Research on Application of Three-Dimensional Design Standardization and Three-Dimensional Design Review Method for Transmission and Transformation Project

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Abstract. This paper systematically introduces a three-dimensional transmission and transformation engineering auxiliary design software, and analyses its function, structure and technical characteristics. The main feature of this software is that it has a relatively powerful three-dimensional auxiliary design capability, which can help designers quickly generate a three-dimensional model of power transmission and transformation projects. The three-dimensional model can not only give the project investor an overall image and visual effect of the project during the design bidding stage, but also serve as a reference for the design of the relevant drawings in the later period. At the same time, after having an accurate model, the designer can verify the correctness and reliability of the design, can directly obtain some spatial information, and can dynamically modify, adjust and verify the model as needed. The software also provides related information statistics, query, modification, retrieval and other functions, and provides corresponding drawing management tools according to drawing management specifications. (With the actual application of the system, the design level and technical capabilities of designers will be further improved to ensure that the design work can be completed with high quality and efficiency.

1. Introduction
With the steady and rapid development of China's economy, the requirements for the construction speed and technical level of the power grid are becoming higher and higher. Power transmission and transformation projects have become an important infrastructure project of the country. The construction of power transmission and transformation is the foundation of power development. Development has played a key role. At present, the construction of power transmission and transformation is gradually developing in the direction of three-dimensional and digital intelligence, and advanced technology is used to achieve precise control of transmission lines and substations. The traditional knowledge model-based power transmission and transformation engineering design method has the problems of poor construction quality effect and low economic benefit of construction results. To solve this problem, the article proposes a three-dimensional digital intelligent technology-based transmission and transformation engineering design method to improve the quality of transmission and transformation design and construction, and enhance the safety of transmission and transformation engineering [1].

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2. Transmission and Transformation Engineering Data Model

Transmission and transformation engineering data has the characteristics of "multi-source, heterogeneous", that is, each engineering physical entity exists uniquely in time and space, and different digital descriptions can be obtained from different perspectives. In this paper, based on the metadata model framework, according to the data types and characteristics of power transmission and transformation projects, the relevant object types are further refined to obtain a data model suitable for the organization and management of power transmission and transformation projects. According to the metadata model shown in Figure 1, the data model of transmission and transformation engineering is refined from the following five aspects: 1) physical object classification refinement; 2) project structured description, that is, the upper and lower information of the data; 3) Data structured description, that is, statistical analysis of data objects, data attributes, and data value sets; 4) Metadata structure, that is, data sources, data objects, data attributes, and data values are used to represent data information; 5) file structure, That is, the source of the data and the structured information of the data package. As shown in Figure 1.

![Figure 1. Data model of transmission and transformation project](image)

2.1. Structured description of the project
Through the Functional Object functional object, a hierarchical structure is established for each Project. Set a Device object for each device node in the functional hierarchy, and according to the setting of the device technical parameters, the device corresponds to the specific material item. At the same time, as the procurement and construction progress, the equipment is mapped to specific product items [2].

2.2. Data structured description
Each Physical Object can have multiple sets of design data, which corresponds to multiple Design Data design data objects. Each data object can have a set of Property Values structured data and a set of Key Values semi-structured data. Among them, Property Values can manage complex values through Value Objects. Each data object can be assigned to a certain data packet according to its data source, and version control and source tracking are performed on the data packet.

3. Web-based 3D platform architecture
The platform uses 3DGIS+BIM information fusion and technology integration, an international frontier technology, based on the B/S architecture to build a BIM application network environment, integrate spatial geographic information resources, power infrastructure BIM models and attribute data resources, to achieve the display of power facilities, The functions of query, retrieval, positioning and safety management form a comprehensive three-dimensional visualization comprehensive application system of power infrastructure. The platform architecture is based on the concept of service-oriented design. Based on the IFC standard and the integrated application ideas and technical methods of the three-dimensional geospatial information platform, the digital platform architecture is designed to
build a 3DGIS+BIM digital power facility information platform based on the B/S network architecture. The platform architecture is shown in Figure 2.

![Network environment construction plan and technical method](image)

**Figure 2.** Network environment construction plan and technical method

### 3.1. Civil Engineering Module
The function of the civil engineering module is mainly to help the designer to establish a three-dimensional model of the civil engineering part of the power transmission and transformation project during the design process, including the drawing of the three-dimensional graphics of the fence, road, house, etc. The designer only needs to enter different parameters according to the specific situation. The corresponding three-dimensional model can be generated by the program. And according to the results of conductor tension calculation to verify the uplift stability of the foundation of the architecture [3].

