Back to the Future

Visualizing the Planning and Building of the Dresden Zwinger from the 18th until the 19th Century

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In this article we[1] present a long-term project on the Dresden Zwinger (figs. 1, 2, 5, 6) using techniques that have been and still are very controversial – the production of imagery of architecture with the possibilities of computer programs. Since the very first thoughts on this topic, the technical requirements, possibilities and ideas about what can be achieved with the help of computer technique have changed dramatically. The question for which areas of application the computer could be necessary is still important today. With this project we want to present our approach in using computer technique for the virtual three-dimensional reconstruction of the history of the Dresden Zwinger.

Fig. 1 View of the Dresden Zwinger, specifically its buildings at the rear of the former fortification wall (photograph: first decade of 21st century).

Fig. 2 Arcaded gallery of the Dresden Zwinger along the fortification wall and moat, centered by a gateway tower, so-called Kronentor (photograph: first decade of 21st century).

Initiated in 2007 for museum-didactical purposes by the Saxon Administration of State-owned Castles and Gardens (Staatliche Schlösser, Burgen und Gärten Sachsen gGmbH) the project 'Back to the future – Visualizing the Planning and Building of the Dresden Zwinger' ('Zurück in die Zukunft – Die Visualisierung planungs- und baugeschichtlicher Aspekte des Dresdner Zwingers') led to a cooperation with the Dresden University of Applied Sciences (HTW – Hochschule für Wirtschaft und Technik) which reflects the working group's name 'Zwingerteam' in terms of a catch-word. The basic intention of this project is the mediation of the building development and the planning history of the Dresden Zwinger for the use in a permanent exhibition. That means that the easily recognizable form of a virtual three-dimensional representation of the complex range of construction activities will be used methodically and didactically as a way of teaching the architectural knowledge, and also as a help for the visitors to manage the mental transfer from the historic two-dimensional sources into the three-dimensional space. In order to produce an understandable survey the complex and lengthy building and planning development of the Zwinger has to be dispersed in a few well-selected phases, our so-called time-cuts. So, the situation is not an art-historical study of the architecture of the Dresden Zwinger, but a practical application with the following main objectives:

- to explain the construction development in its temporal sequence,
- to give an idea of selected complex range planning designs,
- to enforce an understanding of the Baroque system architecture, and
- to enforce a sense for architectural proportions, façade elements and spatial relationships.

Introduction

The Dresden Zwinger is the most famous Baroque building in the city with a diverse history and of art-historical importance. It started in 1709 under the reign of Augustus the Strong (at that time prince elector of Saxony and king of Poland) as an orangery laid out on one of the city's fortification walls at the rear of the Residential Castle (fig. 3),[2] and from 1711 this was extended due to the absolutist need for additional representative facilities (a planning example in fig. 4). In 1728 construction activities waned. From that year onwards the Zwinger buildings, meanwhile enclosing a courtyard at three sides, were used as a museum for the royal collections. Finally, in the midst of the 19th century, the gap on the north side was closed with the public picture gallery designed by Gottfried Semper (figs. 5, 6). In the mere consideration of that long term building development an extensive project grew out of an initially small task with increasing knowledge of the sources since 2007, such that in the end fourteen construction and planning phases of the Dresden Zwinger (as listed below in fig. 12) were virtually reconstructed respectively simulated in detail and fitted into a schematic topographic model of the closer surroundings (examples in figs. 7 and 10).

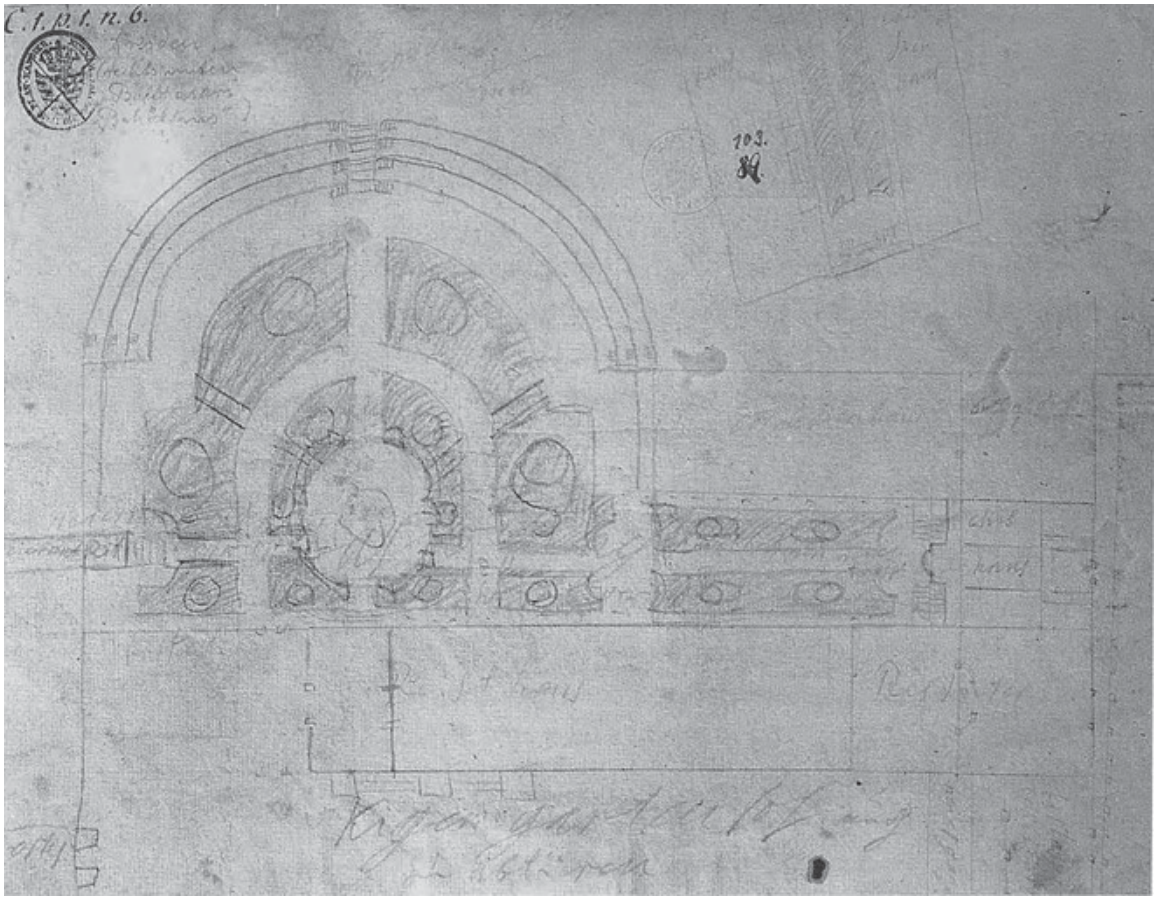

Fig. 3 Sketch by August the Strong from 1709 of an orangery laid out at the rear of the fortification wall beneath the residential castle of Dresden (so-called Zwinger area), used in the project as main source for time-cut no. 1.

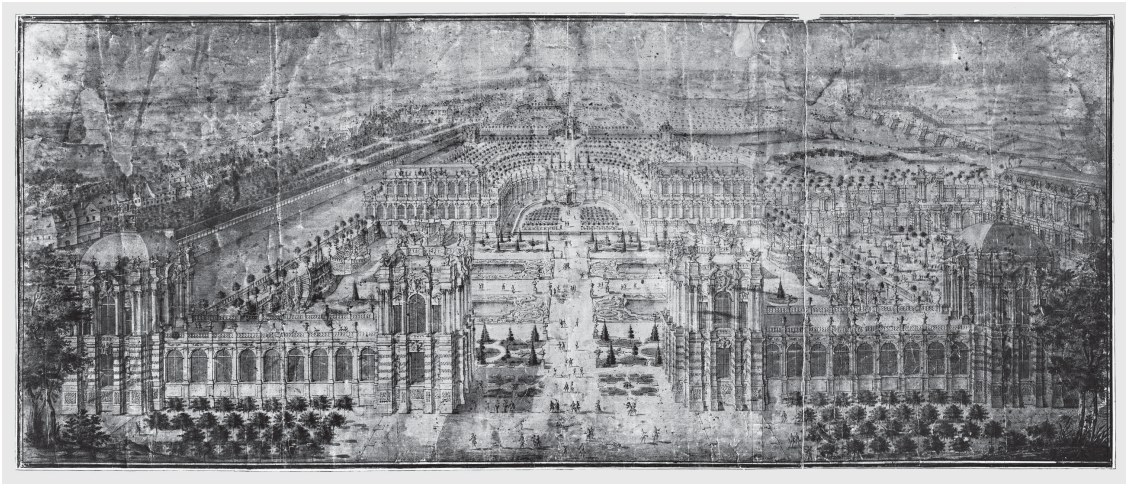

Fig. 4 Bird's eye view of an unexecuted Zwinger extension designed by Pöppelmann, 1712-13 (original lost since 1945), in the project used as main source for time-cut no. 3.

Fig. 5 Aerial view of the Dresden Zwinger: at the right the court church and the residential castle with the adjoined Taschenberg Palace is situated; above, between the Zwinger courtyard and the river Elbe, the 2nd court theatre, today known as 'Semper-Oper' (photograph: first decade of 21st century).

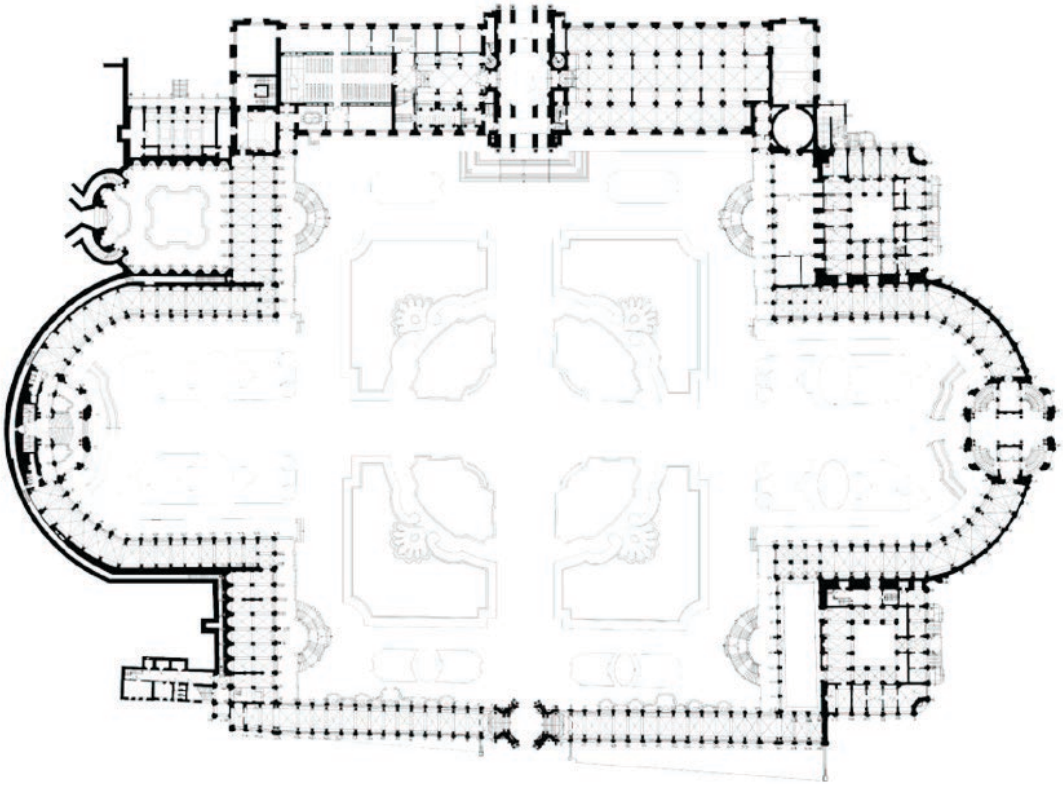

Fig. 6 Ground plan of the Dresden Zwinger from an architectural survey from 2008: on the left the initial Ω-shaped buildings at the rear of the fortification wall; on the right the mirrored buildings nearby the residential castle and the city; at the bottom the gallery aisle centered by the crowned gate; and at the top the picture museum added in the 19th century.

