INTEGRATION OF HISTORICAL PLANS INTO A MODERN FACILITY MANAGEMENT SYSTEM TAKING THE CASTLE OF HEIDELBERG AS AN EXAMPLE

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ABSTRACT

In some cases superb data captures from the past are available for famous historical buildings. These precious data sets consisting of analogous plans, drawings and measurements are stored normally inside archives and therefore, cannot be used directly for building archaeology or new data captures.
For the Castle of Heidelberg a detailed data capture from 1883-1889 exists. More than 700 plans and drawings in different scales and numerous measurement lines as well as separate measures are archived. These analogous plans were digitised by a scanner and analysed concerning accuracy and reliability. The digitised ground plans were transformed into the existing coordinate system by means of more than 100 control points, which cover the whole area of the castle. A comparison of these data with recent measurements shows differences of about ± 2 cm. The old plans with their high accuracy and reliability provide a good basis for the use of modern digital technology. Consequently, the huge amount of historical measurements should be combined with modern digital technology. Taking into account the efficiency of ten employees who have been working for six years to analyse the construction of the castle it is necessary to use those valuable plans in the present process of building archaeology. Nowadays, it would be impossible to repeat the work in such a dimension. Comparing the measurements and views, it was important to record the facades with photogrammetric cameras. Geometric rectification was applied for the photos of the plane facades. A comparison of historical data and photogrammetric evaluation showed structural alterations, damages on the construction and replacements of stones (for instance new red sandstone).
For the last two centuries, the quality of historical measurements legitimates the integration of these archaeological documentations into recent construction work and tasks of restoration. These historical documentations of the castle supply essential information, which support the present research and provide a basis for a public Facility Management System.

1. INTRODUCTION

Historical plans can be found in national archives for major monuments, which are under monumental protection. Besides these precious documents, historic building recordings from national surveys exist for the last two centuries.
Therefore, it is essential to examine the ancient construction plans in order to conserve and restore national monuments. For instance, the plans of the castle of Heidelberg from the 19th century will be used as a data basis for a Facility Management System. During seven years of data captures (1883 - 89) more than 700 plans, drawings and sketches have
from Koch and Seitz, 1883 - 1889.
His name was due to several impressive mirrors decorating the north wall of a long hall in the second floor.
Using this documentation for present civil works, the efficiency can be clearly raised and as a result of the gain of time the costs will be decreased. Consequently these plans provide a basis for 3D-CAD works.

2. THE RENAISSANCE BUILDING "GLÄSER-NER SAALBAU"

The "Gläserner Saalbau" (Vitreous Hall Building), which was built up in 1549 by the elector Friedrich II. (1544 - 1556) on the fundament of a destroyed mediaeval castle construc-tion, is presented exemplarily in figure 1 for the present results and analyses as well as in figure 2 which represents a drawing of the yard façade as a renaissance building recorded from Koch and Seitz, 1883 - 1889. His name was due to several impressive mirrors decorating the north wall of a long hall in the second floor.

3. USING HISTORICAL PLANS FOR MODERN CONSTRUCTION

In general the plans were glued on special cartons. The size of these cartons is approximately 8.00.1×(m^2). The plans show parts of the castle in horizontal and vertical sections.
Furthermore the transversal scale and measurement lines plus the values are included (figure 3). In order to use the drawings, the validation of the precise scale was necessary at first. The results of the deformations are shown in the following table:

Longitudinal direction		Transverse direction	
min	max	min	max
0 cm	±5 cm	0 cm	±5 cm

The comparison of the maximum values between the longitudinal and transverse direction indicates no significant difference but is accurate enough for current construction work. In figure 4 the measurement of the main transverse axis (true distance: 33.883 m) produces an error of 2.7 cm.

4. FROM ANALOGOUS TO DIGITAL PLANS

Because of the thickness of the analogous plans a common scanning procedure was not possible. Therefore a special camera system was used for the recordation of the documents. The technical specification is described as follows:

- Lens: APO-SYMMAR (300 mm focal length)
- Distortion-free image formation: < 0.1%
- Object distance: 3.5 m

Behind the camera a scanback system *PHASEONE* is fixed integrating a line scanner with 10000 Pixel. The image area is around 100 ×84 (mm^2) which is equivalent to 380 megabyte (colour value: rgb). The size of one pixel is 0.08 mm in the original plan (figure 3). The scanning period is several minutes per image. The system was developed by the photographer Mr. F. Gross in Karlsruhe.

