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

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Abstract

In recent years, dynamic construction process demonstration technology has played an increasingly significant role in assisting construction within engineering practice. To address the current technical challenges of high creation barriers, difficult integrated management, and low reusability for dynamic construction processes, this paper achieves rapid and precise creation from the perspective of multi-source data parameter sharing. Furthermore, by employing software engineering methodologies, a BIM-based construction process management platform was developed, enabling enterprise-level centralized creation and integrated management of dynamic construction processes, thereby effectively facilitating on-site management. Engineering practice demonstrates that the BIM-based construction process management platform can realize integrated management and extensive reuse of construction processes, exhibiting excellent application prospects.

Full Text

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

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Abstract: In recent years, dynamic construction process visualization technology has played an increasingly important auxiliary role in engineering practice. However, dynamic construction processes face significant technical challenges, including high creation thresholds, 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. Combined with software engineering methodologies, we have 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

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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 [**?**]. 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 "application value recognition" of BIM technology for the construction industry. The results indicated that BIM technology application in construction process visualization is currently the most widely covered and highest value-recognized application content in the construction industry [**?**].

In engineering practice, traditional construction process visualization has primarily relied on "static display," which suffers from certain technical limitations. For instance, static displays lack sufficient dimensionality and cannot comprehensively reflect the technical and quality control points in construction processes, let alone capture the rich and complex logical sequences and intersection timing that constitute core elements of construction processes. Against this backdrop, "video display" technologies represented by 3Ds Max have gradually become the mainstream approach for construction process visualization.

As engineering practices have evolved, video display technologies have played an increasingly significant role in supporting construction activities. However, this approach also faces several technical bottlenecks: high creation thresholds, difficult integration management of video display outputs, low reusability, and particularly the frequent separation of video display achievements from BIM data, which limits its practical application [**?**]. Therefore, how to deeply integrate static and dynamic displays to fully leverage their respective technical advantages, and how to utilize modern information technology to reduce the creation threshold for video displays while achieving integrated management and extensive reuse of construction processes, have become new demands in the construction industry.

Multi-Source Data Parameter Sharing Technology Research

Parameter sharing represents a distinctive technical feature of BIM technology and serves as the foundation for its full supportive role throughout the entire construction lifecycle [**?**]. 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 pathway suitable for BIM-based construction process creation, laying a solid foundation for the research and application of BIM-based construction process management platforms.

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.

Implementation Process

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

[Figure 1: see original paper]

Implementation Method

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

1. **Suite Workflow Creation:** Suite workflow is a parameter sharing medium embedded directly 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 establishing link relationships between source and target data. The significance of exporting these relationships is that when parameters in the source data change, Suite workflow automatically propagates these changes to the target data. 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.

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.

Parameter Sharing Effectiveness 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 table shows 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. This demonstrates that Suite workflow offers significant technical advantages in improving BIM model reusability compared to the other methods.

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 analyze 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 figures demonstrate that Suite workflow provides significant technical advantages in reducing parameter sharing time and improving technical staff efficiency compared to the other three methods, both in overall work efficiency and in each of the four individual stages.

BIM-Based Construction Process Management Platform Research and Application

Since 2013, we have conducted multiple training sessions on construction process visualization based on BIM and 3Ds Max data for various subsidiaries, exploring innovative and universal applications of construction process visualization in ongoing projects. As our work progressed, we observed that while subsidiaries had created and accumulated a collection of construction process achievements based on BIM and 3Ds Max data, several characteristics emerged due to uneven BIM technology development and diversified business areas: (1) significant variation in creation quality and standardization levels; (2) considerable redundant creation across subsidiaries; and (3) discrete storage methods that hindered sharing, circulation, and centralized control of achievements among project sites 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 [**?**][**?**].

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 achievements.

Implementation Process

The implementation process is illustrated below:

[Figure 7: see original paper]

Implementation Method

Construction Process Data Creation Construction process data creation includes the following steps:

1. **Process Catalog Development:** We invited on-site technical personnel to compile a multi-disciplinary construction process catalog based on the advancement and reusability of construction processes.

[Figure 8: see original paper]

2. **Text Template Compilation:** Based on the process catalog, we developed text disclosure templates. During compilation, we emphasized standardization, 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 compiled these text disclosure 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 various 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 families.

[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. Based on this foundation, we developed the construction process management platform to achieve integrated management of all construction process data.

Platform Function Introduction Using 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 [**?**][**?**].

[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-based, PC, and mobile platforms.

[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 technical characteristic of combining "text + images + BIM data + dynamic video"to achieve centralized control of construction process data from the perspective of integrating these four major data resources.

[Figure 22: see original paper]

The data statistics and analysis function is shown above. This function enables dynamic statistics on user distribution areas, download quantities of various construction process data types, and other metrics at any time. 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 through a two-level authentication and review mechanism at the headquarters and subsidiary levels, we ensure data security for the R&D achievements.

Engineering Practice

Currently, the phased R&D achievements have been extensively trained, trialed, and promoted across various subsidiaries, with continuous refinement based on on-site application feedback.

This paper takes Qingdao New Airport, Chongqing Raffles City, and Cambodia National Stadium projects as examples, with implementation across more than 40 projects.

[Figure 25: see original paper]

[Figure 26: see original paper]

[Figure 27: see original paper]

Engineering practice demonstrates that this achievement has played a significant auxiliary role and shows promising application prospects, whether in the bidding phase or construction phase, for improving business skills of enterprise employees or for precise disclosure to labor teams, receiving widespread acclaim from all project participants.

This paper addresses practical engineering needs, achieving construction process parameter sharing and data reuse between BIM data and 3Ds Max data based on Suite workflow. On this foundation, we independently developed a BIM-based construction process management platform. Engineering practice shows that this 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.