

# USING A DATABASE AS A DATA SOURCE FOR CREATING A 3D MODEL

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## Abstract:

*There are several stages in processing primary surveyed data to a 3D model: collecting primary data, its processing usually into point, polyline or polygon features and finally creating a 3D model usually consisting of triangular patches.*

*An approach presented in this paper makes things more complex. The main intent is creating the 3D model not directly from surveyed data but use a database as data source for creating the model. The database contains data in a data model describing logical parts of buildings, such as walls, floors, windows etc. The article focuses on the process of converting survey data into the data model and then using them for creating a 3D model. All stages of this process have been successfully tested (some of them with real data, some with pilot data only). In the tests, 2D and 3D geodetic survey, GNSS survey, photogrammetry and laser scanning and their combinations were used as methods of collecting the primary data. As a data format of the 3D model a KML was used.*

*The data model is only one part of a more complex data model developed in cooperation between Institute of National Heritage and University of West Bohemia that allows storing a data regarding real estates, furniture and even exteriors. However the paper does not describe whole data model nor its relation to existing databases used in custody of Cultural Heritage.*

## 1. INTRODUCTION

Although conventional 2D GIS plays important role in the cultural heritage custody, its abilities seems today as overcome. A lot of information on cultural heritage has the third dimension and it turned out that a 3D GIS can bring additional functionality (for example when coupled with furniture registers). There is also other aspect of 3D information – today's great popularity of 3D models that applies to models of cultural heritage also. Such 3D models are created either for documentation purposes or for an attractive visualization of the part of cultural heritage.

Our project aims at creating a geographic data model focused on the areal of a castle. The data model implemented in GIS allows both visualization and coupling with current database of cultural heritage (particularly compatible with Czech national paGIS data model). This paper describes a process of filling in a part of data model regarding interiors of building and using it for making a 3D model of the building.

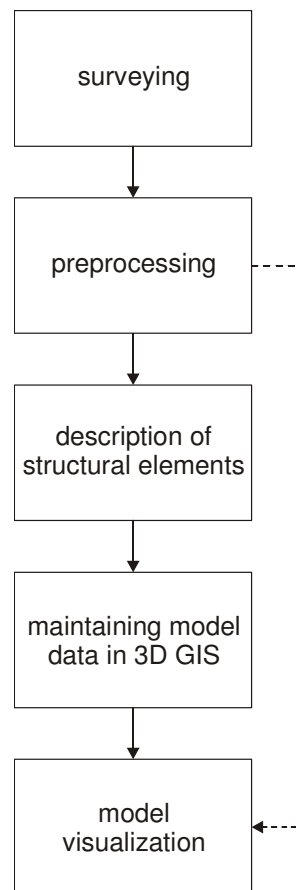
## 2. RELATED WORK

3D models are results of many projects. Many of them result in CAD 3D model derived from surveyed data (e.g. [3], [1]). Others, originating mainly from laser scanning, result in point cloud or densely triangulated surfaces (e.g. [4]). Such models are not suitable for storing in 3D GIS and integration with a cultural heritage database. Very similar to our project is SIArch-Univaq [2]. It also deals with a data model intended for

storing building elements in 3D GIS together with additional data describing other than geometric characteristics of architectural heritage, particularly, integrating it with Italian national Risk Map database.

Our data model is focused on storing geographic data regarding the areal of a castle and is compatible with national data model used by the Institute of National Heritage (official institution maintaining cultural heritage data in the Czech Republic). The data model meets requirements stated by the Institute of National Heritage in [10]. However, this paper does not describe the data model. Details of the data model can be found in [6].

