outlined procedure is only applicable to objects which are built in a kind of prefabricated construction like *Herrenchiemsee* with a number of identically shaped elements. Therefore, a rigorous analysis of the monument and its history has to be performed by the architect prior to the measurement.

In general, the combination of a theodolite-based recording system and photogrammetry may bring together the advantages of both surveying methods. The processing of the measured 3-D data within the CAD system results in a digital data base of the building suitable for all further investigations.

References

KORTE, M., 1991: CASOB - Computergestützte Techniken der Bauaufnahme. Deutsche Bauzeitung 125 (1), pp. 74-91