

Application and Practical Research of BIM5D in Intelligent Construction Engineering Design

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Abstract

In order to determine the application of BIM5D in engineering design, the authors are familiar with BIM5D through the author's practical BIM5D technology. At the same time, the authors investigate the degree of understanding about BIM5D, its application and the important impact of BIM on the construction industry. In the information-based society, the traditional way of building is relatively backward. Using BIM5D as an intelligent construction technology is more in conformity with the progress of time. BIM5D is adopted to comprehensive use of the environmental, technical, economic, resources and other conditions which are required for intelligent construction projects, effectively improving the efficiency of engineering design. Simultaneously, BIM5D increases the work intensity of designers and requires personnel to be professional in BIM technology. To use a clearer perspective to reflect the overall planning and specific construction intent of the project, BIM5D is used. BIM5D effectively improves the engineering design, while meeting the functional needs of the project and the individual needs of the users. The rapid development of BIM technology has promoted the transformation and upgrading of the construction industry and opened up a new development direction for the construction industry. Under the "Internet +" development model, BIM5D alleviates the problem of missing credit and the conversion between different documents in the construction process. However, there are still some problems in the application of BIM5D to practical engineering.

Keywords

BIM5D; Intelligent Construction; Engineering Design; Practical Research.

1. Introduction to BIM5D Technology

Building Information Modeling is known as a digital model of the buildings. BIM5D is based on the three dimensions of the original BIM technology, expanding the cost and time dimensions to form a five-dimensional data model[3]. BIM5D integrates quantity, project progress and cost information. Post-BIM5D links the 3D model and construction progress of building components, dynamically simulates the construction process and monitors the construction progress and cost in real time. As a platform for the exchange and sharing of engineering construction information, BIM5D effectively improves the integration of construction engineering information. Design enterprises apply BIM technology to improve the design model, enhance the value of design products and improve market competitiveness. In practical applications, the specific process is shown in Figure1 [1]. First, select the model data of the required profession among many majors involved in BIM. Secondly, select the appropriate modeling software to design the model file. Thirdly, export 5D integration file into the full- professional BIM5D model. And finally, kinds of applications of the BIM are carried out according to the integration data.