Focus of the Project

During a long processing time of more than five years the editing focus of the project has shifted considerably from the pure construction history towards favouring the ideal type of design planning. In these historic plans the Zwinger courtyard was not the sole subject of the draft, but rather part of a court complex that has always been connected with the residential castle, where it took the secondary role of an integrated garden (examples in figs. 4, 9). The expansion of such designs would range far into the contemporary urban space and would inevitably overlap them. The reflection of the models gives the future visitor the chance to find out where the planned buildings would have been located in case of their erection. This way they are able to get a keen sense of the dimensions based on their own physical experiences (figs. 7, 10).

Fig. 7 Virtual model of the building development in 1712-18 (time-cut no. 4), fitted into a schematic virtual model of the historic surroundings (modelling of buildings of the Zwinger in 2009-12, modelling of surroundings in 2011-12, merging of the individual models in 2013, rendering 2013).

In fact, this link between the built architecture of the Zwinger, its surroundings, and the historic unexecuted designs is also an added value for architectural research – namely, a verifying building simulation of unexecuted historic designs in combination with reconstructed building phases. Moreover, a review of the pure construction history of the Dresden Zwinger seems quite fragmentary considering the fact that many building activities must be regarded as a partial execution of more extensive designs. Since our efforts in preparing the three-dimensional reconstructions and simulations of buildings had evidenced that within the historic source material the discrepancies were more the rule than the exception, especially between ground plan and elevation, the critical harmonisation of differing sources turned out to be a special problem. A comparable problem was the question how gaps in the documentation could be filled in a convincing way. The experience made in the course of the modelling often led to a deeper understanding of a draft, and in the end to a critical and revising historical reflection on its structure, logic, quality and the possibility of realization. All these issues are of interest for the art-historical view on the Dresden Zwinger.

To present the project results within an exhibition we have taken into consideration the form of a teaching video for this purpose. The film will consist of the historical sources combined with the reconstruction of a fictional walk through the different states of the Zwinger building including adjacent areas of the town.[3]

Fig. 8 Virtual model of Pöppelmann's design for the Dresden Zwinger in 1722 (time-cut no. 8) in card board optic with part of the present Zwinger buildings and the residential castle in textured optic (modelling 2007).

The Sources

In order to achieve a valuable source library for the virtual models, our research consisted of assembling all visual source material which can give some evidence of the building and planning history of the Zwinger area. This material is very heterogeneously composed of plans, elevations, perspective views, and photographs (examples in figs. 9 and 12). To make all of it accessible for our project, the way of research led via the illustrations in relevant modern book publications into the archives and collections in Dresden which preserve the majority of the originals.[4]

The next step was a revision of the common opinions about the building and planning history of the Zwinger. The new reconstruction of Matthäus Daniel Pöppelmann's last vast garden project which has only been partially published in the so-called Zwingerstichwerk, Pöppelmann's own copperplate-publication of his architectural inventions, can be regarded as the most important result of this effort (figs. 9, 10).[5]

Fig. 9 Compiled sources for Pöppelmann's vast garden project of 1716–18, time-cut no. 5 (photo collage made in 2012 on the basis of situation plan and an elevation from ca 1715, copperplate prints from 1729, two new photographs from ca 2008/10).

Fig. 10 Virtual model of time-cut no. 5 (cf. fig. 9) fitted into an adequate schematic 3D model of the surroundings (modelling of buildings of the Zwinger in 2009-11, modelling of surroundings in 2011-12, merging of the individual models in 2013, rendering 2013).

In the end, fourteen so-called time-cuts were distilled from the visual sources (figs. 11, 12). They represent important building phases or design states. Our selection criteria have been the following: Primarily, the main building phases should be represented. Accordingly those five time-cuts (nos. 2, 4, 7, 12 and 14) are dedicated to the real building development of the area. From the more than 34 known projects which have remained unexecuted, we subjectively selected the eight most attractive and precious ones with respect to their urbanistic importance as well as their impressiveness. For pragmatic reasons we decided to model only those planning phases which are documented sufficiently by ground plans and elevations or which could be reconstructed without any further problems (discussion below). We also decided to represent all architects who were involved in the planning of the Zwinger area, beginning with Pöppelmann and ending with Gottfried Semper including Zacharias Longuelune, Jean De Bodt and Gaetano Chiaveri.

Fig. 11 Overview of the chosen 14-time-cuts mirroring the development of the Dresden Zwinger, each represented by one characteristic source.

1. Prince elector August the Strong 1709-10: sketched first idea (project)

Matthäus Daniel Pöppelmann:

2. 1711-13: Orangery at the back side of the fortification wall (building phase)
3. 1712-13: Extension of the orangery with garden and festivity areas (project)
4. 1713-18: Extension of the orangery with a central pavilion ('Wallpavillon') and a towered gateway ('Kronentor') between galleries (building phase)
5. 1716: Extension of the orangery with a water theatre and an enclosed garden (project)
6. 1716-18: Integration of the orangery in a vast new residential castle (project)
7. 1719: Mirroring of the orangery for obtaining a festivity yard and closing of the latter with an ephemeral stand (building phase; the last main one of the Baroque era)
8. 1722: Extension of the festivity yard with museum halls and a central pavilion (project)

Followers of Pöppelmann:

9. Zacharias Longuelune 1728: Extension of the Zwinger courtyard with a new residential castle (project)
10. Jean De Bodt 1736-37: Extension of the Zwinger courtyard with a new residential castle (project)
11. Gaetano Chiaveri 1746-47: Extension of the Zwinger courtyard with a new residential castle (project)
12. Anonymus before 1800: Provisory closing of the Zwinger courtyard with an arcaded wall (building phase; the wall was substituted for a new one and finally since 1847 for the picture gallery)

19th Century: Gottfried Semper:

13. 1842: Extension of the Baroque Zwinger courtyard into a forum with picture gallery and court theatre (project)
14. 1847-69: Closing of the Baroque Zwinger courtyard with a picture gallery in addition of the already erected court theatre (building phase; the theatre was destroyed 1869 by fire)

Fig. 12 List of the 14 chosen time-cuts mirroring the development of the Dresden Zwinger with date and main architect.

As a last step, the collected visual sources for the chosen fourteen time-cuts were digitized, uploaded and organized into a database to which the whole team had online access (fig. 13; http://www2.htw-dresden.de/~zwinger/, last accessed on 09.07.2015).

Fig. 13 Web-based database and project page at http://www2.htw-dresden.de/~zwinger/ (last accessed on 09.07.2015).

Modelling

In order to produce the virtual models in the computer, students of the HTW Dresden were recruited from the Media Computer Science degree program. In total 27 students have participated in the project to model the different time-cuts.[6] We started with the modelling tool 3D Studio Max 7, upgraded almost every year to a new version (fig. 14) which imposed a considerable amount of conversion work (last version: 3D Studio Max 2014). Moreover we also integrated the outstanding expertise of some members of the group with other modelling tools like Cinema 4D and Blender (cf. fig. 18 right) for which we had to find an exchange format and also an exchange workflow (at the end the file format 'obj' and adaption by hand worked best). Moreover the changing and replacement of team members (which we called 'student generations') were a big issue in our team which was tackled by intensive meeting and integration phases.

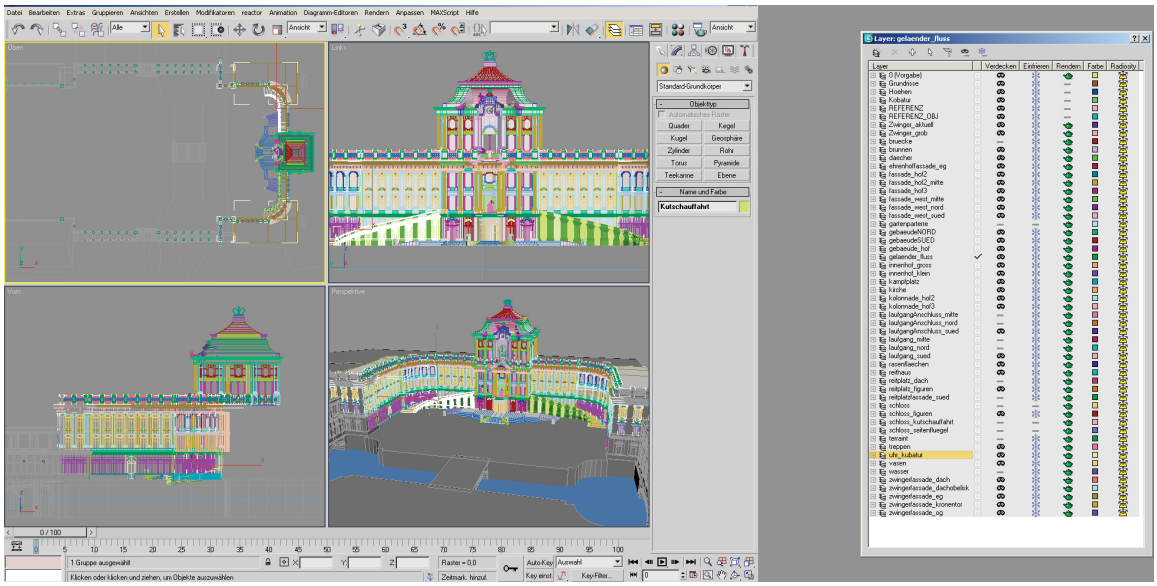

Fig. 14 Virtual model of time-cut no. 6 uploaded in the modelling software Autodesk 3D Studio Max 9 (model from 2010-11, screenshot from 2012).

Regarding the creation of the models, an immense amount of hand work has to be done to achieve the present state of each model, accompanied by intensive inspection and revision meetings (discussed below). Nevertheless some basic key modelling steps are presented next in order to give an idea of the modelling work. Here we concentrate on two main techniques: the box modelling and the spline modelling. Both start with orthogonal projected representations of the desired building such as the ground and elevation plan. But before that, as preparation, the information content of the compiled sources had to be sorted for assigning the elevations to a ground plan. Special diagrams of those correlations had been arranged for each time-cut to give the modellers a kind of guide line. The one shown in figure 15, prepared for the modelling of time-cut no. 11, i.e. the castle designed by Gaetano Chiaveri, exemplifies in another aspect also a sufficient supply of source material. The dealing of more problematic cases for the reconstruction, in which sources have been lacking, will be discussed below.

Before explaining the two modelling techniques, it must be pointed out that the 'Back to the Future' project focuses only on the cubic structure and the façades of the buildings, while their internal structure is not modelled.[7] The formal execution of architectonic elements varies depending on the specific quality and availability of the source material between the different time-cuts. Within a time-cut, however, a homogeneous level of detail has been pursued. The gradation of abstraction results from a steady and regular simplification of forms. In the course of abstraction considerable attention is paid to the compliance with the architectonic system.

