BIM, GIS and semantic models of cultural heritage buildings

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Abstract

Even though there has been a great development in using building information models in the AEC (Architecture/Engineering/Construction) sector recently, creation of models of existing buildings is not very common yet. The cultural heritage documentation, in most cases, is still kept in the form of 2D drawings containing only geometry without semantics, attributes or definitions of the relationships and hierarchies between particular building elements. This paper is based on the existing literature and focuses on the historic building information modelling to provide information about the current state of the art. First, a summary of available software is introduced, while not only BIM tools but also related GIS software is considered. This is followed by a review of existing efforts worldwide, while the efforts found are separated into two categories, considering their main focus (3D modelling or resulting data management). The last part of this article is dedicated to the summary of the facts found in the preceding review. The requirements on a resulting information model and the selection of suitable software are discussed and the abilities of BIM and GIS tools are compared.

Keywords: BIM; historic building information modelling; GIS; 3D model; cultural heritage.

Introduction

If we want to perform the tasks related to the administration and maintenance of cultural heritage buildings, we urgently need comprehensive information about the objects of interest. To facilitate this, a large amount of data from various sources and in diverse file formats is to be brought together. Then, an integrated information system, which covers all physical and functional characteristics of a building, can be created. Indeed, the required data can be highly heterogeneous – we are talking about textual and graphical historical documents, plans, maps but also about up-to-date data from structural-historical investigations, geodetic surveys or photographic reconnaissance. Considering that all architectural heritage objects inherently have three-dimensional spatial characteristics, the resulting information system, which will comprise all the mentioned documents, should allow the management of 3D models. Even that might not be sufficient because we often need a 4D representation of a historic building to describe its changes in time.

Today cultural heritage documentation, in most cases, is still kept in the form of 2D drawings either digitally or on paper. These drawings often contain only geometric elements without defining semantics or the relationships between particular objects. However, for the purpose of facility management and planning reconstructions, the ability to browse a building in a virtual 3D environment and to perform spatial and multi-criteria queries would be convenient. Therefore, it is necessary to know the structure of the building, i.e. the interrelationships between architectural elements, integrate heterogeneous data sources – enrich the elements and thus create a semantic building model.

The creation of semantic building information models (BIM) is currently developing mainly in the field of the design and construction of new buildings (as-designed BIM). Nevertheless, with the use of modern data acquisition methods, such as laser scanning and digital photogrammetry, BIM tools can also be used to develop models of already existing buildings (as-built BIM) [22]. Besides classical BIM software which is used in the AEC (Architecture/Engineering/Construction) sector, we could also use geographic information systems (GIS) tools in the BIM process. Although GIS tools were originally developed to represent larger areas in 2D, they provide sophisticated methods of database storage, relationships definition and attribute and spatial queries creation, which also makes them a suitable tool for the management of information about historic buildings. Moreover, the methods of 3D editing and representation in GIS have also been further developed.

This article investigates, with the use of available literature, the field of historic building information modelling and focuses on the comparison of BIM and GIS tools. First, the existing software for information modelling is summarized. Then, a review of recent efforts is introduced. Last, a discussion that sums up the acquired knowledge is presented. It is necessary to mention that this article expects basic knowledge in the field of BIM. Otherwise see e.g. [24] for more information.

Existing software tools

Building information modelling is a long-term process which should, in the ideal case, describe a building during its whole life cycle. Numerous stakeholders – experts from various fields participate in the creation of the resulting model. Thus, it is not surprising that there is no single BIM application and the BIM process is rather based on data exchange between particular professionals while each of them uses their dedicated software tool.

The summary of the most important software tools available is in table 1. According to [16], the current BIM software can be separated into three categories:

1. Tools for the design of 3D models (3D modellers)
2. Applications for the viewing and inspection of models
3. Analytical software

Besides the software tools presented in the table, which are more suitable for design and construction, there exists a group of programs utilisable during the longest stage of the building lifecycle, i.e. during its operation and maintenance. Such tools can also be used to manage information about already existing (or even historic) buildings. Here, we are speaking about facility management software, such as ArchiBUS or Graphisoft ArchiFM and, last but not least, about GIS tools, e.g. ESRI ArcGIS.

