Research on a Revit-based 3D Collaborative Design Platform (Postprint)

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Abstract

Based on the Revit software suite, combined with shared folders and collaborative design cloud, and taking actual projects as case studies, this paper analyzes and discusses the functions of the 3D collaborative design platform and workflow, extends the 3D collaborative design methodology, and provides reference and guidance for the design of similar projects.

Full Text

Study on 3D Collaborative Design Platform Based on Revit

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Abstract

Based on Revit series software, combined with shared folders and a collaborative design cloud, this paper analyzes and discusses the functions of a 3D collaborative design platform and the 3D collaborative design process through a practical project example. The extension of 3D collaborative design applications provides valuable reference for similar projects.

Key Words: Revit; Shared Folder; Collaborative Cloud; 3D Collaborative Design Platform; 3D Collaborative Design

Introduction

3D collaborative design refers to collaborative work conducted by designers from different disciplines on a 3D design platform based on 3D digital technology

to achieve common design objectives; it is fundamentally a process of data sharing and integration. The development of BIM technology provides essential technical support for 3D collaborative design. In the future, collaborative design will no longer be merely a means of design communication, organization, and management; rather, it will integrate with BIM and become part of the design methodology itself—BIM-based collaborative design. Due to industry-specific requirements, various 3D collaborative design platforms are employed. Selecting the appropriate collaborative design platform according to specific project needs is therefore of great significance.

Revit-Based 3D Collaborative Design Platform

The Revit-based 3D collaborative design platform primarily consists of three major components: Revit series software, a shared workspace, and a collaborative design cloud. The collaborative design cloud is a customized plugin for Autodesk Revit and CAD software developed by the authors' organization after comprehensively investigating various 3D collaborative design platforms to meet its specific collaborative design requirements. It includes three main functional modules: cloud center, version management, and collaborative work. With this collaborative design cloud, designers can achieve seamless integration between 2D and 3D design.

Revit 3D Collaborative Design Process

Project Overview

The expansion project of the Chengdu Gas Company' s storage and distribution station is primarily for office use, with a total floor area of approximately 20,000 m^2, including five above-ground floors and two underground floors. The above-ground building height is 22.2 m, while the underground portion extends 9 m deep. The design scope encompasses all disciplines, requiring multiple designers to participate. The building features an irregular, non-standard shape. Due to comfort requirements, the client demanded maximizing the clear height of each floor. Given the limitations of traditional 2D design in clearance analysis, the project team decided to adopt a Revit-based 3D collaborative platform for detailed design development. The design workflow is shown in Figure 1 [Figure 1: see original paper].

Preparation Work

Development of Project-Level 3D Collaborative Design Manual The development of a project-level 3D collaborative design manual is crucial for standardizing collaborative design. After establishing project application objectives, the project manager comprehensively considers modeling depth, naming conventions for model components across disciplines, model color specifications, model splitting principles, folder naming rules, and other elements to compile the manual. Taking the architectural discipline as an example, model depth should

include design parameters for detailed construction, material specifications, fire ratings, process requirements, and other information. For instance, an infill wall between the 3rd and 4th floor levels with wall number NQ1 and thickness of 200 mm would be named 3F-NQ-NQ1_{200}, with its color matching that in the CAD drawings. Additionally, architectural designers create axis grids and elevations based on origin coordinates, which other disciplines use by linking to this model. A unified axis grid file across disciplines ensures proper alignment during model integration.

Project Template Configuration Before project model development, project templates should be established to meet drawing standards and design practices. Revit' s default template files do not comply with Chinese engineering design drawing standards. Moreover, different disciplines have varying requirements, and some settings in the system template files cannot satisfy professional needs, causing designers to spend considerable time on tedious configurations during 3D collaborative design. Therefore, before modeling, discipline-specific project template files should be created according to the unique requirements of each discipline. For example, adding MEP piping systems, unifying dimension styles, fonts, line weights, and other elements.

Standardization of Operating Systems and Software 3D collaborative design should be conducted within a unified environment to ensure consistency in design requirements and standards throughout project implementation. Therefore, project teams should standardize operating systems, software versions, and data formats. In this project, all team members uniformly used Revit 2014 and CAD 2014 software on the Windows 7 operating system.

Shared Folder Setup and Permission Management To standardize project management and file storage locations, project shared folders must be created when implementing 3D collaborative design. A project directory hierarchy is established within the shared folders according to project needs, with unified permission settings for designers' read, download, and delete access. During the early design phase of the Chengdu Gas Company' s storage and distribution station expansion project, folders were created for architecture, structure, plumbing, HVAC, electrical, clash reports, consolidated files, and other disciplines. The project manager has full permissions to create, delete, read, and download files across the entire project folder. Discipline leads can create subfolders within their respective disciplines but cannot create subfolders or delete folders in other disciplines' directories. Other designers only have upload, read, and download permissions and cannot delete any files in the project folders. This ensures secure storage and access of project information while enhancing controllability and security. Figure 2 [Figure 2: see original paper] shows the shared folder configuration.

