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(Re-)Creating the past: digital historical reconstructions using BIM

Position Statement

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Context

Starting in 2003 the Department of Architecture of the University of Leuven (KU Leuven) has conducted digital reconstructions as subject of several master's dissertations. In 2014 I finished my own Master's thesis on a digital reconstruction of the Prince's Court at Bruges, and since than I have been supervising different topics, ranging from Burgundian residences to lost religious heritage, thus addressing a range of methodological difficulties specific to dealing with historic architecture using modern technologies.

HBIM

Building Information Modelling is a tool oriented towards the implementation process, designed to handle high levels of accuracy and efficiency. However, when using BIM for historical reconstructions (HBIM), we are forced to use less reliable information. Source material can range from archeological excavations (with a decent level of accuracy) to drawings or paintings, where no real measurements are included. This leads to methodological challenges originating from the discrepancies between current building practice and (lost) historical architecture. The reconstruction of the garden pavilion of the Rubens House,[1] for instance, reveals several discrepancies between the different 2D survey drawings, which have been manually drafted during the reconstruction and restoration works.

The last few years there is a growing systematic approach in digital reconstructions at the Department of Architecture of the KU Leuven. We are convinced that modelling a (partially) lost building forces to make a coherent construction, exposing possible flaws in the argumentation. Moreover, a reconstruction is more than a visualization of lost architecture, it can serve as a carrier of data concerning the sources of the model.

The real methodological turning point in the context of digital heritage has come with the implementation of Building Information Modeling (BIM) in the field.
The difference when using BIM software – rather than CAD software – lies in the overall configuration of the model. Rather than separately making 3D models and 2D plans for different floors, sections and facades, BIM represents a holistic approach: the model and all its related documents are inherently connected.

[1] Boeykens, 'Reflections on the Digital Reconstruction of the Portico and Garden Pavilion of the Rubens House'.

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The combination of geometry (dimensions, sizes, quantities) and embedded information offers a major advantage for reconstruction. The model becomes a rich knowledge base for a project, a 'thick description'[2] capturing and assembling data from different sources into a single and interoperable whole.

In this paper we will focus on three considerations, crucial for a reliable and reusable reconstruction project.

Historical validation

An important issue concerns the 're-traceability' of every element in the model, in other words its critical underpinnings. As assumptions and hypotheses are inherent to the reconstruction process, it is of importance to show these to the viewer. The challenge here lies in the historic validation of the decision process and its communication towards any third parties, particularly the viewers of the digital model. With the adoption of BIM techniques, however, it has become possible to actually embed parts of these meta-data into the model and having them steer the representation. This helps to integrate conclusions more deeply with the model, reduces the workload and chances of errors creeping in. A data driven visualization can show the reasoning behind the model and the level of hypothesis and accuracy, therefore avoiding the illusion of realism that is specific to renderings (fig. 1)[3].

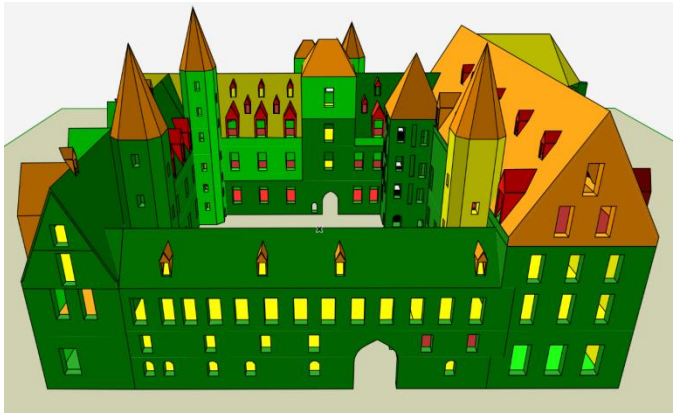

Figure 1: hypothesis model of the Palais Rihour at Lille.