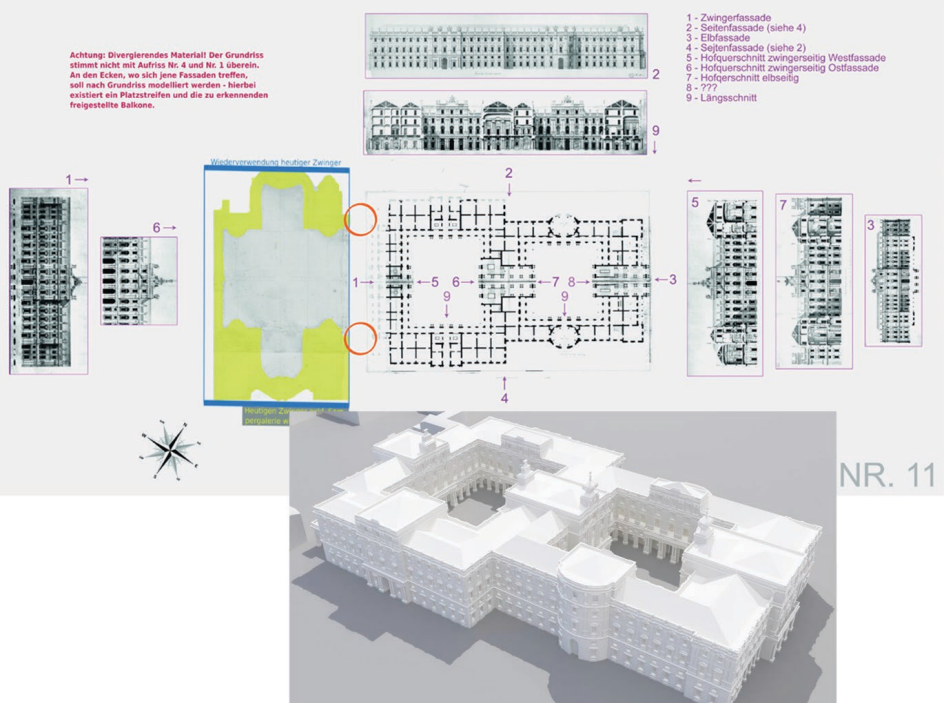

Fig. 15 Diagram (2008) of the correlating source material (ground plan and elevations) provided for the modeller of time-cut no. 11, i.e. Chiaveri's castle project of 1746-47, and corresponding virtual model (2008-12).

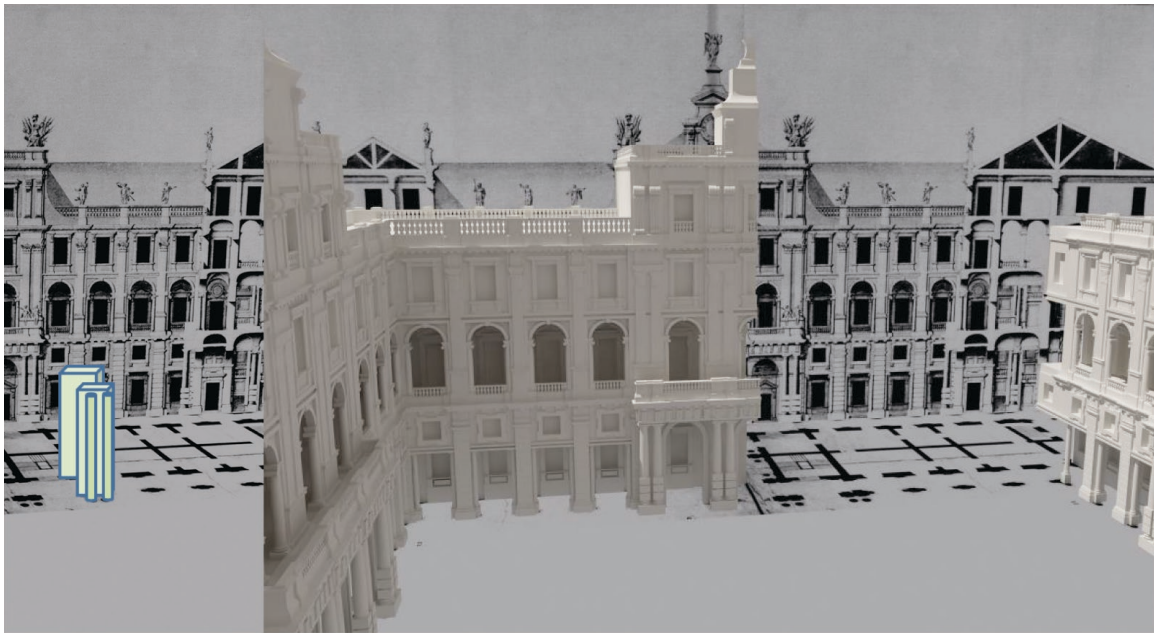

Fig. 16 Box modelling (left) and virtual model (2008-12) over the ground plan and in front of an elevation plan (right), exemplified by time-cut no. 11, i.e. Chiaveri's castle project of 1746–47 (photo collage 2012).

The box modelling technique (fig. 16) starts with very simple geometry such as a box for main buildings or cylinders for columns. They are adapted in shape to the right dimensions and placed in the correct position in the model (fig. 16 left). By this approach a rough outline of the desired object is quickly achieved and the cubature becomes visible. Afterwards a very time-consuming process of subdivision and adaptation of the representing mesh (i.e. its vertices) follows in order to elaborate the initial raw model into a more detailed architecture (fig. 16 right). Often predefined tools and modifiers (e.g. local shrinking, bending) can be used but in the end extensive work by hand is inevitable to achieve even finest details.

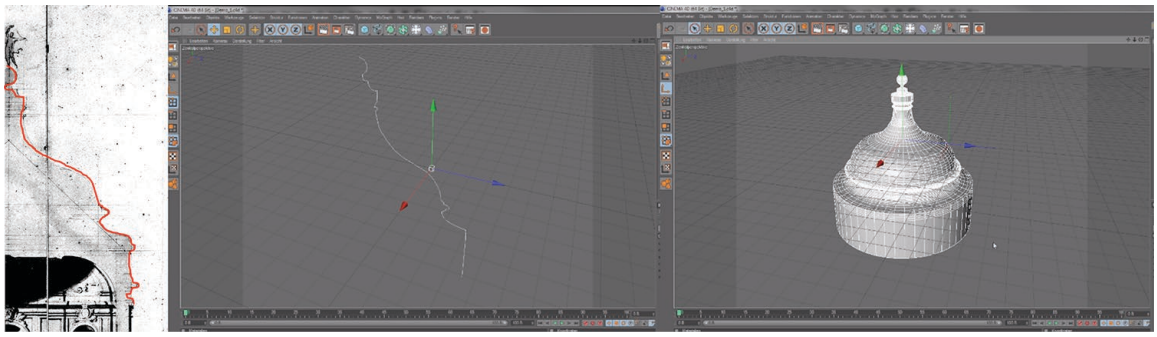

Fig. 17 Phases of the spline modelling technique exemplified by a cupola design taken out from the source material for time-cut no. 9, cf. above fig. 11, no. 9 (model fragments from 2009-10, screenshots 2012, photo collage 2012, software: Cinema 4D).

The spline modelling technique (fig. 17) consists of drawing lines (e.g. splines) for the contours of the building in some main directions on the plans. This process ends up with a line cage that can then be transformed into a mesh which is then processed as described above to model the details.

Presenting Mode of the Models

The inhomogeneous source material also required a longer readjustment process in regard to visuals because the aesthetic appearance of the reconstruction directly affects its understanding in terms of the intended knowledge transfer. On the one hand, we would like to show the current state of the Zwinger and its construction phases. On the other hand, we want to present unexecuted designs as well as building elements of a certain time period which do not exist anymore. For the representation of the existing building substance a richly-detailed, polygonal model is being used in order to create an impression of the present state as authentic as possible (fig. 18 right, 19).

Fig. 18 Inner staircase of the western central pavilion (so-called Wallpavillon) of the Dresden Zwinger
Left: photograph of the original building from 2012
Right: rendering of a textured polygon model from 2012 (software: Cinema 4D).

Regarding the representation of designs, the general aim is to interpret the historical image sources as little as possible. It was therefore attempted to transfer the source directly to the raw cubature of a building (fig. 8). However, the result distorts the visitor's spatial understanding since the components are extracted from the original context of the source image. Ultimately, the decision for the graphic realization was made for an architectonic model made out of cardboard which is the generally known type (see for example the model in fig. 15). Due to this display mode all levels of abstraction can be represented easily, the status of the modelling seems clear and the distinction or separation from the existing Zwinger buildings is obvious (figs. 8, 10; cf. also as variant fig. 19).

Fig. 19 Virtual model of the actual Dresden Zwinger (time-cut no. 14) contrasting the Baroque buildings with the added picture gallery of the 19th century by using textured and cardboard appearance (models from 2009-11, texturing 2012, rendering 2012).

If sources for a complete reconstruction are missing, the gap will either be bridged by deducing analogies from the current architectonic system (as discussed below) or by closing it neutrally, in the form of either naked cubature (fig. 20) or plastically modelled ground plans in the sense of foundation runs (fig. 21).[8] This approach guarantees that the layout of every building is represented in the model, even if there are no indications of any detail.

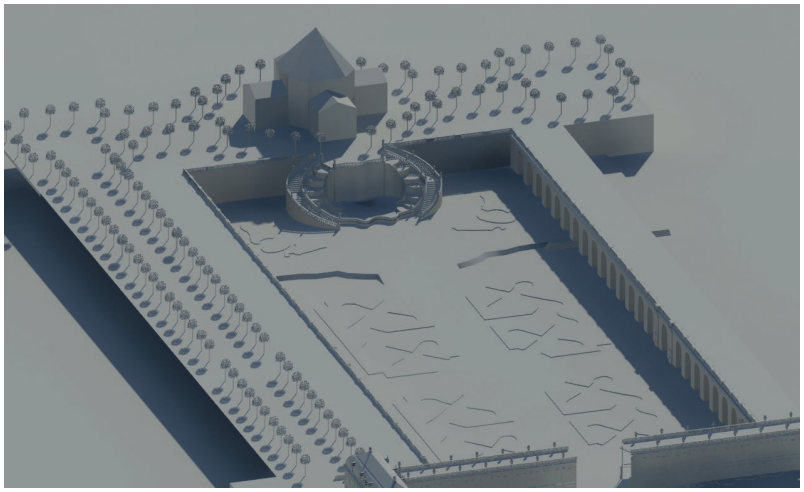

Fig. 20 Part of the virtual model (2010-11) of time-cut no. 5 with neutrally closed structure in form of naked cubatures (polygonal pavilion with projections in cross-form located on the wall terrace along the riverside; its form can be taken solely from the ground plan of the project; cf. fig. 9).

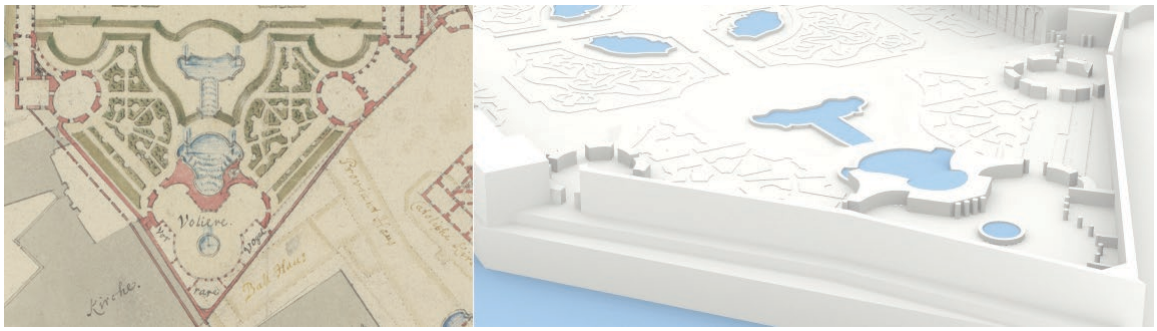

Fig. 21 Detail of the ground plan source (1716/18) for time-cut no. 6 and related virtual model (2010-11). Because of the lack of any further information the area (towered water theatre of the Zwinger garden with an aviary at the rear and adjacent rounded pavilions) is modelled neutrally in form of a plastic ground plan.

A further modelling step consists in the integration of the Zwinger buildings and projects into topographic models of the surroundings to establish correlations with the urban space. The layout of the surrounding buildings has to be conformable to the historic topographic situation of each time-cut. Their models are reduced to a neutral cubic volume to contrast with the Zwinger architecture, but accented with a few significant architectonic details for easier identification (see above figs. 7, 10).

