Research on 4D Visual BIM Technology in Dynamic Decoration Building Site Construction

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Abstract: Exploring BIM 4D visualization technology applied to the dynamic construction site of residential decoration and decoration. The Project and Revit models were built by Autodesk Navisworks software from different angles, and customized solutions were modified according to customer needs to meet the internal needs of today's fashionable residential decoration.

1. Introduction
In the construction management of building decoration and decoration projects, the factors to be considered are relatively complicated and numerous, and not only the construction technology, technology, materials and human resources are considered. It is also necessary to consider other factors in the overall process of decoration and decoration, as an auxiliary means in the management of the decoration and construction progress, so that the coordination of construction quality and construction progress cannot be achieved. At present, the application of 0BIM visualization technology (Fig. 1) in the decoration construction management can effectively solve this problem. Through BIM technology, dynamic management of time dimension and precise visualization can be realized effectively, real dynamic construction simulation can be realized.

So far, many experts and scholars have studied and discussed the research on the dynamic construction of house decoration and decoration. For example: 2019[1] Zhang Xinggang pointed out that the application of BIM technology in architectural decoration design can effectively avoid the drawbacks in traditional architectural decoration design and greatly improve the efficiency and rationality of design. 2019[2] Yang Buping provides reference for building construction optimization and dynamic management based on BIM and 4D technologies. 2018[3] Qiu Lan explores the dynamic layout of the construction site by BIM in 4D model and optimization technology. 2018[4] Chen Peihua found that the application of BIM technology in the construction and decoration of buildings can achieve the effect of shortening the construction period and saving costs. 2018[5] Wang Huajie uses dynamic cost management to achieve effective control of the cost of decorative engineering projects. 2018[6] Zhang Qiang uses the visual citesspaceV software to analyze the knowledge map and reveal the continuous attention in the field of architectural design in China. 2017[7] Zhang Ailin et al. used BIM technology combined with 3D scanning integrated dynamic management system to provide decision analysis for the information management of fabricated building construction. 2016[8] Ding Yongjun passed the construction plan provided by BIM management information system to make the decoration project achieve energy saving and emission reduction economic and environmental protection purposes. 2013[9] Duan Yujuan realized the cost dynamic control and management of construction general contracting through BIM.
information integration platform to reduce construction cost. 2013\cite{10} Liu Bo passed the case of LY company project to improve the management method and technology of interior decoration engineering cost control. 2013\cite{11} Wang Hao proposed the project cost dynamic control measures in combination with the decoration engineering example to effectively reduce the construction cost. 2009\cite{12} Mo Wugang focused on the construction and dynamic design of prefabricated residential buildings.

![BIM visualization technology](image)

**Figure 1. BIM visualization technology**

### 2. Revit Features

Revit is an integrated platform for design functions that provides the design, drawings and schedules required for building information models. In the Revit software model, all drawings, 2D and 3D views and schedules are used to present information in the same virtual building model. When working with building models, Revit collects information about building projects and integrates all other project content to present this information. The Revit Parametric Change Engine automatically coordinates your changes in any model view (Figure 2), drawings, schedules, sections, and planes. The features of Revit are as follows:

![Revit parametric design model view](image)

**Figure 2. Revit parametric design model view**

1. **Architectural design**
   - Perspective analysis: Optimize building performance by centrally accessing performance data and high-level analysis engines.
   - Conceptual design tools: Draw and create free-form models and create quantitative analysis.
3D design visualization: Use the Ray tracer rendering engine to render faster and more accurately, making it easy to explore, validate and communicate designs.

Cloud rendering: Produces realistic visualization without requiring a computer or using special rendering hardware.

Point Cloud Tool: Connect the Light Scan directly to the BIM process to create an established model.

FormIt Converter: Share conceptual design data created with Revit in FormIt to continue to develop designs using BIM.

Building model: Add architectural elements to the building model, including walls, doors, windows, and components.

(2) Structural engineering and manufacturing

Physical and analytical models: Create physical models of coordination and documentation, and correlation analysis models for structural analysis.

Revit's structural analysis: Perform static analysis and gravity analysis in the cloud while working on Revit or performing parallel analysis, and browse the results in Revit.

Enhance details: Create 3D enhanced designs. Production of reinforcement shop drawings and bar schedules.

Structural steel styling: Use the various parameter steel connections in Revit for higher-order detail model connections.

