

Building Knowledge Spaces

Scientific Reconstruction and Modeling of the Medieval City of Bamberg

Stefan Breitling (Otto-Friedrich-Universität Bamberg, Germany)

Martin Buba (Otto-Friedrich-Universität Bamberg, Germany)

Jan Fuhrmann (Otto-Friedrich-Universität Bamberg, Germany)

Project Description

Within the framework of the project '4D City Model of Bamberg around 1300', run by the Professur für Bauforschung und Baugeschichte of the Otto-Friedrich-Universität Bamberg in cooperation with the Department of City Planning, City of Bamberg, funded by the Oberfrankenstiftung and the Städtebauförderung, a scientific reconstruction of medieval Bamberg as it was around the year 1300 is being created that can be combined with the existing digital model of the city as it is in the present day. '4D' is the expression for the ambitious goal of incorporating the dimension of time into the project, in addition to the three dimensions of space and of building not only a visual reconstruction but also a multidimensional knowledge space. This is being done by openly showing and recording the different stages leading to the final reconstruction, by combining the visualization of historical situations with scientific institutions and references, and finally by linking the virtual model to the official web-based model of the city of Bamberg to gain sustainability and a broader range of users, including the World Heritage Centre Bamberg. Through this combination, the development of the historical town and the substantial remains and changes in today's city can be seen and virtually explored. The close relationship of the present day to the city as it was, such as the location of the streets and individual buildings, becomes easily comprehensible. This is achieved through the use of geodesic data for all of the digital models, and through the coordination of the programs used and the way that the information is depicted (fig. 1). The exact spatial relationship of the surviving historical construction material within modern constructions is interesting for historical sciences as well as for preservation and renovation projects and future city planning. The virtual model is an excellent basis for integrative uses of researchers and the city's authorities as well as tourists and 'laymen'.



Fig. 1 The digital reconstruction model of the medieval city of Bamberg at around 1300. Bird's eye view from the northeast with the three medieval centres Theuerstadt, Inselstadt and Bergstadt. Interactive Google-Earth-Surface with navigation panel, lists of buildings and tours (2014).

The idea of a digital city model following historical development with multiple layers of time was already developed in 2008 by the World Heritage Center Bamberg (Welterbezentrum) and the Department of City Planning (Stadtplanungsamt), and was presented in front of the General Assembly of the International Council on Monuments and Sites (ICOMOS) in Canada. In 2014 the new model was presented at the 'MS Wissenschaft', an initiative of the German Ministry of Education and Research (Bundesministerium für Bildung und Forschung).

Scientific Reconstruction of the City of Bamberg around 1300

Having started in 2010 and running for three years, the '4D' project is meant to be a continuation of current work. Scientific support for the project is being provided especially through the research of the Bayerisches Landesamt für Denkmalpflege (Bavarian State Office for Building Preservation), the work of city archaeologists, the World Heritage Center, and a number of additional partners. The volume *Die Kunstdenkmäler von Bayern, Stadt Bamberg, Band 1: Das Stadtdenkmal Bamberg* (*The Monuments of Art of Bavaria, City of Bamberg, Volume 1: The Municipal Monument of Bamberg*), published by the BLfD (Bayerisches Landesamt für Denkmalpflege) in 2012, explains the

necessary requirements for the reconstruction of the medieval city and its objective of making known facts about the medieval history of Bamberg accessible.

A number of new methods have been utilized in this project. Project labor has been divided between different institutions, and new scientific modeling and reconstruction methods have been used as well. The reconstruction of medieval Bamberg keeps a distance from the photorealistic model of the city as it is today, in order to give the observer's fantasy and intellect room to play. The ultimate goal was to combine the present day with the historical city, so that the historical basis of the remaining building structures as well as the city's development becomes obvious (fig. 2).

