A REVIEW OF IMPLEMENTATION OF BUILDING INFORMATION MODELING IN ELECTRICAL DESIGN

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ABSTRACT

This paper presents the fundamental concepts of the BIM methodology for engineering coordination as a response to the process of innovation and digitalization that the current energy world is demanding. Initially, the templates for the primary and secondary engineering requirements are defined for the implementation of code or automated subroutines. Later, the equipment and components databases are generated with their manuals and guide documents, which can be a switch as an element of an electrical substation or an electrical board of a house, which allow executing the basic and detailed engineering to finally obtain calculation memories, single line diagrams with their corresponding standards. In this way, each added and improved feature within the software has great advantages such as time reduction and remote access to the project since changes are generated at a general level of the structure involving minimal changes and at the same time identifying possible errors or necessary adjustments.

KEYWORDS: BIM, Engineering Base, Electrical Board, LoD, Revit

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1. INTRODUCTION

The concept of modeling refers to a broad and general definition which refers to taking information from the real world, converting it into digital formats and using this digitalization to perform mathematical analysis, as well as understanding how different objects and/or structures are related. With the development of CAD software (computer-aided design) as a tool that has been evolving sequentially according to the needs and challenges that arise, has allowed in recent years to model from small devices to more complex applications in large industries, it should be noted that the evolution of new technologies every day requires greater efficiency and product innovation so it has been improving the software interface to get all the information in the cloud and with the advantage of access from the work environment or remotely.

The new global work environments have been directed in the interaction of different agents and/or professionals in search of the same goal by integrating a whole set at the professional level in infrastructure projects has resulted in the BIM (Building Information Modeling) which goes beyond having a structure in three dimensions, transcending a virtual replica of the project with its physical and technical characteristics leading to a real process of construction [1]. Also, it analyzes the context in which the project is developed and with the great advantage that the different actors involved in the different stages of the project will work collaboratively within the same environment resulting in time reduction, optimizing the result, by having control of changes and automatic general adjustment of the structure of the different variables modified at any time in the software [2].

The integrated approach of the BIM model not only offers a significant increase in productivity but also serves as a basis for better-coordinated designs and construction processes based on an updated core model. This indicates that the BIM creation tool should completely cover the workflow independent of the modification. Therefore, it is a vital question whether the design, documentation, implementation and operation of the electrical design are supported by the BIM tool, starting with conceptual design to the documentation of the design, through construction, administration, construction management and finally, commissioning [3].

2. BUILDING INFORMATION MODELING – BIM

It is a unified platform that connects the data of any project in real-time from design to construction, which strengthens informed decision making and leads to more predictable and profitable results. The virtual model also provides the ability to simulate all aspects of the building, such as security, building comfort and energy efficiency, during all phases of the building's life cycle. The health and well-being of construction workers depend on these factors. By increasing transparency, risk can be minimized for investors, owners and operators. In the case that the primary source is commercial energy, the telecommunications company has its transformers or makes use of the electricity network from a transformer of the electricity company corresponding to the area where the base station is located [4].

Figure 1: Digitization with BIM. Taken from [5]

3. REVIT

This software is designed specifically for Building Information Modeling (BIM), which allows design and engineering professionals to take a coordinated process from concept to construction with a model-based approach. It includes the functionality of all disciplines in a unified interface; enabling design and documentation through the generation of floor plans, elevations, sections, schedules, 3D views and representations. Optimizes structure performance by performing cost estimates and monitoring changes and performance over the life of the project and structure with the extension of design to

virtual reality. Initially the classification and ordering are done within the database specifically for primary engineering. Therefore, it is important to keep in mind the concept of families in the software.

Revit families are all the elements that can be added to a project. They will have a series of properties according to the element and the function it fulfills in the model. It is essential to know that families are not the only elements that make up the model. The families contain several parameters that will give value to the virtual model, thanks to these can be made analysis, measurements, budgets and much more documentation essential for the development of the project [6].

Engineering Base (EB) is the platform for highly efficient engineering cooperation. EB is object-oriented, with the SQL database used in the computer-aided engineering tools (CAE) that offer electrical engineering, instrumentation and energy solutions for different industries. This pioneering software technology ensures high availability and intuitive handling during the process.