[2] Hoppe, 'Northern Gothic, Italian Renaissance and beyond. Toward a 'thick' description of style'. After Clifford Geertz.

[3] Bosmans, 'Digitale Reconstructie Palais Rihour (MSc Thesis)'

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What-if scenarios

BIM software has no explicit support for the complex phasing often required for reconstructions stretching over a certain period of time. Typically, it can tackle a renovation project, with new/existing and demolished states for model elements, but nothing more extensive. In the reconstruction of the Graethem chapel,[4] the model was split up in a series of complementary partial models, making it possible to formulate what-if scenarios: a single model may contain multiple variants of a reconstruction while staying coherent.
In combination with a customized layer structure, different phases can be assembled and redundancy is avoided. This encourages the researcher to investigate possible interpretations more thoroughly, and also to communicate them more adequately and with less effort. In the past, as shown by many reconstruction projects applying regular CAD or 3D visualization systems, this often required the creation of several, disconnected models.

Custom libraries

Modeling a building within a BIM environment essentially implies breaking it down into its constituent elements and assembling it up from there. The model becomes a hierarchic aggregate of elements, their components and the relations between elements. The current generation of BIM software, while fairly mature and increasingly widespread, focuses mostly on contemporary building practice, especially on the documentation of recent residential and commercial buildings. Likewise, the included material libraries only cover contemporary machine-produced brick masonry and industrial wood construction. When transposed to the historical domain, the available BIM libraries naturally do not fully cover the wide gamut of architectural styles and construction techniques needed to 're-compose' historical buildings. Their application in the context of historical reconstruction thus presents severe limitations.
Moreover, BIM tools are inherently constrained: walls are commonly vertical, with a constant thickness; floors are horizontal and windows are rectangular; stairs are straight and obey building code rules. Even though there is some flexibility in the native element tools, they are meant for an idealized description of a building. For heritage documentation and especially in the restoration context, it is as a result very hard to properly describe the actual situation with its irregularities and finer detail. Modeling a profiled vault, timber construction or dormer window thus becomes very complex rather quickly.

[4] Massart, 'Digitale Reconstructie van de Bouwfase van de Graethemkapel Te Borgloon (MSc Thesis)'.

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A possible solution to this would be a custom library of historic elements. A first possibility, which most systems provide, is the direct modeling of these elements as static geometry. This method is only applicable when actual artefacts are available and accessible. When there are no physical artifacts left of a particular site, comparative reconstructions can be based on descriptions, excavations, and analogies with other still existing buildings of the same period and style. By adding the necessary attributes, it is possible to integrate such objects with reasonable results into the model. While by far the easiest way to add custom elements, this approach nevertheless does not profit by the added value of BIM: these objects are not flexible to adapt and do not react to the expected representation settings found in regular BIM objects, such as scale-sensitive display or adapting to changes in dimensions and properties.

In order to use the full potential of the BIM approach in historic reconstruction, a custom library is seen as the better solution. Here the forms and architectural elements that constitute the basis of the architecture to be reconstructed are defined. It is most efficient to define generic, parametric elements according to a particular “style” or period, so they can be used for different projects, thus creating a re-usable library (fig. 2).

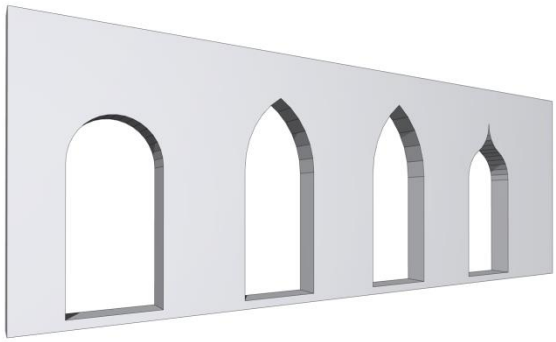

figure 2: arched opening with parametrically controlled dimensions and arch type. © Stefan Boeykens

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