3D Collaborative Modeling

Interaction with CAD Drawings Developing 3D models in Revit based on CAD drawings is crucial for 3D collaborative design. In the early design phase of the Chengdu Gas Company' s storage and distribution station expansion project, designers completed preliminary designs in CAD and uploaded the finished drawings to the cloud. Designers could then view them through the cloud in Revit and import the CAD drawings for modeling. Figure 3 [Figure 3: see original paper] illustrates the CAD collaboration process.

Collaborative Mode During the design process, project team members adopted the workset creation mode for data-level real-time collaborative design. Using the workset approach, team members work on the same 3D engineering information model on their local computers. Each member' s design content can be promptly synchronized to the project central file on the file server. Members can also borrow individual elements belonging to others for cross-disciplinary design, thereby achieving real-time data sharing among team members. Figure 4 [Figure 4: see original paper] shows the workset configuration.

Family File Invocation For Revit-based 3D collaborative design, families are essential elements for model construction. During model development, designers can download and invoke families previously accumulated and stored in the cloud through the "Family Favorites" feature in the "Collaborative Design Cloud," eliminating the need for redundant family creation. Simultaneously, newly created families in the project can be uploaded to the cloud for future projects. Different types of families are stored in specific folders, facilitating unified family library management while providing family sharing for other designers. Designers can conveniently invoke families when switching computers or entering other projects. Figure 5 [Figure 5: see original paper] shows the family favorites interface.

Project Information Communication In traditional 2D design, project information exchange primarily relies on internet communication tools, which require external network access. When external network failures occur, this often causes delays in information exchange. Using the Revit-based 3D collaborative design platform, team members can communicate project information through the "Instant Messaging" tool in the "Collaborative Design Cloud" even without external network access, notifying each other of design changes, version updates, or project meetings. This ensures project communication is not restricted by external network conditions. Figure 6 [Figure 6: see original paper] illustrates the instant messaging functionality.

Design Optimization and Quality Management

Design Optimization The key to design optimization lies in MEP coordination and clash detection. 3D design offers the advantage of visually displaying

equipment, pipeline dimensions, and spatial relationships. After designers from various disciplines complete their respective models in Revit, they can consolidate the full-discipline models through "linking" to detect clashes, eliminate hard clashes, and minimize soft clashes as much as possible. This optimizes clear height and pipeline layout schemes, deepens design development, and reduces error losses and rework. Figure 7 [Figure 7: see original paper] shows the architectural model, Figure 8 [Figure 8: see original paper] shows the MEP model, and Figure 9 [Figure 9: see original paper] illustrates the design optimization process.

Quality Management After modifying the clash detection model in Revit, project designers can use the "History Version" function in the "Collaborative Design Cloud" to describe the modified version and save the model to the cloud at any time. If designers need to open previous files, they can use the "History Version"tool to retrieve historical files and compare models before and after clash detection. Figure 10 [Figure 10: see original paper] shows the submission and save process, while Figure 11 [Figure 11: see original paper] illustrates history version management. Additionally, team members can upload relevant clash detection records and work logs to the cloud using the "Cloud Sticky Notes" tool in the "Collaborative Design Cloud," allowing the project manager to review them on computers or other terminal devices at any time. Figure 12 [Figure 12: see original paper] shows the cloud sticky notes interface. These process records constitute an important component of design quality management.

Extension of 3D Collaborative Design

Client-Side Collaboration After installing the "Collaborative Design Cloud" client, project participants no longer need to install professional design software. They can directly view various project files, such as RVT and DWG formats, through the client' s DWG editor and IFC browser functions. This is simple, efficient, and saves costs on purchasing certain professional software. Figure 13 [Figure 13: see original paper] shows the client interface.

Mobile Collaboration Project participants can also achieve anytime, anywhere collaborative design through the "Collaborative Design Cloud" mobile application. After installing the collaborative design cloud on Android mobile devices, users can upload and download files via mobile. During construction, project members can photograph design issues on-site and upload them to the cloud, enabling designers to make immediate drawing modifications based on the problems identified in the images. This fully realizes dynamic collaboration in 3D design and avoids the "information silo" phenomenon common in traditional design. Figure 14 [Figure 14: see original paper] shows the mobile interface.

Conclusion

3D collaborative design represents a revolutionary design approach with incomparable advantages over 2D design. The unified collaborative platform transforms the fragmented communication mode of traditional design, enabling centralized information storage and access, shortening project cycles, enhancing the timeliness and accuracy of information exchange, and improving collaborative efficiency among all project participants. The application of 3D collaborative design in the Chengdu Gas Company' s storage and distribution station expansion project demonstrates that Revit-based 3D collaborative design, combined with shared folders and a collaborative design cloud, can significantly improve design efficiency and quality. The extensions to client and mobile applications enable real-time information interaction among all project participants, achieving dynamic synchronization of design and construction progress tracking, and laying a solid foundation for comprehensive anytime, anywhere collaboration.

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Note: Figure translations are in progress. See original paper for figures.