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THOUGHTS ON THE REFORM OF UNDERGRADUATE TEACHING IN CIVIL ENGINEERING MAJORS IN THE BIM ERA

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Abstract: The emergence and development of BIM technology has triggered another revolution in the construction industry. How to promote BIM technology and how to cultivate BIM technology application talents is an urgent problem that needs to be solved in front of major universities. Based on the preliminary results of the teaching reform of civil engineering majors at home and abroad, this article discusses the teaching objectives, teaching content, and teaching organization form of BIM courses, analyzes the problems faced by the BIM teaching reform of civil engineering majors, and proposes the integration of BIM knowledge into civil engineering. Implementation suggestions in engineering major teaching provide reference for the establishment of BIM courses in civil engineering majors and BIM teaching reform.
Keywords: Civil engineering; BIM; Undergraduate teaching reform

1 CURRENT STATUS OF BIM TECHNOLOGY APPLICATION AT HOME AND ABROAD

BIM (Building Information Modeling) was first proposed by a team of American engineers based on the concept of "virtual construction technology". It implants the engineering information of the "full life cycle" of the building into the computer three-dimensional data model, thereby providing a detailed expression of the engineering project. It has intuitive expression, facilitates the collaborative work of various departments, and can simulate a certain life moment of the building. Deduction characteristics, and can propose optimization measures based on simulation deduction, and finally form a reasonable and feasible technical solution to be output and expressed. [1] BIM technology is actually a large-scale information data platform that associates a large amount of construction project-related information with three-dimensional digital models, and can be easily called at any time to simulate the shape of the building in a certain period of time. In this data platform Engineering and technical personnel can realize the rapid sharing and transmission of information, thereby ensuring the smooth progress of collaboration, acceptance inspection, operation management and other aspects of the project investment, construction, operation and maintenance and other processes.
BIM technology was first proposed by American engineers around 2000, and its prototype is "virtual construction technology". Since its introduction, it has attracted attention and recognition from the engineering and technical circles. As of 2012, BIM technology coverage of engineering projects in the U.S. construction field has reached 71%; at the beginning of the birth of BIM technology, the United Kingdom also specified a detailed BIM technology promotion plan and required that engineering project collaboration based on BIM technology be fully realized by 2016. management; in 2010, South Korea also proposed a ten-year development plan for BIM technology, preparing to establish a complete BIM technology application system for large public buildings by 2020. According to BIM technology implementation cases in foreign engineering projects, the application and implementation of BIM can reduce engineering project changes by 60%-70%, enable engineering and technical personnel to save 20%-30% of collaborative docking time, and accelerate project progress by 5%-10%. , and at the same time reduce project expenses by an average of about 1.5%. [2] With the birth and rapid development of BIM technology, the era of traditional planning, design, construction, operation, maintenance and management based on two-dimensional CAD drawings will be gone forever. Its production and promotion is another production technology revolution in the field of construction manufacturing after two-dimensional CAD drawings replaced manual drawings. It will bring profound changes to the construction industry and related industries, and in the near future will become an important technical means for construction projects to be applied in the "full life cycle of construction projects".
While BIM is developing in full swing abroad, BIM technology is gradually being exposed and recognized by Chinese engineering and technical personnel. In 2005, my country's first BIM laboratory was established under the joint initiative of South China University of Technology and AUTODESK. In 2010, Tsinghua University organized scientific and technical personnel to tackle key problems and creatively proposed the China Building Information Model Standard Framework. Based on this model standard framework, it further proposed IT technology standards for the technical layer and user implementation standards for the application layer. [1] In 2011, the Ministry of Housing and Urban-Rural Development issued a guiding document for the development of BIM technology, the "2011-2015 Construction Industry Informatization Development Outline", which clearly emphasized that during 2011-2015, breakthroughs in

