# BIM-Based Training of Vocational Ability of Engineering Cost Major in Higher Vocational Colleges

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***Abstract*—With the promotion and application of BIM technology, having BIM professional skills has become the core competitiveness of the construction industry. This paper has carried out relevant exploration and teaching practice on BIM talent training in higher vocational colleges. Fully in line with the talent market, we have established a curriculum system with BIM technology as the core, explored and practiced BIM technology teaching methods, and built a team of professional teachers based on BIM technology, so as to improve the teaching quality of engineering cost and cultivate comprehensive and complex high-quality architectural professionals.**

***Keywords*—engineering cost of higher vocational colleges, BIM, professional ability, teaching reform**

## I. Introduction

The construction industry is an important pillar industry in our national economy. The extensive construction mode of the traditional construction industry has caused problems such as inefficient construction efficiency, low profit margins, waste of resources, and serious environmental pollution [1]. With the development of economy and society, major projects are developed and the number of complex engineering projects are increasing, the construction industry is in urgent need of transformation and upgrading. It is urgent to formulate a construction industry development strategy integrating with industrialization and information technology, and completely change the inefficient, extensive and high-consumption engineering construction model. The use of digital technology, information modeling, visual construction, and industrial production can achieve project planning, planning and design, construction production, operation and maintenance services integration, and high-efficiency collaboration. As the application and innovation of the new generation of information technology in the construction field, BIM (Building Information Modeling) technology is an important carrier and effective means for the transformation, upgrading and development of the construction industry.

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Most projects adopt phased cost management in the decision-making phase, design stage, bidding stage, construction stage and completion stage, and the cost information lacks continuity and the level of sharing is poor [2]. While the BIM-based integration model can realize circulation, sharing and collaborative operation of cost information in each stage. At the same time, the integration of BIM with the new generation of information technology such as big data and cloud technology has led to fundamental changes in the project cost business. The division of labor and professional technical capabilities of the project cost posts have also changed. Having the practical skills of BIM application has become the core competitiveness of engineering cost practitioners, and BIM talents have become the "talent" orientation of employers. Therefore, the goal of training talents of engineering cost major in higher vocational colleges is to cultivate interdisciplinary talents with BIM engineering cost software operation ability as well as BIM management ability. The urgent problem to be solved at present is how to integrate BIM technology into the talent training of higher vocational engineering cost major, fully in line with the talent market, and to meet the needs of the society for engineering cost personnel, the author of this paper and her team conducted a series of exploration and research in this respect.

## II. The Current Situation and Existing Problems of BIM Technology in the Teaching of Engineering Cost Specialty in Higher Vocational Colleges

BIM technology started late in China and is mainly applied in some major national projects, so many higher vocational colleges have not paid enough attention to BIM talents training. The funds and resources invested in teaching and scientific research are quite limited [3]. Specific to the engineering cost major, the following problems exist in the teaching of BIM technology.

### *A. BIM as the Core of the Curriculum System Needs to Be Improved*

Although BIM technology is widely recognized as an advanced technology, it is still a problem to integrate BIM technology into the existing curriculum system. The original professional curriculum system must be

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continuously innovated and adjusted based on the adaptability of BIM technology. As a result, a complete, scientific, comprehensive and compatible curriculum system is formed as a whole.

Engineering cost courses cover core competence courses such as engineering technology, management, economics, etc. The ability systems promote, link and integrate with each other, which can only be achieved by learning many professional courses. At present, the BIM teaching and practice of engineering cost major is still in the early stage. The common practice is to set up BIM software operation courses, or embed BIM into a few professional courses, which mainly teach BIM modeling methods and BIM management software operation and application, and BIM courses have not been integrated into the personnel training program. Industrial upgrading changes brought by BIM, new demands for job skills and other contents are rarely involved, and the lack of top-level design and professional guidance of BIM practice curriculum system makes it difficult for professional practice teaching reform to have a great breakthrough and innovation.

