

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

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Abstract

Based on the Revit series software, combined with shared folders and collaborative design cloud platforms, and taking actual projects as case studies, this paper analyzes and explores the functionalities of three-dimensional collaborative design platforms and their workflows, extends the concept of three-dimensional collaborative design, and provides valuable references and guidance for the design of similar projects.

Full Text

Study on a 3D Collaborative Design Platform Based on Revit

Introduction

Three-dimensional collaborative design refers to a cooperative design process undertaken by designers from different disciplines to achieve common design objectives, built upon 3D digital technology and carried out through a 3D design platform. It is fundamentally a process of data sharing and integration [?]. The development of Building Information Modeling (BIM) technology has provided technical support for 3D collaborative design. Future collaborative design will no longer be merely a means of design communication, organization, and management; rather, it will integrate with BIM to become an integral part of the design methodology itself—that is, BIM-based collaborative design [?]. Due to industry variations, the selection of 3D collaborative design platforms differs accordingly. Choosing the appropriate collaborative design platform based on specific requirements holds significant importance for effective collaboration [?].

The envisioned future model involves designers working on the same platform, under the same standards, and within the same environment, with real-time data, information, and knowledge sharing among disciplines, enabling collaborative work anytime and anywhere. This paradigm breaks the traditional design

mode' s concept of “temporal sequence,” implementing parallel design across disciplines, shortening project design cycles, achieving seamless integration of team design work, and substantially improving overall project design efficiency and quality.

The Revit 3D Collaborative Design Platform

The Revit 3D collaborative design platform primarily comprises 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 comprehensive investigation of various 3D collaborative design platforms, tailored to meet the organization' s specific collaborative design requirements. It mainly includes three functional modules: cloud center, version management, and collaborative work. Through the collaborative design cloud, designers can achieve seamless connection between 2D and 3D design.

Revit 3D Collaborative Design Process

2.1 Project Overview The Chengdu Gas Company storage and distribution station expansion project primarily serves office functions, with a total floor area of approximately 20,000 m². The building consists of five above-ground floors and two underground floors, with an above-ground height of 22.2 m and an underground height of 9 m. The design scope encompasses all disciplines, requiring participation from multiple designers. The building features an irregular-shaped structure. Due to requirements for architectural comfort, the client demanded maximized floor-to-ceiling heights on each level. Given the limitations of traditional 2D design in clearance analysis, the project team decided to adopt a Revit-based 3D collaborative platform for drawing deepening. The design workflow is illustrated in [Figure 1: see original paper].

2.2 Preparatory Work 2.2.1 Development of Project-Level 3D Collaborative Design Manual

Developing a project-level 3D collaborative design manual is crucial for standardizing collaborative design implementation. After establishing project application objectives, the project leader comprehensively considers modeling depth, component naming conventions for each discipline, 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, materials, fire ratings, process requirements, and other information for detailed components. For instance, an infill wall between the 3rd and 4th floor levels, designated as wall number NQ1 with a thickness of 200 mm, would be named “3F-NQ-NQ1_{200},” with its color matching that of the CAD drawing. Simultaneously, architectural designers create axis grids and elevations based on origin coordinates for use by other disciplines

through model linking. A unified axis grid file across disciplines ensures proper alignment during model integration.

2.2.2 Project Template File Configuration

Before model construction, project templates conforming to drawing standards and design practices should be established. Revit's default project template files do not meet Chinese engineering design drafting standards, and the system template's settings cannot satisfy discipline-specific requirements. During 3D collaborative design, designers would otherwise need to spend considerable time on tedious configuration tasks. Therefore, prior to modeling, discipline-specific project template files should be configured according to each discipline's unique requirements—for example, adding mechanical and electrical piping systems and unifying dimension styles, fonts, and line weights.

2.2.3 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 used Revit 2014 and CAD 2014 software under the Windows 7 operating system.

2.2.4 Shared Folder and Permission Setup

To uniformly manage projects and standardize file storage locations, project shared folders must be created when implementing 3D collaborative design. Within these shared folders, a hierarchical directory structure is established according to project needs, with unified permissions set for designers' read, download, and delete capabilities. For the Chengdu Gas Company project, folders were organized by discipline into architecture, structure, plumbing, HVAC, electrical, clash detection reports, and consolidated files. The project leader possesses full permissions for creating, deleting, reading, and downloading across all project folders. Discipline leaders can create subfolders within their respective disciplines but cannot create subfolders or delete folders in other disciplines. Other designers have only upload, read, and download permissions, without deletion rights for any files under project folders. This ensures secure storage and access of project information while enhancing controllability and security. The shared folder configuration is shown in [Figure 2: see original paper].