Structure File: Create an accurate and detailed multi-material design structure file.

Two-way linking and analysis: Integrate the results of the analysis into the BIM process and iteratively work in the design workflow.

Link Structure Manufacturing: The operability between Revit and Advance Steel helps provide a seamless BIM process from steel design to manufacturing.

Graphic Control Structure Engineering: Dynamo provides structural engineers with the tools to develop optimized structural systems using computational logic.

(3) MEP Engineering and Manufacturing

AWWA Valves and Pumps: Revit includes an expanded library of waste water system content based on the American Water Works Association standards.

Consolidation: Insight optimizes build performance by centrally accessing performance data and advanced analytic engines.

Manufacturing Service Transformation: Use the Design Build tool to transform design-level model elements into construction level detail elements.

Making files: Revit provides the ability to record, arrange, and mark manufacturing elements to make file model layouts more efficient.

HVAC Design and Documentation: Design complex pipelines and piping systems to express intent and simulate pipelines and piping systems with mechanical design content.

Electrical design and documentation: Design models and documentation electrical systems. Track the electrical load of the entire distribution system.

Pipeline Design and Documentation: Create sanitary plumbing systems with inclined pipes and layout piping systems to design and document intent.

MEP Manufacturing Details: Create a finished model in Revit. The MEP LOD 400 component can be modeled and coordinated.

(4) Construction

Architectural modeling: The construction content is derived from the design model. Split and operate the wall and concrete casting and prepare the factory drawings.

Construction coordination: Upload the Revit model to the BIM 360 Glue and synchronize it with the BIM 360 Layout. View and share data in the BIM 360 Glue web interface or the BIM 360 Layout iPad app.

Structural Engineering Manufacturing: Linked to Advance Steel for steel detailing and manufacturing to help accelerate design to steel structures.
MEP Engineering: Converts the detailed model elements of the design side into detailed elements of the manufacturing side for detailed coordinated production and installation.

3. Introduction of BIM

BIM is the life cycle of buildings 2D, 3D, 4D, 5D, and 6D. It’s relatively a plan view composed of 2D dotted circular polygons. The various schemes, preliminary design drawings and construction drawings used are 2D. On 3D contains all the geometric, physical, functional and performance information of the project. This information can be used at different stages of the project, and various types and professional calculations, analysis and simulation work are carried out on the building, so 3D is also called virtual building. And 4D is the time simulation of construction progress and construction. However, 5D is an early form between BIM 3D and BIM 4D. That is to use the form of animation to simulate the construction environment, that is, based on the building information model, incorporating "time schedule information and cost cost information" to form a 5D building information model with 3D model + 1D and 4D time progress + 1D cost. Through the 5D BIM, the digital three-control two-pipe project master control system with the goal of “progress control, investment control, quality control, contract management and resource management” can be realized. For BIM, 6D includes simulation analysis of building performance including sound, light, gas, water and heat. Its detailed description is as follows:

1. The 2D of BIM is obtained by plane drawing, such as the plane 2D or 3D drawing of CAD drawn by Guang-lian-da (Fig. 3)

![Figure 3. 2D or 3D plane drawing of BIM](image)

2. The 3D and 4D models of BIM are mainly composed of structural model, architectural model and electromechanical equipment model. The structural model mainly includes the components such as foundation, beam, plate, column and node. In the process of modeling, the basic principles from bottom to top need to be followed, and the standardized component naming standard is adopted. Building modeling includes related components such as doors and windows, walls, and stairs, as shown in the building integration model (Figure 4). Contains all the geometry of the project, physics, function and performance information can be used at different stages of the project to perform various types and professional calculations, analysis, and simulation work on buildings. Such 3D is also called virtual building.
The application of BIM in 3D technology in architectural decoration engineering mainly utilizes 3D in the physical simulation of construction schemes, physical effect display of building decoration components, construction entity display and sand table production. For 3D modeling, model splitting adjustment, parameter setting, component printing, component processing, scenario simulation, etc., it’s fully and dynamically completed. After measuring the dimensions in the field, use Revit for 3D modeling to simulate the feasibility of the solution in a computer.

At the same time, through the coloring on the 3D model, the problems of partitioning and deployment of the construction section are displayed, which not only reflects the scale of the model, but also satisfies the accuracy requirements more fully in the accuracy, specifically the limitation of the structural components of the building decoration, which requires high printing precision and cost. Higher limits and more. It means that with the continuous development of 3D technology and building decoration industry, the combination application will be more compact, and solve many shortcomings of the current building decoration industry, especially the dynamic construction requirements of decoration that meet the temporary changes in decoration.

