Application Status of BIM Collaborative Design in Architecture Major

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Abstract: After the concept of BIM (Building Information Modeling) was proposed around 2000, it developed slowly. With the rapid development of hardware, the IFC standard provides reference standards for BIM collaborative design, enabling BIM collaborative design to effectively solve the shortcomings of traditional 2D drawing design and become a new market trend.

Keywords: BIM; Collaborative design; Collision test; VR

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DOI: http://doi.org/10.30564/frae.v1i3.66

1. Introduction

China's fixed assets investment, from 3.7 trillion in 2001 to 60.65 trillion in 2016, increased by about 20 times in 15 years, belonging to the national pillar industry. One of the main manifestations of fixed assets is engineering projects. The complexity of engineering projects is constantly improving and the design cycle is compressed. The traditional design methods can no longer meet the market demand.[1] The design fee is generally less than 1% of the total life cost of the construction project, but it is the cost of this less than 1% that affects the investment up to 75%.[2] In the design of individual projects, the choice of construction and structural schemes and the selection of construction materials have a great impact on investment.[3]

Collaboration is the process of sharing information, analyzing information, and improving information. The high efficiency, synergy and collision verification of BIM collaborative design effectively solves the contradiction between project complexity and design cycle compression.

In China, BIM technology started to lag behind Western countries, and it was not until 2001 that it was valued and developed, but the penetration rate has not been high. With the continuous improvement of green building, energy conservation and environmental protection requirements, and the to reduce design loopholes and errors, the "Architecture Industry Informatization Development Outline (2011-2015)" proposes: Promote the construction and application of collaborative design systems based on BIM technology, improve engineering survey problem analysis ability, improve the level of detection, monitoring and analysis, and improve the degree of design integration and intelligence. The "Architecture Industry Informatization Development Outline (2016-2020)" further proposes to promote BIM-based collaborative design, carry out data sharing and collaboration among multiple professions, optimize the design process, and improve design quality and efficiency. Conduct research and development of BIM-based integrated design systems and collaborative work systems to achieve information integration and sharing of architecture, structure, plumbing and other professionals.

With the development of technology and economy, the complexity of a construction project is increasing, and the design work becomes a team work. The team involved various professional designers, based on the architectural drawings to do secondary design in structure, water supply and drainage, ventilation and air conditioning, fire alarm, strong electricity, weak electricity and other professional design. At present, all majors in the society are developing corresponding BIM software, each with its own advantages and disadvantages. Therefore, communication between majors requires a public BIM platform.

The international IFC standard (Industry Foundation Class) enables data on different software to be shared without loss, providing a common platform for collaborative design. There are also two standards in the IDM (Information Delivery Manual) and IFD (International Framework for Dictionaries).[4] Collaborative design is to use the same set of standards to complete the same design project in the same environment. During the design process, each major is designed in parallel, and the communication is accurate and timely.[5]

2. BIM Collaborative Design Support Software

Currently, BIM software commonly used in the architectural engineering design market includes Revit, Tekla, MigiCAD, Lumion, Navisworks and other software.

Revit software is one of the BIM products of Autodesk in the United States, which can realize 3D design work in architecture, structure and installation in the same model. Because of professional features and database issues, it is commonly used in architecture and structural design. Basic models and platforms can be provided for BIM collaborative design through the IFC standard.

Tekla is mainly used in the design of steel structures. It can automatically generate steel structure details and various reports after creating a 3D model to achieve convenient view functions.

MigiCAD is an installation design software based on AutoCAD or Revit software for secondary development. Mainly used for professional module design of heating, ventilation, air conditioning, water supply and drainage, spraying and electrical. The software integrates conventional installation equipment and well-known brand equipment to ensure the normal installation and use of the equipment and to solve collision problems.

Lumion is a real-time 3D visualization software that can deliver live demonstrations, increase lighting, ventilation, surrounding environment, climate and other factors for simulation rendering, providing a foundation for VR and AR technology implementation.

Navisworks enables real-time visualization while supporting roaming and checking user time and space coordination. A model with all kinds of professional architecture information is formed by integrating 3D data of various formats of various professions. Promptly check and discover errors and collisions in the building. Allowing designers to modify building models before plotting can effectively avoid design changes caused by errors, collisions, and omissions.

