7th INTERNATIONAL SYMPOSIUM ON INDUSTRIAL ENGINEERING

INDUSTRIAL ENGINEERING DEPARTMENT,
FACULTY OF MECHANICAL ENGINEERING,
UNIVERSITY OF BELGRADE, SERBIA
&
STEINBEIS ADVANCED RISK TECHNOLOGIES,
STUTTGART, GERMANY
&
INNOVATION CENTER OF THE FACULTY OF MECHANICAL ENGINEERING,
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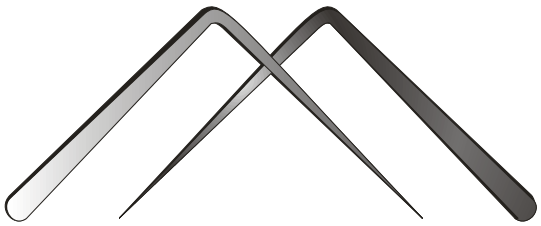

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Vesna Spasojević-Brkić
Mirjana Misita
Dragan D. Milanović

27th-28th September 2018
Belgrade, Serbia

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SIMPLE BUILDING INFORMATION MODELING BY USING INDUSTRY FOUNDATION CLASSES

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Abstract. *Building Information Modeling (BIM) is a rising technology, already widely used in AEC & HVAC industry around the world. The basic idea of BIM, to create, store and use the building information efficiently is currently the work in progress. Namely, a significant amount of relevant information about the building is impossible to create or use by the existing software. Originally established as an exchange format, Industry Foundation Classes (IFC) represent both the information repository and the framework to generate new or use the existing information. The paper presents a way of low-level information modeling by using an IFC format.*

Keywords: *Building Information Modeling, Industry Foundation Classes, low-level BIM*

1.INTRODUCTION

Since the genesis of Computer Aided Design (CAD) in the 1970's, this technology is in a persistent process of development. Originated in mechanical engineering in the early 1980's, 3D CAD is shortly thereafter adopted by architects and structural designers, which eventually lead to establishing of BIM by the end of 1980's. In 2011, the UK government created a strategy [1] for adopting BIM as mandatory for all government construction projects. In the past few years, several European countries followed the UK's example.

As opposed to CAD, BIM is much more than a 3D geometry model of a building. It is rather a comprehensive building information database, including all the relevant data regarding planning, design, construction, operation, and maintenance. Furthermore, BIM stands for the special collaborative business model which supports the establishment of such a database [1].

Benefits of using BIM are widely recognized by investors, owners, designers, contractors, and operators of buildings. Although emphasized as one of the main advantages of using BIM, a free flow of all possible kinds and formats of information about the building is currently limited to the modeling functionalities of BIM software. A considerable amount of relevant data lacks modeling framework in available software solutions.

Another challenge of the efficient use of BIM is interoperability i.e. the ability to transfer data between applications [2]. To overcome the interoperability obstacle, the buildingSMART organization [3] developed a standardized data format for the manufacturer-independent exchange of digital building models: IFC. Currently, all commercial BIM software solutions can export their native formats to IFC. Although an exchange format, IFC can be used as a modeling tool for non-standard information. After a short introduction to IFC basics, the paper presents the method to modify the IFC file content in order to model the specific information. Finally, the case study illustrating the proposed solution is presented.

2. PROPOSED SOLUTION

The IFC schema is a specification for sharing data between disciplines and software applications during the project life-cycle [3]. The schema is written in the EXPRESS data definition language. It contains definitions of classes (entities) representing almost

all relevant elements to be modeled. Besides element classes, the schema specifies various kinds of relationships between different elements. Instances of some element classes can have one or more geometric representations. Several methods for defining geometry are provided in the schema as well. Therefore, the IFC schema provides an open framework for BIM. In order to be able to generate a highly detailed IFC files, commercial software modeling frameworks should comply with the IFC schema as much as possible. However, currently available BIM software solutions considerably vary in the quality of IFC export. Moreover, some information is impossible to model. This paper proposes the information modeling by externally modifying the IFC file. It could be done manually in case of minor modification, or by using some of the available programming toolboxes [3] for large-scale modification.

IFC file is a clear text file with ".ifc" file format extension. It is in accordance with the STEP physical file format, governed by the IFC schema in EXPRESS [3]. To model the lacking data, one should follow the algorithm presented in Figure 1.

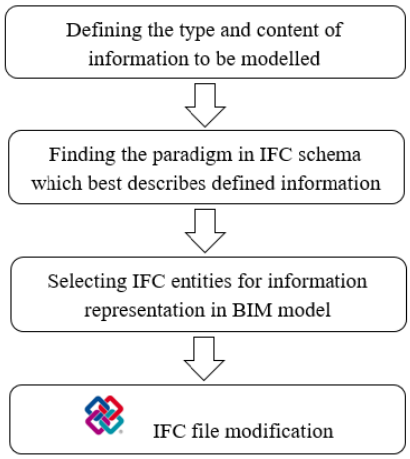

Figure 1. Algorithm for modelling by external IFC modification

3. CASE STUDY

For the purpose of illustrating the proposed method, an IFC file representing a part of heating equipment will be modified so that a part of user manual i.e. Troubleshooting is added. The IFC file capturing the BIM representation of Buderus Oil and Gas Fired Boiler Logano G215 is downloaded from the Open IFC Model Repository [5] (Figure 2). Following the proposed algorithm, firstly it is necessary to define the type and content of information to be added to the model. For the sake of easier operating, a snippet of the user manual regarding troubleshooting is going to be added. The snippet is the textual data describing two potential problems.

