Research and Application of a BIM-based Construction Process Management Platform (Postprint)

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Date: 2018-10-26T00:00:00+00:00

Abstract

In recent years, dynamic construction process demonstration technology has played an increasingly important auxiliary role in engineering practice. To address the current technical situation where dynamic construction process creation has a high technical threshold, integrated management is difficult, and reusability is low, this paper achieves rapid and precise creation from the perspective of multi-source data parameter sharing. Simultaneously, by combining software engineering methodologies, a BIM-based construction process management platform was developed, realizing enterprise-level centralized creation and integrated management of dynamic construction processes, effectively assisting on-site management. Engineering practice demonstrates that the BIM-based construction process management platform can achieve integrated management and extensive reuse of construction processes, showing excellent application prospects.

Full Text

Preamble

Research and Application of Construction Process Management Platform Based on BIM Technology

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Abstract: In recent years, dynamic construction process display technology has played an increasingly important auxiliary role in engineering practice. However, the creation of dynamic construction processes faces significant technical challenges, including high technical barriers, difficult integration management, and low reusability. This paper addresses these issues by implementing rapid

and precise creation of dynamic construction processes from the perspective of multi-source data parameter sharing. Combining software engineering methodologies, we developed a BIM-based construction process management platform that enables enterprise-level centralized creation and integrated management of dynamic construction processes, effectively supporting on-site management. Engineering practice demonstrates that this platform can achieve integrated management and extensive reuse of construction processes, showing excellent application prospects.

Keywords: BIM technology; Multi-source data parameter sharing technology; Construction process management platform

1. Introduction

With the continuous improvement of engineering construction standards, BIM technology has become increasingly widespread in the construction industry. Numerous engineering practices have shown that BIM technology has endowed the construction industry with new technological vitality [1]. In 2016, the "China Construction Industry Informatization Development Report"compiled under the leadership of the Ministry of Housing and Urban-Rural Development conducted extensive research on the "application coverage" and "recognized application value" of BIM technology for the construction industry. The results indicated that the application of BIM technology in construction process display currently represents the most widely covered and highest value-recognized application content in the engineering construction sector [2].

In engineering practice, traditional construction process displays have primarily relied on "static display," which suffers from certain technical limitations. For instance, static display lacks sufficient dimensional depth, making it difficult to comprehensively reflect the technical and quality control points within construction processes. More importantly, it cannot fully represent the rich and complex logical sequences, timing coordination, and other core elements inherent in construction processes. Against this backdrop, "video display" represented by 3Ds Max has gradually become the mainstream approach for construction process presentation.

As engineering practice has evolved, video display has played an increasingly significant role in supporting construction activities. However, this approach also faces notable technical bottlenecks: high creation technical barriers, difficult integration management of video display outputs, low reusability, and particularly the frequent separation of video display results from BIM data, which restricts its application in engineering practice [3]. Therefore, how to deeply integrate "static display" and "dynamic display" to fully leverage their respective technical advantages, and how to utilize modern information technology to reduce the technical barriers for video display creation while achieving integrated management and extensive reuse of construction processes, have become new demands in the construction industry.

2. Research on Multi-Source Data Parameter Sharing Technology

Parameter sharing represents a distinctive technical feature of BIM technology and serves as the foundation for BIM to fully 发挥其辅助建造作用 throughout the entire construction lifecycle [4]. Based on engineering practice, we have identified that insufficient parameter sharing capability among multi-source data constitutes the primary technical constraint hindering the development of BIM-based construction process management platforms.

To address this technical challenge, we investigated construction process parameter sharing technology based on Suite workflows. From the perspective of front-end data preparation, we explored a multi-source data parameter sharing approach suitable for BIM-based construction process creation, thereby establishing a solid foundation for the research and application of BIM-based construction process management platforms.

2.1 Basic Principles

In our research, we utilized BIM data as source data, 3Ds Max data as target data, and Suite workflow as the parameter sharing medium. Through parameter export and transfer, we achieved parameter sharing between the two platforms.

2.2 Implementation Process

The implementation process for multi-source data parameter sharing based on Suite workflow is illustrated below:

[Figure 1: see original paper]

2.3 Implementation Method

The Suite workflow-based multi-source data parameter sharing technology consists of the following steps:

(1) Suite Workflow Creation
Suite workflow is a parameter sharing medium directly embedded within Autodesk products provided by Autodesk. It installs automatically with Autodesk products and enables parameter sharing between Autodesk products of the same version.

[Figure 2: see original paper]

(2) Parameter Export
The second step involves parameter export. In the Revit environment, parameter export includes the export of link relationships between source and target data. The significance of exporting these link relationships lies in enabling Suite workflow to propagate changes from source data parameters to target data when

modifications occur. Additionally, parameter export in Revit includes material properties, lighting attributes, and camera properties.

[Figure 3: see original paper]

(3) Parameter Transfer
The third step is parameter transfer. In the 3Ds Max environment, parameter transfer facilitates the propagation of parameters from source data to target data.

[Figure 4: see original paper]

This completes the entire process of multi-source data parameter sharing based on Suite workflow.

2.4 Performance Analysis

Currently, besides the Suite workflow method, commonly used multi-source data parameter sharing technologies include methods based on intermediate media (DWG, FBX) and direct linking methods. Here, we analyze the performance of these three approaches—Suite workflow, intermediate media (DWG, FBX), and direct linking—from two perspectives: parameter sharing effectiveness and work efficiency.

