The Teaching Reform of Civil Engineering in the Direction of Prefabricated Building Based on BIM

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Abstract. With the promotion and application of BIM technology and prefabricated structure in the construction field of China, the construction industry has gradually entered the era of informatization and industrialization. There is a growing demand for applied talents in civil engineering who master BIM and prefabricated structure technology in the construction job market. However, the talent development of BIM and prefabricated structural technology in civil engineering of Chinese universities is still in the exploratory stage. This paper systematically illustrates the necessity of developing a combination of BIM and fabricated structural technology, and the problems encountered by undergraduate colleges in training construction-related technical talents. The reform plan of prefabricated structure based on the BIM technology in civil engineering was put forward which provided a reference for the teaching reform of civil engineering in colleges and universities.

Introduction

The Building Information Model (BIM) is based on all kinds of data and information of construction projects. It can effectively eliminate the obstacles of information transmission by simulating the real information of buildings with digital technology\(^[1]\). Prefabricated building is to build houses in an industrialized way, that is, systematic design, industrial production, professional installation on site. It has the advantages of green construction, energy conservation, environmental protection, high efficiency, good quality, et. However, information cannot be shared in real time, and the level of project management is low, which restricts the development of prefabricated buildings. BIM Technology can realize the information integration of all specialties and links in the whole life cycle of the building, thus breaking the information barrier\(^[2]\). The deep integration of BIM Technology and prefabricated building will greatly promote the rapid development of information and industrialization in the construction field.

With the wide application of BIM Technology and prefabricated building\(^[3,4]\), BIM Technology and prefabricated building professional knowledge will become the necessary skills for civil engineering professionals. However, a large-scale survey shows that many construction practitioners are seriously inadequate in the application analysis of BIM technology, and lack of relevant theoretical knowledge of prefabricated buildings, resulting in a lack of BIM technology and prefabricated application talents. Therefore, the 13th Five-year Plan\(^[5]\) proposed to "optimize the discipline layout and talent training mechanism, and encourage the qualified undergraduate colleges and universities to change into Application-oriented colleges and universities". BIM technology is one of the main application technologies in the construction industry in the future\(^[6]\). And prefabricated building is the future development direction of the construction industry\(^[7]\). The colleges and universities are the main strategic positions for training technical talents in the construction industry. Thus there is no side loan to promote the training of application-oriented talents with BIM technology and prefabricated building technology for colleges and universities.
The Analysis of the Current Situation of Civil Engineering Talents Training

At present, the training of civil engineering professionals in Chinese colleges and universities is mostly limited to the two-dimensional abstract theory teaching in the classroom, that is, the traditional teaching method of blackboard and PPT courseware. The civil engineering specialty courses have abstract theoretical knowledge, detailed conceptual knowledge points, complex knowledge structures, and strong technical applicability. The two-dimensional teaching method is not conducive to the intuitive understanding of students’ learning, and it is difficult to form an overall concept of construction engineering. In view of the complexity of the construction site, the long period of project construction, the variety of structure types, safety and other factors, the on-site practical teaching still cannot meet the needs of practical hands-on training. At the same time, there are still some problems in the teaching of civil engineering, such as the lack of the related teaching materials of BIM Technology and prefabricated buildings, and the lack of resources of teachers who can skillfully operate BIM software in colleges and universities.

The above situation makes it difficult for most universities to cultivate comprehensive talents of the construction industry to meet the demand of BIM Technology in the employment market. However, the construction industry's requirements for application-oriented and technical talents are increasing. Therefore, to break the deadlock and meet the market demand, the teaching reform of civil engineering is imperative.

The Teaching Reform Plan of BIM Technology and Prefabricated Building

The teaching based on BIM technology in the perspective of prefabricated buildings should meet the needs of the society for integrated talents of BIM technology and prefabricated buildings, so that students can master the theoretical knowledge of BIM technology and prefabricated buildings, and the various application methods and practices of BIM technology. Operate and understand the construction technology and development trend of prefabricated buildings. The following aspects can be used to improve students' BIM awareness, encourage students to cultivate self-learning ability, independent thinking skills, team spirit, cross-professional communication learning capability and comprehensive application capacity of professional knowledge, and to realize talent cultivation in line with the needs of the compound talents with BIM Technology and prefabricated building technology in the construction industry.

