Cartographic Symbols for 3D Visualization in Facility Management Domain

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Extended Abstract

This paper describes possibilities of 3D visualization in the areas of *Facility Management* (FM) and *Building Information Modelling* (BIM). 3D models and their utilization in location based services allow better orientation in distribution systems and in facilities.

Pilot study has been made based on data from Building and Technology Passport, summary referred as Building Documentation System. Since 2004, the Facility Management Division of the University Campus at Masaryk University has collected digital spatial data of the real-estate property of the Masaryk University. Building passport contains information about buildings, floors, rooms and stairs, elevators and windows, their ground plan's shape and attributes. In 2007, shortly after the Building Passport, the Technology Passport started – technologies in buildings and rooms including location of all electronic devices, air-conditioning system, fire equipment, water distribution system or heat distribution system. Building Documentation System is primarily 2D, because DWG files and ESRI geodatabases are utilized for storing spatial information (Herman et al. 2015). Technology Passport and especially Building Passport are used as a base data in various gradually formed positioning and navigation services. Such service is the application "Building MU", which has been developed by Facility Management Division.

Usage of 2D cartographic visualization in case of technological passports and facility management domain is limited. Frequent overlaps of individual objects in the classical 2D visualization (in both, plain or side view) are main limitation. This situation is also described in Du & Zlatanova (2006). Overlaps occur especially in rooms with high density of objects (e.g. boiler rooms). There is also required height information for precise localization of

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technical devices (e.g. valve). So, 3D view is preferred for visualization of indoor utility networks. Within the technology documentation is primarily the resolution of individual technologies and equipment, with regard to cartographic methods it is visualization of qualitative characteristics.

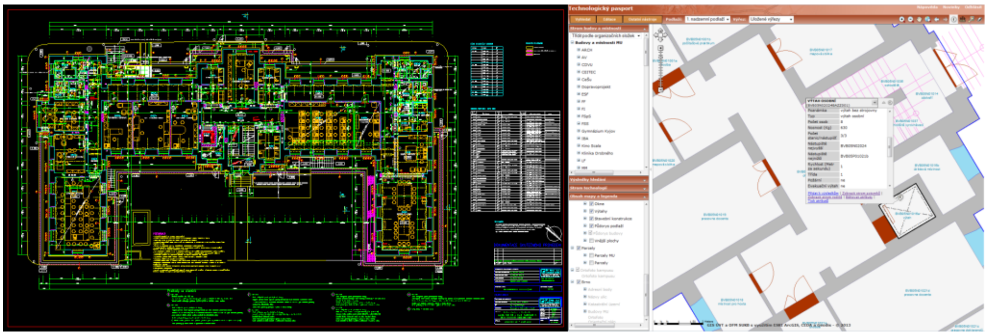

Figure 1. Data from Building Documentation System – DWG file and ESRI geodatabases.

Robinson et al. (1995) divides symbols for qualitative data on the basis of their localization to space of cartographical visualization into: point (figurative) symbols, linear symbols and areal symbols. In 3D visualization, it is necessary to deal with volume symbols. However, it should be emphasized that the differences between the volume characteristics and the other three groups are relatively fuzzy. Symbols localized as points can be full 3D (with nonzero volume) or only 2D, which are in field of computer graphics called as billboards. Billboards consist of 2D images, which are applied as a texture on a simple polygon, usually a rectangle. The underlying polygons are transparent. The position of billboards rotates in such way, that the symbols (billboards) are still vertically oriented to the virtual camera and users.

In scope of the practical testing were created 3D interior models of rooms from two buildings in campus of Faculty of Science. Processed rooms were classroom and boiler room. All technologies have been mapped in these rooms according to methodology used by Facility Management Division of the University Campus.

Various classes of utilities were differenced by colour in map legend (e.g. water, gas, heavy current or weak current). Shape or inner structure was used for representation of concrete devices. Two variants of cartographic symbols were created, tested and compared for point symbols. First variant were billboards and second variant were 3D volume symbols. Billboards were adapted from 2D map symbols, which were originally designed by Farkasova (2013). 3D symbols have been designed and created anew.

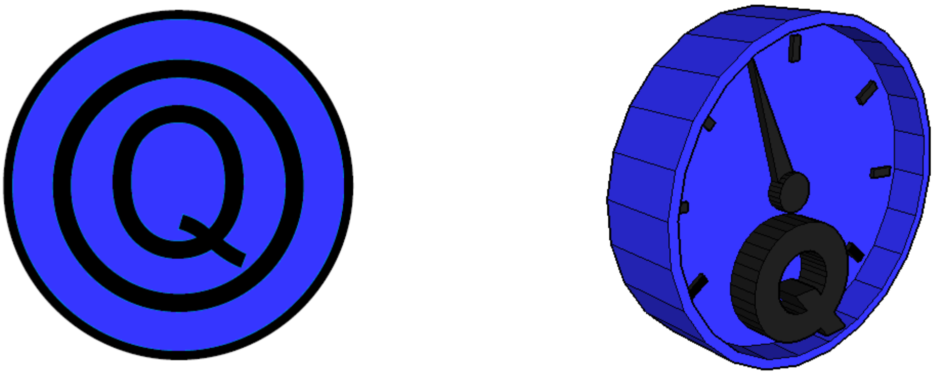

Figure 2. Two proposed map symbols for flowmeter (2D variant is on the left, 3D is on the right).

Volume symbols were used for larger devices (bigger than 10 x 10 x 10 cm). They were made automatically from 2D lines or polygons stored in source database. ArcGIS software (version 10.1 with 3D Analyst extension) was employed for automatic processing, it was 3D Buffer tool for creating volume pipelines from lines and Extrude tool for creating volume objects (e.g. radiators) from their plan view.

Comparison of size and speed of rendering was made in ArcGIS (in ArcScene module) as representative of desktop software and in X3DOM library as example of web technologies running directly in usual web browser. Combination of 3D symbols with 3D model of whole building (made from Building Passport) was tested as well. Verification of the technical parameters of symbols should is followed by testing of user cognition. This testing will be carried out by using the software MUTEP (*Multivariate TEsting Programme*), which is designed and utilized for this purpose in cooperation of cartographers and psychologists (Sterba et al. 2014).

3D symbols can be utilized in virtual reality, but also in mixed or augmented reality as well. Cartographic principles that should be followed when using the cartographic symbols describe Stanek & Friedmannova (2010). 3D symbols that have been proposed in our study could be applied in future in location based services in the field of facility management. Such services could be used for example by repairman for orientation in complicated piping or for precise localization of fault location in pipes and devices.

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