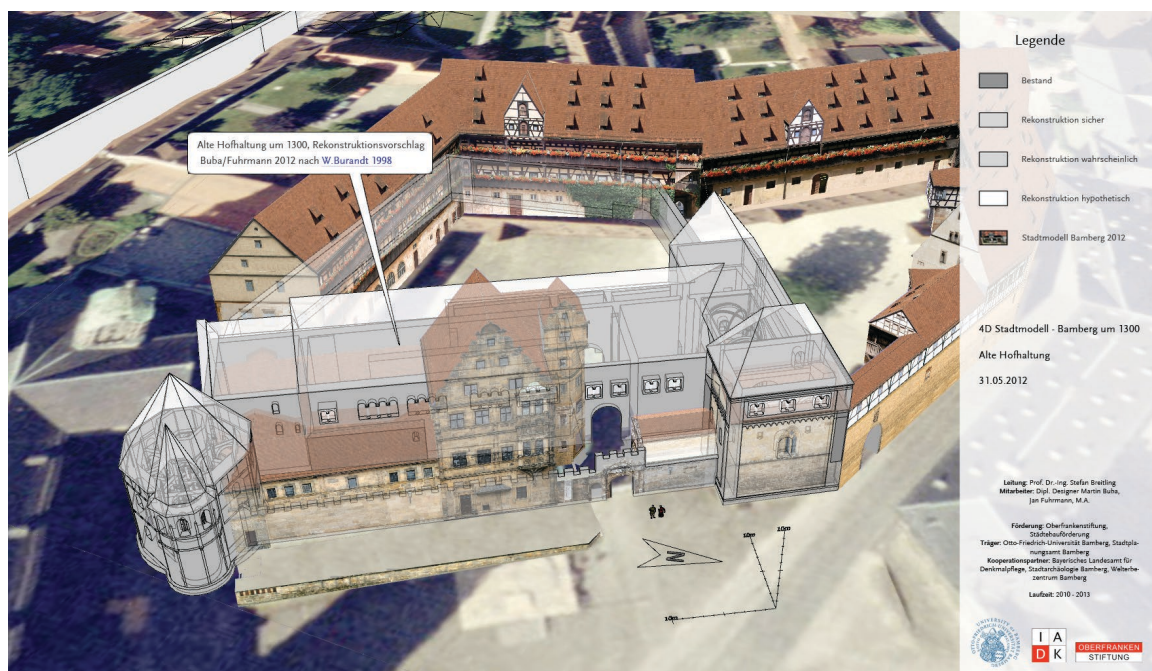


Fig. 2 Bamberg, Alte Hofhaltung at around 1300. Overlay of the medieval palace with the photorealistic model of the surrounding area, as it is today (1998/2012).

In the first stage of the project, geoscans from the Bavarian Land Survey Office (Landesvermessungsamt) were transformed into meshed vector geometry, in order to show changes in the relief model and also portray the historical path of the river, the height of the (likely) water level as it was around 1300, and other known deviations from the relief of the modern city. Reconstructions of medieval buildings and other elements of the city, whose locations are known due to preserved remains, can be precisely fit into the model (fig. 3).

A team of archaeologists, building historians, and building researchers is collecting the historical information and working on suggestions for the reconstruction. One deciding criterion for the scientific nature of the model is the confirmability of individually selected solutions.