### 3.2. Equipment operation module
The function of the equipment operation module is mainly to help designers quickly select, place and move different electrical equipment models, as well as make necessary preparations for later statistical work. Specific functions include placing devices, editing device attributes, editing the layer to which the device belongs, and device movement. Among them, the first three functions are related to the external image library and description file, and can perform retrieval, modification, addition, deletion and other operations, which is helpful for designers to quickly select the required equipment and perform various operations among many equipment’s. The device moving function can make all conductors connected to the device move after moving a device, avoiding repeated labour of the user. Different from the previous drawing design software, this drawing design system generates three-dimensional graphics, which saves the designer a lot of time to build a three-dimensional model. The
construction personnel can see the drawings at a glance during construction, which is more intuitive and prepares materials for the construction personnel. It provides convenience and is conducive to the improvement of construction technology. In the design process, the module strictly follows the national technical and economic policies, abides by the relevant regulations issued by superiors, and according to the power system conditions, natural environment characteristics and operation, maintenance, and construction requirements, reasonable steps are placed in the program and equipment selection, so that power distribution The device continues to innovate [4].

3.3. Conductor operation module
This module is a system that integrates wire tension calculation, sag calculation, wire length calculation and graphics automatic generation. It implements the functions of automatic calculation and automatic drawing. This chapter will discuss how to use AUTOCAD 2010 and Visual Lisp to realize the basics of the above functions. principle. This module is faced with the connection line, bus bar and lower lead of the power system distribution device. It can automatically calculate the tension of the selected wire and calculate the length of the required wire from the required sag. All the generated graphics are three-dimensional Graphics [5].

Flexible conductor connection and rigid conductor connection can create a three-dimensional connection between any two devices or conductors. According to the different input parameters, the conductor can have different lengths, colours and appearance, which is very convenient to use. The function of moving the conductor can move the end point of the conductor from one point to another point. The length of the conductor automatically changes, and all the conductors connected to the conductor will also automatically move with it. The entire process is completed automatically, avoiding the designer’s repeated labour. The function of displaying conductor properties can automatically obtain the length, section and other information of any conductor. Using this function, you can accurately obtain the properties of the connecting conductor between any two devices and related safety distance information such as crossing and crossing. It can be directly applied in the construction, reducing material loss and shortening the construction period. Use value. Metal conductors are subjected to forces when they are in outdoor working conditions. Taking the wind pressure on the wire as an example, the calculation formula is as follows:

$$P_f = \frac{a_f k_f A_f V_f^2}{16}$$

(1)

In the formula: \(P_f\) represents the wind pressure on the wire (kgf) \(a_f\) represents the coefficient of uneven wind speed, \(a_f=1\) \(k_f\) represents the aerodynamic coefficient, \(K d=1\) \(A_f\) represents the projected area of the wire in the direction of the wind (m2), when calculating the split wire Regardless of the shielding effect, the combined conductor must be multiplied by the shielding factor of 0.8, \(V_f^2\) stands for wind speed (m/s).

4. Experimental analysis
In order to verify the digital transfer performance of the power transmission and transformation project using the three-dimensional verification design, the traditional information exchange method based on the knowledge model is used as a comparison. It uses software to directly exchange information. The experiment adopts the method of this paper to analyse the construction quality of a power transmission and transformation project in a certain area, and implements the detection of each construction part of the power transmission and transformation project. The test results are described in Table 1. It can be clearly seen from the test results of construction quality in Table 1 that for the transmission and transformation projects designed by this method, the quality qualification rate of all engineering projects, whether they are branch projects or sub-projects, is 100%, indicating that the methods
designed by this method. Power transmission and transformation projects have high construction quality and strong safety performance. The experiment evaluated the sociality and technicality of the transmission and transformation project designed by the three-dimensional digital intelligent technology, and invited 20 famous transmission and transformation engineering experts to evaluate the 220 kV transmission and transformation project in a county designed by the method in this paper. Tables 1 and 2 are the social evaluation results and technical evaluation results of the transmission and transformation project, respectively [6].

Table 1. Construction quality test results

| Project name                  | Number of branch projects completed | Qualified number of branch projects | Inspection quality pass rate/% | Number of sub-projects completed | Qualified number of sub-projects | Inspection quality pass rate/% |
|------------------------------|------------------------------------|-----------------------------------|--------------------------------|----------------------------------|--------------------------------|--------------------------------|
| Main control building        | 7                                  | 7                                 | 100                            | 47                               | 47                               | 100                            |
| Distribution room            | 7                                  | 7                                 | 100                            | 39                               | 39                               | 100                            |
| Main transformer foundation   | 5                                  | 5                                 | 100                            | 29                               | 29                               | 100                            |
| 220 kV outdoor distribution equipment | 2                              | 2                                 | 100                            | 8                                | 8                                | 100                            |
| 110 kV outdoor distribution equipment | 2                              | 2                                 | 100                            | 9                                | 9                                | 100                            |
| Cable trench                 | 2                                  | 2                                 | 100                            | 10                               | 10                               | 100                            |
| Drainage                     | 4                                  | 4                                 | 100                            | 10                               | 10                               | 100                            |
| Fence                        | 6                                  | 6                                 | 100                            | 14                               | 14                               | 100                            |
| Capacitor base and bracket   | 2                                  | 2                                 | 100                            | 8                                | 8                                | 100                            |
| Site engineering             | 1                                  | 1                                 | 100                            | 7                                | 7                                | 100                            |

