Dynamo platform for automation Revit

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Abstract

The use of BIM in the construction industry is enabling greater productivity and quality in workflows, reducing costs and downtime. However, there are still a series of challenges that must be overcome. One of them lies in the existing problem in the exchange of information between the agents involved in constructive projects. From an open BIM perspective (Open BIM), the IFC presents itself with the best open standard and neutral alternative used to facilitate this exchange. However, there is still a lack of knowledge about what this standard should be used correctly for the exchange in each case, and about the limitations existing in the programs when it comes to allowing their importation and exportation. This article analyzes and discusses some of the difficulties and shortcomings in this exchange process for the context of project development at the national level. The article concludes with the presentation of a case study to illustrate some of the problems in the import of models in IFC format can be corrected in an automated way. Specifically, using the Dynamo plugin within the Revit program.

Keywords: BIM, Dynamo, engineering, script, AUTODESK

Content

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1. Introduction

The need for data exchange between applications of the construction sector arises, basically, from the collaborative nature for the development of projects[1]. The use of BIM allows obtaining greater productivity and quality in the workflows for these developments, reducing costs and downtime[2]. However, the adoption of the BIM by the industry is still presenting a challenge, with a steep learning curve, and forcing a paradigm shift in the business models to be able to take advantage of their advantages.

An analysis of foreign scientific literature has shown a large number of publications on the effectiveness of BIM [3-12]. The authors of the article [10] emphasize the effectiveness of BIM in the calendar planning and estimation of the cost of construction of buildings and structures. Articles [13-18] are devoted to the interaction of BIM and the strategy of "green" construction. In the domestic literature, a large number of sources for training with tools BIM, but, unfortunately, there is not enough publications on the topic of the study [19].

To facilitate the management of work processes through the BIM, a large number of standards and methodologies have been emerging over the last few years with the aim of making collaboration easier and more flexible[20]. One of these standards is the IFC, created by buildingSMART Intemacional solution for an open exchange of information between applications. However, the use of this standard is a series of difficulties to meet the objective for which file design: capacity of the programs for their correct interpretation, impossibility of representing all the modeling rules in a single scheme, etc. This leads to a series of undesired results: the information has to be remodeled, it arrives incomplete, with unnecessary parameters, and often without propagating the corresponding restrictions, among other drawbacks. Another open standard for the management and coordination of the BIM is the BCF format (BIM Collaboration Format), designed to facilitate the inspection and verification of the virtual model. The standard allows to report possible errors and issues related to the details of the elements of the model, visually[21].

On the other hand, recently a set of standards and guides have emerged in response to the need to specify the information must be exchanged in the different phases of a constructive project. This type of information is usually defined in contractual documents, before starting the project, and where all the affected parties specify what their information requirements are. The answer to the need to have a specification for the exchange of information between the different agents, along projects developed in BIM, was the BEP (BIM Execution Plan). One of the first internationally recognized guides, developed for this type of specification, was the "BIM Project Execution Planning Guide", created at the Pennsylvania State University based on the conclusions of the thesis developed by Chitwan Saluja (2009)[22]. The guide states that with a good documentation of the BEP "will ensure that all parties are clearly aware of the opportunities and responsibilities associated with the incorporation of the BIM in the workflow of the project." Other countries (the United Kingdom, Australia, New Zealand, Singapore, and others) have developed guidelines based on the BEP, adapted to their own needs. However, there is no evidence that at present there is any initiative of specification BEP adapted for the scope of our country.

One way to anticipate the problems of interoperability that may arise in the development of projects in BIM, is to establish a categorization of the level of detail of the information to be exchanged in the BEP. To respond to this need, Vico Software introduced in 2005 the term LOD, which corresponds to the abbreviation in English of "Level Of Detail", for a type of classification that was then generalized by the ALA (American Institute of Architects) level of development in the guide "E202-2008: Exhibit Building Information Modeling Protocol", published in 2008[21]. In this new generalized approach, a unique number is assigned to define the definition level of the information of the elements of the model for each of the stages of the life cycle of the project. Most guides suggest a classification based on 6 or 7 levels, which can be increased depending on the needs of each project. Most of the guides are usually accompanied by templates-type documents, which include tables for the LOD specification, plus a document from the BEP.

2. Methods

Considering that the construction sector is formed by a fragmented industry, with different degrees of maturity in the use of BIM, and where an important part still has a lack of knowledge about the advantages of working with a virtual model of the building, many they continue to use 2D CAD programs and tools that have not been designed for this purpose.