(3) BIM 4D technology mainly simulates the 4D construction progress generated by the connection of progress-related event information and dynamic 3D model (Figure 5). In other words, the software is used to gradually build up the corresponding 3D model, while also using various visualized devices to virtually describe the project additional time dimension. Using the WBS-related construction schedule, each work during the construction period shows the virtual construction process of the building components in a visual form, so that the construction schedule management work can be implemented more effectively.

The earliest time of the 4D theory was proposed by the Stanford University Engineering Center in 1996. After years of development in the construction progress, the goal of dynamic management of 3D visualization and dynamic management of construction site layout was realized. In recent years, the building information model has been continuously developed and applied, and the life cycle of buildings is oriented towards 5D and 6D technologies.
Nowadays, the application value of BIM is highly valued by the current construction industry. The reason is that the research on construction optimization management theory and 4D construction management method has made in-depth research, so that its role in construction project construction management can be fully exerted. In order to fully reflect the value of BIM technology in 4D construction schedule simulation, this paper takes the dynamic construction of architectural decoration as the research background, through Navisworks software. Establish a BIM model and a construction schedule project file, and dynamically demonstrate the overall and partial construction process and construction site layout, and build a 4D simulation model through Navisworks software. In this way, the dynamic simulation progress simulation model and value of architectural decoration decoration are studied and deepened and applied.

Dynamic building management based on BIM in 4D technology refers to the dynamic management of construction in time. There are many factors in the complexity of construction and decoration management. Due to the continuous development of technology and construction industry, BIM technology has been widely used in 4D construction schedule simulation. This provides a certain convenience for the construction project management work, and also ensures the effect and quality of the construction project management, which has positive significance for promoting the better development of the construction industry.

(4) BIM 5D refers to the refined management platform in the construction stage. Using the data integration capability of the BIM model, the project schedule, contract, cost, quality, safety, drawings, materials and other information are integrated and visualized (Figure 6). 5D realizes the management application of data visualization, process and archive, and provides data support for project progress, cost control and material management. Realize effective decision-making and fine management, so as to reduce construction delays, shorten construction time, control costs, and improve quality. The 5D that created BIM has become an effective tool for construction units to achieve refined project management on the construction site.
(5) BIM 6D technology can scientifically improve the economy and reliability of data center operation and maintenance. Based on the operation and maintenance system, you can deepen the operation and maintenance requirements of the customized data center on each branch. Management data through the model's intuitive feedback, simply enumerate the following points.

(a) Efficiency Manager: BIM 6D can be more efficiently managed based on visualization, and can monitor your data center in real time through mobile terminals (mobile phones, ipads, etc.), greatly improving management efficiency. If you open a iPad on a business trip or travel, you can see the information of each device in the data center and its operation status.

(b) Quality Manager: BIM 6D can effectively improve the quality of operation and maintenance. Intelligent management replaces manual management, and powerful information entry function can accurately collect information about various stages of the project and equipment, such as project planning, design, construction, equipment information, maintenance and other information. All equipment information is integrated into the model and transmitted to the operation and maintenance system through the data connection to realize intelligent operation and maintenance management. When the maintenance deadline is reached, the system will automatically generate a work order to remind the equipment to be maintained in time. The more powerful function of the BIM 6D operation and maintenance system is that the accident detection has zero tolerance for accidents. Through the dynamic monitoring and big data collection of the data center, it can receive the accident alarm in advance and kill the accident in the bud.

(c) Money steward: Under the high efficiency, high quality and energy saving and environmental protection awareness, the next most intuitive money saving problem. The data center's assessment of
energy efficiency has not only looked at PUE, but also comprehensively considered WUE, SU other indexes, and launched new energy-efficient MLC and ELC. The setting of all these standards is nothing more than a fuss about energy-saving and efficient operation and maintenance. However, BIM 6D can provide you with intelligent management, reducing energy consumption by at least 20%, saving a lot of labor, energy and maintenance costs.