It is apparent from the table that the leading software companies offer tools which cover most functions needed during the BIM process. These software solutions are then designated for commercial use and are, of course, paid. The open source software Edificus Free UPP is one of the few free of charge BIM tools. However, its users have to pay for printing projects and for several tasks third-party applications, which are not free, have to be used, e.g. Trimble SketchUp for 3D modelling. Thus, only BIM viewers with limited functionality, such as Autodesk Navisworks Freedom, can be considered as truly free BIM tools [16].

In the following section, a review of the most important efforts that deal with the information modelling of historic buildings will be introduced. It is worth mentioning that nine out of 16 efforts use the Autodesk Revit software for 3D modelling. This is in accordance with the studies described in the article by David M. Foxe [12] claiming that Revit has a 67% market share followed by the products by Bentley and Graphisoft.

Recent efforts

In table 2, there is a list of efforts which use BIM or GIS to create information models of cultural heritage buildings. The basis for this enumeration was found in the article by Saygi and Remondino [22] and it was modified and further extended with other works found. Although this list is definitely not complete, it allows studying the approaches and tools used quite well.

The efforts on the list can be separated into categories considering the chosen approach. The majority of the efforts are rather focused on the use of BIM software. In these cases a library of parametric objects is usually developed. Such a library is usable for the conversion of an unstructured point cloud, generated by laser scanning, into the form of a parametric 3D model.

The second group of efforts uses a combination of BIM and GIS tools while BIM is usually used to create 3D models and GIS to manage the resulting information. The last category can be described as the GIS approach because no classical BIM software is used. However, the workflow is very similar to the combined BIM/GIS way. In the two following sections we will describe particular efforts in greater detail.

The efforts focused on 3D modelling

The creation of a 3D model must be preceded by data collection. Currently laser scanning and digital photogrammetry are understood as modern methods of data acquisition. The result of laser scanning is a dense point cloud. Although this point cloud can be used for some preservation purposes, it is hardly a full-fledged 3D model. Therefore, it is no surprise that there are a lot of efforts dealing with the conversion of the acquired data from the point cloud into a parametric 3D model. For example, the work by Fai et al. [11] is focused on problems bound with combining laser scanning data and 3D models from BIM modelling software. However, this work uses generic object libraries which are not adapted for the specific needs of historic buildings.

The creation of a prototype library designed specifically for the needs of the cultural heritage preservation was first described in the article by Murphy et al. [19] while it was named Historic Building Information Modelling (HBIM). This method was further developed in the paper [18]. The HBIM process begins with the creation of data sets using terestrial laser scanning and photogrammetry. The next stage involves the design and development of a particular

Table 1: Commercial and open-source BIM tools (modified from [16])

Product Name	Manufacturer	BIM Use	Primary Function
Revit Architecture	Autodesk	Creating and reviewing 3D models	Architectural modelling and parametric design
Bentley Architecture	Bentley Systems	Creating and reviewing 3D models	Architectural Modelling
SketchUp Pro	Trimble	Conceptual 3D modelling	Conceptual design modelling
ArchiCAD	Graphisoft	Conceptual 3D architectural model	Architectural model creation
TeklaStructures	Tekla	Conceptual 3D modelling	Architectural 3D model application
DProfiler	Beck Technology	Conceptual design and cost estimation	3D conceptual modelling with real-time cost estimation
Vectorworks Designer	Nemetschek	Conceptual 3D modelling	Architectural model creation
Affinity	Trelligence	Conceptual 3D modelling	Early concept design
Edificus	AccaSoftware	Architectural BIM design and 3D object CAD	Architectural modelling
Vico Office	Vico Software	Conceptual 5D modelling	5D conceptual model, cost and schedule data
Revit Structure	Autodesk	Structural	Structural modelling and parametric design
SDS/2	Design Data	Structural	3D structural modelling and detailing
RISA	RISA Technologies	Structural	Full suite of structural design applications
Robot	Autodesk	Structural analysis	Bi-directional link with Revit Structure
Green Building Studio	Autodesk	Energy analysis	Energy use and carbon footprint calculation
Structural Analysis, Design Detailing, Building Performance	Bentley Systems	Structural analysis, detailing, quantity take-off, building performance	Measures, assess and reports building performance
Solibri Model Checker	Solibri	Model checking and validation	Rule based checking for compliance and validation of all objects in model
Tekla BIMSight	Tekla	Model Viewer	Models combination, clashes checking
Navisworks Manage/Simulate	Autodesk	Model checking and validation	Clashes checking, 4D simulations of construction progress
xBIMXplorer	Open BIM	IFC Viewer	IFC files opening and viewing
Solibri Model Viewer	Solibri	Model viewer	IFC files opening and viewing
Navisworks Freedom	Autodesk	Model viewer	IFC files opening and viewing