2.4.1 Parameter Sharing Effect Analysis In engineering practice, we analyzed the effectiveness of these three parameter sharing technologies based on over 100 BIM data and 3Ds Max parameter sharing samples. The results are as follows:

The analysis reveals that all three methods can transfer component types, quantities, and dimensions from BIM data to 3Ds Max data. However, regarding process video inheritance, only Suite workflow enables this capability. Consequently, Suite workflow demonstrates significant technical advantages in enhancing BIM model reusability compared to the other two methods.

2.4.2 Work Efficiency Analysis Currently, parameter sharing from source to target data involves four stages: BIM data organization, conversion settings, 3Ds Max data organization, and material addition. We analyzed the performance of the three parameter sharing technologies based on time spent in these four stages.

[Figure 5: see original paper]

[Figure 6: see original paper]

The results demonstrate that Suite workflow offers significant technical advantages in reducing parameter sharing time and improving technical personnel efficiency, both in overall work efficiency and across the four individual stages.

3. Research and Application of BIM-Based Construction Process Management Platform

Since 2013, we have conducted multiple training sessions on construction process display based on BIM and 3Ds Max data for various subsidiaries, exploring innovative and universal applications of construction process display in ongoing projects. As our work progressed, we observed that while subsidiaries had created and accumulated a collection of construction process outputs based on BIM and 3Ds Max data, these outputs exhibited several characteristics due to uneven BIM technology development and diversified business domains. First, the creation quality varied significantly with inconsistent standardization levels. Second, considerable duplication in creation existed among subsidiaries. Third, the discrete storage approach hindered sharing, circulation, and centralized control of outputs across projects and within the enterprise. To address these issues, we developed a BIM-based construction process management platform to achieve integrated management and extensive reuse of construction processes [5][6].

3.1 Basic Principles

In this research, we used Java as the programming language and developed the BIM-based construction process management platform from an enterprise centralized control perspective to achieve integrated management and extensive reuse of global outputs.

3.2 Implementation Process

The implementation process is illustrated below:

[Figure 7: see original paper]

3.3 Implementation Method

3.3.1 Construction Process Data Creation Construction process data creation involves the following steps:

(1) Process Directory Compilation
We invited on-site technical personnel to compile a multi-disciplinary construction process directory based on the advancement and reusability of construction processes.

[Figure 8: see original paper]

(2) Text Template Development
Based on the process directory, we developed text disclosure templates. During development, we focused on standard compliance, construction preparation, process flow, construction methods, quality requirements and assurance measures, precautions, finished product protection, and safety and civilized construction.

The research and development team created these templates to form a text library.

[Figure 9: see original paper]

[Figure 10: see original paper]

(3) Resource Library Creation
We summarized commonly used construction materials and machinery to create image libraries for both.

[Figure 11: see original paper]

(4) BIM Template Creation
We centralized BIM technical backbone personnel from subsidiaries to create BIM model templates and BIM family file templates. During creation, we emphasized software support for templates, based on which the R&D team developed BIM models and BIM family files.

[Figure 12: see original paper]

[Figure 13: see original paper]

(5) Dynamic Process Creation
Using BIM data as source data, we created BIM-based dynamic construction processes to form a dynamic process library.

[Figure 14: see original paper]

This completes the creation of various types of construction process data. Subsequently, we developed the construction process management platform to achieve integrated management of these data.

3.3.2 Platform Functionality Overview Following object-oriented software development methodology, we developed the construction process management platform using Java as the programming language and BIM and 3Ds Max as the foundational data [7][8].

[Figure 15: see original paper]

[Figure 16: see original paper]

The platform interface is shown above. The construction process management platform supports three usage modes: web, PC, and mobile.

[Figure 17: see original paper]

[Figure 18: see original paper]

[Figure 19: see original paper]

[Figure 20: see original paper]

[Figure 21: see original paper]

The platform features the integration of "text + images + BIM data + dynamic video" and achieves centralized control of construction process data from the perspective of these four major data resource categories.

[Figure 22: see original paper]

The data statistics and analysis function is illustrated above. This function enables dynamic statistics on user distribution regions, download quantities of various construction process data types, and other metrics. Based on these results, we can strategically determine subsequent R&D priorities.

[Figure 23: see original paper]

[Figure 24: see original paper]

Using authorization codes and employee IDs, a two-level authentication and review mechanism between headquarters and subsidiaries ensures data security for the R&D outcomes.

4. Engineering Practice

Currently, the phased R&D results have been extensively trained, trialed, and promoted across subsidiaries, with continuous refinement based on on-site application feedback. This paper presents engineering practice across over 40 projects, including Qingdao New Airport, Chongqing Raffles, and Cambodia National Stadium projects.

[Figure 25: see original paper]

[Figure 26: see original paper]

[Figure 27: see original paper]

Engineering practice demonstrates that these results have delivered significant auxiliary effectiveness and promotion prospects, whether in bidding or construction phases, for enhancing employee business skills or delivering precise technical briefings to labor teams, receiving widespread acclaim from all project participants.

This paper addresses practical engineering needs by achieving construction process parameter sharing and data reuse between BIM and 3Ds Max data based on Suite workflow. On this foundation, we independently developed a BIM-based construction process management platform. Engineering practice confirms that the BIM-based construction process management platform can achieve integrated management and extensive reuse of construction processes, demonstrating excellent application prospects.

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