Construction of innovation training system of civil engineering based on BIM

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Abstract. According to the industry's demand for BIM talents, a four-stage and three-dimensional civil engineering innovation training system based on BIM is constructed. Through four stages of preliminary import, key reinforcement, comprehensive application and expand to improve of BIM theory teaching and practice, and taking projects and competitions as carriers, by means of practice, combining the class inside and outside of the three-dimensional model, the students achieve basic skills, comprehensive application ability, preliminary design ability and innovative ability. It is proved by practice that BIM teaching is an effective way to cultivate innovative composite talents.

1. Introduction
Since the 13th five-year plan, China's major strategies of innovation-driven development, "made in China 2025" and "Internet plus" have provided new opportunities and injected new impetus into China's innovation and development. In today's social development tide of "mass entrepreneurship and innovation", only through the organic integration of professional education and innovation and entrepreneurship education can the cultivation goal of innovative talents be truly realized.

In recent years, the promotion and application of building information modeling (BIM) technology is the concrete embodiment of the innovation and development of the construction industry and informatization, and it is the inevitable trend of the industry development. There is an urgent demand for compound talents who master BIM technology in the industry, but there is still a big gap in talent supply. Therefore, it is imperative for colleges and universities to find the integration point of innovation and entrepreneurship education in professional teaching and realize education mode and talent training driven by new technologies when cultivating much-needed professional talents in the construction industry. The organic integration of BIM teaching into the cultivation system of civil engineering majors is an effective way to cultivate "specialty + innovation and entrepreneurship" innovative compound talents and a new carrier to meet the practical needs of society in cultivating BIM talents.

2. Current situation of BIM talent cultivation in China
BIM-based talent development direction includes three categories: one is the modelers of BIM (including model maintenance), one is the implementation personnel of BIM (who can use BIM technology to implement project management), and one is the strategic planning personnel of BIM. Three types of talents correspond to the functional application, project-level application and enterprise-level application promoted by BIM. Due to the relatively backward cultivation of BIM talents in China and the rapid promotion and application of BIM technology in the industry in recent
years, there is a large talent gap, especially the lack of high-level talents for BIM implementation and strategic planning. At present, the training of colleges and universities and the demands of the industry are still unable to achieve a seamless connection, and there are still the following problems in the talent training of colleges and universities.

2.1 The training program lacks characteristics and the curriculum system is generic, which cannot meet the needs of the industry
The training program does not reflect the characteristics of the industry, lags behind the development of the industry, the curriculum is universal, ignores the cultivation of students' innovation ability and information ability, and the achievement of students' ability is divorced from the needs of the industry.

2.2 Lack of integration and penetration of BIM technology in professional teaching.
Education focuses on the cultivation of students' professional knowledge and skills based on the curriculum system. Education focuses on the cultivation of students' innovation ability based on professional knowledge and skills. The two complement each other and integrate organically, so as to realize one-stop cultivation of students' learning ability, practical ability, innovation ability and development ability. Professional education is separated from innovation and entrepreneurship education, so that BIM technology is not integrated with professional course teaching.

2.3 Lack of teaching resources such as BIM teachers and textbooks
Although college teachers have solid theoretical knowledge, they lack engineering practical experience, and few of them can master BIM technology systematically, which leads to the shortage of BIM teachers and affects the development of teaching. In addition, there are many reference books about BIM technology, but there are few suitable textbooks suitable for professional teaching and matching with the curriculum system, so the construction of textbooks is also an urgent task.

3. Construction of four-stage and three-dimensional BIM capability innovation training system
Due to large and complex knowledge system, plus one needs through information technology project whole life cycle from design to production use and the management during the demolition and coordinated management of each contractors involved BIM applications mainly include architectural design, structural design, collision check and engineering quantity valuation, construction management, engineering, etc. It integrates different professional knowledge of civil engineering major university for 4 years. It is difficult for students to master and apply BIM technology systematically in a short period of time. Therefore, according to the rules of students' learning cognition and the arrangement of the original curriculum system, a four-stage, three-dimensional [5] training system is constructed (see Figure 1).

3.1 Four-stage BIM capability innovation training system
The first stage: preliminary introduction stage. In introduction to civil engineering, engineering drawing, building architecture courses such as introduction of BIM technology and ideas, such as with BIM technology to create a model as an example this paper introduces the basic structure of the building construction, in order to develop the students' ability of space thinking and knowledge chart modeling, attracting students to the attention of BIM, stimulate students' innovation spirit and consciousness of creation.

