Merging IFC-Based BIM Models: A New Paradigm and Co-Design Support Tool

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ABSTRACT

Interoperability is a key factor for BIM and helps to simplify the communication and the cooperation between different actors during the project life-cycle. IFC appears as the best option to exchange data between different software platforms. The purpose of this paper is to offer a proposal for exchanging data by merging IFC-based BIM models. We consider a BIM project model like a large system of multi modules where each part represents a structure (building, road, bridge and tunnel) and should be completed by an IFC model. This article presents a numerical tool which allows the co-design step through a Graphical User Interface (GUI) developed in Java language using the IfcToolsProjects libraries. This work is situated in non-automatic merging models being problematic. The proposal is clearly a co-design assistance. This Interface allows the merging of many buildings represented by different IFC files and produces a new IFC-based buildings complex model. The result is fully exploitable without any data loss. The new merging approach avoids the disadvantages of the “linking” function.

KEYWORDS

Co-design, IFC, IfcToolsProject, Interoperability, Merging Models, User Interface

INTRODUCTION

Since the end of 2000, BIM, or “Building Information Modelling” has been widely adopted in the world of construction (Celnik et al., 2014). More than planning and design phase of the project, BIM is used for supporting processes including cost management, construction management, project management and facility operation and also the maintenance (Leite & Akinci, 2012; Liu & Akinci, 2009). This way of conducting a project revolves around a digital model on which all projects stakeholders can exchange information. This digital model especially implements a set of 3D models containing all information relating to the construction which organized around a database composed of objects.

Interoperability is a key factor for BIM allowing to simplify the communication and the cooperation between different actors during the project life-cycle. BIM is changing rapidly, but interoperability remains a difficult point to resolve, and the process of information exchange is complex and becomes increasingly a limiting factor (Zhou et al., 2009). Several researches in the domain of BIM and interoperability have been done. Grilo and Jardim (2010) analysed the value of interoperability on BIM and concluded by addressing the need for enhancing interoperability in BIM to achieve higher value levels in the AEC “Architecture, Engineering and Construction” sector; and Karan & Irizarry (2015) presented an extending BIM interoperability framework to preconstruction.
operations using geospatial analyses and semantic web services. Industry Foundation Classes (IFC) appears as the best option to exchange data between different software platforms through a neutral format.

To improve interoperability in construction, IAI “International Alliance for Interoperability” is created in 1994 under the leadership of Autodesk®. This alliance, currently named “BuildingSmart”, aims to promote conditions of the exchange of information between different software and multiple actors in construction projects. In order to help actors working together despite differences, the alliance proposes to develop a new standard for information exchange. Thus, in 1994 a first version of the IFC standard (ISO, 2013) is proposed. It defines the construction objects, their characteristics and relationships with other objects. Furthermore, the standard also defines a physical exchange format “.ifc”. It contains all the information of a construction project, expressed according to a specific textual syntax.

The IFC standard is based on the STEP “STandard for the Exchange of Product model data” standard (Herbst, 1994). The main features of STEP permit to establish the IFC foundations (Charles et al., 2005). As the name suggests, this standard was aiming to organize the exchange of object models in the wider field of industry. These exchanges are now ISO standardized and governed by the object-oriented description language EXPRESS (Ait-Ameur et al., 2000). Thus, the IFC standard is an adaptation of the STEP standard in the building world. It is object-oriented, and the organization of objects in IFC models is also written in EXPRESS language. The exchange format “.step” has also been adapted into “.ifc” format.

Once the IFC standard implemented by the design software editors, the shared information in the context of a BIM project are viable in principle, reliable and stable over time through the standardization of IFC models.

However, the adoption of IFC format by editors is relatively slow. IFC models alone, do not allow a full interoperability. Information is often lost when exchanging between different software. The interoperability is not “reversible” when importing a model using it for calculations, then exporting it again into another software, the same data as initial would not be found again necessarily. In addition, IFC complexity and its “computer” character do not favour readability by construction industry specialists. The project actors are often tempted to use other solutions. In practice, BIM syntheses are often carried out using a geometric clashes management in a central model, such as using Navisworks. This contains several models, but in different formats, including IFC only for the structure part generally. Therefore, there is no connection between the different models and that just produces overlays. These overlays are only geometric and all other information contained in the models is not exploitable. Thus, IFC’s potentials are not fully used.

Considering this, some questions might be arisen: How to improve the exchange of information by limiting the number of exchange formats? Can IFC become the only medium of information exchange futures in a BIM project? If so, how to realize the synthesis project from IFC models knowing that no platform or solution currently does allow this?

This paper proposes a new way of understanding data exchanges with IFC. This new approach offers an alternative of information exchange by merging models. It is an automatic merge tool, assisted by an IFC objects manipulation interface. It allows an automatic merging in order to create one consistent IFC synthesis model which allows understanding the IFC models created by the different designers displaying their data such as objects tree, quantity of objects by type, etc. The result may be used by all BIM software without any loss of information.

In the first section, the IFC and their implementation will be described. In the second part, the new merging approach and main findings through a fairly simple concrete case on assisted merging of two building models will be presented.
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