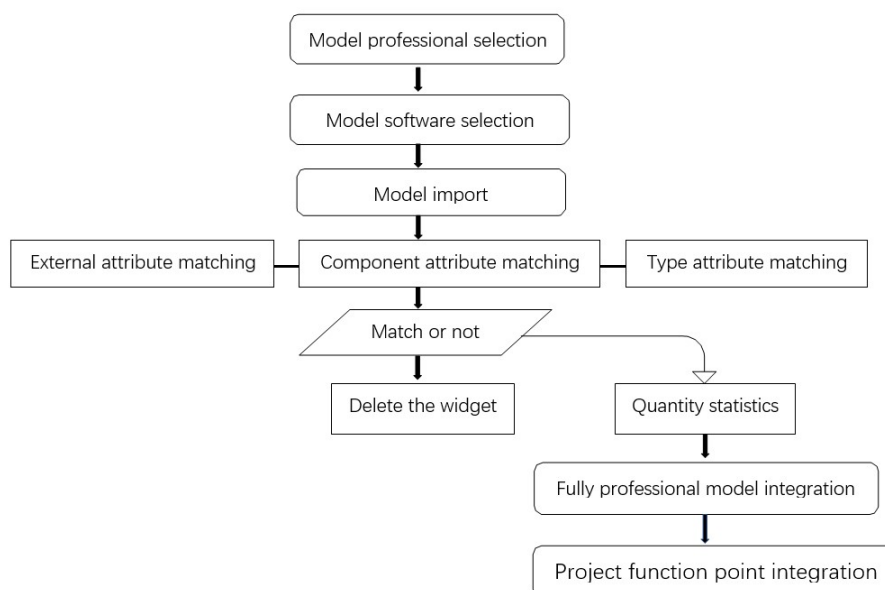


Figure 1. BIM5D application process

2. The Development Process of BIM5D Technology

2.1 Background of Technology Generation

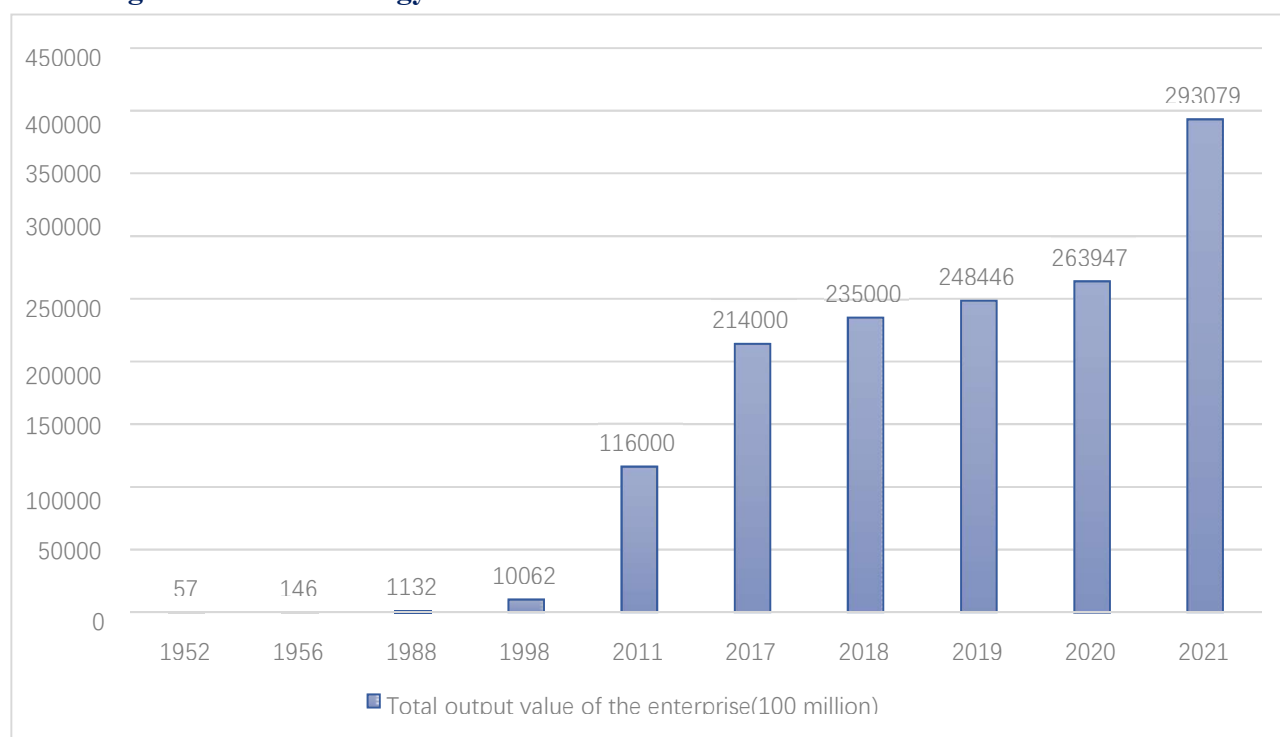


Figure 2. The total output value of national construction enterprise at each stage

Old buildings are constantly aging. The construction of new buildings now has more complex requirements. In the 72nd anniversary of the founding of New China, the national construction industry has developed rapidly. The scale of enterprise output value continues to expand, constantly breaking through the record (Figure 2). The total output value of construction enterprises in the country increased from 5.7 billion in 1952 to 29307.9 billion in 2021. At the same time, the townspeople's per capita housing floor area is increasing year by year. The construction industry has become a pillar industry in China. In an informatized and intelligent society, the construction industry needs an efficient, accurate and simple technology to transform the construction industry to intelligent

construction and adapt to the development of the times trend. During this period, some major basic projects related to the national economy and people's livelihood were built, such as the Qinghai-Tibet Railway Road and the Hua long No. 1. China is launching the "Built in China" brand internationally. However, the information connection between the various modules of traditional engineering design is not smooth, and it is easy to cause the lack of information when sorting out information. It not only slows down the progress of the project, but also requires a lot of additional manpower and material resources.

2.2 Foreign Development and Existing Circumstance

In foreign countries, many researchers, enterprises and departments have made significant contributions to the application of BIM technology. First, American professor Chuck Eastman was internationally recognized the earliest researcher on BIM. He provides theoretical requirements for the study of BIM techniques. Concurrently, the UK construction industry has developed a series of standards for BIM-related software and analyzed three phases of BIM application (Phase 1: the participation project itself to establish a suitable a database; Phase 2: designers provide BIM model information and establish synergies with the participants; Phase 3: full cooperation between the participants). Foreign business models focus on long-term development, and the degree of industry standardization, specialization, standardization and marketization has the same characteristics as BIM. Foreign countries not only have a complete BIM solution for the project construction process, but also further deepen the study of how BIM affects the project organization relationship, so foreign countries have already crossed 5D to construction phase. Many related application software abroad, such as Autodesk, Bentley, Tekla, etc. are widely used in the construction process. According to foreign research and application status, it can be seen that the application of foreign BIM technology not only breaks through the dimensions of time and cost in the project itself, but also forms through BIM ideas and technologies, achieving multi-dimensional comprehensive utilization and development. And more importantly, it has begun to study all aspects of the project and the people, materials and things involved.

