Application of 3D Design Technology Based on BIM in Substation Design

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ABSTRACT. With the information technology era of intelligent grid of the new concept of deepening, substation as an important part of the smart grid has been sustained attention, substation design technology is also constantly improved to meet the new requirements of the national grid, building information model (referred to BIM) is one of the more widely used design techniques. This article briefly describes the use of Revit for three-dimensional design process, the establishment of family and so on. In addition, the advantages and limitations of the current three-dimensional design in the design of electrical specialty, civil engineering design and collaborative design are also discussed.

1. Introduction
In recent years, 3D design technology has developed rapidly in the design industry due to its characteristics of visualization, coordination, simulation, optimization, and portability [2]. Therefore, the state clearly proposed in the “Twelfth Five-Year Plan” to accelerate the application of Building Information Model (BIM) in engineering [3]. But its use in substation construction projects has been slow. Substation construction is an important part of power grid construction, and its position in the power industry cannot be ignored. Therefore, it is very necessary to promote three-dimensional design technology in substation design [4]. This paper takes Revit as an example to briefly explain the three-dimensional design method of substation, and analyzes the advantages and disadvantages of three-dimensional design in the current substation.

2. The establishment of the Revit electrical family

2.1. Electrical family establishment method
The establishment of electrical families can come from two aspects: First, it is directly provided by electrical manufacturers. This type is generally an electrical device that is complex and standardized. After the check, it can be directly placed in the model, which greatly saves the modeling time; second, it needs to establish the ethnic family itself. This type of electrical equipment has different functions and dimensions in different situations, and manufacturers cannot directly provide ethnic families. At this point we need to establish ourselves according to the actual situation.
When building electrical communities, we cannot unify them under one design because of the variety of electrical equipment. For cable trough boxes, brackets and conduits, because of their regular appearance, uniform materials, and less information, it is easier to establish a family. We can establish a parametric family according to the sample and change its appearance by changing its size to achieve the effect corresponding to the actual situation. For the control cabinets, lamps and other equipment, it should be as simple as possible. Otherwise, too many parameters will be input during the establishment of the ethnic family, which will take a lot of time. For transformers, lightning arresters, and reactive power compensation devices, such as complex structures and more information, it is necessary to first model each part and finally assemble them.

2.2. Revit electrical family establishment example
Before the device family is established, the corresponding device parameters (appearance dimensions, internal structure, material, etc.) must be collected and then confirmed by the electrical professional before modeling can begin. Below we refer to a project as an example, in the case where the manufacturer does not provide a device model, the electrical equipment family is established based on the information obtained.

2.2.1. The low-voltage cabinet is a device with uniform appearance, uniform material and less information. We use a simplified model to build its model, as shown in Figure 1.

![Fig. 1 Low voltage cabinet](image1)

2.2.2. Transformer, which belongs to an important electrical equipment with complex internal structure and containing more information, so we must first split it into multiple simple parts and design the information according to its different materials as shown in Figure 2.

![Fig. 2 Transformer exploded view](image2)

Subsequently, the parts shown in Fig. 2 are respectively positioned and combined to obtain a complete transformer model.
Fig. 3 Transformer

After collecting and establishing the electrical ethnic family, it cooperates with the civil engineering and other professions, and carries out collaborative design based on the general layout plan. Finally, the project manager unifies the drawing and completes the design.

2.3. Advantages and disadvantages of electrical design with Revit

The 3D model generated by Revit software has powerful functions in terms of visual intuition, model information expression and professional collision check. The electrical professional BIM design has the incomparable advantages of conventional 2D design [5]. However, in the case of Revit, the electrical profession is a profession with a poor degree of development. Due to the wide variety of electrical equipment, most of the equipment is complex in structure, which makes the information contained in the model too rich, which restricts the development and application of Revit in electrical design.

3. Revit civil construction family establishment

3.1. Method of establishing civil families

The creation of the civil engineering family must first determine the basic information of the building through the funding of the electrical profession. The required populations are then collected, the family library is established and its accuracy checked.

Due to the long history of Revit's architectural design and the corresponding ethnic family (Figures 4 and 5), most of the families can be found in the ethnic group, and because of the different electrical professions, there are fewer types of civil engineering professionals. Most of the families are uniform in material and regular in appearance. In most cases, they can be used directly by modifying the parameters of the existing family.

Fig. 4 Structure part of the family
3.2. Revit civil family establishment example

Taking the new construction of a substation in Jiangxi as an example. The ethnic family is established for its 110kV distribution area. According to the electrical financing of this project, the foundation form, size and material are determined by calculation and the corresponding ethnic families are established.