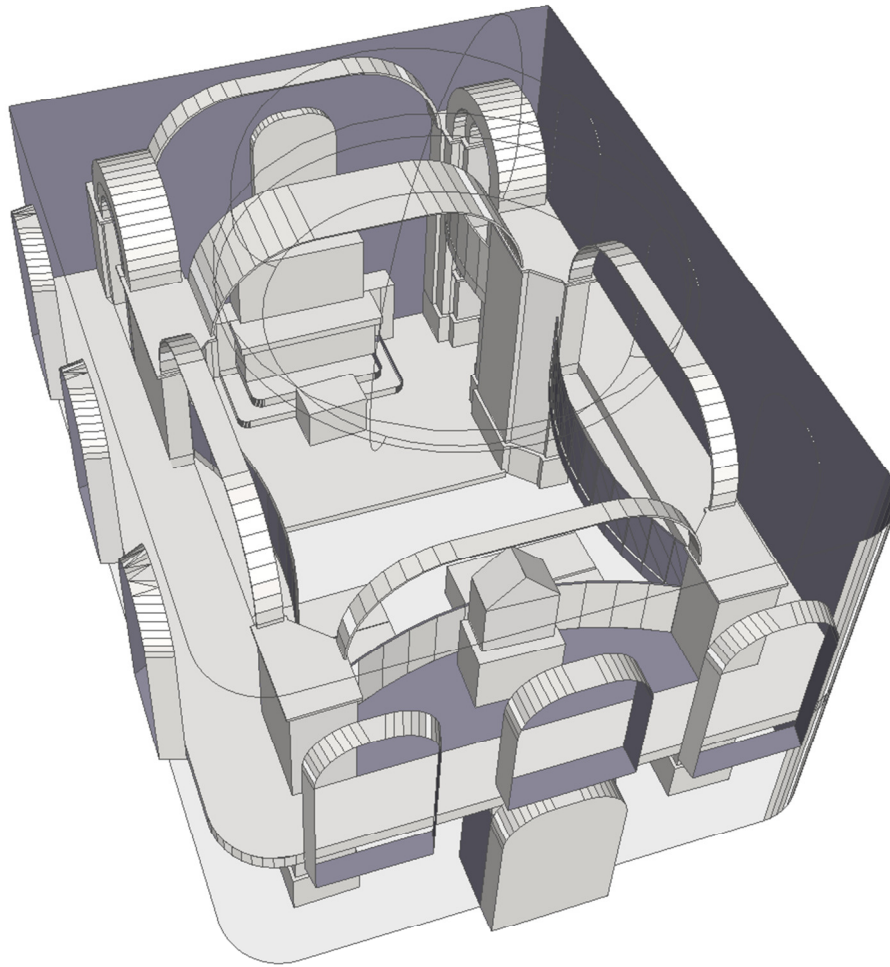
### 3. PROCESS DESCRIPTION



**Figure 1:** Five steps of creating a 3D model

A process of creating a 3D model can be divided into five consecutive steps (see Figure 1). Surveying as a source of primary data is not constrained by data model. Geodetic survey, GNSS survey, photogrammetry, laser scanning or possibly other surveying methods can be used. Software tools and necessary effort in preprocessing step strongly depends on surveying methods (or their combination) used. While in case of geodetic survey mainly coordinate transformation and triangulation take place, in case of photogrammetry or laser scanning important point and their coordinates have to be measured at first. In case studies several combination of surveying methods has been proved to be a suitable source of primary data: geodetic and GNSS survey in [7], geodetic survey and laser scanning in [5] and geodetic survey and photogrammetry in [9].

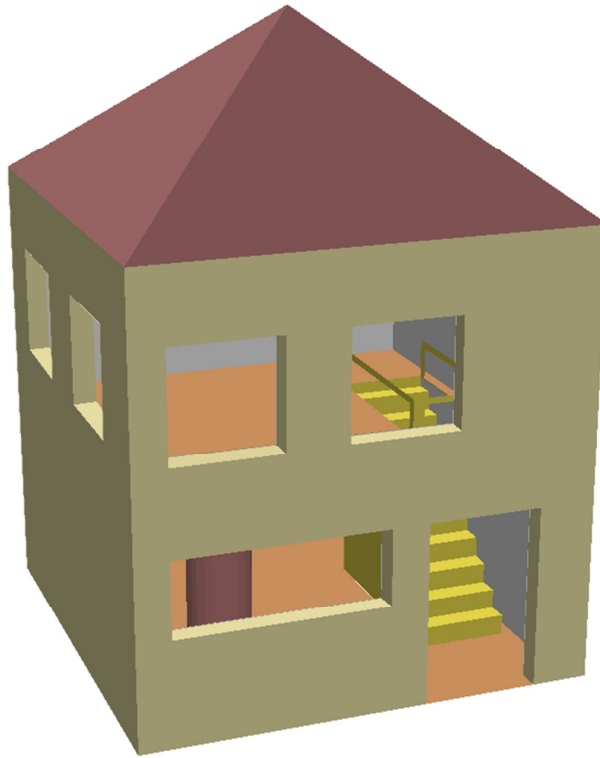
Following step in the process is a description of structural elements of the building. The elements are described by its type (floor, ceiling, wall, building opening) and geometry (vertices and facets). Example of building decomposition to the structural elements is illustrated in Figure 2. For this step a CAD software tool (e.g. Microstation) is required.



**Figure 2:** Decomposition of building to structural elements

The structural elements of the building have to be imported to the GIS. This step showed to be a bit tricky because it depends on capabilities of the GIS to import a CAD data and format and content of CAD files imported. In a case study (see [8]) Microstation and ArcGIS 9.3 was used. Several ways has been found to import the structural data into GIS. Some of them needs the facets to be triangulated, some require importing element by element and so on. Because various software tools, or even various versions of the same software tool, behave differently, this step processing cannot be described unambiguously.