In addition, the BIM model involves modeling and design, construction management, measurement and pricing, bidding and other links, forming an organic unity of collaboration between professional courses. The current situation is that most BIM courses are independent of each other, the course content cannot be connected, and the course objectives and information cannot be shared. BIM-based professional practice teaching reform has lost its value and practical significance. Fragmented teaching, scattered learning and independent training make students only master the ability required by a single course teaching, and it is difficult to meet the overall requirements of coordinated development between professional knowledge and skills [4].

### *B. BIM Practical Teaching Methods Are not Enough, and the Practical Platform Is not Perfect*

As an emerging discipline, BIM technology requires teachers and students to master cross-professional knowledge, comprehensive analysis, abstract thinking, flexible application, and practical innovation ability, etc.

At the present stage, the BIM practice teaching mode lacks the matching practice conditions and the training path of comprehensive ability, which makes it difficult to cultivate interdisciplinary talents. It is difficult to meet the new demands by only offering BIM software operation courses and a small amount of BIM course design teaching. The practical teaching should pay more attention to the new problems brought by the BIM technology development and industrial changes, so as to make up for the lack of knowledge and ability in course teaching. Therefore, how to cultivate students' professional practice skills and innovation ability needs a new model and a new path. From the perspective of content, practice, and innovation are based on the learning, thinking, organization, and reconstruction of professional knowledge. Theoretical learning and practical training are integrated to realize innovation in practice and consolidate practice in innovation. Improving the BIM integrated practice platform can realize the simulation of the whole process of the project. With the advantages of visualization, simulation and digitalization of BIM, students can have a more comprehensive and systematic understanding of the design estimate of the project cost, construction drawing budget, completion final account and other cost control, thus cultivating students' teamwork spirit and innovation ability.

### *C. The Ability of BIM Teachers Are not Strong*

It has been more than ten years since domestic higher vocational colleges have carried out BIM related research or offered BIM courses, but few colleges have really offered BIM technology majors, so graduates of this major are quite scarce. At present, Domestic full-time lecturers of BIM technology are mostly operators of various software companies. They mainly teach software operation and often have sales purposes. While the BIM teachers in higher vocational colleges are mostly part-time or transformed teachers from other courses. The relevant knowledge of BIM is only through social training or self-study, and there are few opportunities to participate in the real BIM technology engineering practice. Therefore, how to establish a complete professional teacher team based on BIM technology is also a major challenge for higher vocational colleges.

## III. Application of BIM Technology in the Teaching of Engineering Cost Specialty in Higher Vocational Colleges

In the past ten years, the higher vocational education has entered a high-quality development stage. Deepening the integration of industry and education, and promoting the organic connection among the talent chain, the industrial chain, and the education chain are the practical needs of comprehensively improving the quality of talent training, expanding employment and entrepreneurship, and promoting economic transformation under the current new situation [5]. In order to solve the problems existing in the current BIM technology teaching, The author and teaching team have carried out relevant exploration and teaching practice, mainly including the establishment of a curriculum system with BIM technology as the core, the exploration of practical teaching methods based on BIM technology, the strengthening of professional teacher team construction, and the improvement of teaching management mechanism.

### *A. Establish a Curriculum System with BIM Technology as the Core*

The curriculum system with BIM technology as the core has been established. Focusing on the cost management and control in the whole process of construction project development, the BIM module has been embedded in the existing curriculum, and a new BIM curriculum system has been developed based on the BIM professional skills standard (see Fig. 1). The college