Control of the Models

One very time-consuming and intensive task in the project was the control and revision of the models by comparison with the sources. Monthly meetings with the modellers in Dresden at the HTW made it possible to discuss the development of the models and their exactness intensively. Protocols of each session, which have been archived internally, supported the control work and will give future possibility to reconstruct the genesis of every modelled time-cut.[9] Our primary media of communication were renderings, i.e. computer generated photo shots of the models from different perspectives or views. For preparing such a meeting the actual renderings were also uploaded into the online-database (folder 'Modelle' above in fig. 13). During the control sessions double projections of the rendered model and the related source on the wall gave the possibility of comparison (fig. 22). A whiteboard was used for explaining difficult structural problems by drawing (fig. 23); sometimes we even projected the rendering of the model on this whiteboard so that we could draw on it to augment or comment the projection (fig. 24). Between the meetings some modellers also communicated via e-mail with the heads of the project to solve problems as soon as possible.

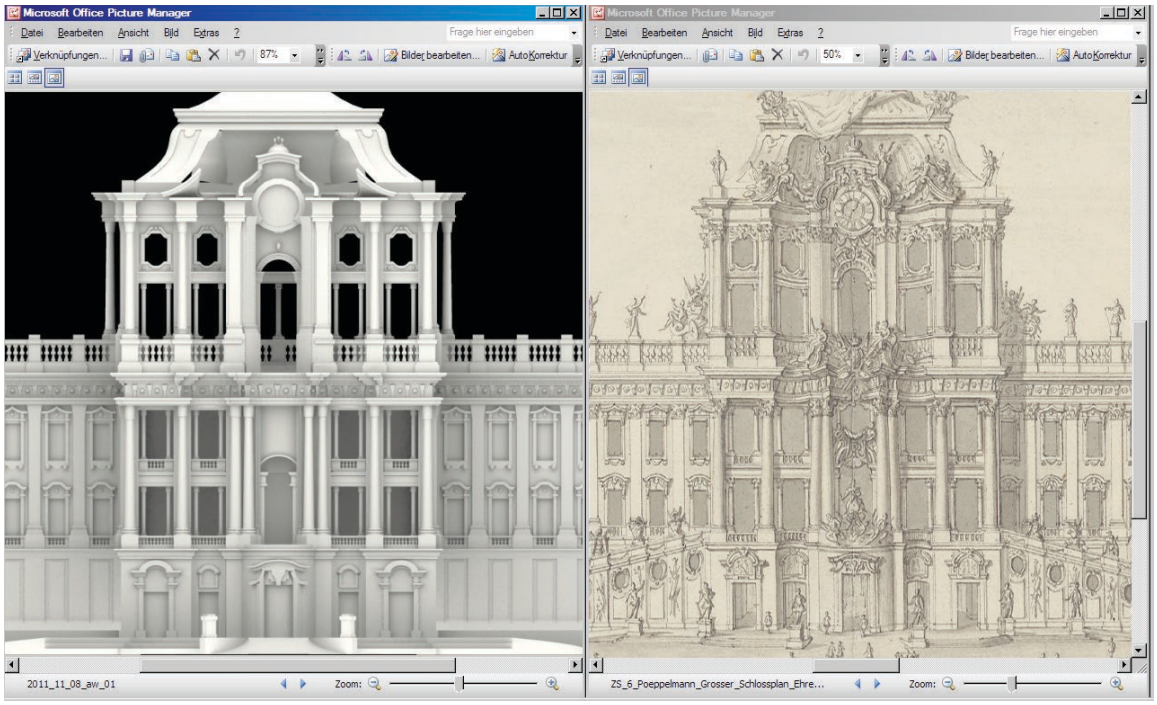

Fig. 22 Double projection of a rendered virtual model from 2010-11 (left) and the related source from 1716/18 (right), exemplified by Pöppelmann's castle project of time-cut no. 6 (in detail the complex curved and structured centre pavilion of the main cour d'honneur). Both images show the building in a mostly correlating view (software: Microsoft office picture manager, screenshot from 2012).

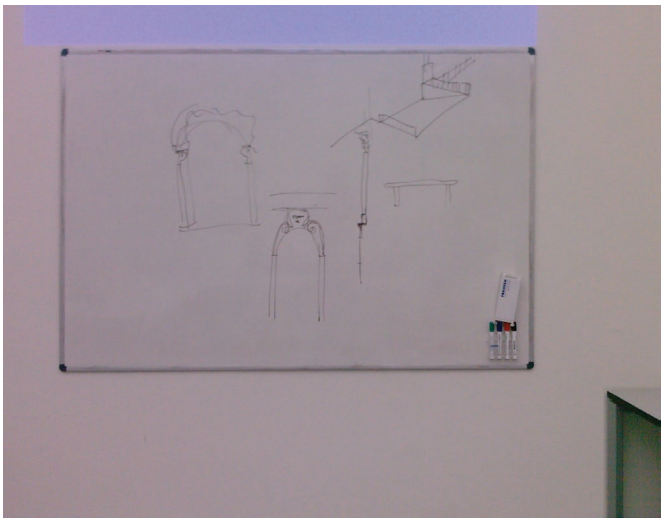

Fig. 23 Whiteboard in the conference room at HTW Dresden, used for drawn explanations of modelling problems; the violet stripe above derives from the projection light of the video beamer (photograph ca 2011, depicting details of the architecture shown in the modelling in fig. 22).

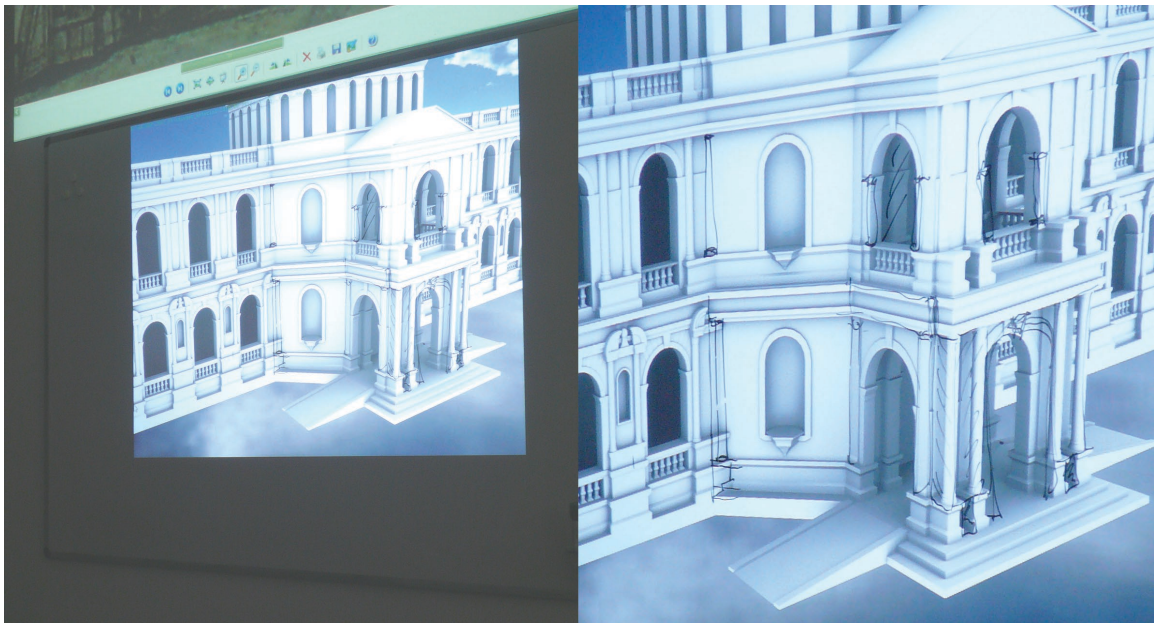

Fig. 24 Projection of a rendered virtual model from 2009-10 (detail of time-cut no. 13, i.e. garden façade of the proposed picture gallery) on the whiteboard seen in fig. 23 for the possibility of drawing corrections over the model (collage of a photograph from 2010 and a detail of it).

In some cases typological references were used to explain an insufficiently documented part of a time-cut. Time-cut no. 3 gives us a good example: The bird's eye view as the main source has been lost since World War II and is only documented by an archive photograph in black-and-white (see above fig. 4), with the effect that the three rounded pavilions which can be seen in its background are hardly recognizable. To give the modeller a better imagination of the buildings we used a comparable pavilion which is located in the Hermitage Garden of Bayreuth (fig. 25).

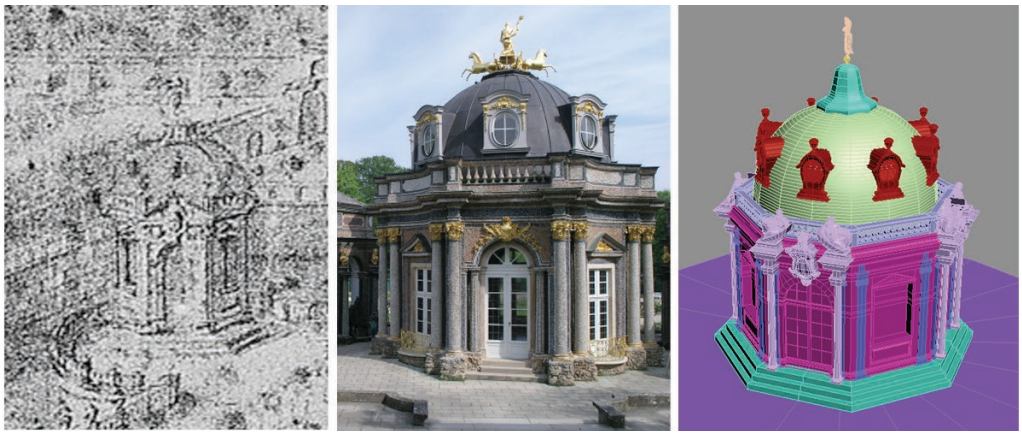

Fig. 25 Insufficiently documented pavilion of time-cut no. 3 (left, cf. fig. 4), being substituted by the Temple of the Sun in the Hermitage Garden of Bayreuth (middle) as pattern for the virtual model from 2011 (right).

Only in the last phase of the project the actual models were directly controlled and corrected together with the modeller in the modelling software (see above fig. 14). In order to handle the immense data masses in real time we had to use the high performance computer of the HTW's motion-capture-system.

Work and Problems with the Sources

As mentioned above, the visual sources for each time-cut consist of different media types and also of different qualities. High definition scans of original drawings and blurry scans from black and white book illustrations mark the two extremes of quality with which the modellers were confronted. We normally used book illustrations if either the originals had been lost since World War II[10] or an archive has not been able to deliver digital images of the originals. Nevertheless, book illustrations bear some general advantages compared to the reproduced originals: they are not only easier to access but also easier to handle because of comparatively small dimensions, and often free of any distortions. In the recourse to book illustrations customary scan techniques can be used in most cases without restraint and very quickly avoiding any problems of conservation connected with the originals. In fact, decisions whether book illustrations or originals should be digitized sometimes had been taken pragmatically in consideration of the respective source situation, efficiency and the modellers' special needs for detailed information. After all, the preparation of the source material was led by the general wish to make it as comfortable as possible for the modellers.

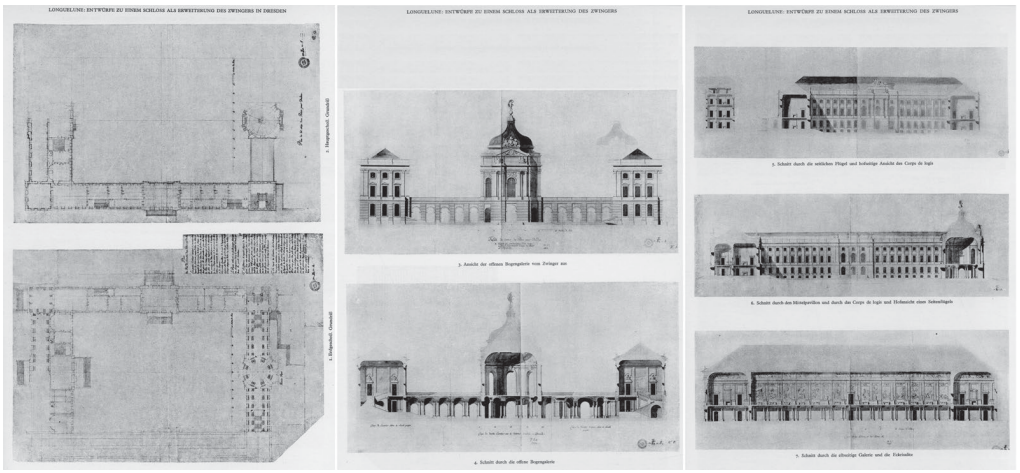

Fig. 26 Book illustrations (1953) of Baroque plan drawings (1728-1733), edited in a quarto volume, taken as source for time-cut no. 9.