information technology in the construction engineering field will be made We will speed up the establishment of a building information platform based on "Internet +", launch guiding standards and technical regulations for building information construction, break foreign technology monopoly, and gradually establish a software information platform with independent intellectual property rights to make my country's building information Technology has gradually reached the international advanced level. In January 2012, the Ministry of Housing and Urban-Rural Development issued the "Notice on Issuing the Revised Plan for the Development of Engineering Construction Standards and Specifications in 2012". The "Notice" puts the formulation of BIM technical standards and procedures on the agenda, and establishes the first five BIM technical standards to be released. In August 2013, in order to accelerate the promotion and application of BIM technology in the field of construction engineering, the Ministry of Housing and Urban-Rural Development issued a "Letter on Soliciting Guidance on Recommending the Application of BIM Technology in the Construction Field." It clearly states that after 2016, all government public construction projects involving more than 20,000m2 and green building projects must apply BIM technology for project management in their design and construction stages; before 2020, the national BIM technology application standards and procedures will be improved. Implementation Guidelines formulate policy outlines to encourage the application and promotion of BIM technology at the national level; and stipulate that BIM technology must be implemented compulsorily in projects applying for construction awards at all levels (such as the Luban Award, survey and design awards at all levels, and regional engineering quality awards). In September 2016, the Ministry of Housing and Urban-Rural Development issued the "2016-2020 Construction Industry Informatization Development Outline" to further clarify the development goals and significance of my country's construction information industry during the 13th Five-Year Plan period.

The promotion and application of BIM technology in the field of construction engineering in my country is imperative, and Chinese educators have begun discussions on curriculum reform based on BIM technology. Zeng Wenhai et al. analyzed the current situation of teaching in colleges and universities today and suggested incorporating the BIM curriculum system into practical teaching [2]; Hao Li proposed a summary of various forms of integrating BIM technology into teaching [3]; Zhao Xuefeng et al. drew lessons from foreign BIM education model, and proposed a BIM course teaching system suitable for China [4]; Liu Hongyong et al. discussed the feasibility of starting BIM courses in colleges and universities, and put forward suggestions on the content, goals, methods and methods of BIM teaching [5]; Li Yanfeng compared developed the training programs for civil engineering majors in China and the United States, and put forward several suggestions for domestic civil engineering education [6].

2 CIVIL ENGINEERING PROFESSIONAL TALENT TRAINING PLAN BASED ON BIM TECHNOLOGY

2.1 About the Talent Training Goals of BIM Technology Courses

According to the differences in the application of BIM technology at home and abroad, in view of my country's civil engineering talent training system and development direction, the popularization of BIM technology should first be carried out in colleges and universities. By formulating corresponding talent training mechanisms and setting up corresponding curriculum systems, we strive to achieve the following training goals in BIM technology education at the undergraduate level:

(1) Understand the concept, application and development direction of BIM, clarify the status and role of BIM technology in the future development of civil engineering, and establish the confidence and determination of college students to learn BIM technology.

(2) Familiar with the application of BIM in the architectural design stage, especially 3D modeling and scheme comparison and selection of different structural forms, pipeline synthesis and collision detection, project quantity statistics, etc.; Familiar with the application of BIM in the building construction and management stage, including Establishment of BIM construction models, 4D and 5D construction progress simulation, spatial conflict detection, etc.

(3) Familiar with the use of large-scale BIM general software, including Revit, CATIA, Navisworks, Luban software, etc. For undergraduates, emphasis should first be placed on mastering the modeling software proficiently, and on the basis of being familiar with the modeling software, they should appropriately expand to the model analysis software.

(4) Through BIM course design and graduation project training, understand the new model of building design, construction, acceptance and operation and maintenance management based on BIM technology, and master the use of BIM technology to solve technical problems and strengthen collaborative work methods between different majors. There are varying degrees of differences between various universities in terms of graduate positioning and training goals. Different universities can establish unique talent training models based on their own training goals to target governments, construction units, design units, construction units, operation management units, etc. Multifaceted talent needs.

2.2 Teaching Content of BIM Courses

Establishing BIM-related courses is not simply to add courses on BIM technology to existing courses, but to carry out drastic reforms in the teaching methods and teaching objectives of the existing course system, and to infiltrate the concepts, principles and application methods of BIM. into each course. As far as conventional civil engineering courses

are concerned, the teaching contents that can be combined with BIM technology include: Introduction to Civil Engineering, Civil Engineering Drawing, Civil Engineering Materials, Housing Architecture, Concrete Structure Design, Steel Structure Design, Architectural CAD, and Engineering Project Overview. Budget, civil engineering construction, graduation project and related course design, etc.