2.3 3D Collaborative Modeling The 3D model forms the core of collaborative design, with the project team's primary design activities based on the model and design outcomes primarily reflected in the model and its extended analyses.

2.3.1 Interaction with CAD Drawings

Developing 3D models in Revit based on CAD drawings is critical to 3D collaborative design. In the initial design phase of the Chengdu Gas Company project,

designers completed preliminary designs in CAD and uploaded the drawings to the cloud. Designers could then view these through the cloud in Revit and import CAD drawings for modeling. This CAD-Revit interaction is illustrated in [Figure 3: see original paper].

2.3.2 Collaborative Mode

During the design process, project team members adopted a workset-based approach for data-level real-time collaborative design. Using the workset mode, team members design on the same 3D engineering information model on their local computers, with each member's design content automatically 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. The workset approach is shown in [Figure 4: see original paper].

2.3.4 Family File Invocation

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

2.3.5 Project Information Communication Methods

In traditional 2D design, project information exchange primarily relies on external network communication tools, which can cause information delays when external networks fail. Using the Revit-based 3D collaborative design platform, team members can communicate 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, ensuring uninterrupted project communication. The instant messaging interface is shown in [Figure 6: see original paper].

2.4 Design Optimization and Quality Management 2.4.1 Design Optimization

The key to design optimization lies in pipeline integration and clash detection. 3D design offers the advantage of visually displaying equipment and pipeline dimensions and spatial relationships. After completing their respective models in Revit, designers from all disciplines can consolidate the full-discipline model through "linking" to detect collisions, eliminate hard clashes, and minimize soft clashes, optimizing clearance heights and pipeline layout schemes, deepening

the design, and reducing errors and rework. The consolidated architectural and mechanical/electrical models are shown in [Figure 7: see original paper] and [Figure 8: see original paper], with design optimization illustrated in [Figure 9: see original paper].

2.4.2 Quality Management

In Revit, after designers modify clash detection models, they can use the “History Version” function in the collaborative design cloud to document version changes and save models to the cloud at any time. If designers need to access previous files, they can use the “History Version” tool to retrieve historical files and compare models before and after clash detection modifications. The version submission and saving process is shown in [Figure 10: see original paper], and historical version management is shown in [Figure 11: see original paper].

Additionally, team members can upload clash detection records and work logs to the cloud through the “Cloud Notes” tool in the collaborative design cloud, allowing the project leader to review them at any time from computers or other terminal devices. These process records constitute an important component of design quality management, as shown in [Figure 12: see original paper].

2.5 Extension of 3D Collaborative Design 3D collaborative design can be applied not only to Revit and CAD software on computers but also extended to client and mobile applications.

2.5.1 Client-Side Collaboration

After installing the collaborative design cloud client, project participants no longer need 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—simple, efficient, and cost-saving by eliminating the need to purchase certain professional software. The client interface is shown in [Figure 13: see original paper].

2.5.2 Mobile Collaboration

Project participants can also achieve anytime, anywhere collaborative design through the collaborative design cloud mobile application. After installing the mobile app on Android devices, team members can upload and download files. During construction, site personnel can photograph design issues, upload them to the cloud, and designers can immediately modify drawings based on the identified problems. This fully realizes dynamic collaboration in 3D design, avoiding the “information silo” phenomenon common in traditional design approaches. Mobile collaboration is illustrated in [Figure 14: see original paper].

Conclusion

3D collaborative design represents a revolutionary design approach with incomparable advantages over 2D design. A unified collaborative platform transforms

traditional decentralized communication patterns, enabling centralized information storage and access, shortening project cycles, enhancing the timeliness and accuracy of communication, and improving collaborative efficiency among all project participants. The application of 3D collaborative design in the Chengdu Gas Company storage and distribution station expansion project demonstrates that the Revit-based platform, combined with shared folders and collaborative design cloud, can substantially enhance design efficiency and quality. The extension to client and mobile applications enables real-time information exchange among all participants, achieving dynamic synchronization of design and construction progress tracking, and establishing a solid foundation for comprehensive, anytime-anywhere collaboration.

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Abstract: Based on Revit series software, combined with shared folders and a collaborative design cloud, this article analyzes and explores the functions of a 3D collaborative design platform and the 3D collaborative design process through a practical project example. By extending 3D collaborative design, this paper can provide reference and guidance for similar projects.

Keywords: Revit; Shared Folder; Collaborative Cloud; 3D Collaborative Design Platform; 3D Collaborative Design

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