An extreme example exhibits time-cut no. 9: This impressive virtual model of a castle designed by Zacharias Longuelune for the area between the Zwinger courtyard and the river Elbe (fig. 27; for the location see above fig. 5) is based on some scanned book illustrations in black and white of small size and poor quality (fig. 26). In this case, the original plan drawings are not lost but of large size with the effect that the preserving archives have had no practicable possibility to digitize it without any distortions.[11] So, unfortunately, we had to resort to the available book illustrations published in the early 1950s. The advantage of their use lay in the lack of distortions, the disadvantage in the deficiency of clarity in regard to details. But in the end the latter problem could be compensated by digital photographs of representative details taken directly of the originals.

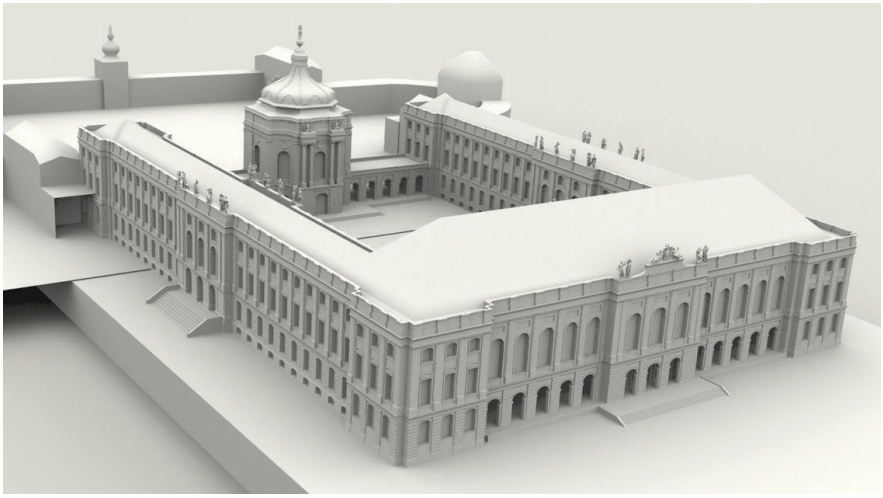

Fig. 27 Virtual model (2009-10) of Zacharias Longuelune's castle project of 1728 (time-cut no. 9).

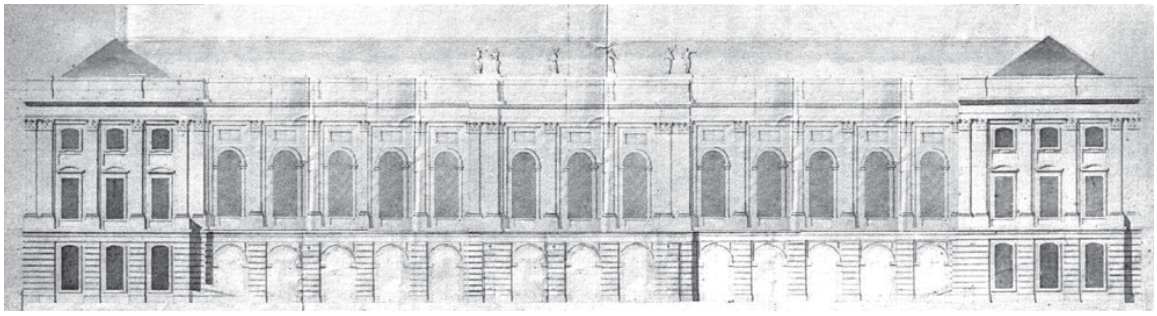

Fig. 28 Reconstruction in Photoshop of a lacking elevation for time-cut no. 9, done by using elements of the elevations depicted in fig. 24. For the virtual model generated on basis of the reconstructed elevation see fig. 24 in the foreground.

The most striking problems during the definition of time-cuts regarding unexecuted projects were either the partial lack of visual sources or the discrepancy of measured ground plans and elevations – or both. For this reason reconstructions have seemed to be indispensable in order to avoid any larger gaps which could irritate or even disillusion the recipient of the virtual model. To fill those gaps in a believable way it is necessary to base the reconstruction on different critical principles. One of them is the deduction from the documented parts of the building project itself. In the case of the aforementioned time-cut no. 9, for example, one front elevation is lacking, namely that of the gallery wing located at the rear of the castle along the riverside. The reconstruction therefore could be completed on the one hand from the existing ground plan together with the sections of this building wing and on the other hand from the homogenous architectonic system which allowed the borrowing of elements from the documented façades. The strict orthogonal projection of the existing plans gave the possibility to produce easily an elevation as instruction tool for the modeller, because the usable façade elements could be brought in a new order with the help of Photoshop software (fig. 28). While this comfortable method of reconstruction was the preferred one, in the worst case, if orthogonal projected plans had been completely lacking, elevations or ground plans would have had to be reconstructed in the form of schematic drawings (with the added problem that none of the leading team members is a professional draughtsman). For this issue the following problem of reconstruction will give an example:

A missing ground plan is of no further problem if one has to deal with cubic architecture. However, it turned out to be a big one for the modellers if the buildings show curvatures and complex systems of columns, pilasters, or lesenes since in orthogonal projected elevations these aspects are not sufficiently readable. As an example for this problem we can take one of the tower buildings of time-cut no. 5: The situation plan shows schematic and inaccurate ground plans for two gateway towers and one fountain tower (see above fig. 9). Two final planning states of these buildings had been published in elevations by Pöppelmann in his own copperplate edition about the Zwinger.[12] Unfortunately, their basement level differs in its form so much from the situation

plan that the reconstruction could not be limited to the buildings itself but also had to include the course of the connecting colonnades. A schematically drawn ground plan was necessary to precisely instruct the modeller (fig. 29).

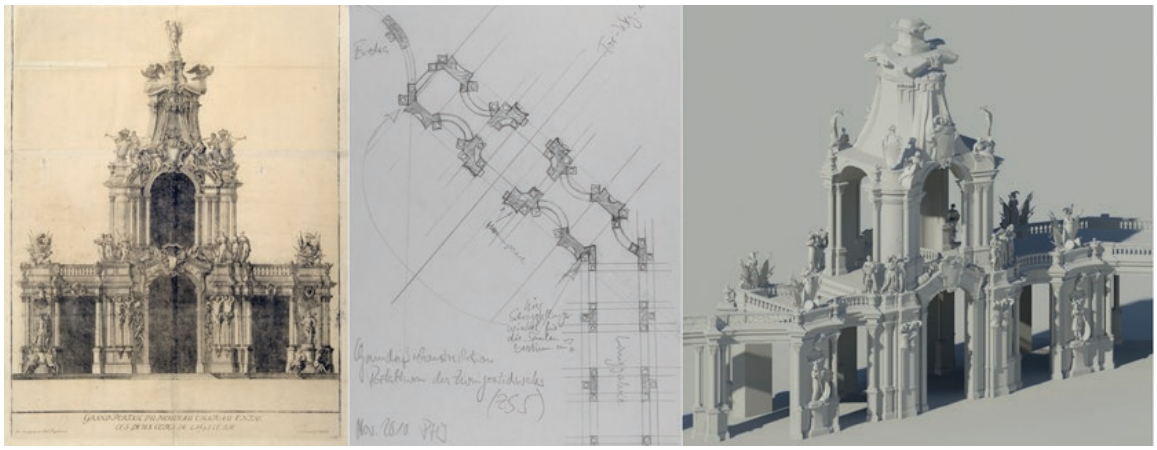

Fig. 29 From elevation (copperplate from 1729) via a sketched reconstruction of the ground plan (2010) to the virtual model (2010-11), exemplified by a gateway tower of time-cut no. 5 (cf. above fig. 9).

The lack of a ground plan can also lead to great difficulties if as elevation only a perspective view of a project has survived like in time-cut no. 3 (see above fig. 4). In this case an existing ground plan correlates only partially with the bird's eye view taken as the main source for the virtual model (fig. 30). A further complication is caused by the fact that the area of inadequateness in the ground plan is solely depicted at half in the elevation source: One can recognize there a tilt-yard flanked by one half of an edifice to be used for festivities. The gap, consisting first of all in a second yard near the riverside, was closed by repeating some recognizable elements from the tilt-yard like the monumental gateway, outside staircase and retaining wall, while the building was completed by mirroring the depicted half. Common building logic gave evidence for the addition of a huge symmetrical staircase hall at the rear of the edifice; the latter naturally conform to the architectonic system of the front façade. Finally the proportions of all the unexecuted buildings had to be found for lack of measured elevations in adjustment with the existing Zwinger architecture.

Comparable to the so far exemplified deductive methods of critical reconstruction is the borrowing of forms from typologically related buildings or designs of the same architect. This was done, for example, in time-cut no. 13 which represents Gottfried Semper's grand forum project. The elevation of the proposed museum building is documented only by a perspective visualization of the project which shows the building on the left with its main façade of the garden side in an extremely shortened view in which all details are unrecognizably distorted (fig. 31). And while nothing of the other main façade on the town side can be seen, only one narrow side of the building is depicted frontally. So in this case, both main façades including the monumental

staircase projection on the town side had to be reconstructed. As measured source material only a ground plan published by Semper exists which could give some orientation.[13] Patterns usable for the reconstruction had been fortunately found in the context of Semper's alternative designs for the Zwinger area. So, the staircase projection of the town façade could be deduced mostly without any alterations from a preparatory sketch for the museum project which proposes for the first time the finally chosen building site (fig. 32). More difficult to reconstruct was the ground storey of the façades because in the source in that area one can only recognize the shadows of some cornices, the arcades and above them some obscure dark spots which have been interpreted as medallions. All these motifs are assembled again at the outer main façade of Semper's executed museum building but there in a varied combination. As often done, the modeller undertook their recombination by some trial-and-error attempts and supported by a sketched elevation drawing (fig. 33).

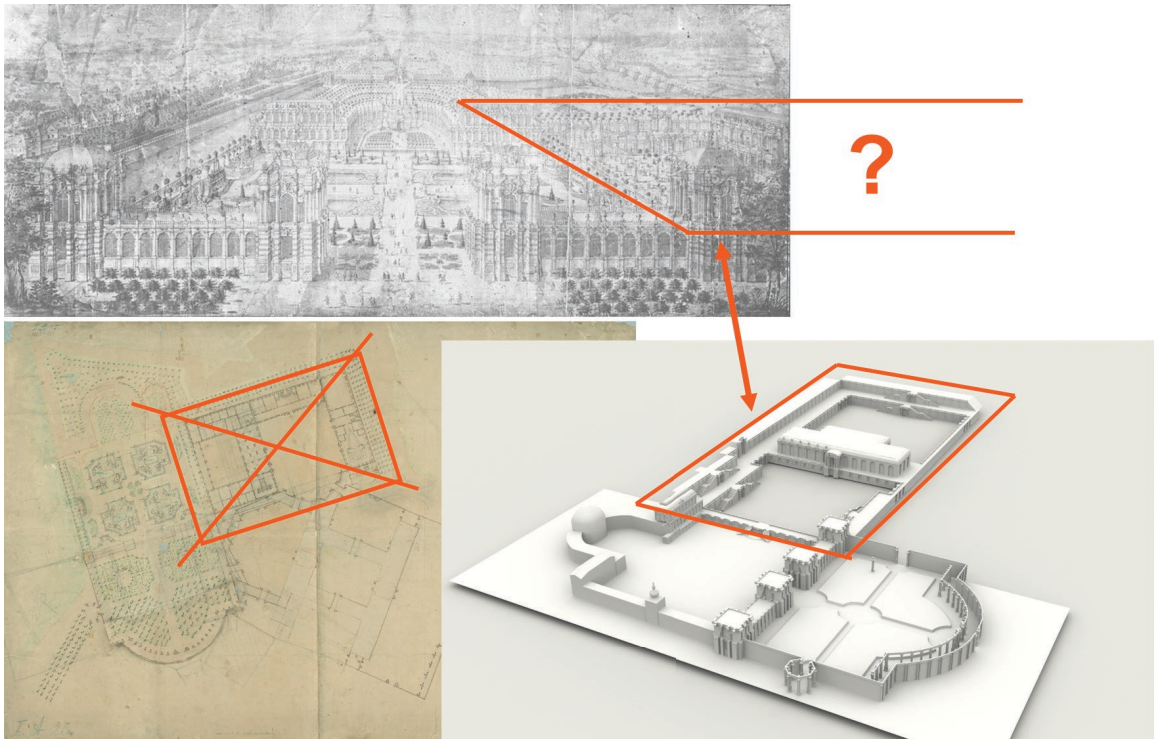

Fig. 30 Confrontation of sources (bird's eye view of fig. 4 and relatable ground plan from 1712/13) and virtual model (2010-11) for time-cut no. 3. The red frames mark a zone of insufficient and inconsistent documentation which had to be modelled partially as a free interpretation but consistently to the architectural system depicted in the elevation source.