library of parametric objects. To fulfill this task the software platform Graphisoft ArchiCAD and the open-source scripting language GDL (Geometric Description Language), which is implemented in ArchiCAD, were used. After the creation of the library, a semi-automatic process of mapping parametric objects into point clouds facilitates the 3D model creation.

Furthermore, Oreni et al. [20], Appolonio et al. [2] or Brumana et al. [6] in their articles also deal with the creation of historic building-specific libraries. All the mentioned accepted

Table 2: Current efforts dealing with the modelling of historic buildings (extended from [22])

Approach	Reference paper(s)	Applied case	Software	Notes
BIM	Garagnani (2012) [13]	An early Byzantine church in Ravenna	Autodesk Revit Architecture, GreenSpider plugin	A plugin facilitating segmentation of unstructured point clouds
BIM	Attar et al. (2010) [3]	Historic warehouses converted into offices in Toronto	Autodesk Revit, AutoCAD, pluginy gbXML, EnergyPlus	Evaluation/analysis of building performance and energetic efficiency
BIM	Achille et al. (2012) [1]	The main spire of the Milan cathedral	Rhinoceros, WebGL, Back Office, Front Office, plugin Pointools	The model used as a repository containing photographic catalogue. *Ability of sharing on the web*
BIM	Oreni et al. (2013) [20]	Various types of historic vaults	Leica Cloudwork, Autodesk Revit, AutoCAD, Rhinoceros	Parametric models of vaults
BIM	Apollonio et al. (2012) [2]	Palladian architecture – doric order	Autodesk Revit	Libraries of parametric objects based on classical architectural literature
BIM	Boeykens et al. (2012) [5]	The Prague Vinohrady synagogue	Graphisoft ArchiCAD, Maxon, Cinema4D	Reconstruction of a *no longer existing* synagogue with the use of BIM
BIM	Fai et al. (2011) [11]	Historic factory areal in Toronto	AutoCAD, Civil 3D, SketchUp, Revit, Navisworks	4D modelling
BIM	Foxe (2010) [12]	Historic buildings in Boston and Durham	?	The resulting information models used as a basis for reconstruction.
BIM	Brumana et al. (2013) [6]	A church in Scaria d'Intelvi, Italy	Autodesk Revit, Autodesk Green Building Studio	Different construction phases captured in the BIM model (stratigraphy). The model further used for energetic efficiency analyses.
BIM	Baik et al. (2014) [4]	Historic buildings in Jeddah, Saudi Arabia	PhotoModeler Scanner, Autodesk RECAP 360, Rhinoceros, Autodesk Revit	Library of parametric objects (JHBIM)
BIM/GIS	Yajing and Cong (2011) [26]	The stone heritage of Kao temple	Autodesk Revit and 3ds Max, Trimble SketchUp, Geomagic, AutoCAD	Revit families for heritage buildings of stone *A GIS and BIM connection for management purposes planned.*
BIM/GIS	San José-Alonso et al. (2009) [21]	Various heritage object in Spain	PINTA	Original sofware platform PINTA combining BIM and GIS functionality
BIM/GIS	Dore and Murphy (2012) [9], Murphy et al. (2013) [18]	Henrietta Street in Dublin	Graphisoft ArchiCAD, SketchUp + CityGML plugin, ArcGIS	Comprehensive workflow of 3D model creation based on laser scanning and a library of parametric objects, export into the GIS environment for the purpose of data management.
BIMxGIS	Saygi and Remondino (2013) [22], Saygi et al. (2013) [23]	Kurşunlu Khan in Turkey	Autodesk Revit Architecture + Revit DB Link, AutoCAD, SketchUp, 3ds Max, ArcGIS, PostGIS	Comparison between the BIM and the GIS approach
GIS	Centofanti et al. (2011) [7]	Villa and churches in Italy	AutoCAD, 3ds Max, Rhinoceros, Rapidform XOR, Microsoft Access, ArcGIS	3D models in the GIS environment, heritage information management and analyses
GIS	Jedlička et al. (2013) [15]	The castle Kozel	Kokeš, RiSCAN, MicroStation, MSR, SketchUp, ArcGIS, City Engine	Comprehensive workflow from data acquisition to import into GIS for further analyses