The Curriculum System Setting

Based on BIM Technology, there are two main ways to reform the course system of civil engineering in the direction of prefabricated building. The one is to set up new professional courses. However, at present, there are many undergraduate courses in civil engineering, and it is difficult to set up several new courses of building information model theory and practice of building information model in the existing courses. Therefore, only one or two professional theoretical courses are added, such as "Introduction to BIM". The other is to implant relevant content in the original course. The theory knowledge and practice skills of BIM Technology and prefabricated building can be implanted into the existing professional courses. At the same time, a BIM technology virtual simulation teaching training platform is established. Moreover, the software teaching content of BIM Technology is added to the software courses such as Architectural CAD to make students familiar with the connection and difference between BIM Technology software and other architectural software.

At present, the teaching course of civil engineering adopts the combination of theoretical knowledge teaching and practical operation teaching. Basic knowledge of BIM can be introduced in basic theory courses such as Architectural Drawing and Housing Architecture. In the course of Concrete Structure Design Principle, Reinforced Concrete Structure and Masonry Structure, the
related theoretical knowledge of prefabricated building is explained to improve the professional theoretical knowledge level of students. In computer courses such as Architectural CAD, Structural Design Software Application, Engineering Cost Software Application, etc., the basic operation methods of BIM Technology are demonstrated, so that students can gradually master the actual operation of BIM software. At graduation, students should have the ability to build three-dimensional models independently. The course system settings are shown in Figure 1.

![Figure 1. The Framework of Curriculum System Setting for Teaching Reform.](image)

The teaching of BIM technology and prefabricated building-related theoretical knowledge is still in a state of continuous updating and improvement, which requires teachers and students to study and explore together. Therefore, the colleges and universities should actively guide students to participate in BIM Technology or assembly architecture lectures conducted by senior experts and scholars, learn the latest BIM Technology and multi-level application, improve students' understanding of BIM Technology and academic frontier knowledge, timely grasp the national policy and development trend of BIM Technology, cultivate interest in prefabricated building, and further improve their learning and practice ability.

### The Teaching Content

BIM Technology covers a wide range of specialties, has a huge application system, focuses on different specialties. The prefabricated building has novel content and rich knowledge system. The teaching reform based on BIM Technology and prefabricated building must be oriented to the needs of the industry. For civil engineering majors, it is necessary to combine the development status of the industry and their own professional characteristics, and implant BIM-related knowledge in the courses that have been opened. In the form of "BIM+ specialized courses", a curriculum teaching system suitable for civil engineering major is formed, which helps students to understand and be familiar with BIM technology and prefabricated building structure.

BIM Technology and prefabricated building concepts, theories and software applications will be embedded in the following courses of civil engineering: Introduction to Civil Engineering, Architectural Drawing, Architectural CAD, Housing Architecture, Project Budget and Bidding, Construction Organization Design of Civil Engineering, Design Principle of Concrete Structure, Reinforced Concrete Structure and Masonry Structure, Application of Structural Design Software,
Application of Engineering Cost Software, Graduation Design. The following are some cases of BIM and prefabricated building knowledge implantation.

(1) To lay the foundation for the following basic courses, in Architectural Drawing course, BIM Technology is used to build three-dimensional view in 1-2 class hours, to exercise students' spatial imagination ability by demonstrating the section and elevation of buildings and building components, and increase students' overall cognition of architectural space.

(2) In Housing Architecture course, taking the actual building project as the main line, combining with the drawings to explain the various components in the building, transforming the two-dimensional view into the three-dimensional model through BIM Technology, cutting out the different angles and positions of the building vividly, demonstrating in the form of roaming animation, combining the dynamic and static, so that students can understand the structure of each component more vividly and intuitively, and students' interest in BIM Technology and major can be enhanced.

(3) In Construction Organization Design of Civil Engineering course, the students' understanding of the construction process and process can be deepen through the use of Revit software to establish a three-dimensional model, simulate the construction process and process flow. In addition, in the process of virtual construction, design problems are found through collision detection, so as to improve students’ ability to find and solve problems. Through the use of BIM software and Project software to control the construction progress, the students’ understanding of the practical application of transverse drawing can be deepen.

(4) In the courses of Concrete Structure Design Principle, Reinforced Concrete Structure and Masonry Structure, the relevant theoretical knowledge and in-depth design method of prefabricated building are explained by adopting the comparative teaching method.

(5) In the computer courses, such as Architectural CAD, Structural Design Software Application, Engineering Cost Software Application, the practice links about BIM related software should be added. By comparing the two-dimensional design of architectural CAD with the three-dimensional design of BIM software, students can enhance their intuitive experience of BIM application, which can also meet the practical operation needs of BIM technical talents in the construction industry.