2.3 Domestic Development and Existing Circumstance

In China, the expected development of BIM by early governments and industry leaders is less clear and optimistic than that of foreign countries. The expression of digital goals and standard setting are incomplete. It will inevitably make the research and development of BIM in China lag later than that of foreign countries, but the popularity of BIM will continue to increase under the condition of clear BIM trends. According to the statistics bureau, the market size of the BIM industry in 2020 is about 260 billion. The development space of BIM is extremely extensive. BIM lectures and training courses are held regularly throughout the country. From design institutes to construction companies, they actively participate in national or local BIM competitions. In 2006, the Housing Authority of Hong Kong, China piloted the application of BIM to project construction, which was the earliest research on BIM in China. It published the first edition of the application standard. At present, domestic BIM enterprises mainly have three aspects: software research and development, inquiry and training. Many of the bidding projects pay more and more attention to the application requirements of BIM in engineering construction. BIM penetration and pilots are increasing, such as the Shanghai Center, the Beijing Water Cube and the China Expo Convention and Exhibition Complex Project. Although there are already many demonstration projects in China, BIM technology has not yet been widely promoted, which has complex relationships and many factors. Since the release of the first BIM application standard in China on July 1, 2017, many provinces and cities have begun to promote the application of BIM technology and issue a series of guidance documents. The construction industry and many universities have also seen the bright trend of BIM in the future and have begun to train a large number of counterpart talents that BIM needs. Looking at the development of BIM in China, it can be divided into three stages: the first stage, research on relevant standards; the second stage, software development and application pilots; and the third stage, the release of standards and national support policies and related software. During the development of BIM, many researchers continue to make

up for the shortcomings, and the research and development system have made great contributions to the development of China's BIM field.

3. The Problems and Strategies in BIM5D Applications

3.1 Problems with BIM5D in Applications

(1) Problems of the software

The research time of BIM5D in China is not long. There are problems with many aspects of BIM software. First, it can be imported but cannot be changed. For example, if you import a REVIT model, you can only modify the model in REVIT, and you cannot correct it in BIM. There is no doubt that the problem is time-consuming and resource-intensive. Second, the compatibility is poor. It is easy to cause missing information when importing different format models, and it is not supported to merge two or more files.

(2) Lack of BIM5D technical talents

BIM5D has not really been applied to building construction for a long time. Most people's understanding of construction and construction is still stuck in traditional construction, and they are not aware of the technical changes and information-based buildings brought about by BIM. Seize the opportunity now to learn about learning BIM.

3.2 Strategies

For these problems in the software, the main thing is to make the software developer aware of the existence of these problem. That requires users to give feedback to the developer, rather than encounter software problems to denigrate the software or not use it. Developers also need to pay attention to consumer feedback to solve technical problems. At the same time, software developers set up corresponding training courses to improve the professional capabilities of technical personnel. Changing the mind and promoting the old ideas of BIM5D technology are stubborn, and it is necessary to reverse the view and adapt to the new ideas in order to adapt to the continuous development exhibition of information intelligent society. BIM5D technology is an opportunity for the construction industry. The informatization of buildings has become an inevitable event, and we need to accept this change and promote BIM5D, a software that improves the efficiency of the construction industry.

4. Advantages of BIM5D Application in Intelligent Construction Engineering Design

The biggest feature of BIM is information attribute, which is widely adapted to the entire project cycle (Figure 3). The project cycle includes five phases: operation management, construction, detailed design and tender, preliminary design and feasibility study. Among the various phases, the design phase has the largest number of people who regularly use the BIM and the least number of people who never use it. The evolution of the design model of the latecomer design enterprises mainly involves value and technology and core elements such as partnerships, dynamic and complex relationships between each element at different stages of BIM application. Designers use the characteristics of BIM technology such as informatization, modeling, and collaboration to design the structure inside and outside building. It involves the initial establishment of the building structure model, the substitution of structural analysis software and the subsequent dynamic update of the structure [6], which can make the building structure more consummate and improve the design efficiency.