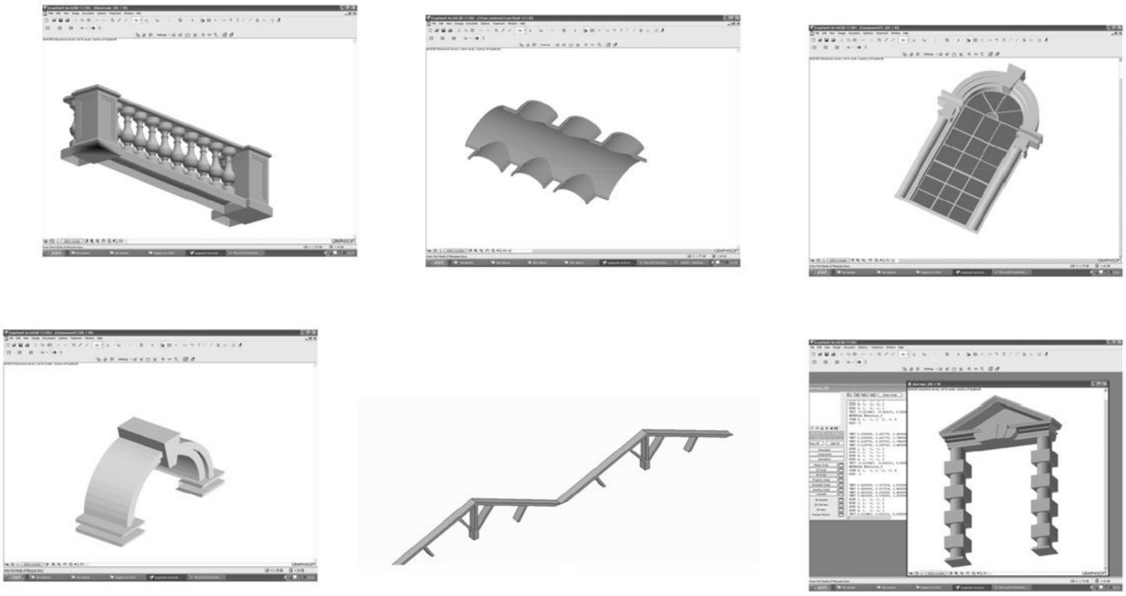

Figure 1: Examples of parametric objects from the HBIM library [18]

the term HBIM. However, it is not clear whether it only describes parametric libraries or the whole modelling process in general. Baik et al. [4], whose paper describes a library specifically designed for the modelling of the Middle East architecture, use the localised term JHBIM (Jeddah Historical Building Information Modelling). Also the work by Yajing and Cong [26] could belong to this group. Even though they do not use the HBIM term, they similarly create their own object library to model stone heritage buildings. Last but not least, Garagnani [13] deals with the description of his plugin GreenSpider, which was developed to facilitate the processing of unstructured point clouds. All the efforts mentioned in this article use, compared to Murphy et al., the BIM tool Autodesk Revit.