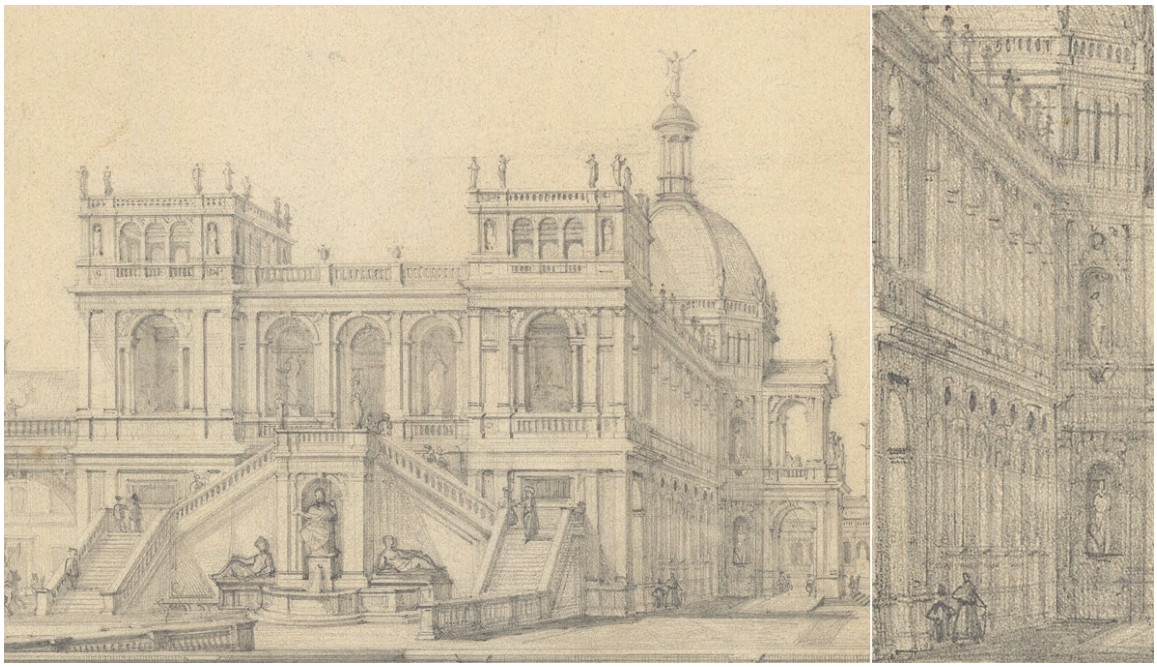

Fig. 31 Details of the main elevation source from 1842 for time-cut no. 13 (cf. above fig. 11, no. 13), showing in extreme perspective distortion Gottfried Semper's proposal for a picture gallery which is laid out in front of the residential castle.

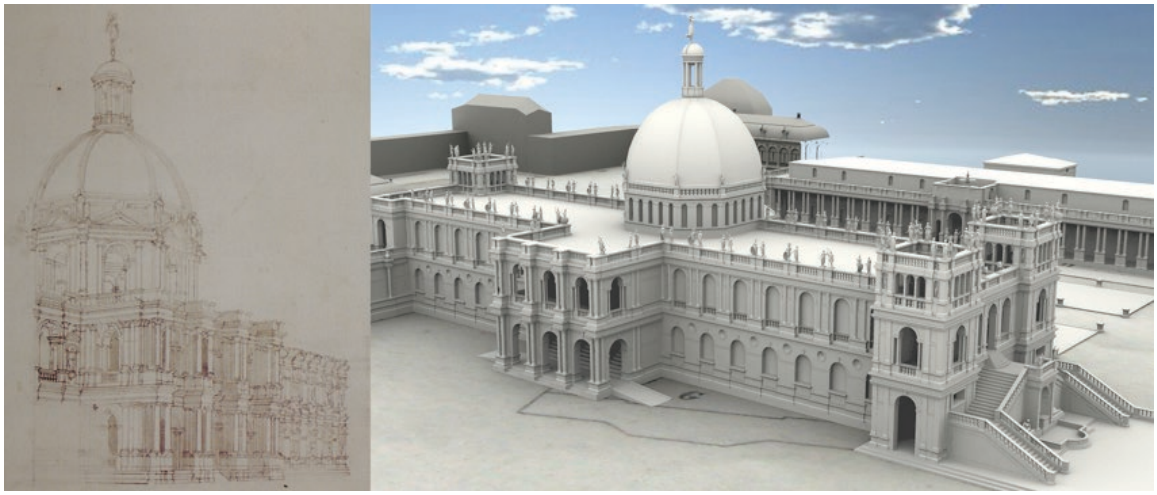

Fig. 32 Sketched design from 1840 of Gottfried Semper for a picture gallery used as pattern for the virtual reconstruction of an insufficiently documented alternative design (time-cut no. 13; cf. fig. 31), namely for the staircase projection at the town side (virtual model 2009-11).

Fig. 33 Reconstruction of the ground storey of Gottfried Semper's design for a picture gallery in front of the residential castle (time-cut no. 13; cf. fig. 31) by borrowing motifs (medallions, cornices, pillar arcades) from the outer façade of the executed building (virtual model 2009-11).

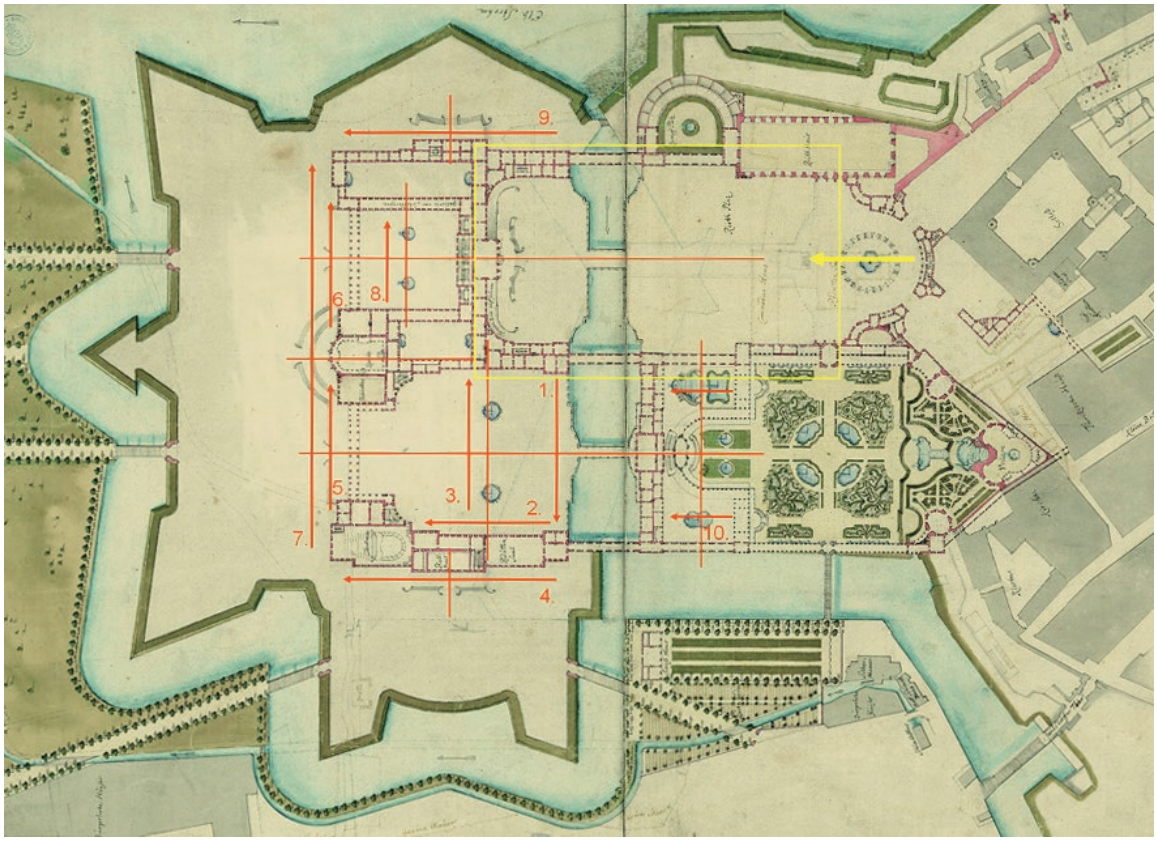

Fig. 34 Situation plan of Pöppelmann's Grand Castle Project from 1716-18 (time-cut no. 6). The yellow frame marks the area depicted in fig. 35. Red arrows together with red lines as symmetry axes mark the ten mirroring steps which had been necessary to reconstruct virtually the complete building cubature of the castle (graphical overlay 2012).

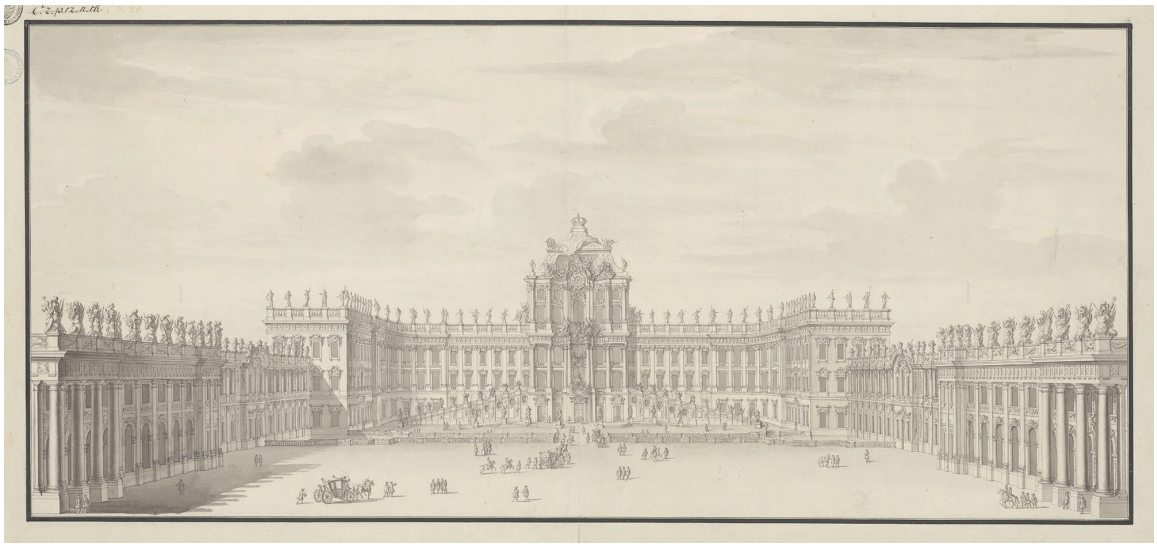

Fig. 35 Perspective view in the main cour d'honneur of Pöppelmann's Grand Castle Project from 1716-18, being the one and only elevation source for time-cut no. 6.