In addition to combining with existing courses, in order to accelerate the promotion of BIM technology in university education, it is also urgent to open targeted BIM introduction courses and practical courses. These courses include: introduction to the development and application of BIM, conventional BIM software and its Operation methods, BIM and architectural visualization, BIM-based full-professional design and design, BIM and construction simulation and management, BIM-based collision, BIM-based construction progress control and cost control, etc.

2.3 Teaching Organization form of BIM Courses

(1) Classroom teaching of BIM knowledge and technology. Classroom teaching is the most basic teaching method and the most direct teaching method to impart BIM knowledge to students. In BIM classroom teaching, the following contents need to be emphasized: the meaning and application of BIM, the operation of BIM software and the establishment of 3D models, BIM-based construction progress display and management, BIM-based project quantity statistics and project cost control, BIM and various The relationship between majors and their application points in each major. The main goal of BIM classroom teaching is to let students understand the basic knowledge structure of BIM, the application points of BIM in the field of civil engineering, become familiar with the types and application scope of BIM modeling and analysis software, and the operating skills of commonly used BIM software, and solve the problem of "how to learn" BIM" issue.

(2) Practical training teaching of BIM. BIM technology emphasizes the practice and application of knowledge, so BIM practical training teaching is an indispensable form of course teaching organization. The design of practical training content should echo the classroom teaching content, and teaching and practice should be carried out simultaneously to effectively establish students' application and practical operation abilities. BIM practical training teaching can include the following content: operation of BIM modeling software, detailed statistics of project quantities based on BIM models, preparation of schedules and display of construction progress, visualization of design plans, collision analysis, building energy consumption analysis, three-dimensional Visualization technology briefing, etc. All in all, BIM practical training teaching is an extension and in-depth of classroom teaching. Through practical training, students' ability to apply classroom knowledge and their self-confidence and enthusiasm for learning are improved, and the problem of "how to apply BIM" is solved.

(3) Lectures by industry experts on BIM. BIM industry experts have been engaged in BIM application and research on the front lines of engineering projects for a long time. They can provide a new perspective for BIM teaching in civil engineering majors and effectively shorten the distance between classroom and actual engineering applications. Although it accounts for a small share of the entire course teaching, it is very critical. During the teaching process, industry experts often use specific project examples to teach the application of BIM in actual projects and the latest research results. Students can understand the application of BIM in actual projects through example explanations, so that students can clearly understand the necessity of learning BIM. , to solve the problem of "why learn BIM".

To sum up, the three organizational forms of BIM courses are complementary to each other and indispensable. Only when BIM teaching is carried out interspersed with the above three links can its teaching effect be significantly improved.

3 PROBLEMS EXISTING IN BIM TEACHING IN CIVIL ENGINEERING MAJORS

3.1 Insufficient BIM-Related Teacher Reserves in Universities

BIM engineers in the industry today can be roughly divided into three categories based on their job functions and nature, namely relevant standard research and formulation engineers, BIM software development engineers and BIM technology implementation engineers. Among them, BIM technology implementation engineers have the greatest social demand, but there are relatively few practitioners, resulting in a serious imbalance between supply and demand. The training goal of civil engineering majors in universities is to cultivate and transport civil engineering technical personnel to society. In order to make up for the shortage of BIM talents, the reform of talent training models in universities is imperative [7]. The construction of university teacher teams is the soul of higher education. The prerequisite for carrying out BIM teaching at the undergraduate level is the establishment of a team of teachers with BIM professional application capabilities. However, at present, in most colleges and universities, most teachers do not have a deep understanding of the purpose and significance of carrying out BIM teaching practice activities, and have insufficient BIM technology application capabilities, which have seriously affected the implementation of BIM teaching. The BIM model contains a lot of engineering information during the entire life cycle of the project, which requires BIM practitioners to have the ability to operate software and project design and planning, construction, or operation and maintenance management. Therefore, teachers who train BIM practitioners also need to have such abilities. Ability, in

order to make BIM teaching and practice smooth and smooth in undergraduate education, it is first necessary to improve the professional quality and ability of the teaching team related to BIM technology.