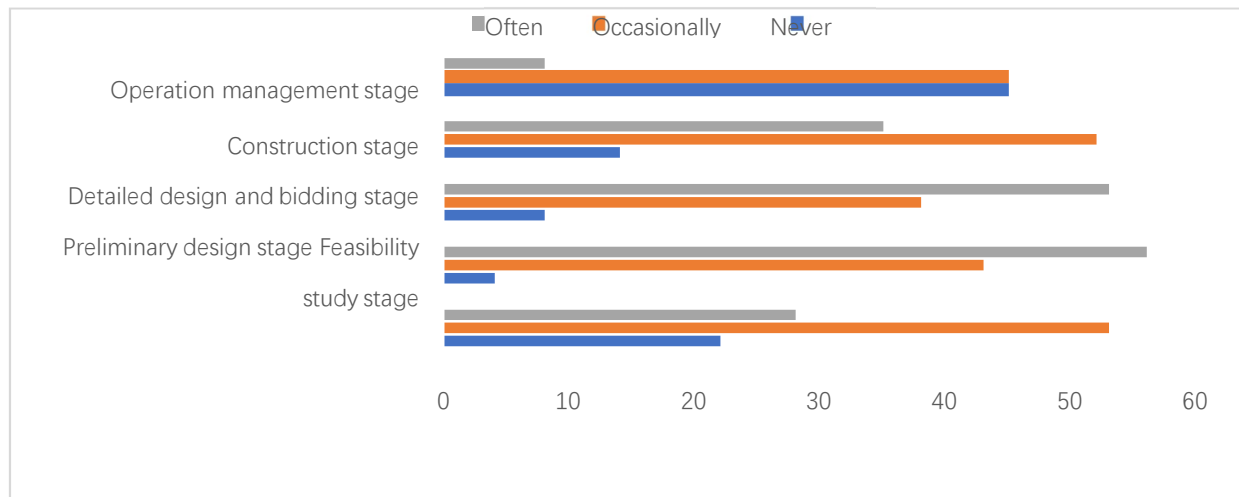


Figure 3. BIM used in each stage of the project

4.1 Visual Acquisition of Complete Information, Convenient for Designers to Design Ideas

BIM5D engineering design is different from the two-dimensional plane of traditional design drawings, and adopts a multi-dimensional spatial perspective to give designers an intuitive feeling. By getting closer to real life, designers are able to easily observe the composition of the various parts of the building. Meanwhile, managers also clearly understand the information and ideas expressed by the designer's engineering design, enhance the communication with designers and the subject, and avoid unnecessary contradictions and the loss of management information. BIM5D reflects large-scale projects on the BIM model, and then overcomes these problems of complex construction, difficult process, lengthy construction and difficult management of most super-large projects. According to the visual dynamic demonstration process of BIM technology, we comprehensively compare different construction schemes, select the optimal scheme, and assist in technical disclosure work [3].

4.2 "Try first and build later" to Find Design Vulnerabilities in Advance

Engineering projects have one-time points. In traditional construction model, it is obviously impossible to "try first and build later", and once the construction begins, there is basically no opportunity to solve the problems in the design, such as resulting in loss of materials, money and manpower. In BIM technology, the construction simulation is first carried out in the software. Design problems and design defects are found, and the design scheme is trimmed before the real construction, which effectively reduces the risks in the project.

4.3 Information Sharing and Efficient Collaboration

When engineering management is carried out through BIM technology, a sterling collaborative working environment can be created, and participants could discuss the problems existing in the project. Collaborative work is a major advantage of BIM, and participants in all disciplines and stages could work "synchronously" based on the same model and unified information standards to achieve real-time collaborative operations [2]. In the BIM collaborative operation mode, the work content of each designer becomes part of the overall model, and each participant completes the overall design model based on common modeling standards.

5. The Future of BIM5D

BIM users are mainly young people, and the TGI (Target Group Index) index reflects the dominance of young people. It means that in the future, a large number of users with BIM knowledge will take up leadership positions, affecting the implementation and development of BIM technology. Policies have played a significant role in promoting the development of BIM. In the future, BIM policies could accurately exert efforts from these aspects of BIM talent training, professional certification, independent software research and development, urban information, and promote the development of

BIM technology in a deeper and broader direction[5]. China has issued a series of related policies such as "Internet +", big data, and prefabricated buildings. Information technology such as cloud computing, Internet of Things, and mobile communications has also developed rapidly.

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