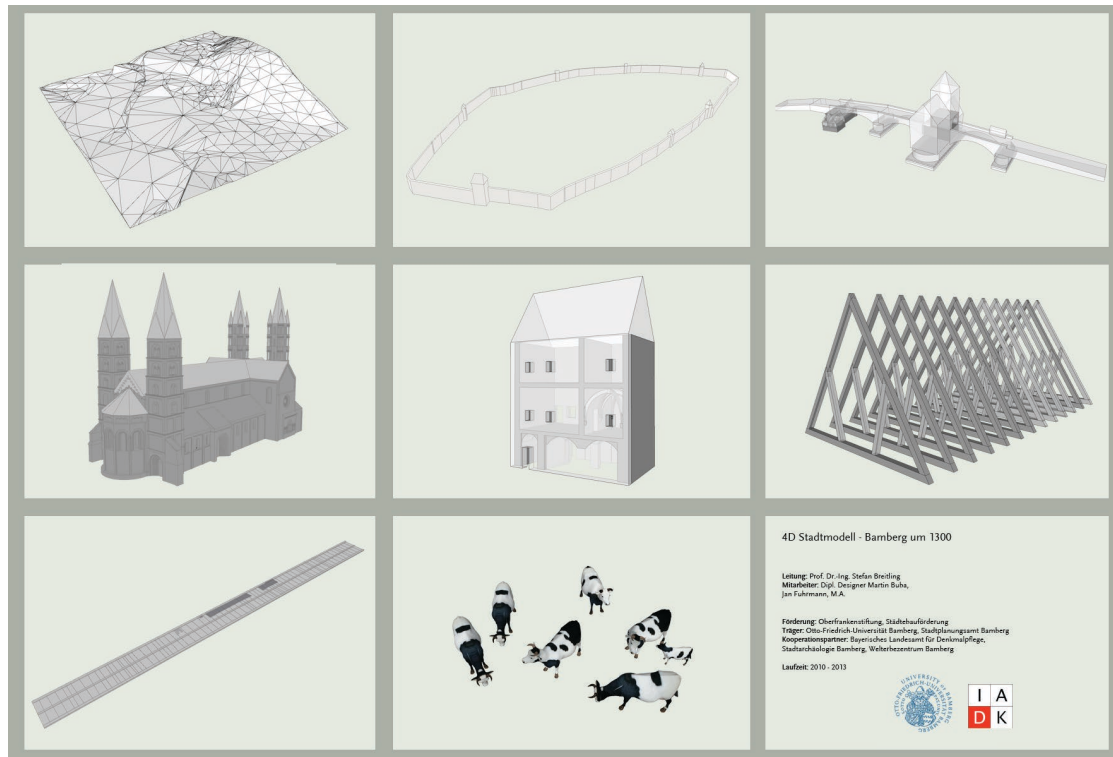


Fig. 3 Elements that make up the medieval city. Historical topography, defences and walls, bridges, churches, houses, historical constructions such as roofs, pathways, elements of the cultural landscape (2012).

This is because in a digital or analog model, everything must be constructed in an unambiguous manner, and nothing can be graphically blurry. However, in many areas of the city or a single building little to nothing is known. Here, in order to close the gaps, researchers are resorting to the use of analogies in local or regional construction. In addition, five stages of certainty of knowledge are included throughout the reconstruction, coded by the degree of detail and color and level of intensity. Archaeological finds from medieval Bamberg, which can be seen in the city, or that have been found through archaeological digs and examinations of historical buildings, are reflected in the depiction of details in the model. Constructions that certainly existed are marked in dark gray. Building elements that had certainly been there, but which are no longer present, are shown in a lighter gray. Building components that are reconstructed using only vague analogy are shown in an even lighter color and are transparent (fig. 4). They are, however, still necessary to round out the (presumable) original appearance and the comprehensibility of the depiction.

A scientific model must also offer the user the possibility of stepping into the discussion about recommendations for the reconstruction. In order to clarify the decision-making process during construction and also protect the achievement of the creators, every recommendation for the reconstruction of a building or building component is referenced in three stages.