The second stage: the key strengthening stage. In BIM introduction, project management, civil engineering, construction and other professional course introduction of BIM full life cycle theory application, using a large number of real cases, using case teaching method in three-dimensional modeling on the basis of visual dynamic simulation, to implement a 4D construction simulation and 5D cost management, to help students expand the BIM technology application. Through this stage, students can master the basic operation skills of BIM.
| Course name | Teaching means | 
|-------------|----------------|
| Introduction to civil engineering, Engineering drawing, Building architecture | teaching |
| BIM introduction, Project management, Civil engineering construction | Teaching, practice |
| Expert lectures, Curriculum design, Graduation design | Experiment, practice |
| project competition | Practice, innovation |

Fig.1 four-stage BIM capability innovation training system

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The third stage: comprehensive application stage. In curriculum design, graduation design into BIM technology, hire experts hold academic lectures, with specific projects as the carrier, combine professional design and computer information technology, which not only provide a new perspective for the teaching, and help students in the limited time master the civil engineering professional knowledge system, so as to realize students' comprehensive application ability, preliminary design ability, research ability and creative practical ability training.

The fourth stage: expansion and improvement stage. To innovation as the guidance, take practice as the goal, to project and competition as the carrier, with interest as the starting point, by organizing students to participate in all kinds of BIM series, such as the national design competition of BIM, innovation entrepreneurship competition of Tianjin, etc, and guide students to participate in the teachers' scientific research project, plus exercise high-level software application ability, to cultivate BIM implementation and strategic planning talents reserves. At this stage, all kinds of projects and competitions in the second class are included in the training system, which can effectively supplement and reasonably expand the teaching in the first class. The combination of inside and outside class has built a platform for students to communicate and demonstrate their achievements in innovation and entrepreneurship, which is conducive to cultivating students' comprehensive skills and project innovation ability.

3.2 Three-dimensional innovation ability training mode
Based on BIM three-dimensional innovation ability training mode from the industry characteristics, fully embody the civil engineering specialty, in "applied" theory teaching, professional ability training practice teaching, innovation, entrepreneurship education and general education as the core of the "four one" training system as the foundation, to build with ability as the goal, on the basis of classroom teaching, by means of practice teaching, to project and competition as the carrier, the combination of inside and outside class BIM application of three-dimensional innovation ability training mode.
3.3 Multi-level BIM talent training objectives

The talents training goal of multi-level BIM [9] (see figure 2), around the student's knowledge chart, drawing and performance ability, ability to design, construction organization and management ability, formed from single to comprehensive, from independence to the cultivation of the fusion system, the students' ability in spiral progressive, namely basic skills training to comprehensive application ability, preliminary design ability, innovation ability training.

![Fig. 2 multi-level BIM talent training objectives](image)

4. Safeguard measures

4.1 Construction of teaching resources supporting software and hardware

Build BIM teaching materials with characteristics and "necessity and adequacy". Given the huge and complex knowledge system of BIM, it is impossible to cover all the content in a limited period of time. Teaching material construction should not only reflect the characteristics of innovation ability training, but also "necessary and sufficient" in depth. It adopts project-driven, project-oriented and BIM life-cycle application as the main line. It conforms to students' cognitive rules and can be well combined with practice.

The construction of "double - teacher" teacher team. The construction of BIM ability innovation training system cannot be separated from the high-level teachers. The construction of the teacher team is oriented by the need of talent training, and talent selection is conducted in multiple directions and channels. On the one hand, enterprise experts with high application level of BIM and strong practical ability are encouraged to serve as professional and part-time teachers in the school. Multiple measures should be taken to build a "double-teacher" teacher team that combines both theory and practice and combines both specialty and practice.

Building a high level BIM laboratory. The supporting BIM experimental environment and the mainstream software and hardware configuration can guarantee the smooth development of relevant teaching work, the second class of students and provide the required environment for innovation and entrepreneurial activities.

4.2 Strengthen school-enterprise cooperation and synergistic education

School-enterprise cooperation, collaborative education, is recognized as an effective way to cultivate application-oriented talents. If the enterprise can strengthen the deep participation in the school teaching practice, then helps the student comprehensive quality and the innovation ability to obtain the actual enhancement. We have made some beneficial explorations in this respect, and brought the real projects of the enterprise into teaching, so as to achieve "real problems and real work". Students have got practical practice, which is also conducive to the transformation of results. In addition, the school and the cooperation in running schools Fang Chengli hopson-pearl river city building, elite class to train talent system for conveying partner 100 talents every year. The goal of talent training is to start from the grass-roots position and grow into a functional manager within 3-5 years.

5. Conclusion

Through the four-stage and three-dimensional professional innovation training based on BIM, civil engineering graduates have strong BIM application ability in school and certain competitive
advantages in employment. Some graduates are directly employed as BIM engineers, and their working ability is recognized by employers. Practice has proved that the organic integration of BIM teaching into the cultivation system of municipal engineering majors is an effective way to cultivate "specialty + innovation and entrepreneurship" innovative compound talents.

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