![Fig. 5 Architecture part of family](image)

After the ethnic families are established, the subsequent collaborative design can be arranged one by one in the corresponding position.

For the GIS foundation, because of the size of its equipment, we can build its entire base as a separate family.

![Fig. 6 110kV framework foundation](image)

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![Fig. 7 110kV GIS foundation](image)

After completing the establishment of the family library, the collaborative design can be carried out. The main building, the main structure and the auxiliary buildings are modeled on the basis of the general floor plan, and the electrical equipment is arranged in coordination with the electrical professional to complete the design.

3.3. Advantages and disadvantages of civil design with Revit

The use of Revit for soil construction timing can achieve the goal of digital and 3D visualization. The 3D view and the corresponding generated elevation and profile can greatly improve the accuracy and efficiency of civil construction design. The intuitive 3D model also provides value-added services for the owners. However, the corresponding shortcomings are also obvious. Due to the short promotion time and insufficient depth of BIM, most design units don’t know enough about it. Just using Revit as
a simple 3D modeling software, the 2D CAD drawing will be designed first and then 3D. Inverted with BIM design ideas, it also greatly increased the design burden, which is not conducive to the development of BIM.

4. 3D collaborative design of substation using Revit
After establishing the family library of the substation, the three-dimensional collaborative design should be based on the general layout plan.

4.1. Substation 3D collaborative design process
Before using Revit for collaborative design, we must first develop a project plan based on the characteristics of the company and the requirements of the project. Collaborative work standards, document naming methods, chart-level classification criteria, and corresponding project information should be identified in the plan.

Secondly, the design team of the project should be formed, including project manager, designer and professional coordinator. Designers must not only master professional design, but also be proficient in the functions of Revit software; professional coordinators are between designers and project managers, not only skilled in Revit software but also in the coordinated professions. Have a certain design experience, responsible for Revit's family management, model review and conflict coordination; project manager is the most important role in the team, responsible for communication and coordination with the owners, and overall management project team.

The third step is to divide the project according to the workload, establish a collaborative work platform, set the central file and start collaborative design. Finally, the corresponding 2D drawings, material reports and other documents are generated from the established 3D model to complete the design.

4.2. Advantages and disadvantages of substation collaborative design
The three-dimensional collaborative design can better cope with the current substation design cycle is short, the construction period is tight, the information exchange between the professional is not smooth, the data reuse rate is low, etc., which is extremely systematic and logical. It can ensure the real-time reading and utilization of a large amount of information of various professions, ensure the timely and accurate data, effectively avoid the rework phenomenon caused by poor communication between professionals, and improve design efficiency. But correspondingly, collaborative design has also brought new problems. Collaborative design puts higher demands on the entire design team. A professional mistake will directly affect the design of other majors. In addition, the two-dimensional drawings derived from the Revit 3D model are often different from the engineering drawings required by China's specifications, and require a lot of time to modify, which adds more or less the burden on the designer [7].

5. Conclusion
It is foreseeable that with the in-depth promotion of smart grid technology, the substation becomes more and more complicated. In the large environment where the traditional design method will not meet the substation design requirements, the 3D design will be visualized and powerful data processing. The advantages of functions, two-dimensional data penetration, efficient engineering statistics and collision inspection have become the development trend of substation design methods in the future.

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References
[1] Wu Wei. Exploration and Implementation of 3D Design Method for Substation[J]. Journal of Electric Power, 2016(12), 31(6): 499-504.
[2] Li Hui. Research on Substation Construction Project Management Based on BIM Technology [D]. North China Electric Power University, 2015.
[3] Zhai Shudong, Wang Yanmei, Tu Qingbo, Hu Yuqiang. Three-dimensional modeling of substation based on BIM technology[J]. China Power Enterprise Management, 2016(10): 88-90.
[4] Xiang Ling, Shao Junwei, Tan Hailan, Li Sihao. Three-dimensional collaborative design of intelligent substation [J]. China Electric Power (technical version), 2012 (11): 454-459.
[5] Li Yingwei, Li Bo, Li Shaosheng. Discussion on Application of 3D Design of Substation[J]. China Electric Power Industry Co., Ltd., 2012(4):26-28.
[6] Li Feng, Tang Wei, Nie Lei. Discussion on 3D Collaborative Design of Outdoor Substation[J]. For Electricity Supply, 2013(02): 46-50.
[7] Li Jianbo, Mu Huaqian. Analysis of BIM collaborative design of building electrical based on REVIT[J]. Intelligent Building Electrical Technology, 2015(01): 8-11.