Currently, the architecture and engineering firms that are implementing the BIM for the development of their projects, usually use programs from large international software suppliers (Autodesk, Graphisoft, Tekla, among the most used) to carry out the modeling in the different disciplines (architectural, aesthetic, facilities, etc.). However, to carry out the calculation in each of these disciplines, these firms use specific programs much more adapted to the state regulations. In most cases, these programs have been developed by national companies, with a long history and experience acquired in their specialty over the years. The large modeling programs, however, currently provide very limited functionalities for the calculation (eg: dimensioning of the elements). This forces us to establish an exchange flow between both types of programs. To ensure that the exchange between both tools occurs without problems, the choice of the tool is a factor to be taken into account, which should be fixed before starting the project.

Currently, in the phases of executive project and construction is where there is a greater complexity when it comes to establishing what should be carried out this exchange. On the one hand, this is a consequence of the large volume

of information on the model of the building that must be managed. On the other, to the variety of participating agents from different disciplines.

3.1. Exchange in the delivery phases of the executive project and construction

For a better understanding of the context in which the exchange of information takes place in the delivery phases of the executive project and construction, the main scenarios that have been identified are described below. These scenarios are analyzed and discussed considering the role of the agent responsible for said exchange:

1. Execution project phase. In this scenario, architecture firms are responsible for the management of information. These ask, mainly, engineers of structures and of facilities (installations of ventilation, heating, protection against fires, telecommunications, health, plumbing and domotics, etc.), their contribution in the development of the model, where the information is usually exchanged basically to through the IFC format, or the native format of the program they use, previously agreed upon in the contractual document. However, the conditions for the exchange are different in each case. For example, when the calculation of structures is required, the IFC is usually more used to preserve the exchange format than in the case of facilities. For example, programs Cypecad o Tricalc have certain mechanisms for importation and exportation through this format. However, the use of this format is not as common in the exchange between modeling programs and calculation of facilities, with a greater complexity and volume of modeling information to be exchanged (volume, flows, flows, etc.).
2. Constructive phase. In this phase the constructor is responsible for managing the information and possible modifications in the model. Once the work is awarded to a contractor, there are several reasons that can condition changes in the model (deficiencies in geotechnical studies, errors due to a lack of information on the part of the designer, lack of coordination between constructive systems included in the project, solutions provided by the builder due to his experience or agreements with specific industrialists, etc.) which require to replace or include new elements in the model of the project to develop the constructive model.

Once the model has been verified, the person in charge of its coordination transmits the necessary information, depending on the case, to the collaborators or subcontracted industry (ex: installer of ventilation ducts). Three basic scenarios can be distinguished for these cases:

a) Model in a native format (eg Revit): this solution may be required in projects where all participants are required to work with native models, normally, due to the complexity involved in exchanging the model. Currently, having a native model is also a requirement that promoters usually require, thus preserving the future responsible for the maintenance of the buildings. The reason is justified by the need to have an efficient bidirectionality between the maintenance software and the BIM model used for design and construction, especially when it comes to large buildings and facilities, where changes must be updated without problems .

b) Model in IFC format: this solution has a series of advantages: 1. It responds to open interoperability criteria, 2. It preserves the information related to the intellectual property of the native model, 3. For the constructor it supposes a greater ease to integrate and combine the returned model with other models, regardless of the program (eg: Solibri, Navisworks, etc.).

The conclusion is that each of the scenarios described above has its own casuistry. However, it is difficult to establish which should be the most appropriate information exchange methods in each case. The way of working with the BIM in each project is usually very specific, determined by the users, the software and the processes that intervene in it. These conditions usually define an optimal way to carry out this exchange in each of the scenarios.

3. Results

The deficiencies that currently exist in the process of importing information from a model defined in IFC format for the exchange context introduced in the previous section, lead to the need to reorganize the information within the program, which may imply having to invest a lot of hours. However, in many cases, operations are often repetitive in nature. In this perspective, and with the intention that the users of the modeling programs can automate this type of operations, without having to be experts in programming, in the last years different programs and complements developed for this purpose have appeared on the market.

In the case of the Revit platform, which focuses on the case study presented below, one of the needs is to be able to transport parameters between the different sub-levels of information of each element. In Revit, the elements are organized by families, where each one has at least one type defined. In this way, for each type there is a set of properties whose value is the same for all model objects, which are called "instances" (instances of type). Considering this organization, in the case that is presented there are certain parameters that must be transported through these sublevels in order to label the elements of the model.

