

Merging GIS and BIM for Architectural Heritage

KulturBauDigital – A Strategy for the German State of Hesse

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Through the modelling of a historical building with BIM and its integration with GIS in order to create a data infrastructure for the German state of Hesse, a best practice guideline has been developed. As the state's cultural heritage property management is currently not completely digitalised, the information is distributed throughout written documents, photographic images and drawings as CAD data, and a variety of database systems, not to mention digital point clouds and anecdotal knowledge. To ensure the persistence and timeliness of knowledge regarding a property a more centralised approach was deemed essential for all participating entities.



Fig. 1. Ballhaus Wilhelmshöhe - Kassel, Germany (© Frankfurt University of Applied Sciences).

In order to achieve this goal, the geometrical information of the building elements have been modelled using Autodesk™ Revit™ and then alphanumeric data has been added as parametric attributes to the geometric elements. These elements were then translated into ArcGIS Pro™ and implemented in a data model (Fig. 1). The data model had been developed during the first stages of the project and then been updated throughout the project iterations. The BIM data model was using

IFC classes wherever possible. Nevertheless, some parameters needed to be specifically related to the architectural heritage use case.

To create a knowledge network spanning many real-estate properties throughout the state at large distances from one another a geographic information system (GIS) has been utilised. As the participating bodies were different organisations with widely distributed building stock the GIS was the fundamental part of the project that managed all the information after describing individual buildings with BIM technology. Aim of the particular BIM project included the development of a workflow from existing buildings through BIM with a translation to GIS.

Table 1. Project milestones

Milestone #	Accomplished task
M1	Basic evaluation, initial skill adaptation training, data acquisition
M2	Conceptual creation of project procedure and intent definition
M3	prototypical cycle using the Prelature at Kloster Seligenstadt
M4	Revit und Dynamo as well as other software evaluated in the context of architectural heritage
M5	Supporting student work
M6	Functionality of coordination models proven in the context of architectural heritage
M7	Evaluating ArcGIS Pro and QGIS for data exchange
M8	Publication in the professional journal „Stadt und Grün“
M9	Documentation and information exchange with project funders

As in cultural heritage the use case mainly lies in the field of facility management and restoration, new-build construction was not considered. Nevertheless the underlying information can be used for conversion measures where necessary. Another major issue was the organisation of documents that have been referenced from within the BIM models. Written documents concerning restoration and contracts, as well as technical information for building services fittings have been added. The documents included a variety of formats such as pdf and dwg. Damage mapping was another major issue.

The peculiarity in heritage conservation is that the information needs to be reverse engineered from existing buildings in contrast to new buildings, where the information is very often concealed. This entails the risk that material information is uncertain as it might be covered by subsequent finishes. In the case of a finished wall it is impossible to obtain all the information about the construction without invasive methods. In the case of door handles or timber flooring the circumstances are quite similar.

In the conventional BIM process the project information model (PIM) is delivered to the owner after finishing the design phase and converted into an asset information model (AIM). In cultural heritage the PIM is therefore non-existent and the focus rests on the retrospective data acquisition, data structuring and implementation of that data into the AIM. After the AIM is fully created it can be used as basis for further interventions.

When dealing with buildings from pre-industrial periods the existing difficulties are accompanied by varying complex geometry. This makes the BIM approach of families and family-types even more complicated to adapt as there are no two identical objects in the building. This was solved by means of geometrical simplification of elements within the BIM approach in architectural heritage. A clear definition of abstraction levels is therefore indispensable.

As a method for data acquisition terrestrial laserscanning has been proven as best practice. Using a Leica scanner and Cyclone REGISTER 360 for referencing the measured point clouds (Fig. 2). The clouds can then be scaled down to the necessary information resolution level using Cloud-Com-pare™. If CloudCompare had been used FME QuickTranslator was the tool for converting .e57 into .rcp format, which could then be used in Revit™ to create abstracted geometries.

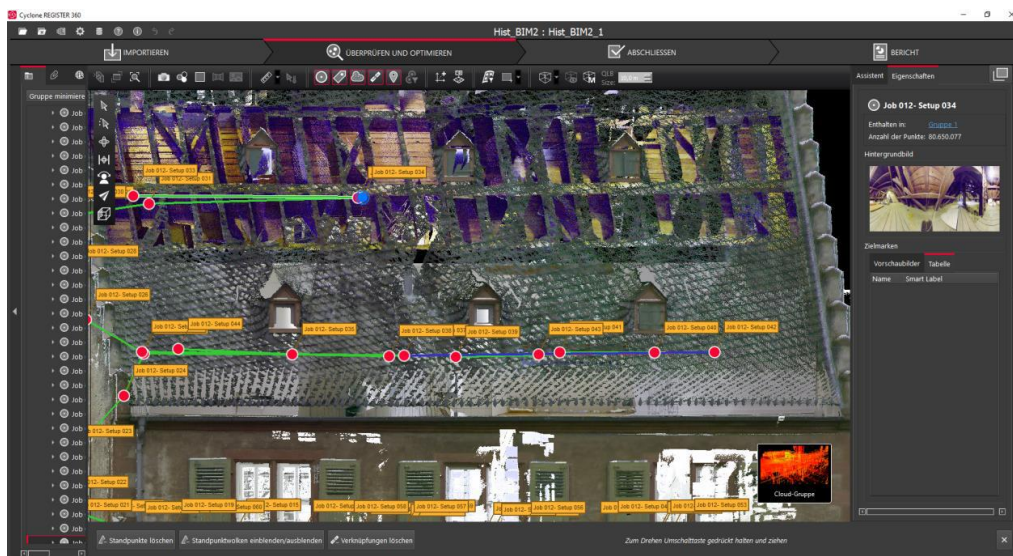


Fig. 2. Pointcloud mill – Kloster Seligenstadt, Germany (© Frankfurt University of Applied Sciences).

After modelling the building and adding relevant information the ArcGIS “BIM to geodatabase” conversion tool was used to transfer information from BIM to GIS. The IFC-Standard could be used as a intermediate step at this point in order to enable a “Big Open BIM” approach.

Although the IFC standard might at this point in time not reflect all needs for the preservation of monuments and historical buildings it offers a huge variety of opportunities to answer a multitude of existing questions and allows for process optimisation. It has been shown that missing attributes can be implemented through custom property sets and can be translated into IFC-standard as soon as it offers the required properties. The normalisation of properties has proved to be advantageous in the digital world and will simplify workflows throughout the building industry including facility management and heritage conservation. The multi-dimensionality of cultural heritage buildings is enormous as a multitude of factors have to be taken into account. Additional attributes such as origin of materials, their inventors and producers as well as semantic relations are of major interest for conservation operations. Therefore tools such as Modelbuilder and Dynamo have been used to evaluate workflow optimisations as well as connections to emerging standards such as the Remote Descriptive Framework (RDF). Additional information can be found at the project homepage (Fig. 3).



Fig. 3. Project homepage, German (© Frankfurt University of Applied Sciences)

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