Not all the efforts use laser scanning data as a basis for 3D modelling. Saygi et al. [22, 23] compare the BIM and the GIS approach to 3D modelling and data management and use archival drawings as their base. Particular elements are then created manually in a suitable 3D modelling software. Autodesk Revit was used to try out the BIM approach and a combination of tools (AutoCAD, Trimble SketchUp and Autodesk 3ds) to examine the possibilities of the GIS processing. Also Boeykens et al. [5] utilise existing documentation in the form of drawings. Laser scanning as a data acquisition method is in their case, of course, out of the question because they model an already non-existent building.

The efforts focused on data management

Even though the research by Saygi et al. [22, 23] was already mentioned in the previous section because it also deals with 3D modelling, its main topic is the analysis of heritage data storage and management. Their articles evaluate the workflows of semantic model creation and storage in detail. The necessity of the 3D model segmentation into particular architectural elements is emphasized because information about each building component can only be stored this way. The possibilities of 3D geometry management and additional information storage

Figure 2: Creation and visualisation of a 3D model based on a point cloud [4]

are evaluated and GIS software (ArcGIS tested) is identified as a currently more suitable tool because of its capabilities of non-homogeneous data aggregation and non-spatial information integration.

The aforementioned is also acknowledged in the article by Dore and Murphy [9], in which the integration of a 3D model, resulting from the HBIM process, into the GIS environment is described. The resulting model should serve as a basis for information management and interconnection with other data sources including external sources, i.e. other information systems. The Trimble SketchUp application with an appropriate CityGML plugin facilitates here the conversion between the BIM software ArchiCAD and the GIS tool ArcGIS. A very similar approach is used in the work by Jedlička et al. [15] though they do not use any actual BIM software.

The same tool, i.e. ArcGIS, is also utilized in the work by Centofanti et al. [7] in order to create an architectural information system specifically designed for the purposes of cultural heritage management and maintenance. This work also states that current BIM software is still immature for the tasks of heritage preservation. Thus, GIS tools are preferred at least for data management. A similar information system is presented in the paper by San José-Alonso et al. [21] where it is named the Cultural Heritage Information System (CHIS). Since the authors had found the currently available software tools insufficient, a new platform called PINTA (Processing INformation sysTem for Architecture) was developed. The PINTA software enables creating a model from laser scanning and digital photogrammetry data, store it and automatically generate drawings and cut sections. The most interesting is then the emphasis on the remote access of users from the ranks of the government and general public (which is aligned with the spirit of BIM cooperation).

Despite the papers mentioned above that prefer the use of GIS for data management, there exist several other works employing exclusively BIM tools. The articles by Foxe [12] or

