IFC-based Modeling and Management of Design Options

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Abstract. The design of a building represents a gradual process with continuously increasing level of detail. Due to complex and dynamic boundary conditions, building design might be subject to modifications and adaptions. To find the optimum solution for the client, possible design options need to be analyzed concerning project-specific requirements. Thus, the investigation and comparison of evolving design options represents an important process in the design of buildings. Early planning phases are frequently subject to changes which may show a decisive influence on the total project course. Considering the generation of design options, complex interdependencies between building elements and structure need to be considered. Modifications may refer to building topology, geometric details or semantic aspects. Traditional approaches base on a manual creation of design options (e.g., providing 2D drawings for possible design options), which represents a time-consuming and error-prone approach. In contrast, the BIM methodology offers new prospects to optimize planning and construction processes due to model-based collaboration between different domains. As BIM models offer rich information concerning geometry and semantics, they are highly applicable for various analysis and simulation tasks and thus, suitable for analyzing design options. To support a consistent exchange of BIM-related data between different project participants and software applications, the use of a neutral and open data format is essential. In this context, Industry Foundation Classes (IFC) represent a standardized format covering a wide range of applications. The application of Graph Data Models is introduced to represent building information as well as design options within one consistent model. Following this approach, architects, designers, contractors and clients are provided with a comprehensible description of design options.

1. Introduction

BIM models cover a wide range of structured information including both semantics and geometry. As the design process is split into planning domains with different software tools, the use of an open data format represents a prerequisite for successful project collaboration. The planning process is determined by a high number of project participants with partly contradicting interests. In the continuously evolving planning process, frequent changes and modifications lead to the investigation of multiple design options, especially at early phases. In this context, complex relationships between building objects need to be considered. Focusing on the management of design options based on an open data format, IFC are limited to the representation of *explicit* design options. Thus, a comparison of alternative designs requires the creation of independent building models. This methodology causes different identifiers for the same object. Furthermore, the use of separate models leads to a high amount of redundant data, which gradually increases with the number of possible design options. By integrating possible options within one consistent model, analysis and simulation tasks become easier as results are directly compared.

This paper is structured as follows. First, possible modifications that might appear in early planning phases are classified into different categories. These so-called “option classes” are described concerning affected elements, occurrence in the planning phase and effect on overall building structure. Exemplary modifications leading to the single option classes are given. Subsequently, the structure and content of the IFC4 data model are analyzed concerning entities that might be affected by the described option classes. General ideas on extending the IFC data