4. Analysis and interpretation
At present, China's construction industry, such as water conservancy projects and electric power engineering, can effectively solve various deficiencies in the construction process. The most obvious problem is the loss of information. Therefore, the focus of attention is on the construction optimization and dynamic management of BIM and 4D technologies. It is expected to promote the development of engineering information construction in China's construction industry, improve the construction level and building performance of China's construction projects, and at the same time ensure quality. If there are more projects, and then promote social development and enhance social and economic benefits, the future has good prospects for development.

In addition, the introduction of various functions of BIM in the past, to understand BIM in the architectural decoration can be clearly defined in the 4D visual BIM technology in the dynamic decoration of the construction site construction site, timely response to the flexibility of construction, saving on-site construction time, cost...etc. This article explores the temporary construction of the interior of the customer, and does not change the main structure. BIM 4D performs process simulation, spatial, conflict checking, quantity estimation, resource allocation, etc., on the building decoration. Different operations are performed according to the needs of the on-site engineering requirements. When the requirements are different, the models and information are not completely the same because of the temporary changes in dynamics. After determining the purpose and needs, the architect can begin to establish a preliminary model. After the building and structure model is developed, the electrical and mechanical engineers will be assigned to determine the division of the MEP model. Each professional engineer can carry out BIM model construction and model integration, and then rely on the judgment and communication of professionals to detect the overlap of models. In addition to the display construction process through BIM 4D visualization, different colors can be displayed on the 3D model according to different construction schedules, and the interior decoration of different buildings can be expressed in the current construction progress. BIM 4D The dynamic display visually shows the hidden meaning behind the project at each time and simulates the construction process, instead of expressing it in the form of text or Gantt chart time, so that the manager can further grasp the progress and status of the whole project.

The visualized BIM 4D model provides constructors, designers and supervisors with more information than the drawings can display, and has better descriptive, explanatory, evaluation, and predictive engineering. Communication has become smoother, and the decision to help the execution of the project has been improved, and the quality of the project has become better. The past architectural decoration construction drawings are presented in 2D or 3D drawings. The information presented is limited, which often leads to the construction process not being able to follow the planned dynamics, and the extension of the construction period changes the original design. In the visualization of the 4D model, a more precise spatial relationship can be presented, and the BIM 4D model generated by the original 3D model plus the time relationship is applied to the pre-construction simulation. It is easier for engineers to understand the details of the project and increase the reliability and correctness of the plan so that the project can be carried out as planned. When the project area is carried out, the damage will be minimized and detected early, so that the damage rate during the construction period can be minimized.

For 4D visualization dynamic construction simulation analysis is realized by BIM software application 4D visualization dynamic construction simulation 4D simulation is based on the construction progress file and 3D model connection based on the technology. The time information in the construction progress file is specified as the component assembly time in the construction model, thereby
forming a specific construction sequence, and performing a 4D time dynamic demonstration through the visualization environment of the three-dimensional model. Based on the BIM construction software Autodest Naviswork, it is possible to check the collision between the same and different professional components. In addition, the 3D model information can effectively realize the 4D visualization dynamic construction simulation process, the building structure integration model and the electromechanical equipment model are all transformed, and the file integration is directly opened by Autodest Navisworks software. Select “timeliner” as the “.mpp” format construction schedule generated by Project and complete the construction schedule, and then set the “rules” of Autodest Naviswork to “Use the same name lowercase to assign TimeLine tasks from column names to selection sets”. This allows for an effective connection between the cross-section diagram, the 3D model, and the specific work tasks. The project is connected to Autodest Navisworks in the construction progress file.

5. Conclusion
Realize real 4D visualization dynamic construction simulation, the specific process includes several aspects:

1) Create project 4D schedule construction simulation, allowing users to simulate and analyze the construction progress with different time unit intervals and different construction sequences, and fully reflect the overall progress of the project.

2) Display the date of the day and the construction tasks completed on the day and the remaining construction tasks during the animation.

3) When the user changes the model according to the actual construction status, the system database will automatically synchronize the construction simulation and update and adjust the data.

4) Identify the construction process in the 3D model using different colors. In the Autodest Navisworks software interface, the components that have been constructed show another color of the component as shown in Figure 5.

Based on the above, the BIM technology is applied in the construction management, which effectively solves the traditional management problems caused by the lack of time dimension of the construction management mode, and is of great significance for the further development of building construction management technology. With the continuous development of technology, construction simulation will inevitably have more dimensional development directions, realize visual simulation of dynamic construction simulation to cost control, resource allocation and process simulation, and realize BIM real life cycle information construction management.

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