5. GEO REFERENCING OF THE PRECIOUS PLANS AND DRAWINGS

Using digital images for CAD works, it is necessary to determine a geographic reference frame. Therefore, basic geodetic measurements have been carried out to measure the geometry of the buildings in order to transform the images into the national geodetic network (Gauß-Krüger system). In figure 5 the control points are marked which are used for the projective transformation to rectify the plans of the "Gläserner Saalbau".
The following table shows the accuracy of the control points after the projective transformation:

Minimum	Average	Maximum
±1.0 cm	±1.5 cm	±3 cm

6. OVERLAYING OF THE HISTORICAL PLANS AND THE PRESENT RECTIFIED IMAGES

Figure 6 shows the overlay of the historical wall with the rectified images taken by the special photogrammetric camera *LINHOF METRICA 45* and digitised subsequently.
The results of the high accuracy of geometric matching methods are specified as follows related to the interior facades of the "Gläserner Saalbau":

	Minimum	Average	Maximum
Control points	±0.2 cm	±0.5 cm	±1.0 cm
Natural points	±1.0 cm	±2.0 cm	±5.0 cm

The analyses are computed by S. Weimer from the Institute of Photogrammetry and Remote Sensing, University of Karlsruhe.

7. DAMAGE MAPPING OF THE INTERIOR FACADES

Using close range photogrammetry as a technique for obtaining geometric information, the digitised and rectified images provide a basis for mappings to preserve and restore the ruins of the castle of Heidelberg.
Thereby following types have been produced for the "Gläserner Saalbau":

- material mapping,
- mortar mapping,
- mapping findings,
- losing mapping.

Following materials are classified in the damage mapping (figure 7):

- quarrystones, handmade and industrial bricks, clay bricks and splice schist → in different colours,
- original, damaged and destroyed surfaces → in different coloured textures,
- plasters from the 16th, 17th and 20th century → in different coloured textures.

8. CONCLUSION

The extensive and detailed documentation by Koch and Seitz was analysed with regard to its application to present construction work and research. The analyses showed a close accordance of the geometry of horizontal projections. In contrast, the facade plans show discrepancies in the presentation of details (figure 6).
In general it is verified that the historic plans can be used for urgent restoration works, which leads to an immense cost reduction. The complete database will be integrated into the new scheduled facility management system, which is in the early development stage.

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Figure 1: The interior view of the renaissance building “Gläserner Saalbau”.

Figure 2: The yard facade of the renaissance construction “Gläserner Saalbau” edited by “General Landesarchiv”, Karlsruhe 2005.