Visualization of the building is usually possible using the GIS handling the data model. It is possible in our project also, however this is not the preferred visualization environment. One of the objectives of our project is presentation of cultural heritage to public. Hence a Google Earth, as a widespread software tool, has been chosen for visualization. Because of that, the data stored in GIS has to be converted to KML. As in previous step, there are several ways how to do that. It is possible to export data from GIS to DXF or DWG format, import it to Google SketchUp and then save it as KML file. Other way is to export data from GIS directly to KML. This step has been tested with a fictional pilot data only. Results can be seen in Figure 3.



**Figure 3:** Data from GIS exported to KML

#### **4. SIMPLIFIED PROCESS**

When collecting data for GIS is not necessary, i.e. when only visualization is required, the process can be significantly simplified. The simplified process is marked up in Figure 1 by dashed line. There is no need to identify and specify structural elements so that the 3D model can be build up from preprocessed primary data only. The preprocessed data can be in form of points selected so that they can be used to construct 3D model of the building with appropriate level of details. The points stored in DXF or DWF format is then imported to Google SketchUp which is used for 3D model construction (see e.g. [9]). The main disadvantage of this practice is that the “point cloud” is poorly organized. Hence it is extremely difficult to detect appropriate points when constructing the 3D model. Another way is to interconnect the points and create facets in CAD, and then import it to Google SketchUp.

#### **5. CONCLUSION**

This paper describes main steps of processing primary surveyed data to the castle data model in GIS and constructing 3D model from the GIS data. All steps has been proved to be a feasible solution, however there is no comprehensive study applying proposed process on the same subject yet. Attention should be paid in incorporation of new features of used software tools into the process. The simplified process has been verified in several case studies, but it is useful only for visualization purposes.

#### **6. REFERENCES**

- [1] Bocconcino, M., Marchis, E., Piumatti, P., Vitali, M. *Integration of Digital Techniques for Three-dimensional Survey: The Case Study of the Baroque Church of “San Giovanni Decollato”* Survey in 22<sup>nd</sup> CIPA Symposium – Digital Documentation, Interpretation & Presentation of Cultural Heritage. Kyoto, 2009.
- [2] Centofanti, M., Continenza, R., Brusaporci, S., Trizio, I. *The Architectural Information System SIArch3D-Univaq for Analysis and Preservation of Architectural Heritage* in ISPRS 3D-ARCH: 3D Virtual Reconstruction and Visualization of Complex Architectures. ISPRS, Volume XXXVIII-5/W16, 2011. ISSN 1682-1777.

- [3] Chiabrando, F., De Bernardi, M. L., Curetti, S. *Integration of Low Cost Geomatic Techniques to Support the Architectonical Project. The Perlo Castle Area Survey* in 22<sup>nd</sup> CIPA Symposium – Digital Documentation, Interpretation & Presentation of Cultural Heritage. Kyoto, 2009.
- [4] Goktepe, A. et al. *3D Modeling of Sille Aya-I Eleni Church with Laser Technology* in 22<sup>nd</sup> CIPA Symposium – Digital Documentation, Interpretation & Presentation of Cultural Heritage. Kyoto, 2009.
- [5] Hrádková, M. *Studie možností sběru a zpracování 3D podrobných dat pro účely památkové péče*. [Diploma work]. Plzeň. Západočeská univerzita v Plzni, 2009. Available at: <http://gis.zcu.cz/studium/ZaverecnePrace/>
- [6] Jedlička, K. *3D Data Model for Purposes of Cultural Heritage Custody – Case Study at the Castle Kozel*. 23<sup>th</sup> CIPA Symposium. Prague, Czech Republic, September 12–16, 2011. Accepted paper.
- [7] Kopejtková, B. *Digitální model hradu Švihov a návrh archeologické databáze pro NPÚ*. [Diploma work]. Plzeň. Západočeská univerzita v Plzni, 2009. Available at: <http://gis.zcu.cz/studium/ZaverecnePrace/>
- [8] Luňák, T. *Geografická datová báze Státního zámku Kozel*. [Diploma work]. Plzeň. Západočeská univerzita v Plzni, 2009. Available at: <http://gis.zcu.cz/studium/ZaverecnePrace/>
- [9] Strejcová, J. *Digitální 3D model zámku Nečtiny*. [Bachelor work]. Plzeň. Západočeská univerzita v Plzni, 2010. Available at: <http://gis.zcu.cz/studium/ZaverecnePrace/>
- [10] NPÚ. *Informační a komunikační strategie NPÚ 2007–2013. Návrh informačních a komunikačních technologií pro rozvoj informační společnosti v oblasti památkové péče v ČR na období 2007–2013*. Národní památkový ústav, internal document.