strengthens the cooperation with enterprises, deepens the integration of production and teaching, establishes a BIM research and teaching training base based on the integration of enterprise resources, unifies the teaching and practice resources of BIM courses, uses BIM technology to connect the professional course system, and designs multiple unified BIM practice teaching cases at the top level, which not only saves teaching resources, but also promotes the overall connection between professional courses [6]. In the actual teaching, the course of "Building Information Model BIM Foundation" is offered in the freshman year to learn the operation of Revit software; The BIM technology is integrated into the teaching of "engineering drawing", a professional basic course, and the two-dimensional CAD graphics are changed to three-dimensional display, which helps students easily grasp the knowledge through perspective. In the sophomore year, the course "Application of Building Information Model (BIM) Technology" is offered, and BIM is integrated into various core cost management courses such as "Measurement and Valuation of Building Engineering" and "Measurement and Valuation of Installation Engineering", and BIM is combined with VR for virtual simulation practice teaching. In the junior year, "Building Information Model (BIM) Comprehensive Practical Training" is offered, which integrates the content of the introductory course, so that students can have a more comprehensive and systematic understanding of the project cost management and control in the whole process of the construction project, so as to cultivate the students' cost management ability in the whole process of the project.

At the same time, the content of vocational skills level examination is integrated into the whole process of personnel training, and the academic certificate course and BIM vocational skills level certificate are integrated and interoperable, so that students can have the operation ability of BIM cost software, the production ability of BIM model cost and the application ability of BIM model cost. On this basis, students' ability of building BIM cost application environment, BIM cost project management and BIM cost business integration can be improved. The BIM capability system is shown in Table I below.

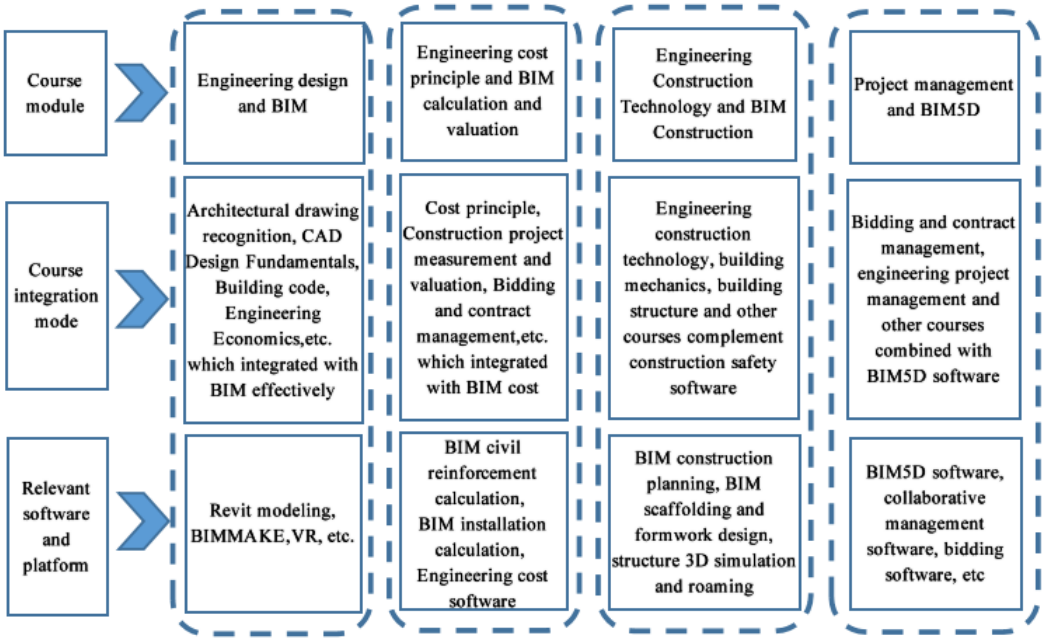


Figure 1. Practical teaching integrating BIM.