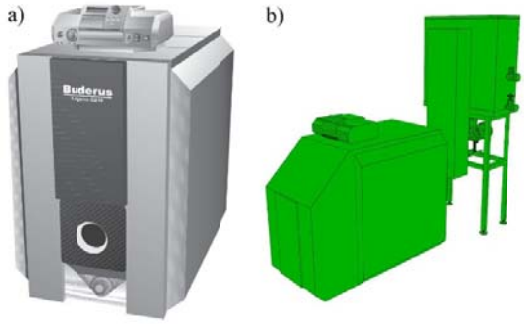

Figure 2. Buderus Oil and Gas Fired Boiler Logano G215: a) Render from user manual, b) IFC geometric representation

This kind of data is possible to model in a few different ways. Although troubleshooting cannot be strictly categorized as a property of the device, in this case, the use of the "property paradigm" for troubleshooting description is completely justified. To support this statement, the existing model is examined. The entity used for the representation of the equipment unit is IfcEnergyConversionDevice from the Shared Building Elements layer of the schema. Properties defining the instance of the mentioned entity contain information such as the manufacturer's website, or compilation date. Thus, the information of interest will be modeled by IfcComplexProperty and IfcPropertySingleValue entities. The architecture of the data and relationships to be added is shown in Figure 3.

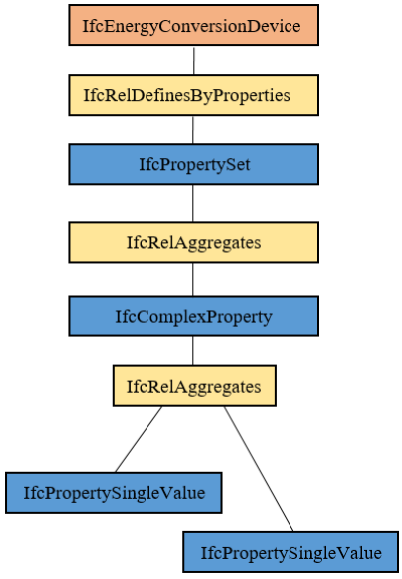

Figure 3. Diagram of the established data structure

The IFC file is modified using text editor. Relevant parts of the file are presented in Figure 4.

```
#120 = IFCENERGYCONVERSIONDEVICE('3M7BrgwhP5MQMQ
  $fudrMnF', #101, '\S\Vl-Brennwertk. Logano
  G215 mit Logamatic 2107 55 kW bud1811', '', $,
   #125, #126, $);
#11333 = IFCRELDEFINESBYPROPERTIES
  ('0nAgIGEXjDbOXtd4dPiA8M', #101, $, $, (#120,
  #11252, #11259, #11266, #11273, #11280,
  #11287, #11294, #11301, #11308, #11315,
  #11322), #11334);
#11334 = IFCPROPERTYSET
  ('0pkUooy8533817opqaghW6', #101, 'VDI3805
  PropertySet', $, (#11335, #11342, #11349,
  #11356, #11569));
#11569 = IFCCOMPLEXPROPERTY('Troubleshooting
  your Heating System', 'Operating
  Instructions', $, (#11570, #11571));
#11570 = IFCPROPERTYSINGLEVALUE('Burner related
  problems', $, 'An alarm light on the burner
  will typically light up during a burner lock -
   out condition (See burner manual). Typically
  this problem is resolved by pressing the
  burner reset button.Press the burner reset
  button once. If the burner does NOT fire,
  contact your local service company for
  assistance.', $);
#11571 = IFCPROPERTYSINGLEVALUE('Problems
  related with the control system and heating
  system', $, 'Problems related to the control
  panel and/or heating system itself, are
  typically shown on the display of the control
  panel, if the boiler is so equipped.Further
  information can be found in the manuals
  supplied with the control panel.', $);
```

Figure 4. Relevant parts of IFC file

4. CONCLUSIONS

The general idea of the BIM is clear: it is supposed to be a central repository of all kinds and formats of information about the building and everything related to it. In spite of the large of available software solutions, a considerable amount of important data lacks the modeling framework. The paper presented a simple method of modeling such an important data and thus supporting BIM. As shown, it is possible to modify the content of the IFC file such that the lacking data comply with the IFC schema ontology and syntax. The paper presented a simple case where only the textual data is added. Nevertheless, IFC provides a consistent framework for establishing much more complex data structures. The result of IFC file modification is shown in a form of the EXPRESS code, however by creating a wrapper around the code, the modeled information would get the missing context. By following the proposed algorithm, it is possible to model a wide variety of information.

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