

Visualizing the medieval cities Mainz, Worms and Speyer (800/1200)

Source-based digital 3D reconstruction and scholarly-approved documentation

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Heading

Since the 1990s, the application of the virtual reconstruction and computer-based visualization of cultural heritage increased. The virtual reconstruction (or digital 3D reconstruction) of lost and/or altered monuments as well as past urban structures and landscapes revealed a new *glittering* research space for object-oriented disciplines such as archaeology, art history and architecture. Nevertheless, the academics concerned with the uprising technology recognized early the lack of documentation standards in this kind of projects, which leads to the loss of information, findings and the fusion of knowledge behind the digital 3D model. Recently, there are various guidelines, like *London Charter* and *Seville Principles* (Bentkowska-Kafel, Denard, and Baker 2012), and promising research approaches to provide inter alia historical 3D-models with human- and machine-readable and in result provide sustainable interoperable 3D information models (Münster 2016).

The Mainz State Museum is currently preparing the state exhibition *The emperors and the pillars of their power – From Charlemagne to Frederick Barbarossa* (September 2020 – April 2021).¹ In June 2018, a cooperation project of the *Institute of Architecture* (AI MAINZ) at the *Hochschule Mainz – University of Applied Sciences* with the *Directorate for Cultural Heritage Rhineland-Palatinate* (GDKE) has started with research and evaluation of the sources and the digital 3D reconstruction of three German imperial cities situated on the river Rhine: Worms, Mainz and Speyer in the time of 800 A.D. and 1200 A.D.

The cooperation project addresses the well-known but still not solved hard questions: How do we communicate to the public the breadth of research that lays behind the digital reconstruction? How do we present authentic data in an engaging way? Which is the best way to convey to the public the uncertainty or lacking of research data? What kind of requirements for the digital research infrastructure and the virtual research environment the scholarly-driven 3d reconstruction entails?

In result six city models (exhibits) will be prepared for computer-based visualization combined with printed 3d models in scale 1:1000. Beside the reconstruction of the urban structure, the fortifications, the churches and monasteries the landscape, including the historic terrain as well as the river Rhine in the course of the early and high Middle Ages will be modelled. For each city and each time cut, two objects, e.g. the cathedrals in Mainz, Worms Speyer, are modelled in detail under Creative Commons license CC-BY-NC-SA 4.0 (Fig. 1). On the one hand the main objective of the exhibits is to document the current stage of our knowledge about the urban structure, the architecture and the landscape and to present the expansion and development of these cities in an uprising Kingdom to the broad audience within the state exhibition. On the other hand, the project develops an innovative virtual research environment to support the human- and machine-readable documentation and explores established documentation standards in the discipline of urban planning, enabling the long-term research, documentation and dissemination of the cultural heritage.

The primary sources are mostly contemporary written documents, historic maps and archaeological results, which are partly already evaluated, partly not. Due to the comprehensive lack of sources or excavations, especially for the early time cut of the 800 A.D., additional analogies and comparison objects are used as the basis for reconstruction of historic buildings and urban structures. The results of the collaborative research concerning the urban structure and the landscape are recorded and geo-referenced in open-source QGIS² and subsequently evaluated in two-dimensional maps. A breakdown of the hypothesis and source-based reconstruction already takes place in the GIS program and can be visualised at any time.