TABLE I. BIM CAPABILITY BUILDING LINE AND GRADE CLASSIFICATION

| **BIM junior applied talents** | | **BIM intermediate applied talents** | | **BIM senior applied talents** | |
|---|---|---|---|---|---|
| BIM Software Operation Capability | BIM Model Creation Capability | BIM Model Application Capability | BIM Environment Building Capacity | BIM Project Management Capability | BIM Business Integration Capability |
| The ability of engineering technical or managerial personnel to master one or several types of BIM software | The ability to use BIM software to build models for different disciplines and different purposes of engineering projects, such as building, structure, site, safety warning and other models | The ability of using BIM model to analyze, simulate and optimize various tasks in different stages of engineering projects, such as scheme demonstration, performance analysis, construction process simulation, etc. | The ability to establish the technical environment required for the smooth implementation of BIM application in an engineering project, including delivery standards, workflow, model element library, software, hardware, network, etc. | The ability to achieve the BIM application goal by Managing and coordinating the project team, including determining the specific BIM application of the project, building and training the BIM application ability of the project team, etc. | The ability to integrate BIM application with enterprise business objectives, including confirming the business value of BIM to the enterprise, calculating and evaluating BIM return on investment, establishing new business models, etc. |

### B. Enrich Practical Teaching Methods Based on BIM Technology

Basic stage: Case teaching method. In this method, teachers set up a specific teaching case according to the needs of teaching objectives and teaching content, and guide students to participate in analysis, discussion, expression and other activities, so that students can actively think and explore in specific problem situations, and cultivate their comprehensive ability [7]. For example, in the teaching of "Building Information Model (BIM) Foundation", the teacher first introduces a short video of a large case project built with BIM technology to stimulate students' interest in BIM technology. Then, adhering to the principle of pertinence and effectiveness, the teacher selects a specific case project, encourages and guides the students to complete all the contents of the case project with the BIM technology software they have learned. Case teaching method ensures students' full participation, broadens their thinking breadth and improves their ability to solve practical problems.

Promotion stage: construct teaching method. It is a process of connecting social and cultural background, changing passive learning into active exploration, and actively building knowledge system. Students can consult relevant materials after class, think carefully and analyze carefully according to the questions raised by the teacher. With the deepening of the problem, the breadth and depth of students' thinking can be developed [8]. For example, in the course of "Application of Building Information Model (BIM) Technology", teachers can strengthen students' thinking ability in combination with different professional directions such as construction engineering technology and engineering cost.

Practice stage: experiential teaching method. The application of BIM technology in practical teaching is conducive to overcoming the one-sidedness of on-site practice, the limitations of the site and the shortage of practice funds. For example, in the training link of the course "Application Practice of Building Information Model", The students who participate in the training are divided into several groups of 5 people. Each group member acts as the project manager, operation manager, financial manager, production manager, procurement manager and other roles. They jointly operate and manage a virtual project to complete the whole process management of the case project [9]. Finally, the student's performance is comprehensively evaluated by the group's net profit, the completion of role tasks, and the training report. Through the experiential teaching method, students have a deeper understanding of the overall operation mode of construction enterprises.

### C. Building a Team of Professional Teachers Based on BIM Technology

Teachers' ability is the key to the efficient implementation of BIM technology education and teaching research, and directly affects the teaching results of BIM technology [10]. As few teachers are proficient in BIM technology, our college actively cooperates with well-known BIM technology software development or model making companies in the industry, and cultivates the education and teaching ability of key teachers through special training, lectures, technology research and innovation, advanced study visits, workshops and other forms. In the teacher team training, the "cross-border attribute" is highlighted to broaden the professional development channel of vocational teachers. The training content is based on the needs of schools and teachers, and personalized training is implemented [11]. At the same time, the college has introduced relevant talent policies to introduce excellent BIM professionals to drive other teachers to jointly improve their teaching level and scientific research ability. Moreover, the number of BIM-related scientific research projects and investment in scientific research funds are increased, and teachers are encouraged to actively participate in BIM-related teaching reform and scientific research.

## IV. Conclusion

The comprehensive promotion and application of BIM in the field of engineering cost has become inevitable. Engineering cost talents with BIM capabilities are social employment orientation, which is the way out of college talents. In terms of professional talent training, we should first combine BIM and innovative and entrepreneurial requirements to reconstruct the knowledge structure of talent training to embed BIM into the knowledge system of engineering cost talent training; secondly, the means to form a complete set of engineering cost talent training and teaching reform system with BIM characteristics.

## Conflict of Interest

The author declares no conflict of interest.

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