Six main stages are identified in the development of the project with a BIM environment and are called dimensions. In the first dimension (Scratch Point) the origin of the project is given, in which the corresponding processes are structured for its later implementation. In the second dimension (Vector), the design and calculation activities for the basic development of the project are carried out. In the third dimension (Modelling) the data and parameters of the model are introduced for all the related disciplines. The fourth dimension (Planning) plans the project and all the work that integrates it to carry it out, through Gantt diagrams or similar. In the fifth dimension (Cost Control), the costs and related expenses are estimated to determine the profitability and make the necessary adjustments in the previous dimensions. Finally, the sixth dimension (Sustainability) allows estimating the management of resources and the possibilities of saving for decision making in several aspects such as environmental, energy, among others.

The primary engineering that starts with an offer to the client according to the needs and/or requirements of the same, where the project cycle starts and the need to enhance the software used is taken into account to reduce times through templates and models. Although the stage and changes to be made sequentially must be taken into account. Within this area the LOD (Level of Development) is handled, which is in charge of identifying the stage of the project with the respective information and its representation in the software to continue its elaboration and allowing to make the appropriate changes, highlighting those that possibly generate problems in the infrastructure [7]. Bearing in mind that elements will be added to the design here, it is necessary to have the databases of each device where each equipment is specified with its respective families, categories, characteristics and its parameterization in such a way that everything is registered and all the possible knowledge of the project is known. This means that the more information I have about the project and the closer it will be to its virtual construction to the real one. The different levels are specified below and presented in Figure 2 [8].

LOD 100: The model element can be represented graphically in the model with a symbol or other generic representation, but does not meet the requirements for LOD 200. Information related to the model element (i.e., cost per square foot, HVAC tonnage, etc.) can be derived from other model elements.

LOD 200: The model element is represented graphically within the model as a generic system, object or assembly with approximate quantities, size, shape, location and orientation. Non-graphic information can also be attached to the model element.

LOD 300: The model element is represented graphically within the model as a specific system, object or set in terms of quantity, size, shape, location and orientation. Non-graphic information can also be attached to the model element.

LOD 350: The model element is represented graphically within the model as a specific system, object or set in terms of quantity, size, shape, orientation and interfaces to other building systems.

LOD 400: The model element is represented graphically within the model as a specific system, object or assembly in terms of size, shape, location, quantity and orientation with detailed, manufacturing, assembly and installation information. Non-graphical information can also be attached to the model element.

LOD 500: The model element is a field verified representation (i.e., how it was built) in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the Model Element.

Figure 2: LOD levels. Taken from [9]

4. IMPLEMENTATION OF BIM IN ELECTRICAL DESIGN

It begins with the identification of each of the company's guidelines and how the different projects that are necessary to carry out the design processes are presented, followed by training in the primary and secondary energy design software "Engineering Base" and "Revit". Next, the database of the equipment and templates that make up the design engineering is collected, in which the manuals and interoperability of these elements are reviewed so that if it is necessary to modernize or adapt them, this is done using the new software. Afterward, the equipment classification stage is continued according to its functionality and to identify the requirements according to their technical specifications.

Taking into account all of the above, we will proceed to develop schematics and Z-diagrams of the equipment used and to complete the existing database. The Z-diagrams are the schematics of the protection equipment where the connection points, terminals, binary inputs and outputs, power supply among others, are located. They are used to identify and cross equipment connections. To deliver the consolidated project, finally, a deliverable will be made explaining the procedure followed for the development of the equipment and that it is the guide manual for the development of future models that are required in the continuous supply of the system database. The information in the table is taken to a spreadsheet that will later be imported into the Revit software. Then use it to size and characterize the equipment that the customer requires. This process should not be lost sight of for the equipment is by way of example as there are different primary engineering devices

previously named to which the same procedure was done. From the organization and debugging of the databases used by the engineering area within the organization, it became necessary to apply a structure and categorization of equipment, models and documentation implemented in the phases of the primary engineering cycle, as shown in Figure 3.