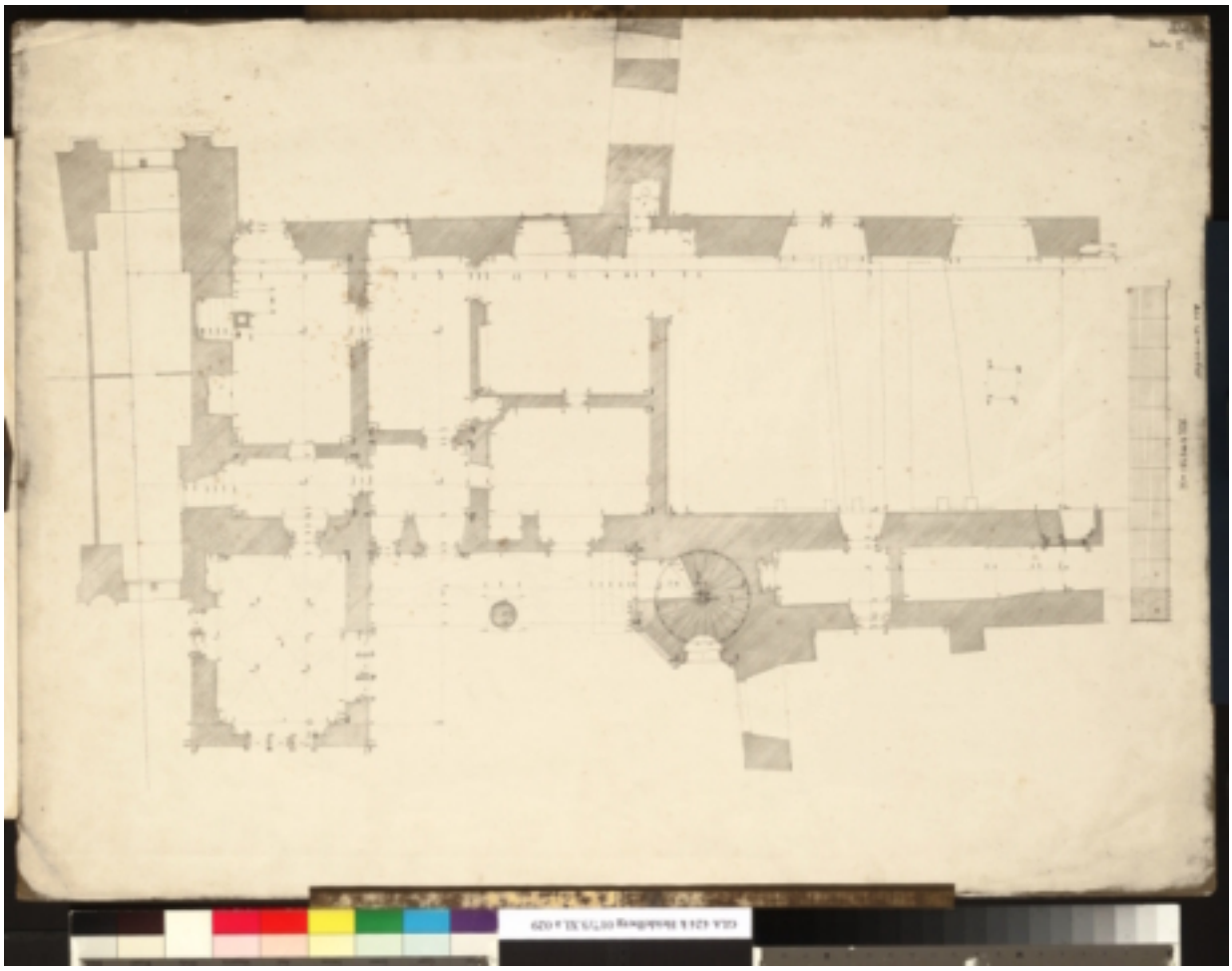

Figure 3: Original plan of the “Gläserner Saalbau“ on the large scale of 1:40 scanned by F. Gross, Karlsruhe 2003.