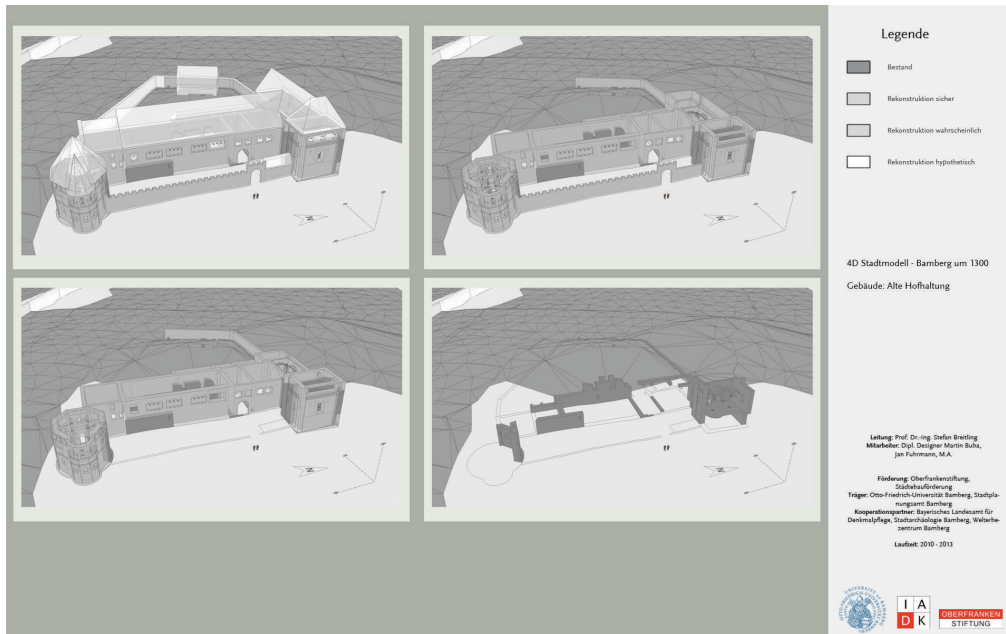


Fig. 4 Bamberg, Alte Hofhaltung at around 1300. Reconstruction with four levels of credibility. Remaining fabric, certain reconstruction, probable reconstruction, hypothetical reconstruction (2012).

In the first, every reference to a certain construction is cited in the model itself. In the second, the used material is stored and the questions that are associated with the building component, and arguments that led to the final reconstruction, are explained. This data base is an integrated part of the model and can be used by the cooperating institutions (fig. 5).

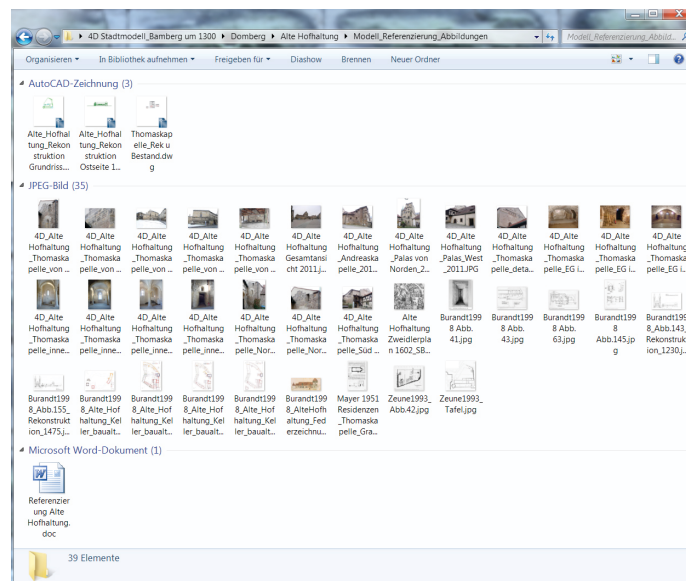


Fig 5 File sheet with collection of basis data for the reconstruction model of the Alte Hofhaltung at Bamberg and commentary on the reconstruction process (2012).

In the third, important findings and additional depictions are incorporated. The final result is a model that can be checked for accuracy, explicitly allows for later changes and corrections, shows gaps in current research, and also shows a path to additional research and new debate about the construction history of the city of Bamberg (see film, fig. 6).

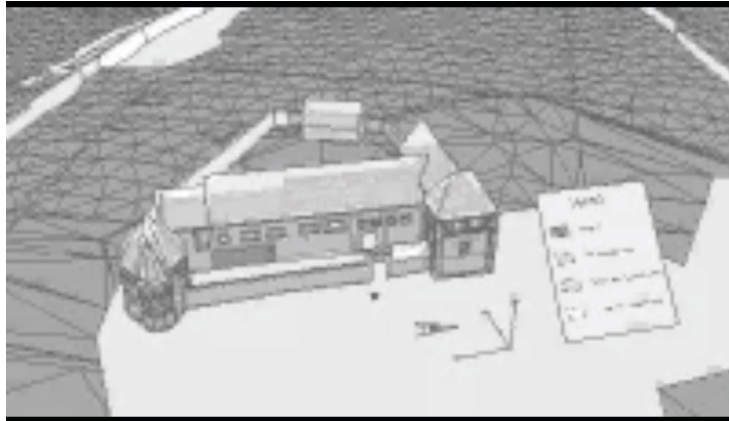


Fig. 6 Animation film: The Alte Hofhaltung at Bamberg at around 1300, remains and architectural reconstruction (film still, 2012).