3.1. The labeling of elements

There are several forms of labeling in Revit. When it comes to tagging elements we can do it by:

1. Category label (specific labels for each category).
2. Multi-category label (to label parameters common to all categories).

In both cases there is the option, in addition, to add new parameters to the defined tags shared parameters.

The problem arises when trying to label by category certain elements that have been imported from a file in IFC format. This is because Revit is not able to interpret these native preserve elements, and therefore, you can not load a category label type for them. On the other hand, when trying to tag them using the multi-category tag tool, it happens that the values that should appear in the respective example or type parameters appear in new sample parameters created by Revit during the IFC import process. In the case of the example we present, these are “NameOverride”.

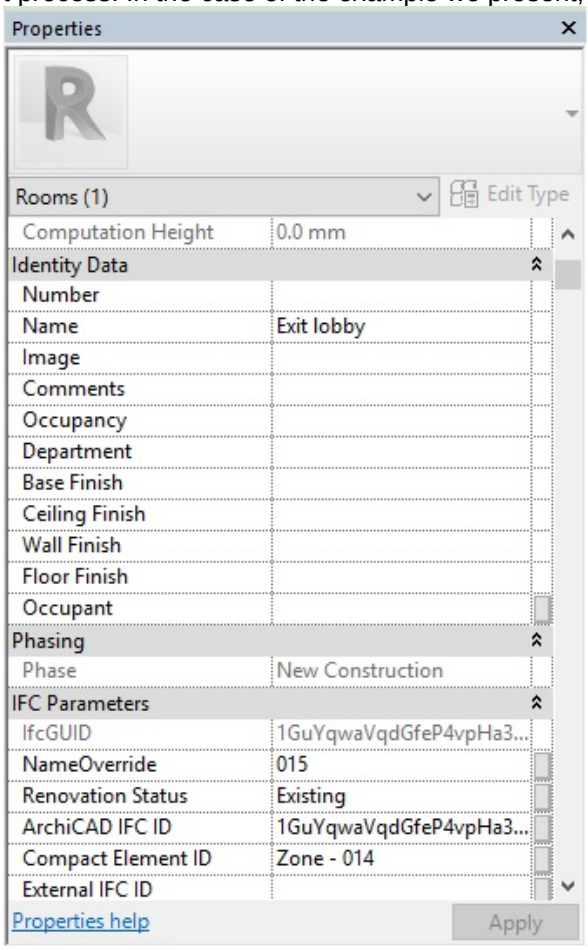

Figure 1. Parameters in conflict after import.

The information of the exemplary parameters, indicated in Figure 1, are in fact, in the case of NameOverride, own information that the Description and Number parameters usually contain. These parameters have been recognized in the IFC import process with new project parameters, which makes it easier for them to be used in planning tables. However, Revit does not allow you to use project parameters in model element labels.

The solution to this problem is to manually enter the information in the parameters of “type9” before mentioned, for its correct labeling. However, here is another problem: Revit does not recognize all the elements that are originally of the same type once imported from a model in IFC. Instead, it creates a different type for each of the copies, which creates an obvious difficulty in its parameterization. Consequently, the assignment of 'type' information for each of the elements must be done one by one, which is a waste of time, as well as an increase in the risk of a human failure in the introduction of the data.

3.2. Use of Script - Transfer of Parameters

The solution to this type of situation is to carry out a transfer of information between parameters. For the case of the labels previously introduced, the information must be transferred from one parameter, which Revit does not allow to label, to another, which does allow this possibility. This transfer requires a manual and tedious process, selecting the elements one by one, and copying the necessary information, since each element belongs to a different type. To avoid this manual process, one solution is to make use of the capabilities of the Dynamo program, which allows it to be automated.

3.3. What is Dynamo?

Dynamo is a visual programming environment for BIM that amplifies the parametric capabilities of Revit with the data environment and the logic of a graphical algorithm editor. It is an open code project for developers and designers with the aim of involving the entire user community in the construction of the tool[23].