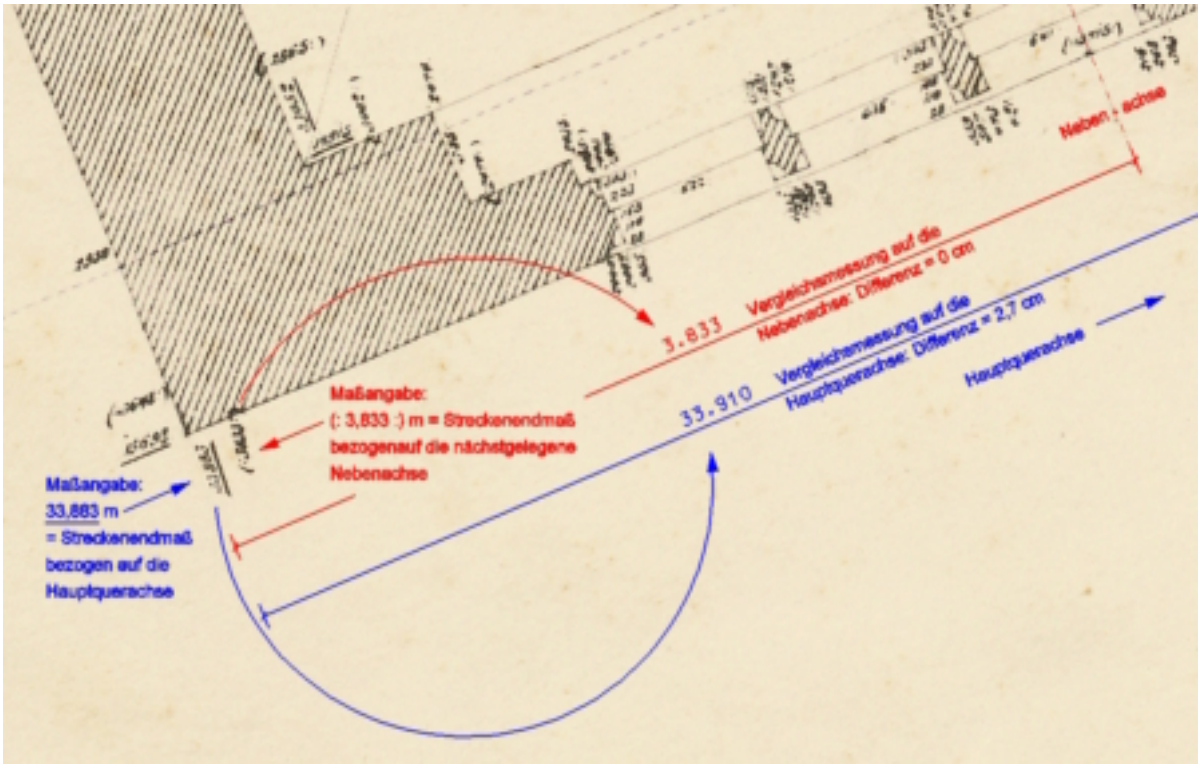

Figure 4: Detail plan of the construction wall “Gläserner Saalbau“ with the variance comparison by T. Peschel, Karlsruhe 2003.

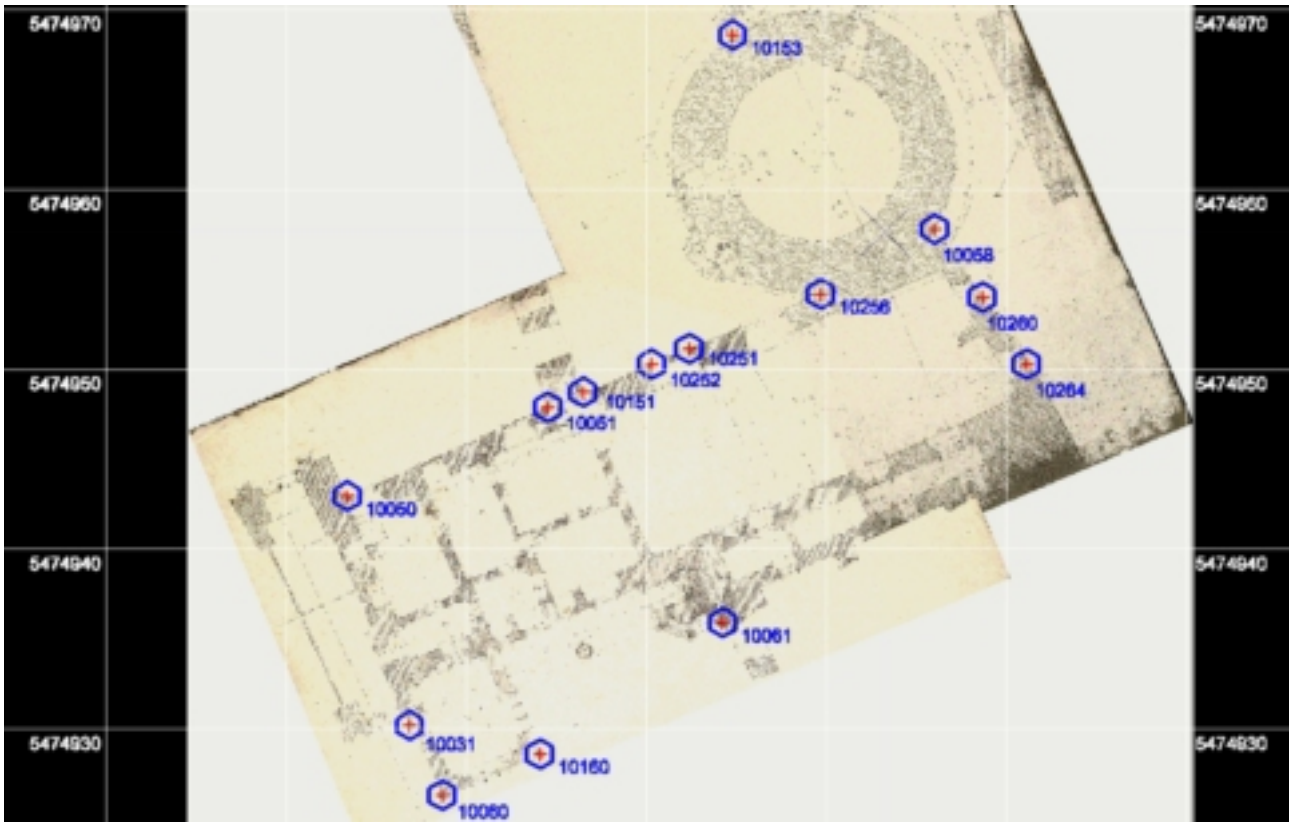

Figure 5: Rectification and combination of two plans presenting the horizontal structure of the “Gläserner Saalbau” made by T. Peschel, Karlsruhe 2003.