3.2 Establishing a BIM Teaching Practice System Requires Drastic Reform of the Entire Teaching System

BIM technology aims to establish a complete set of management and control solutions throughout the life cycle of engineering projects. Therefore, the establishment of a BIM technology teaching practice system is not simply to open a few courses on BIM technology knowledge, but to penetrate BIM technology knowledge into all aspects of university civil engineering professional courses, that is, in housing architecture, structural design theory and methods, civil engineering, etc. The teaching of different courses such as engineering construction, engineering project management, project budget, and civil engineering materials is interspersed with the introduction of relevant BIM technical knowledge and the application methods of BIM technology in the course. It is necessary to adopt a new teaching method that integrates and collaborates with multiple courses. . This teaching method is closely integrated with the full life cycle application of BIM buildings and multi-party collaborative applications, which can maximize the teaching effect of BIM technical knowledge. However, teachers of various courses are required to master BIM technology and implement collaborative teaching of multiple courses. However, BIM teachers in various universities are currently relatively scarce, and this type of collaborative education is difficult to achieve in a short period of time.

3.3 There are Many Software Related to BIM, and It is Difficult to Cover Everything Within the Limited Class Time

Currently, there are hundreds of BIM-related software on the market, which can be divided into two categories according to their functions: modeling software and model-using software. Among them, modeling software includes BIM core modeling software, BIM solution design software, and geometric modeling software that interfaces with BIM; while the family of modeling software is even larger, including sustainable (green) analysis software, visualization software, and model checking software. , in-depth design software, comprehensive collision inspection software, cost management software, operation management software, etc. BIM engineers cannot rely on one software to solve all problems, but need to choose different BIM software based on the requirements of the construction unit, the use function of the project, the architectural and structural characteristics, the scale and modeling characteristics of the project. For example, we need to choose a modeling software for BIM3D model modeling. If you are designing a civil building, you often choose Autodesk Revit for modeling; if you are designing an industrial plant or infrastructure, you often choose Bentley series software; if the project building or structural configuration is complex, Digital Project or CATIA software is often the best choice for BIM engineers. software of choice. It can be seen that it is very difficult for students to be fully competent in daily BIM work through limited classroom time and case practice.

4 SUGGESTIONS ON PROMOTING BIM TECHNOLOGY IN UNDERGRADUATE TEACHING OF CIVIL ENGINEERING MAJORS

After CAD technology replaced manual drawing, engineers began to use 2D CAD drawings to express 3D design plans; with the emergence and development of BIM technology, architectural expression methods gradually transitioned from 2D to 3D and 4D. (schedule control dimension) or even 5 dimensions (cost control dimension). BIM technology is a major breakthrough in the design, construction, operation and maintenance of the construction industry, and is the future development trend in the construction field. Strengthening the promotion of BIM technology at the undergraduate level greatly responds to the national applied talent training strategy, so that the entire education stage can effectively apply what they have learned, and on the other hand, it also stimulates students' enthusiasm for learning. However, the teaching of BIM in most domestic universities is still in the exploratory stage.

4.1 Educate College Students on BIM Technology Concepts and Application Fields as Early as Possible so that Students can be Exposed to BIM Technology as Early as Possible

The introduction of BIM concepts and technologies should start from freshmen. It is advisable to set up special topics in professional introductory courses such as Introduction to Civil Engineering, and invite well-known BIM experts or BIM engineers from large design institutes and construction units to carry out BIM training for students. Knowledge lectures. Make students aware of the important impact of BIM on their employment and even future work, realize the importance of mastering BIM technology, and stimulate students' enthusiasm for learning BIM.

4.2 Combine with Existing Teaching Plans and Rationally Plan the BIM Course System

When formulating a BIM teaching plan, students' mastery of professional knowledge, BIM technology, and software practical calculations must be comprehensively considered. The method is adopted to teach BIM technology related to the professional courses while studying professional courses, so that the teaching of professional courses and BIM

courses complement each other and are integrated. Here, the author provides a set of feasible curriculum system setting methods for reference (as shown in Table 1).