The power of Dynamo lies, mainly, in giving the user the ability to:

1. Connect the workflows with different software.
2. Access the Revit API.
3. Automate processes.

Dynamo Script in Revit

The objective of the script that has been designed is clear: transfer the information of elements to be tagged from a non-taggable parameter to a taggable parameter. This information is defined as follows:

1. Category of elements to be imported.
2. Parameter container of information to be tagged: NameOverride
3. Parameter (labeling) information receiver

The Dynamo script is based on three fundamental actions:

1. Selection of those elements to be manipulated, provided through a list. For the case illustrated in the example, the elements to be selected are columns that present the same problem once imported. Through access to the Revit API, Dynamo allows you to obtain a selection of all the elements of the Rooms category.
2. Select from the previous list of Rooms elements, the information contained in the "NameOverride" parameter, thus obtaining a new list with the same order as the previous one, with the respective data.
3. 3. Transfer of information in each of the elements, indicating the parameter where to dump it. In this case, the information is assigned in the copy parameter "Number".

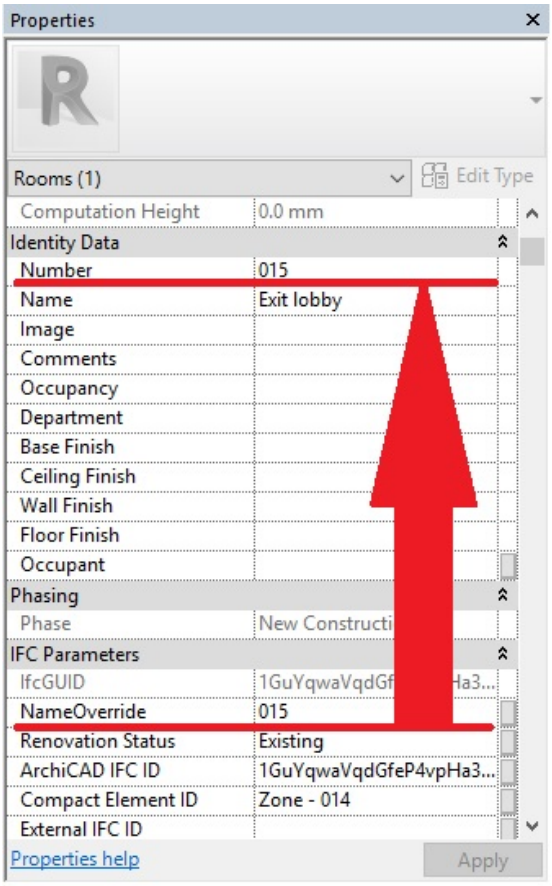

Figure 2. Parameter transferred after the execution of the Dynamo script.

It is possible that this example can be solved through a more adequate specification of the information initially defined in the IFC file, which is then imported into the Revit program. However, the objective of the case study is to show the reader how these problems can be corrected through automatisms created with Dynamo.

4. Conclusion

This article briefly analyzes the main problems and deficiencies in the exchange of information in projects based on BIM, through an analysis of the current state of existing standards and guides and these are being applied to improve collaboration in projects constructive. As a result of this analysis, a first conclusion is that many of the technologies and standards for collaborative work are still in an embryonic phase, especially in our country. Even so there are a number of generic problems that large modeling software platforms present when interoperating through open standards. This article has shown an example in which some deficiencies in the importation of models in IFC can be corrected through alternative tools, in this case Dynamo, to allow to give the modeling programs, in this case Revit, a greater degree of flexibility in the management of the internal data of the application. This type of support tools makes the use of the IFC format more viable for an exchange of information beyond the simple coordination and verification of the model.

Part of the conclusions exposed in this article are the result of the professional experience of the authors and the revision of the published material referring to the theme of the BIM.

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Платформа Dynamo для автоматизации Revit

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Информация о статье обзор

Аннотация *Использование BIM в строительной отрасли позволяет повысить производительность и качество рабочих процессов, сократить затраты и сократить время простоя. Однако по-прежнему существуют ряд проблем, которые необходимо преодолеть. Одна из них заключается в существующей проблеме обмена информацией между специалистами, участвующими в разработке проектов. По-прежнему отсутствует информация о том, как правильно выполнять обмен информацией в каждом отдельном случае и об ограничениях в программах при экспорте и импорте файлов. В этой статье анализируются и обсуждаются трудности и недостатки обмена информации при разработке проектов. В заключении статьи изложены проблемы импорта моделей в формате IFC и как их можно скорректировать автоматическим способом. В частности, использование плагина Dynamo в программе Revit.*

Ключевые слова: BIM, Dynamo, проектирование, скрипт, AUTODESK

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