¹ <http://www.kaiser2020.de/>

² <https://www.qgis.org/de/site/>

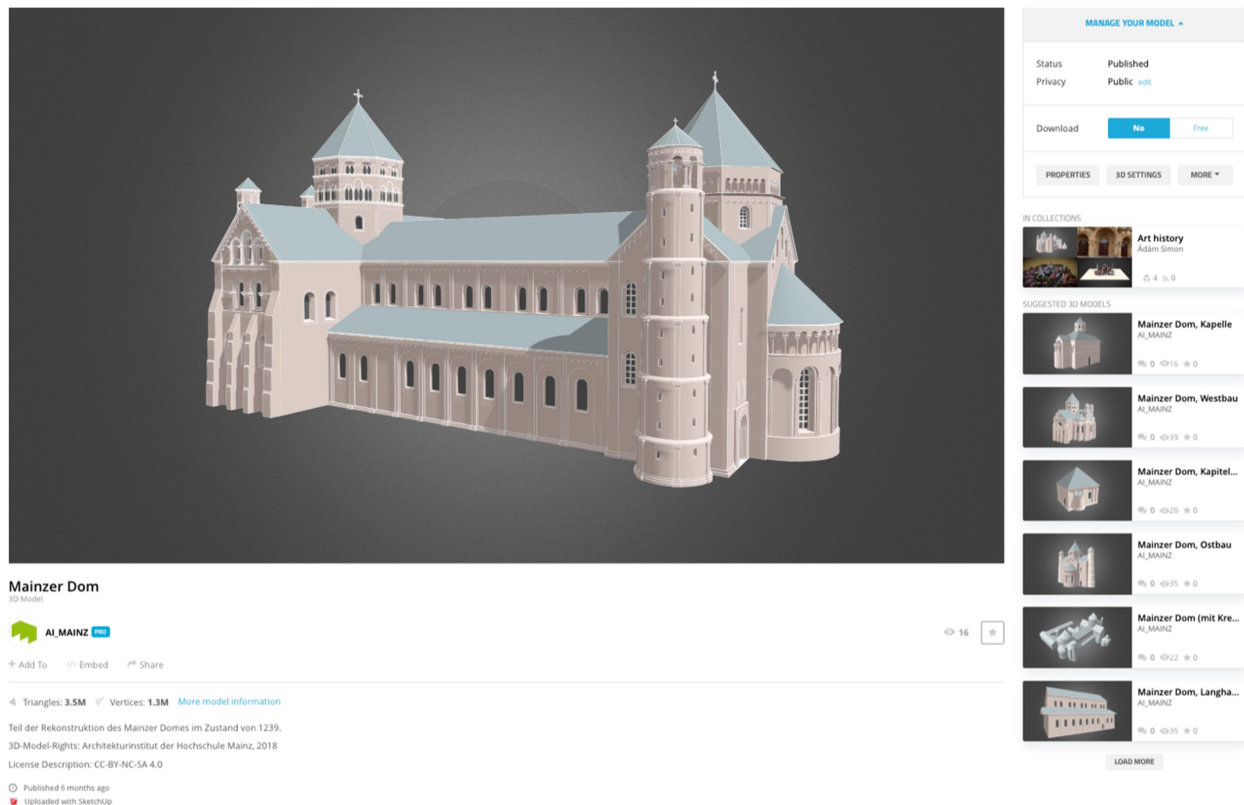


Fig. 1. Digital 3D model of the Mainz cathedral 1239 A.D., web-based visualization on sketchfab.com (© 2019, AI MAINZ / GDKE)

The two-dimensional layout plan can be translated into a 3d model by using popular modelling software such as SketchUp or ARCHICAD. In case of large scale 3d modelling, the *City Geography Markup Language* (CityGML) has been successfully implemented as an open data model and XML-based format for the storage and exchange of virtual 3D city models.³ The data model is used by municipal administration and urban planning offices, offering standards concerning the specifications for structured geo-referenced data and *Level of Detail* (LoD 0-5) for the development of the geometry. The project examines CityEditor⁴, a commercial software package supporting CityGML within SketchUp, to implement the crucial research data (meta- and paradata) beside the standard information used by modern urban planners, in order to proof the exchange and interoperability with the municipal planning office.

In addition to the QGIS-based information aggregation and compilation in two-dimensional plans a customized virtual research environment supports the collaborative research process and ensures the sustainability of digital research data. The presentation subscribes a scientific methodology and a collaborative web-based virtual research environment followed by crucial features for this kind of projects (Kuroczyński 2017). As the groundwork a human- and machine-readable data model (CIDOC CRM referenced) and the implementation of this semantic patterns for spatial research purposes on lost and/or altered tangible cultural heritage will be discussed. According to the documentation and visualisation of inaccuracy/uncertainty in digital models there are several approaches, which seems to be complicated for the wide implementation because of the complexity (Apollonio 2016). The project surveys the usage of three step system of representing the uncertainty in the data model behind the 3d model.

The presentation intends to show the state-of-the-art on the way to a digital research infrastructure based on the experience obtained at the AI MAINZ in several research projects. The focus lies on the introduction of scholarly approved and sustainable digital 3D reconstruction of large scale models, complaint with recognised documentation standards in the area of urban plannand following the Linked Data requirements.

³ <https://www.opengeospatial.org/standards/citygml>

⁴ <https://www.3dis.de/cityeditor/>

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