The Practical Teaching System Plan

The cultivation of practical operation ability is an important content of Civil Engineering Teaching. However, there are many problems for civil engineering students to enter the construction site for practice. It is very danger and easy to cause safety accidents. And it is difficult to participate in the whole process of the construction project because of the short practice time. To avoid the above problems, based on BIM Technology, the practical teaching system scheme is as follows:

(1) According to the civil engineering major covered by itself, construction BIM practical teaching and training platform in the school is established by selecting the proper BIM software. Using BIM Technology to establish three-dimensional model, through simulating the whole life cycle process of bidding, design, construction, management and maintenance of engineering projects in the virtual simulation laboratory, the safe, efficient and complete engineering project practice can be achieved and no longer rely on the long-term field practice.

(2) In the process of graduation design, to realize the whole process design based on BIM technology, we should actively encourage students of different majors to cooperate with each other to complete graduation design. For example, students majoring in urban planning carry out project feasibility study. Students majoring in architecture carry out architecture design. Students majoring
in civil engineering carry out structural calculation and design. Students majoring in building environment and equipment carry out equipment design. Students majoring in engineering cost and management carry out conduct bidding, budget and construction organization design. Based on BIM Technology, students of all specialties complete an engineering project together, which can cultivate the ability of collaborative design and overall awareness, and promote students to master BIM Technology.

(3) It is advocated to take professional competition as the carrier and combine competition with teaching. The specific measures are to actively encourage and organize students to participate in BIM Technology competition, improve students' cognition and professional practice ability of BIM Technology, and improve their ability to find and solve problems from practice.

(4) The platform for off campus practical teaching can be established by the way of school and enterprise cooperation. Students can be encouraged to use cognitive practice, professional practice and graduation practice to enter the enterprise, participate in the assembly construction project of BIM Technology. Through the training in the actual project, the comprehensive application ability of the combination of BIM theoretical knowledge and practice can be cultivated. This way can better meet the actual requirements of the construction industry for BIM technical personnel, and cultivate qualified application-oriented BIM technical personnel.

The Faculty Construction Plan
The teaching level of teachers directly determines the quality of teaching. Therefore, colleges and universities should attach a great importance to the construction of teaching staff. The way of "bringing in and going out" can be adopted to enhance teachers' comprehensive teaching ability. The specific measures are as follows.

(1) The rules and regulations for the treatment, training and future development of imported talents should be formulated. The personnel system should be reformed. For the high-end BIM technical talents the preferential welfare policies need to be introduced. And hire high-end BIM technical talents as BIM practical training tutors to improve students' practical operation ability of BIM Technology.

(2) In cooperation with BIM Technology companies and scientific research institutes, we will use the advantageous resources of enterprises to provide BIM Technology Training for professional teachers in Colleges and universities. The combination of university teachers and enterprise mentors can be established to form a cross domain BIM guidance teaching team co-trained by two mentors. Students are arranged to practice in cooperative enterprises regularly after theory teaching by professors. Enterprises can recruit high-quality students in advance. Eventually the school-enterprise cooperation can form a mutually beneficial and win-win situation.

(3) Relevant experts in the construction industry are invited to regularly carry out special lectures and exchanges at the school to enable students to understand the frontiers of the industry and broaden their professional horizons. Teachers should be organized to participate in teaching lectures on BIM technology, communicate with professional teachers in other colleges, and sum up their teaching experience and deficiencies. Due to the rapid update of BIM technology knowledge, teachers should constantly learn new BIM technology and update teaching knowledge. Only by improving the teaching quality of the teaching staff can we ensure that the professor's BIM professional knowledge is consistent with the needs of social development.

Conclusion
With the acceleration of informatization and industrialization in China's construction industry, BIM
Technology and prefabricated building are more and more widely used, and the demand for BIM technical talents is increasing. The training of civil engineering talents is not only the problem of technical talents training, but also related to the development process of China's construction industry. This paper mainly expounded the necessity of BIM Technology and prefabricated building development, the current situation of civil engineering talents training in domestic universities, and proposed the teaching reform scheme suitable for the development of civil engineering in our university. However, cultivating professional application talents who meet the requirements of national policies and the needs of industry development and possess BIM technology and assembly style also requires the full support and cooperation of the government, enterprises, and universities, as well as the joint efforts of all stakeholders.

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