1	2	ETIQUETA			ETIQUETA INGLÉS	COMENTARIOS
		1	2	3		
138	03	04	00	00	00	00
207	04	00	00	00	00	00
208	04	00	00	00	00	00
209	04	00	00	00	00	00
210	04	00	00	00	00	00
211	04	00	00	00	00	00
212	04	00	00	00	00	00
213	04	00	00	00	00	00
214	04	00	00	00	00	00
215	04	00	00	00	00	00
216	04	00	00	00	00	00
217	04	00	00	00	00	00
218	04	00	00	00	00	00
219	04	00	00	00	00	00
220	04	00	00	00	00	00
221	04	00	00	00	00	00
222	04	00	00	00	00	00
223	04	00	00	00	00	00
224	04	00	00	00	00	00
225	04	00	00	00	00	00
226	04	00	00	00	00	00
227	04	00	00	00	00	00
228	04	00	00	00	00	00
229	04	00	00	00	00	00
230	04	00	00	00	00	00
231	04	00	00	00	00	00
232	04	00	00	00	00	00
233	04	00	00	00	00	00
234	04	00	00	00	00	00
235	04	00	00	00	00	00
236	04	00	00	00	00	00
237	04	00	00	00	00	00
238	04	00	00	00	00	00
239	04	00	00	00	00	00
240	04	00	00	00	00	00
241	04	00	00	00	00	00
242	04	00	00	00	00	00
243	04	00	00	00	00	00
244	04	00	00	00	00	00
245	04	00	00	00	00	00
246	04	00	00	00	00	00
247	04	00	00	00	00	00
248	04	00	00	00	00	00
249	04	00	00	00	00	00
250	04	00	00	00	00	00

Figure 3: Codification of primary engineering equipment

According to the classification, the following properties are given to understand the database. The first number refers to the type of structure that is being used, the process was developed only with the code 04 to which the power equipment is assigned such as switches, disconnectors, surge arresters, instrument transformers (CT's and PT's), in addition to many compensation systems such as FACTS, capacitor banks and inductive elements. Also in this category are secondary engineering equipment such as photovoltaic panels, batteries, chargers, medium voltage cells, among others. Together, the categorization includes civil and architectural works.

For the database, all the available information on the equipment was organized in duly cataloged folders. Bearing in mind that the type of structure of each piece of equipment belongs to a family or subcategory which is represented by the second digit, the reading and handling of information in the database become more fluid and with a better understanding.

Specifically, this second digit contains components and families such as CT's and PT's, sectionalizers, passive elements, HVDC, among others. It is worth mentioning that there are different folders containing information about the general design of the substation, that is why we talk about subcategories since within each main folder there is equipment to be used with its respective description and technical specifications. The design must go hand in hand with the information of the equipment being modeled, that is why with the BIM methodology the equipment can be modified if required. Figure 4 shows the information provided by a manufacturer.