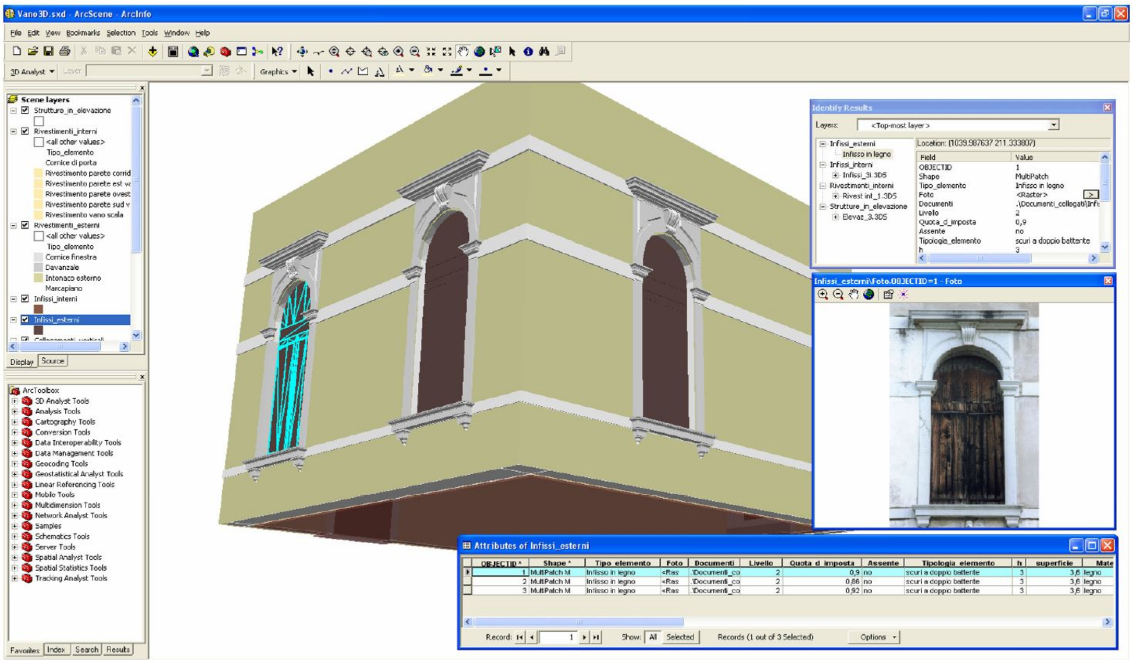

Figure 3: 3D model of a heritage bulding in the GIS environment [7]

Attar et al. [3] can be such examples while they describe efforts utilizing BIM for planning reconstructions or energy efficiency analyses. Nevertheless, it should be noted that both papers are focused on heritage buildings in North America which are significantly newer than is usual in Europe. Therefore, they are structurally much closer to modern buildings which BIM was designed for. A similar situation is depicted in the contribution by Fai et al. [11]. Here, the BIM software is used to plan the reconstruction of a defunct factory and shows its strength in 4D modelling, i.e. the ability to capture changes over time. Finally, Brumana et al. [6] also utilise BIM to visualise different constructive phases in 3D (stratigraphy – see fig. 4).

Discussion

This section will summarize the most important questions which come out during the historic building information modelling process and will be based on the aforementioned literature. First, it is necessary to realise that BIM workflows, currently relatively well developed in the AEC sector, are in most cases focused on the design and construction of new buildings. The requirements on the creation of existing building models may be significantly different. Speaking about historic cultural heritage buildings the situation is even more difficult because such buildings contain a lot of irregular architectural elements which can be damaged or worn-out. The requirements on data management are also very high because the resulting 3D model has to comprise a large amount of heterogeneous data sources.

The requirements on an information model

The resulting 3D model should contain semantics, characteristics of the object structure and relationships between particular architectural elements [22]. Therefore, during the modelling

cent.XV	?? first fresco cycle. Bell tower?	1753	completed church's floor, realized vault's frescos in first and second spans
cent.XVI	?? second fresco cycle	1754	completata baptistery's floor, end works in Crocefisso's chapel
1593	pastoral visit of Como's Bishop	1757	chancel's step and balauster
1599	first statement about baptistery's recess	1764	?? end "Virgin's coronation" fresco (second span)
cent.XVII	?? cloister in the facade? Main altar	1772	roof completed, marble steps placed at the altars, main altar and bapistery adjusted
1635	statement about the presence of Genovesi's chapel	1775-1800	end of works: roof, facade, sacresty, wooden door finishes, pulpit adjusted
1708	start works in the choir	cent.XIX	Genovesi's chapel and baptistery's gates
1710-11	end building new walls + choir's roof	1963	demolition old parish house + built new one
1718-20	start works in the sacristy	after 1975	latest restoration interventions
1721	start nave's walls works		
1724-26	chancel's decorations		
1741-46	facade decoration, statues' positioning		
1740-50	chapels' transformations		
1752	still not realized paintings in the chapels, chancel's walls frescos, decorations in first and second spans		

Figure 4: Architectural elements differentiated by particular constructive phases [6]

stage capturing only visible surfaces is not sufficient and we also have to model the "detail behind the object's surfac", i.e. concern methods of construction and materials of architectural elements [18].

On the other hand, it is necessary to consider what level of detail is suitable for our needs. Foxe in his article [12] reminds that in the case of an existing building its model is always to a certain extent different from the actual object. There is always a certain level of simplification and abstraction and too much detail can also be inappropriate considering the increasing amounts of data which must be processed during further work with the model. Moreover, it is worth mentioning that the level of detail does not only apply to geometry but it is also related to the accuracy of attributes – descriptive information. In this context, the term level of development is more suitable. This term was first used by the American Institute of Architects (AIA) in 2008 and expresses the model detail with 5 values (100 – 500) [8]. In figure 5, there is a slightly simplified depiction of LOD by Foxe. Although the levels of development were originally designed for newly built buildings, they can also be applied to historic buildings especially if their reconstruction is planned. What LOD we want to achieve should be carefully thought out so that the model structure allows further addition of details.