Figure 6: Overlaying of the Koch/Seitz plan and the rectified image (north wall).

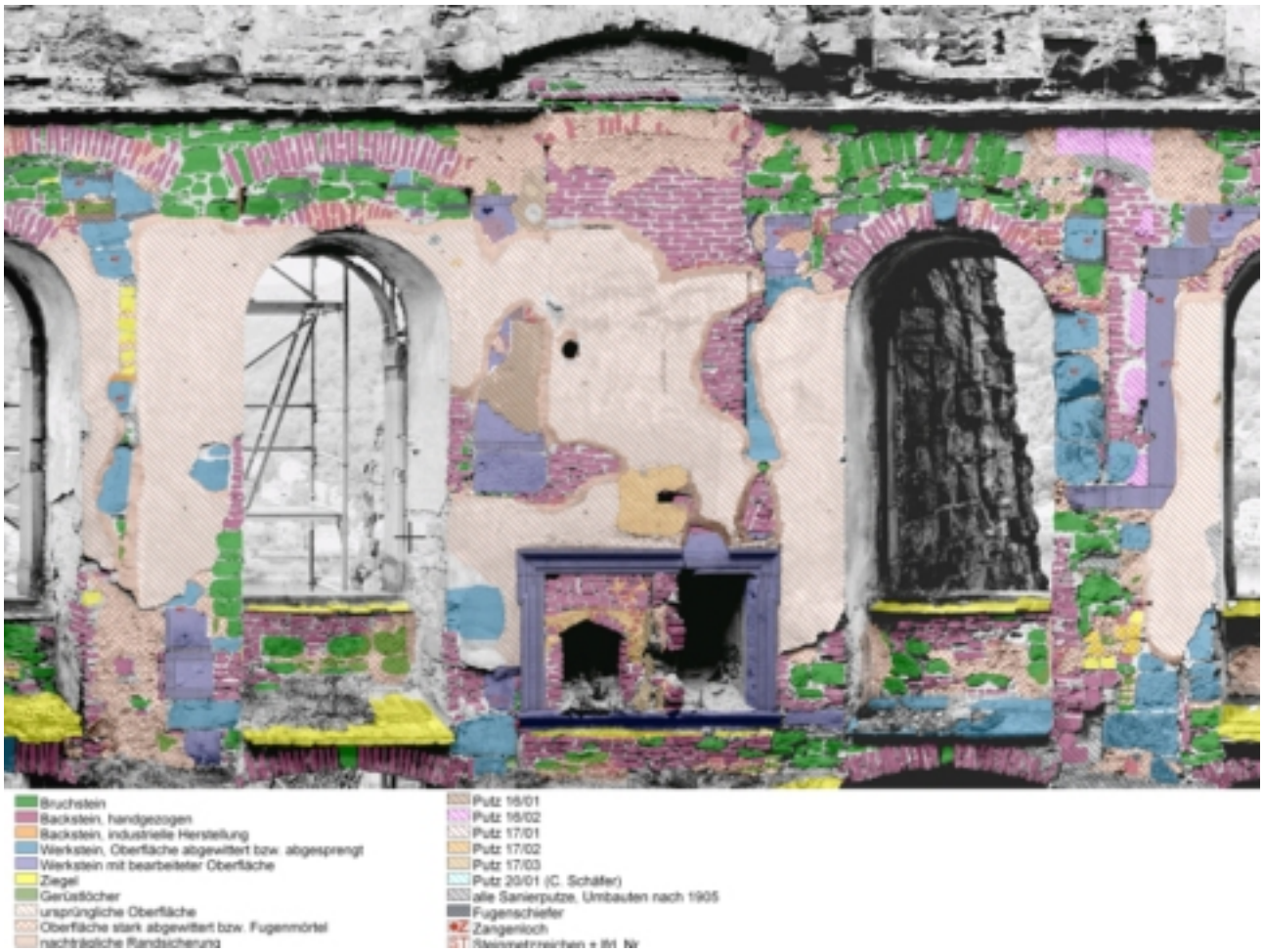

Figure 7: Damage mapping of the north wall.