A further used deductive principle of critical reconstruction, the deduction of forms and structures from typologically and stylistically related buildings, was already mentioned above in the case of the octagonal pavilions of time-cut no. 3 which are documented only by an unclear perspective view of a small size (see above fig. 25).

Another guideline of critical reconstruction was based on the baroque architectural principle of symmetry. This principle proved to be very successful in the reconstruction of time-cut no. 6 representing Pöppelmann's so-called Grand Castle Project which reduces the Zwinger courtyard to a secret garden of a gigantic residential area with three cours d'honneur. From this ambitious design we only have the situation plan (fig. 34) and an impressive perspective view of the main cour d'honneur (fig. 35). The remaining two cours d'honneur on the rear can be completed in most parts by mirroring one side wing of the depicted corps de logis, first to the left side and from there inside the court, then along the rear front to the right side, afterwards inside the right court and finally along both outer side façades as shown in the diagram of fig. 34. In addition, the position of colossal columns could be read out of the situation plan by comparison of diameters because in the perspective view some of those colossal columns are depicted and therefore locatable. The result of this reconstruction attempt is an impressive virtual model which allows experiencing plastically the vast dimensions of an excessive Baroque building project (fig. 36).

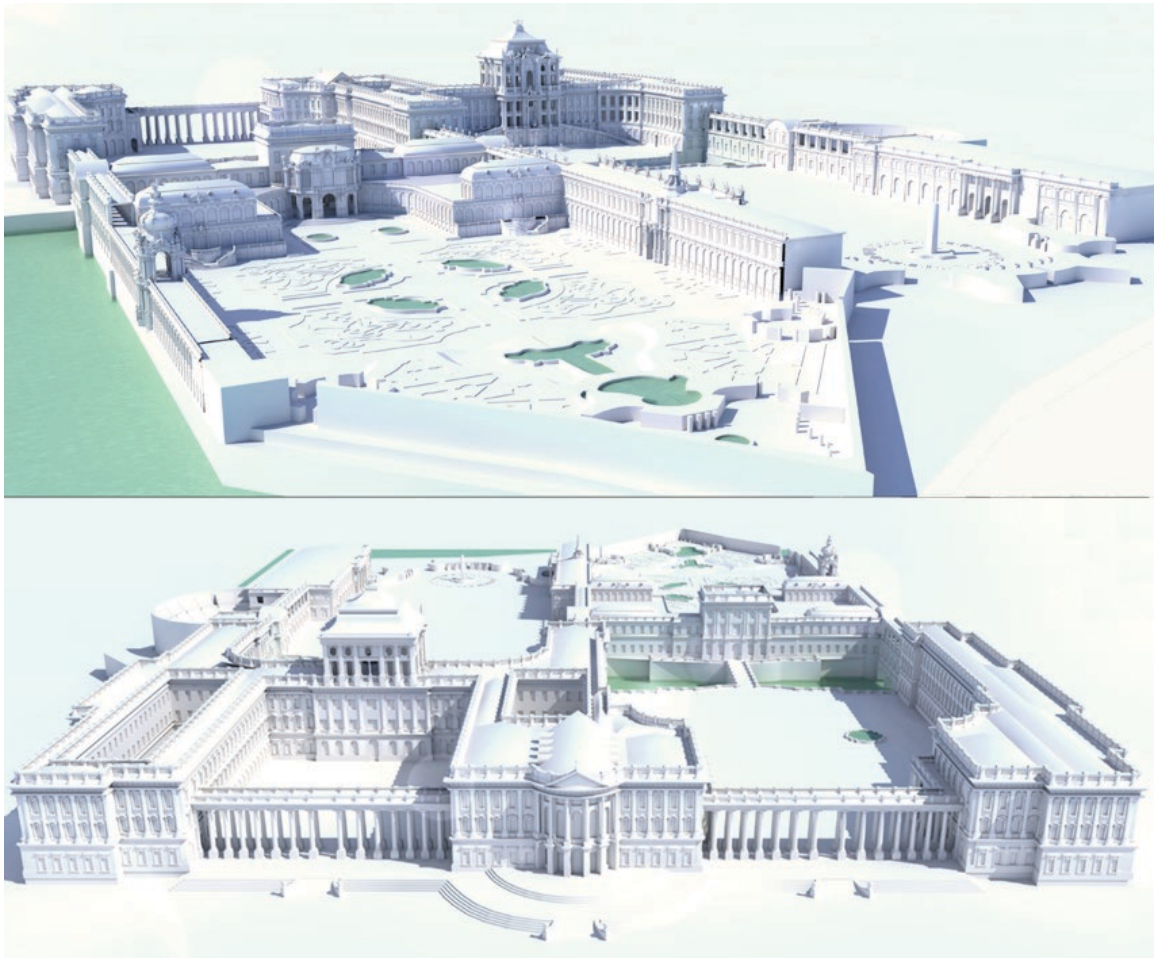

Fig. 36 Virtual model (2010-11) of Pöppelmann's Grand Castle Project from 1716-18 (time-cut no. 6).

Scientific Results

The virtual reconstruction of the Dresden Zwinger developed during the described project gives us a deeper analytic insight into the historic planning process and its inherent problems. For example, from rectifying the perspective view of time-cut number 6 we were able to learn how much the historic media of architectural visualization can deceive us: If you count the axes strictly according to the ground plan, the virtual model demonstrates that some parts of the side façades show a somewhat strange disproportion while they do not appear to do so in the distorted perspective view (fig. 37).

Taking into consideration the many discrepancies between ground plans and elevations we have to ask if this is the result of a fragmentary conservation or of a drafting process which continues during the drawing process. In our opinion it is plausible that, while an elevation plan

was being drawn, alterations to an already existing ground plan could be made by the architect and directly integrated into the new elevation drawing. In fact, before the acceptance of a project it was not really necessary that all the plans made for it correspond to each other since discrepancies could be taken in a positive sense as alternative proposals. A need for coordination was only given if the plans would have had to fulfil a function on an actual construction site. The refusing of a draft must have made such coordination work seem like an additional and, in the end, senseless toil, with the effect that partially non-correlating plans could be archived.

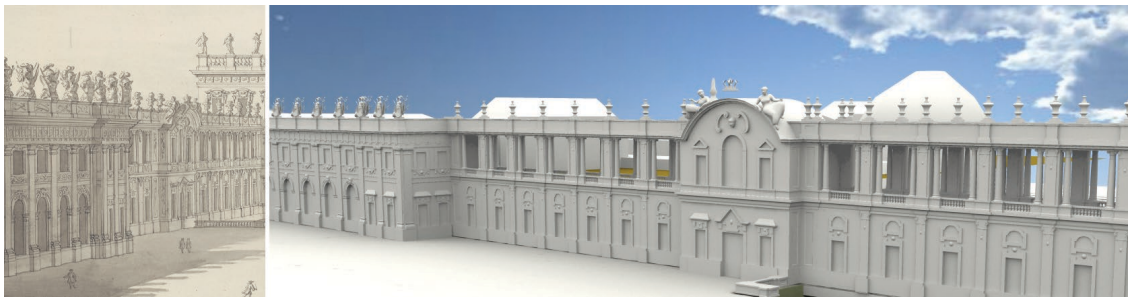

Fig. 37 Perspective distorted detail in the elevation source for time-cut no. 6 (cf. fig. 35) and its rectifying by the virtual model (2010-11). The axes of the architecture appear slender in the historic depiction but broad and portly in the model.

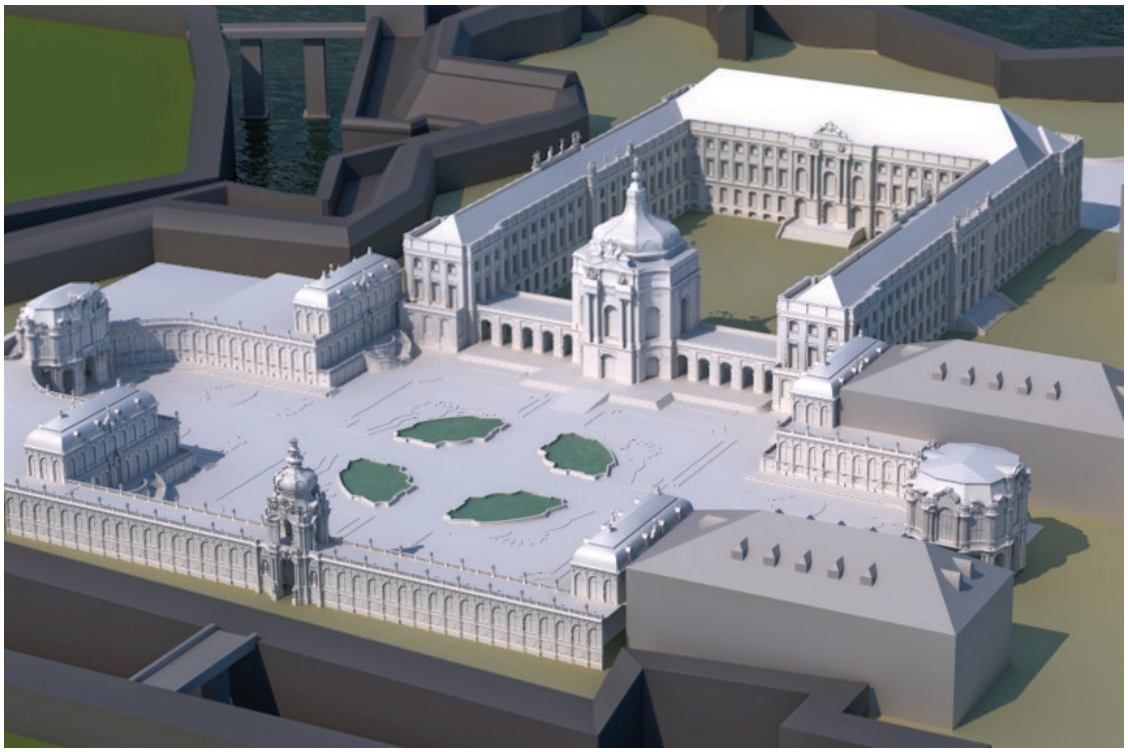

Fig. 38 Virtual model of Zacharias Longuelune's castle project 1728 (time-cut no. 9) in addition to the already existing Zwinger courtyard (modelling of the court of the Zwinger 2009-11, extension of the castle 2009-10, surroundings 2011-12, merging of the individual models 2013, rendering 2013).

Highly illuminating was the possibility to combine the castle projects of Pöppelmann's successors with the Zwinger courtyard erected by him. In the 18th century, such a combination was obviously mostly done in two-dimensional situation plans but only seldom in elevations. One fine example is the central polygonal pavilion of Zacharias Longuelune's castle project (time-cut no. 9) which was supposed to become the counterpart of Pöppelmann's crowned gateway tower (so-called Kronentor; see above fig. 2). As an isolated form in the elevation plan the pavilion looks precious and delicate (see above fig. 26, middle column). In combination with Pöppelmann's architecture, however, it takes on a monstrous aspect. The Zwinger courtyard almost appears like the front garden of a somewhat oversized castle (fig. 38, cf. also fig. 27).

Conclusion

The project 'Back to the future – Visualizing the Planning and Building of the Dresden Zwinger', initiated by the Saxon Administration of State-owned Castles and Gardens, had begun with a certain museum-didactic aim: the building development and planning history of the Dresden Zwinger should be modelled virtually for instructing future visitors of that famous Baroque building. But in the course of the project's progress it has in the end also achieved some scientific results of diverse value. As primary output fourteen more or less complex virtual three-dimensional models of construction and planning phases (so-called time-cuts) have been produced including a richly-detailed one of the existing buildings as well as fourteen schematic ones of the historic correlating surroundings. This result must be taken as the admirable work of more than two dozens of students who participated in the degree program of Media Computer Science taught at the Dresden University of Applied Sciences (HTW). The scientific output on the one hand consists of the remarkable number of image and plan sources which were, as preparation, collected and in parts newly arranged, and on the other hand in the elucidating new information which the virtual models can give about the truthfulness of an historic image source and, as in the case of a not realized draft, about its structure, logic, correlation, quality and possibility of realization. Correlation in context with the latter means the interaction between such a draft and the adjacent historic, as well as actual urban space. To sum it up: verification with the help of virtual reconstruction and building simulation.