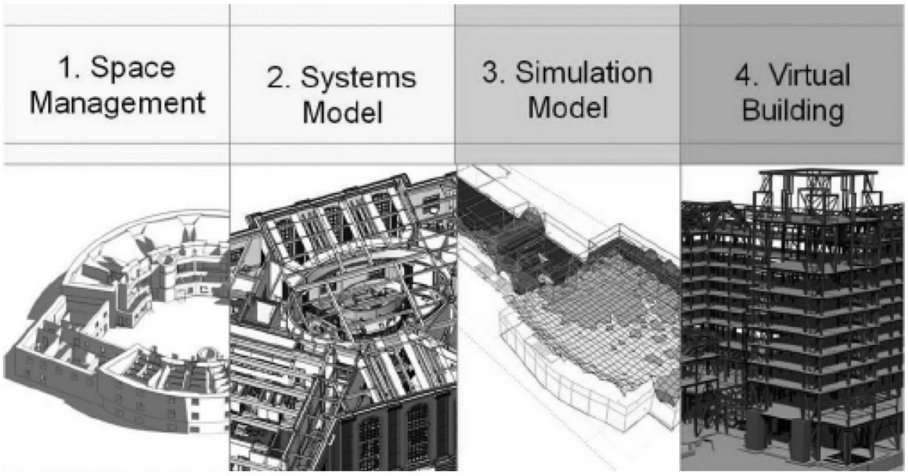

Figure 5: The levels of BIM according to [12]

3D geometric models which depict current as-found physical characteristics of heritage buildings can be considered as the primary result for the needs of cultural heritage preservation. However, descriptive information must also be integrated to meet the requirements of BIM. In the result, the following data will be included [7, 17]:

1. Building location and identification – coordinates in the national coordinate system, cadastral information (number of the building, land parcel number, owner, mode of building using. . .)
2. Historical documents
   - textual documents – historical review – history of the building, archival sources, chronicles, transcriptions. . .
   - raster data – old maps, plans, archival photographs and other image material
3. Architectural analysis of the building – used material, construction systems, information about particular building elements, construction history, differentiation of structures according construction stages, art-historical and aesthetic evaluation of parts of the building
4. Information about the condition of the building – closely related to the previous item
   - textual documents from surveys – used materials, construction techniques, condition, damage and structural problems
   - raster data from surveys – drawings, photographs, photoplans, maps
   - vector data from surveys – documentation created during the geodetic survey (site plans, elevations, sections, floor plans. . .)
5. Information about reconstructions, maintenance and other interventions – in raster or vector formats

It is clear from the list above that the results of the structural-historical investigation [17] are a crucial data source for the creation of HBIM in the Czech Republic.

The resulting models of historic buildings will be an integral part of an information system. The required functionality of this information system can be summarized as follows [22, 18, 7]:

1. The ability to define the interrelationships and hierarchies between the objects of the model
2. Management of descriptive information – attribute data which the model is enhanced by
3. 4D representation – the ability to represent temporal data
4. Tools for 3D editing
5. 2D and 3D visualisation at suitable scales
6. The capability to browse attribute data, photographs and other documents
7. The interface for asking attribute, spatial and multi-criteria queries
8. Automatic export into the form of documentation suitable for planning of reconstructions and historical studies

The selection of suitable tools

To be able to create and manage an information model, the right choice of software tools is crucial. Unfortunately, today there is no comprehensive solution specifically designed to model and manage semantically enhanced 3D models of historic buildings [22]. The currently available approaches to spatial information management, i.e. BIM and GIS, have both their pros and cons (see fig. 3), therefore, we cannot definitely prioritize one of them. Thus, meanwhile it will be necessary to employ both solutions, combine suitable software tools and utilise their advantages.