Table 1 BIM curriculum system for civil engineering majors

Starting grade	Course Title	Course organization format	Course nature	BIM application level
First year undergraduate	Introduction to Civil Engineering	Classroom teaching, expert lectures	Penetration and fusion	3D
	architectural drawings	Classroom teaching, practical teaching	Penetration and fusion	3D
	Housing Architecture	Classroom teaching, practical teaching	Penetration and fusion	3D
Second year undergraduate	building materials	classroom teaching	Penetration and fusion	3D
	building structure	Classroom teaching, practical teaching	Penetration and fusion	3D
	Architectural CAD and BIM	Classroom teaching, practical teaching	New courses	3D
Third year undergraduate	Engineering project management	Classroom teaching, expert lectures	Penetration and fusion	3D, 4D, 5D
	Project cost management	Classroom teaching, practical teaching	Penetration and fusion	3D, 5D
	Civil engineering construction	Classroom teaching, practical teaching, expert lectures	Penetration and fusion	3D, 4D
Fourth year undergraduate	building information modeling	Classroom teaching, practical teaching, expert lectures	New courses	3D
	Graduation Project	practical teaching	Penetration and fusion	3D, 4D, 5D

4.3 BIM Teaching Reform should Adopt a Step-by-Step Approach

The teaching reform of BIM technology cannot be achieved overnight. In order to avoid a "cliff transition" in the teaching reform process from traditional teaching methods to professional knowledge BIM technology integration, it is recommended to adopt a step-by-step approach, that is, first add one or two BIM technology introduction courses to the existing civil engineering training program. This is a comprehensive course, and the teaching content is mainly based on the concepts, applications and software operations of BIM. At the same time, we will gradually strengthen the training of teachers and promote the transformation and transition of teaching content, and accelerate the integration of BIM technical knowledge and existing courses. After the teaching team, teaching material construction, software and hardware facilities are gradually improved, practical learning links that are consistent with the BIM teaching content will be gradually added to enhance students' hands-on ability. Ultimately, a teaching system is formed that integrates BIM technology with other civil engineering professional courses. The implementation steps of the teaching reform can be shown in Table 2.

Table 2 Implementation steps of BIM teaching system reform

stage	Milestones	Teaching content
1	New BIM course	Systematically explains the development and application of BIM technology in detail, suitable for explaining the conceptual application of BIM and the operation of modeling software.
2	Open BIM practice sessions	It simulates and solves practical problems in the form of practical tasks, which is suitable for training the operation of BIM software and multi-party collaborative application capabilities.
3	Opening a graduation project in BIM direction	Training on the comprehensive application of BIM technology is suitable for students with a foundation in BIM technology.
4	Application across multiple courses	The application of BIM technology throughout the teaching of various professional courses is most in line with the full life cycle application characteristics of BIM and is an ideal teaching form.

4.4 BIM Courses Should Mostly Use Case Teaching Methods, and the Teaching Process Should Focus on Cultivating Students' Self-Learning Ability

BIM course teaching focuses on the practical application based on understanding of BIM technology. As many real cases as possible should be introduced during the teaching process to realize virtual design, virtual construction, spatial collision inspection, project schedule preparation, project quantity and project cost analysis, etc. Work to enhance students' understanding of BIM knowledge and improve their ability to apply knowledge.

Among the many cases presented in class, due to the different characteristics of the project itself and the different BIM technology requirements, different software and different BIM technology application methods may be used. Due to limited class time, it is impossible to explain the use of all software and the application process of all BIM technologies during the teaching process. However, we should seize the similarities between many projects and focus on the explanation of application methods and ideas. For detailed issues, students can be asked to self-study. , and understand students' self-study status on time, so that BIM learning can achieve the effect of analogy.

5 CONCLUSION

The emergence of BIM technology is brewing another revolution in the construction industry. The data platform based on BIM technology integrates a large amount of data information at all stages in the entire building life cycle, providing engineering and technical personnel with complete, real-time, and accurate building information, which greatly improves the operating efficiency of the construction industry. Therefore, the most urgent need in the industry in the future will be compound talents who are both proficient in civil engineering technology and have a certain foundation in BIM technology. However, the establishment of a civil engineering teaching system based on BIM technology is still in the exploratory stage. There are still a lot of issues worthy of our college teachers to think about. to solve. Therefore, the introduction of BIM technology is a challenge to today's civil engineering professional education, and it is also an opportunity to develop an applied talent training model. The rapid promotion of BIM technology and its full implementation in the construction industry urgently require all construction departments to actively explore and communicate on BIM teaching reform. Only through continuous exploration on the road of teaching and application can we form a civil engineering major and BIM suitable for our country as soon as possible. Technology-integrated teaching and education program.

COMPETING INTERESTS

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