Meanwhile, the fourteen virtual models are waiting in a raw state for the production of an adequate presentation form because, as already mentioned, in the end the visitors of the famous Dresden Zwinger shall be their primary recipients. A first attempt has already been made when a video including the time cuts 1 to 8, 12 and 13 was produced for the exhibition 'Pöppelmann 3D – Bücher, Pläne, Raumwelten' presented in Dresden in the Saxon State and University Library (Sächsische Landesbibliothek – Staats- und Universitätsbibliothek – SLUB) from 16 May until 1 September 2013.[14] The reactions of the audience were mostly that of surprise due to the fact that the film was able to show so many unknown aspects about such a supposedly familiar building as the Zwinger. It goes without saying that the building simulation of Pöppelmann's stupendous unexecuted drafts created a great amount of amazement. As expected, our project reveals that looking back in history via virtual models to obtain results for future knowledge really works!

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Preliminary remark: Only a selected bibliography concerning the architectural history of the Dresden Zwinger is given. Complementary to the topic of this article see Jahn and Welich 2009.

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Illustrations

Preliminary remark: For all virtual models depicted in the illustrations (fig. 8, 10, 14-22, 24, 25, 27, 29, 30, 32, 33, 36-38), and any reproductions of them, the copyright is held by Staatliche Schlösser, Burgen und Gärten Sachsen gGmbH, Dresden. Hereafter for these illustrations only the names of the modellers are given as additional information.

Fig. 1-2, and 5 Dresden, Staatliche Schlösser, Burgen und Gärten Sachsen gGmbH.

Fig. 3 Dresden, Sächsisches Staatsarchiv, Hauptstaatsarchiv, Rißfach 99, Nr. 14. (Black and white photograph of the 1709 drawing)

Fig. 4 Dresden, Sächsische Landesbibliothek – Staats- und Universitätsbibliothek – SLUB, Deutsche Fotothek, Hauptkatalog 0095526.

Fig. 6 Dresden, Staatsbetrieb Sächsisches Immobilien- und Baumanagement – SIB, IS-Objekt-Nr. G 001442, Plannr. 05.

Fig. 7 Modellers: Philipp Hackbarth, Falk Schieber and Steve Kuttig (Zwinger buildings), Romy Ebert (surroundings), Rainer Uhlemann (adjusting of both models).

Fig. 8 Modeller: Markus Zönnchen.

Fig. 9 Photomontage by Peter H. Jahn of a ground plan (Dresden, Sächsisches Staatsarchiv, Hauptstaatsarchiv, OHMA P, Cap. I A, Nr. 26, Bl. 1-3), an elevation drawing (Dresden, Sächsische Landesbibliothek – Staats- und Universitätsbibliothek – SLUB, Kartensammlung B 1978), and three printed elevations (Matthäus Daniel Pöppelmann, *Vorstellung und Beschreibung* […] *Der Königl.*[ichen] *Orangerie zu Dreßden* [Dresden, 1729]).

Fig. 10 Modellers: Philipp Hackbarth, Falk Schieber and Steve Kuttig (Zwinger buildings in beige colour), Chris Leister and Toni Seifert (Zwinger buildings in white colour), Romy Ebert (surroundings), Rainer Uhlemann (adjusting of the models).

Fig. 11 Photomontage by Peter H. Jahn of different image sources mostly preserved in the archives mentioned in endnote 4. Exceptions are no. 8, which shows a painting in possession of Staatliche Kunstsammlungen Dresden, Gemäldegalerie Alte Meister, and no. 13; for the latter see below fig. 31. Detailed information about no. 6 is given below at fig. 35 and about no. 9 at fig. 26.

Fig. 12 Written by Peter H. Jahn.

Fig. 13 See impressum of the webpage: http://www2.htw-dresden.de/~zwinger/webs/impress.html.

Fig. 14 Screenshot of a virtual model uploaded in the modelling software (Modeller: Anne Weinert).

Fig. 15 Photomontage by Peter H. Jahn of a diagram (author: Loreen Pogrzeba) and a virtual model (modeller: Josephin Seibt).

Fig. 16 Photomontage by Markus Wacker (modeller: Josephin Seibt).

Fig. 17 Photomontage by Markus Wacker basing on three screenshots of a virtual model (modeller: Rainer Uhlemann).

Fig. 18 Photomontage by Markus Wacker of a photograph (photographer unknown) and a rendering of a virtual model (modeller: Steve Kuttig).

Fig. 19 Modellers: Philipp Hackbarth, Falk Schieber and Steve Kuttig (Baroque Zwinger buildings; texturing also by Kuttig), Michael Marschner (picture gallery).

Fig. 20 Modeller: Chris Leister.

Fig. 21 Photomontage by Peter H. Jahn of details of fig. 34 and the model depicted in fig. 36 (modeller: Conny Coburger).

Fig. 22 Modeller: Anne Weinert; for the depicted source at the right half see fig. 35.

Fig. 23 Dresden, Hochschule für Wirtschaft und Technik.

Fig. 24 Dresden, Hochschule für Wirtschaft und Technik (modeller: Michael Marschner).

Fig. 25 Photomontage by Peter H. Jahn of a detail of fig. 4, an own photograph and a screenshot of a virtual model (modeller: Rainer Uhlemann).

Fig. 26 Franz 1953, plates I-III, fig. 1-7.

Fig. 27 Modeller: Rainer Uhlemann.

Fig. 28 Photomontage by Peter H. Jahn, using details of Franz 1953, plates II and III, fig. 3, 5 and 6.

Fig. 29 Photomontage by Peter H. Jahn, using a printed elevation (M. D. Pöppelmann, *Vorstellung und Beschreibung […] Der Königl.[ichen] Orangerie zu Dreßden* [Dresden, 1729]), an own drawn pencil sketch and a rendering of a virtual model (modeller: Chris Leister).

Fig. 30 Photomontage by Peter H. Jahn of fig. 4, a ground plan (Dresden, Sächsisches Staatsarchiv, Hauptstaatsarchiv, OHMA P, Cap. I A, Nr. 25a, Bl. 1-3) and a rendering of a virtual model (modeller: Rainer Uhlemann).

Fig. 31 Zurich, Eidgenössische Technische Hochschule (ETH), Institut für Geschichte und Theorie der Architektur (gta), estate of Gottfried Semper, n. 20-052-1/MV 52-1-1.

Fig. 32 Photomontage by Peter H. Jahn of a sketched architectonic draft (Dresden, Sächsisches Landesamt für Denkmalpflege, Plansammlung, M 52. C. Bl. 15 / MV 89 g- 41-5) and a rendering of a virtual model (modeller: Michael Marschner).

Fig. 33 Photomontage by Peter H. Jahn of a photography (photographer: Uwe Miersch, Oßling; source: http://www.dresden-und-sachsen.de/dresden/sempergalerie.htm, last accessed on 09.07.2015) and a rendering of a virtual model (modeller: Michael Marschner).

Fig. 34 Photomontage by Peter H. Jahn basing on a ground plan (Dresden, Sächsisches Staatsarchiv, Hauptstaatsarchiv, Ing. Corps Dresden Nr. 35e).

Fig. 35 Dresden, Sächsisches Staatsarchiv, Hauptstaatsarchiv, Ing. Corps Dresden Nr. 35c.

Fig. 36 Modellers: Philipp Hackbarth, Falk Schieber and Steve Kuttig (Zwinger courtyard); Conny Coburger and Anne Weinert (castle).

Fig. 37 Photomontage by Peter H. Jahn of a detail of fig. 35 and a rendering of a virtual model (modeller: Conny Coburger).

Fig. 38 Modellers: Philipp Hackbarth, Falk Schieber and Steve Kuttig (Zwinger courtyard), Romy Ebert (surroundings), Rainer Uhlemann (castle; adjusting of all models).

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[1] As authorship is divided conform to the leading responsibilities within the project, the parts of the text concerning its conception are written by Dirk Welich, those related to technical aspects of computer modelling by Markus Wacker, and those related to preparatory and accompanying architectural historic research and its results by Peter Heinrich Jahn. The latter has done the editorial work, following Markus Wacker's proposal for organizing the arguments. Thanks for partial preliminary copy-editing to Anne Kleiner as well as to Jessica Buskirk and Bertram Kaschek. The heads of the project are Mr. Welich as representative of the commissioning institution and Mr. Wacker as that of the cooperating one.

[2] The name of the building derives from this special location: 'Zwinger' means the outer courtyard between a castle and its outer wall.

[3] A first attempt of such a teaching video will be mentioned at the end of this text.

[4] The four most important of these archives are: Sächsisches Staatsarchiv, Hauptstaatsarchiv (Saxon Main State Archives), Sächsisches Landesamt für Denkmalpflege, Plansammlung (Plan Collection of the Saxon State Bureau of Monument Protection), Sächsische Landesbibliothek – Staats- und Universitätsbibliothek – SLUB (Saxon State and University Library), and Staatliche Kunstsammlungen, Kupferstichkabinett (Graphical Cabinet of the State-owned Art-collections). Detailed references to used sources and secondary literature for time-cuts 1-8 are already given by Jahn and Welich 2009. A follow-up article concerning time-cuts 9-14 is still a desideratum.

[5] Matthäus Daniel Pöppelmann, *Vorstellung und Beschreibung Des von S[eine]r. Königl.[ichen] Majestät in Pohlen, Churf[ürst]l.[ichen] Durchl.[aucht] zu Sachßen/ erbauten so genannten Zwinger=Gartens Gebäuden, Oder Der Königl.[ichen] Orangerie zu Dreßden* (Dresden: self-published by the author, 1729). For a commented facsimile-reprint reduced to small size, see Keller 1980.

[6] For a list of all modellers see the webpage of the project: http://www2.htw-dresden.de/~zwinger/webs/mitwirk.html.

[7] With the exception of some diaphanous gateway buildings like that of time-cut no. 5 (cf. figs. 10, 29).

[8] If the insufficiently documented structure was too complex, the modelling of a ground plan was preferred.

[9] The protocols were written until May 2009 by Loreen Pogrzeba, and from then on by Conny Coburger and Anne Weiner.

[10] This is still a serious problem in Dresden. Sources were either burnt by fire during air raids or they are missing as a result of evacuation paired with misplacement or even displacement.

[11] Namely the Plan Collection of the Saxon State Bureau of Monument Protection (for the official German name see above note 4). The same procedure was necessary for modelling time-cut no. 11. In this case the plan sources were taken from Sponsel 1924, plates 87-91 (cf. fig. 15).

[12] Cited above in note 5.

[13] Gottfried Semper, *Das königliche Hoftheater zu Dresden* (Braunschweig: Vieweg, 1849), plate I.

[14] Implemented as a cooperation between ENBaCH – European Network for Baroque Cultural Heritage, represented by the Institute of Romance Philology of the Technical University Dresden, Faculty of Philology and Cultural Humanities (Institut für Romanistik der Technischen Universität Dresden, Fakultät Sprach-, Literatur- und Kulturwissenschaften), SLUB (as fully named above in the text) and the Saxon Administration of State-owned Castles and Gardens (Staatliche Schlösser, Burgen und Gärten Sachsen gGmbH). The mentioned teaching video was produced by Rainer Uhlemann. A work of the same is also a demo-trailer of 2012 which was shown at public presentations of the 'Zwingerteam' project, one time within the 'Mitschnitt-Festival' of the HTW Dresden in 19 July 2012 and another time during a press conference dedicated to the project in 12 March 2013; both events were held at the 'ufa-Palast' cinema in Dresden. While at this time a future public presentation of the exhibition film is quite unclear, the demo-trailer can be seen online: http://vimeo.com/46621228.