Table 2. Social evaluation results

| First-level indicators        | Secondary indicators                               | excellent | good | difference | inferior |
|------------------------------|----------------------------------------------------|-----------|------|------------|----------|
| Regional economic judgment    | The degree of optimization of the regional power grid | 0.8       | 0.1  | 0          | 0        |
|                              | Promote the regional economy                       | 0.8       | 0.1  | 0          | 0        |
|                              | Degree of improvement of the lives of local residents | 0.7       | 0.1  | 0.1        | 0        |
| Regional environmental assessment | Sound environmental impact                           | 0.8       | 0.1  | 0          | 0        |
|                              | Water environmental impact                          | 0.9       | 0.1  | 0          | 0        |
|                              | Solid waste impact                                  | 0.7       | 0.2  | 0          | 0        |

It can be obtained from Table 2: the proportion of the personnel with excellent regional economic judgment level is (0.8+0.8+0.7)/3≈0.77; the proportion of the judgment level is good is (0.1 + 0.1 +
0.1)/3=0.1; the judgment level is The ratio in is (0.1+0.1+0.1)/3=0.1; the ratio of the judgment level is poor is 0.1/3=0.03; the ratio of inferiority is 0. The proportion of personnel with excellent regional environmental assessment rank is (0.8+0.9+0.7)/3=0.8; the proportion of assessment rank is good is (0.1+0.1+0.2)/3≈0.13; the proportion of assessment rank is medium is (0.1 +0.1)/3≈0.07; the proportion of those with poor and poor evaluation levels is 0.

Table 3. Technical evaluation results

| First-level indicators | Secondary indicators               | excellent | good | in | inferior | inferior |
|------------------------|------------------------------------|-----------|------|----|----------|----------|
| Substation location    | Transportation conditions           | 0.8       | 0.1  | 0  | 0        | 0        |
|                        | Engineering geological conditions   | 0.8       | 0.1  | 0  | 0        | 0        |
|                        | Device Selection                   | 0.8       | 0.1  | 0  | 0        | 0        |
| Substation engineering | Planning and layout                | 0.9       | 0.1  | 0  | 0        | 0        |
| design                 | auxiliary system                   | 0.9       | 0.1  | 0  | 0        | 0        |
| Transmission line      | Line path scheme                   | 0.7       | 0.2  | 0  | 0        | 0        |
| engineering design     | engineering design                 | 0.9       | 0.1  | 0  | 0        | 0        |

From Table 3, it can be obtained that: the ratio of the people with the best rating in the substation site selection is 0.8; the ratio of the people with the good rating and good is 0.1; the ratio of the poor and inferior is 0. The proportions of excellent and good grades in substation engineering design are 0.9 and 0.1, respectively, and there is no medium, poor, etc.; the proportions of excellent, good, and bad grades in transmission line engineering design are 0.8, 0.1, and 0.1, respectively. There is no difference or inferiority. It can be seen from the technical level that the transmission and transformation project is evaluated. The technical evaluation of the transmission and transformation project designed by this method is good, indicating that the experts have a high degree of approval of the method and can be used for large-scale transmission and transformation. In electrical engineering design [7].

5. Conclusion

In the context of the continuous updating and development of science and technology, 3D design technology has emerged and is gradually applied to many fields of society. Therefore, the introduction of 3D design technology in power transmission and transformation projects is an inevitable trend to promote the development of power systems. This article starts with the connotation of the three-dimensional design technology of power transmission and transformation engineering, and concludes that this technology can greatly improve the efficiency of the design process and the quality of the designed products, so it is very necessary to apply it to power transmission and transformation engineering. In addition, this article focuses on the four specific applications of 3D design technology and the deployment of 3D software in power transmission and transformation projects. Among them, specific applications are survey information mining technology, collision detection, optimized design and construction plan, and integration of various models and platforms. Finally, this article discusses the application prospects of three-dimensional design technology in power transmission and transformation projects, hoping to promote the development of my country's power industry towards a better future and enhance the level of science and technology in my country.

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