3. Collaborative Design Goals

3.1 Reduce the Occurrence of Errors Such as "Errors, Missing Items, and Collisions" and Improve the Quality of Drawing Design

The construction engineering design involves a wide range and a wide range of professions. Complex projects require high depth requirements and precision, while the designers have a single business capability and do not understand other professional design technical points. Designers who specialize in the industry are difficult to coordinate in depth and breadth. Therefore, there will be design parameter errors, missing items, and collisions between different professions.

When structural engineers and installers design their own professional architectural drawings, the space requirements and understandings form a hard collision due to insufficient communication. These collisions led to later modifications to the design and changes to the design drawings. At the same time, some designers have limited professional knowledge and generally only engage in a single business content. Due to insufficient coordination between the various professions, there is a conflict between the occupations of space between different professions. BIM collaborative design can test collisions between different professions during the design process. Based on the Revit platform, MigiCAD can perform collision testing for building and installation professionals to solve some collision problems. All professional softwares are imported into Navisworks through the IFC protocol, which enables collision testing between majors.

3.2 Visual Design to Form a "What you See Is What you Get" Design pattern

In the conventional architectural design, the designer needs to form a two-dimensional drawing through the projection of the three-dimensional engineering design plan through the flat, vertical and sectional views according to his own imagination to the space. Other designers based on this design drawing need to convert the 2D into 3D according to the 2D drawings and further design. Then the design is formed into a two-dimensional drawing, which is passed down in turn. Everyone needs to see a three-dimensional building by imagination. BIM collaborative design can realize three-dimensional design, transfer the model downward through IFC protocol, realize the whole process three-dimensional design, and visually visualize.

3.3 Solve Complex Engineering Design Accuracy, Optimization and Control Issues

Among the many reasons for engineering quality accidents, design quality problems rank first.[6] Many large and complex construction projects are not reasonable enough due to the design of the functional design, or the lack of precision control, affecting the normal use of the building. Some professional designs conflict with each other, causing the construction process to occur due to design errors, rework, and change. Some cause quality defects and safety hazards, causing huge losses to the country and the people, resulting in waste of investment and increased project cost.[6]

3.4 VR (Virtual Reality) and AR (Augmented Reality) Technology Enhance Design Interaction and Enable Customers to Participate in Design and Improve Design Quality

In the conventional design, after the customer proposes the design requirements, the designer needs to design according to his own understanding. In the process of information exchange, deviations often occur due to differences in expression and understanding. For non-professional customers, it is not possible to use 2D drawings to understand the appearance, size and size of the construction project. Deviations from information exchange will continue until the project entity is created, causing irreparable defects or increased costs due to program changes.

VR design can create a virtual simulation system through BIM software to simulate the design environment. Customers can intuitively feel the design through the VR eye design. Correctly correct and modify the design deviation caused by the expression and understanding deviation to improve the design quality.

AR technology is based on the development of VR technology, which can superimpose virtual design schemes in real world information for seamless integration. The design that could not be experienced in the real world is perceived by human senses in a certain time and space.

4. There Are Still Existing Problems with BIM Collaborative Design

4.1 The Penetration Rate of BIM Technology Is Not High

Experienced designers are not well-recognized with new technologies and can't master new technologies in a short time. Young designers have the ability and speed to accept new things, but lack practical design experience and are difficult to be responsible for complex projects. Complex projects require multi-person collaboration and it is more difficult to organize BIM design teams.

4.2 BIM Collaboration Costs Are Too High

Because BIM technology is developing rapidly, software and hardware are getting shorter and shorter, and Revit, for example, will release a new version every year. The addition of new software features means more and more hardware space. The single interface software is tens of thousands, and the professional drawing workstation market price ranges from tens of thousands to hundreds of thousands. At the same time, it takes more time and money to train the designers. The IFC protocol can transfer models almost perfectly and requires near-perfect model design. Short-term training is difficult to meet the demanding model requirements.

5. Conclusion

The BIM collaborative design is based on a unified universal protocol, which can solve the problem of poor communication of designers in the traditional two-dimensional drawing design because of relative independence. BIM collaborative design improves design quality while shortening design cycle, better meeting the design needs of complex construction projects while reducing costs. At the same time as the rapid development of BIM technology, it is also necessary for all parties to work together, and BIM really plays its role.

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