Possible Applications, Linkage, Sustainability, and Possibilities for Expansion

The basic structure allows for the long-term usage of the model through different users, even after the conclusion of the project. There are already plans for the model to be retrievable online. The digital city model can also be further developed. Users can interactively browse the history of the city and individual quarters, and additional time periods can be added. The implementation of the Zweidler city map of Bamberg from 1602 into three-dimensional geometry is already in progress. The reconstruction model can always be expanded with new details and themes. In doing so, there is a running portrayal of historical and world heritage elements in the city. This is especially important in the conveyance of historical significance, which can remain dormant in the historical buildings of Bamberg. In the virtual world, connections and aspects can be made clear that are otherwise difficult to show or are simply no longer accessible (fig. 7).



Fig 7. The digital reconstruction model of the medieval city of Bamberg at around 1300. Bird's eye view from the northwest towards the center with town hall, bridges and other elements of every-day life (2014).

An important user and communicator for the 4D city model of Bamberg is the World Heritage Center of the City of Bamberg. In addition to information about city history, all sorts of additional, geo-referenced topics can be added to the map that can help touristic development of the city's world heritage characteristics. During city tours, via a handheld or smartphone with Augmented Reality (Mobile HR), it would be possible to give people visual clues about their location and information about the buildings in the area. In addition, different user groups could have thematic virtual tours. Projects that already exist, like the interactive use of the map as part of the 'Beam me up!' project of the Department of City Planning, which allows for users to learn about the complexity of the cultural heritage of Bamberg in a playful way, opens up a wide field of scientific knowledge spaces.

Bibliography

On the significance of a city model for the World Heritage Center:

Dengler-Schreiber, Karin, 'Das virtuelle Stadtmodell', *Rathaus Journal*, 21 (2008), p. 10.

Gunzelmann, Thomas, Röhrer, Armin, 'Zeitschichten – die Analyse des Stadtdenkmals Bamberg im Geographischen Informationssystem', *Bericht des Historischen Vereins Bamberg*, 142 (2006), pp. 357-371.

About the running '4D' project:

Breitling, Stefan, Buba, Martin, Fuhrmann, Jan, 'Das Modell der Stadt Bamberg im Mittelalter. Digitale Modelle als Möglichkeit zur Vernetzung von Bauforschung, Archäologie und Denkmalpflege', in *Bericht über die 48. Tagung für Ausgrabungswissenschaft und Bauforschung*, ed. Kolde-
wey-Gesellschaft (Stuttgart/Dresden, 2015), pp. 63-72.

Breitling, Stefan, Schramm, Karl-Heinz, 'Bamberg vierdimensional. Ausbau und Ergänzung des digitalen Planungsmodells durch die Rekonstruktion der mittelalterlichen Stadt', in *Uni.vers For-
schung, Digital Humanities. Technologien für die Geisteswissenschaften* (Bamberg, 2011), pp. 6-10.

For the German discussion of the scientific nature of analog and digital reconstruction models in the field of building history see the annual meetings of *EVA (Electronic Visualisation and the Arts)* in Berlin, the conference *Projecting Spaces, 9th international eaea conference*, Cottbus 2009, and the initiative *Digitale Rekonstruktion* of the Institute of Informations- und Kommunikationstechnologie in der Architektur at the TU Darmstadt.

Illustrations

Fig. 1 Breitling/Buba/Fuhrmann 2014.

Fig. 2 Breitling/Buba/Fuhrmann/Uni Bamberg 2012, building research by Burandt 1998, now-days city model by Carlo Schramm, Stadtplanungsamt Bamberg 2012.

Fig. 3 Breitling/Buba/Fuhrmann/Lunemann/Trommer/Mattern/Uni Bamberg 2012.

Fig. 4 Breitling/Buba/Fuhrmann/Uni Bamberg 2012.

Fig. 5 Breitling/Buba/Fuhrmann/Uni Bamberg 2012.

Fig. 6 Breitling/Buba/Fuhrmann/Uni Bamberg 2012.

Fig. 7 Breitling/Buba/Fuhrmann 2014.