PTF_SDT_1077D	45	13200 V / 226-130.5 V	1258	1078		1239	394	472	1082	887	Dyn5	Ojo	260	684
PTF_SDT_1078D	75	11400 V / 214-123.6 V	1322	1176		1413	386	520	1092	889	Dyn5	Pala 4 Huecos	292,4	774
PTF_SDT_1079D	75	13200 V / 226-130.6 V	1258	1078		1239	394	472	1082	887	Dyn5	Pala 4 Huecos	250	729
PTF_SDT_1080D	112,5	13200 V / 214-123.6 V	1258	1207		1208	394	472	1082	887	Dyn5	Pala 4 Huecos	255	799
PTF_SDT_1081D	112,5	11400 V / 214-123.7 V	1258	1287		1208	394	472	1082	887	Dyn5	Pala 4 Huecos	253	803
PTF_SDT_1082D	112,5	13200 V / 226-130.6 V	1322	1200		1453	386	520	1092	889	Dyn5	Pala 4 Huecos	253,4	769
PTF_SDT_1083D	150	11400 V / 214-123.6 V	1258	1207		1208	394	472	1072	887	Dyn5	Pala 4 Huecos	245	859
PTF_SDT_1084D	150	13200 V / 226-130.5 V	1258	1207		1218	394	472	1072	888	Dyn5	Pala 4 Huecos	248	895
PTF_SDT_1085D	150	13200 V / 214-123.6 V	1322	1240		1413	386	520	1092	889	Dyn5	Pala 4 Huecos	248	822
PTF_SDT_1086D	225	13200 V / 214-123.6 V	1323	1479		1281	456	474	1131	944	Dyn5	Pala 4 Huecos	352	1132
PTF_SDT_1087D	225	11400 V / 456-263.3 V	1398	1517		1452	536	520	1168	1069	Dyn5	Pala 4 Huecos	444	1229
PTF_SDT_1088D	225	11400 V / 214-123.6 V	1328	1397		1261	464	472	1156	957	Dyn5	Pala 4 Huecos	355	1154
PTF_SDT_1089D	225	13200 V / 456-263.3 V	1428	1350		1580	526	444	1170	1099	Dyn5	Pala 4 Huecos	505,7	1255
PTF_SDT_1090D	225	13200 V / 226-130.5 V	1328	1476		1261	464	472	1156	957	Dyn5	Pala 4 Huecos	343	1116
PTF_SDT_1091D	300	13200 V / 226-130.5 V	1328	1371		1261	479	472	1156	957	Dyn5	Pala 4 Huecos	349	1243
PTF_SDT_1092D	300	11400 V / 456-263.3 V	1277	1006		1617	527	545	1277	1000	Dyn5	Pala 4 Huecos	473,4	1373
PTF_SDT_1093D	300	13200 V / 214-123.6 V	1328	1492		1281	479	472	1156	957	Dyn5	Pala 4 Huecos	379	1279
PTF_SDT_1094D	400	13200 V / 214-123.6 V	1368	1516		1370	544	472	1162	997	Dyn5	Pala 4 Huecos	475	1541
PTF_SDT_1095D	400	11400 V / 456-263.3 V	1398	1335		1020	536	520	1168	1069	Dyn5	Pala 4 Huecos	432	1410
PTF_SDT_1096D	500	11400 V / 214-123.6 V	1408	1603		1360	504	472	1162	1037	Dyn5	Pala 4 Huecos	462	1634
PTF_SDT_1098D	630	13200 V / 214-123.6 V	1540	1752		1700	536	520	1313	1169	Dyn5	Pala 4 Huecos	611,7	1923
REFERENCIA	kVA	AT / BT (Vacío)	mm								GRUPO DE CONEXION	CONECTOR BT	L	kg
	POTENCIA	TENSIÓN	A	B	C	D	E	F	G	H			VOLUMEN ACEITE	PESO TOTAL

Figure 4: Equipment specifications

The information in the table is taken to a spreadsheet that will later be imported into the Revit software. Then the transformer required by the customer is sized and characterized. This process should not be lost sight of for the equipment is by way of example since there are different primary engineering devices previously named to which the same procedure was done.

With the technical specification tables for the different equipment already digitized, the BIM methodology can be used because when changing the voltage level or the transformer (equipment), the program will look for the parameters that are modified and update the conditions that depend on them, for example, the model was created with a "D" parameter which refers to the height of the same, but from this same parameter certain conditions are created which coordinate different heights that the transformer has, so just by modifying a parameter, the height of the radiator and other information about it varies.

5. CONCLUSIONS

The implementation of new technologies in the development of processes within the company allows solutions to customers in less time, efficiency and quality. Therefore, the improvement and in this case the use of BIM methodology for the development of projects marks an important point between the conventional and the modern in terms of infrastructure construction and interaction of the different professionals involved.

The digitalization process is providing a huge technological advance. About the energy field, the electricity demand has exponential growth and the challenges that the company has is to provide solutions in a short time but efficient and this is achieved with professionals capable of providing answers and solutions to the challenges that arise.

Each added and improved feature within the software has great advantages such as time reduction and remote access to the project since changes are generated at a general level of the structure involving minimal changes while identifying possible errors or adjustments needed to adapt the structure.

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