Table 3: The comparison of BIM and GIS capabilities [22]

Criteria for Information Management Process	BIM	GIS
Definition of specified mutual and hierarchical relationships	X	✓
Enhanced attribute management	X	✓
3D editing functionalities	✓	X
Spatial and multi-criteria query-able characteristics	X	✓
Representation of multi-layered conceptual themes in 3D	✓	X
Temporal (4D) representations	✓	✓

The most important advantage of BIM is the ability to create 3D models using intelligent parametric elements. On the other hand, existing libraries of parametric objects are generally not suitable for the 3D reconstruction of heritage buildings because in such buildings even objects of the same type (walls, columns. . .) can be highly different in shape because of missing industrialisation and prefabrication in the past. Furthermore, the definition of the heritage preservation-specific attributes, integration of non-homogeneous datasets and possibilities of asking spatial queries are limited in BIM [22, 23, 18]. Nevertheless, despite these drawbacks, BIM remains a very powerful tool for the modelling phase. The design of new libraries which facilitate conversion from unstructured point clouds into the form of volumetric 3D models is then a very frequent topic of scientific works [20, 2, 6, 4, 26, 18, 19].

GIS, on the other hand, has been primarily designed to manage and query spatial information. In the GIS environment we can easily work with semantically enriched objects, non-geometric attributes can be linked with geometry and managed in relational databases. Spatial and attribute queries can be asked. However, the possibilities of 3D editing are still rather limited. Thus, it is no surprise that the most efficient workflow remains the aforementioned combination of BIM tools for 3D modelling and GIS tools for data management [22, 23, 26, 21, 9, 15].

In the context of BIM the term of parametric modelling is often mentioned while it is necessary to realise that there are more approaches to parametric reconstruction of buildings. What approach is suitable for our needs depends mostly on our input data. Classic BIM software is an advanced 3D CAD tool which utilises intelligent parametric objects. These objects represent all physical and functional properties of real-world architectural elements. In addition, interrelationships between the elements can be defined. If we can obtain building documentation in the form of 2D drawings, we can create a virtual 3D model manually from the elements (see e.g. [22]).

A slightly different type of parametric modelling can be used to process the laser scanning or digital-photogrammetry data. If we have a parametric library prepared, we can automate the process of mapping vector data onto point clouds. The library can be created based on historical architectural books and it contains a textual description of particular elements in a text file, e.g. with the use of the GDL language. The architectural elements are then semi-automatically identified in point clouds and a discrete model can be replaced with continuous geometric primitives [18].

Lastly, the procedural modelling of buildings with the use of shape grammars can be understood as a type of parametric modelling. This approach is similar to the previous mentioned because it employs a textual, human-readable description of architecture. The creation of models is based on different architectural styles. Buildings are divided into parts and represented by a set of basic shapes. These shapes are controlled by replacement rules while each shape can be replaced with more detailed shapes or it can be changed by a transformation. Although procedural modelling was developed to create models of larger urban areas and for visualisation purposes [14, 25], it might also be a suitable method for 3D reconstructions of single buildings if the 2D drawings are available [10]. Furthermore, the focus on semantics and defining objects hierarchies is very similar to BIM.

Conclusion

The goal of this review was to summarize recent efforts dealing with the information modelling of cultural heritage buildings and to compare the abilities of BIM and GIS for this purpose. Today, there is no comprehensive software solution designed specifically for creating and managing information about historic buildings, i.e. for the whole workflow of processing measured data and other data sources, 3D modelling, management of the resulting model, analyses and visualisations. This is apparent from the review because most of the existing works utilise a combination of several BIM and GIS software tools.

The existing efforts can be divided in two parts according to the approach used. BIM tools are currently employed mainly for 3D modelling based on laser-scanning and photogrammetry data. The design of parametric libraries and conversion from an unstructured point cloud into a continuous model are very important topics here. GIS, on the other hand, is used mainly for the management of the resulting models and establishing connections with descriptive attributes or even other information systems. However, the question of transformation from BIM into the GIS environment seems to be still not fully resolved.

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