

Research on Multi-Major Collaborative Design Theory and Practice Innovation of BIM in Architecture Majors in Universities

Fengyi Han
*Institute of BIM Technology Industry
Changchun Institute of Technology
Dandong, China*

Shufan Lin
*Changchun Institute of Technology
Shenyang, China*

Abstract—The demand for talents to master new construction technology is increasing in the construction industry, and colleges and universities should timely adjust the personnel training mode to conform to the development of market economy. As a new technology leading the construction industry towards information intelligence and green and low-carbon development, BIM should be comprehensively promoted in colleges and universities that cultivate architectural talents. In addition, BIM teaching should be carried out through the whole talent training stage by offering BIM general elective courses, BIM compulsory courses, BIM collaborative graduation design and other links in colleges and universities. In this paper, the author proposed specific measures and implementation plans of BIM teaching reform in universities and colleges, conducted in-depth research on how to reform and innovate the personnel training mode in universities and colleges, and emphasized the importance of training mode combining BIM teaching engineering with practice.

Keywords—colleges and universities, personnel training, BIM, more professional, collaborative design

I. INTRODUCTION

In order to keep up with the pace of national economic development and the ever-growing demand for compound talents in the construction industry, colleges and universities, as the delivery of talents to the society, must keep up with the pace of the Times in the reform and innovation of personnel training mode. Reform the traditional talent training mode, break the original framework system, and develop the corresponding talent training mode according to the development trend of market economy.

The complex structure and shape of buildings must be supported by sufficient architectural technology, which fundamentally requires colleges and universities to find a talent training mode in line with China's national

Corresponding Author: Fengyi Han, Institute of BIM Technology Industry, Changchun Institute of Technology, Dandong, China.

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conditions as soon as possible [1]. In the era of information under the situation of rapid development of Internet technology, colleges and universities across the country have been Building Information Modeling (BIM) laboratory and practice base, BIM application talents for enterprise, not only for the enterprise and society saved secondary training time and cost, also improved the school itself on talent cultivation of the core competitive ability.

II. APPLICATION AND DEVELOPMENT OF BIM AT THE CURRENT STAGE

Building Information Modeling (BIM) is another 3d digital technology applied in the field of architectural engineering after the era of Computer Aided Design (CAD) graphic recognition. It will bring about a driving change in the field of architecture in line with the trend of the Times [2]. BIM integrates all project data information into an information model on the basis of 3d digital technology, and makes a detailed description of it. Compared with the traditional 2d-CAD technology, BIM has five major advantages, including collaboration, simulation, visualization, optimization and graphic ability [3]. Applying BIM technology to engineering projects can avoid unnecessary rework from the initial stage of design to the later stage of construction to the greatest extent, save human and material resources and improve work efficiency. And in the whole process of the project from construction to completion to demolition, digitalization and intellectualization of the project have been realized, and the project cycle has been shortened fundamentally..

After the closing of the 17th National People's Congress in 2007, the National Forum on Information Technology Exchange in Survey and Design Industry was held, Mr. Wu Yiliang, the director of China Academy of Survey and Design, first mentioned the application of 3d model to the architectural design and construction in the late stage, the impact of the application of BIM technology in the project would not only to the early stage of design, construction management, operation and maintenance of saving a large amount of manpower and resources, but also accelerate the process of the whole project. For example, BIM is applied in Beijing Olympic Games, Shanghai World Expo and

urban rail transit construction [4]. It is also a good embodiment of the scientific outlook on development [5]. Since the first BIM Application Design Competition jointly held by China Reconnaissance and Design Association and AutoCAD Software (China) Co., Ltd. in 2010, thousands of designers still participate in the BIM Design Competition every year. Although these industry associations have propelled the preliminary construction of BIM in China, the use of information technology on construction industry have not reached a certain value, the application of BIM technology and popularization in our country has not been widely covered, so many enterprises and employers are very scarce for such talents at present stage. On the road of development of construction industry in China, it has become an important link in the development of construction industry [6].

In order to cultivate application-oriented technical talents suitable for the development of the current construction industry, many colleges and universities have opened BIM related courses in recent years. According to the survey, 70% of American colleges and universities have integrated BIM into their teaching, and 97% of schools that do not have BIM courses will soon include BIM [7]. Since 2009, major universities in China have also started to preliminarily explore the personnel training mode of BIM, and set relevant basic theory courses to enable students in universities to have a preliminary understanding of BIM. For example, Tsinghua University, Huazhong University of Science and Technology and Harbin Institute of Technology have all provided a good start for China to explore the BIM talent training mode. At the same time, many large construction enterprises and institutions are also actively carrying out skills training related to BIM, to accelerate the full application and coverage of BIM in enterprises and institutions. It is of great urgency to promote BIM teaching in various construction colleges and universities. It can not only save a lot of human and material resources for national enterprises and public institutions, but also enable students to get in touch with and master the technology applied in future work, and put it into work practice more quickly and accurately, so as to create value and wealth for enterprises and society.

Although many colleges and universities in China have started to establish the personnel training mode system based on BIM, the application of BIM and BIM teaching reform in most colleges and universities are still in the primary stage, and it is inevitable to encounter many difficulties when the personnel training program is implemented. The teaching staff, software and hardware facilities are not complete, and the curriculum system construction is not perfect, which will lead to the failure of students to systematically learn relevant knowledge. The lack of internship and practice experience will also make students unable to quickly and accurately put into the future work and social practice after graduation. Therefore, it is of great significance to explore and practice the talent training mode in colleges and universities.

III. EXPLORATION OF PERSONNEL TRAINING MODE BASED ON BIM

Establish a "double-qualified" teaching staff to improve the BIM level of teachers. Overall level of teachers in the school to carry out all aspects of the teaching activities plays a decisive role, BIM as a comprehensive strong discipline, on the teachers' staff selection should be first out "double type" teachers, requiring faculty have enterprise working experience and at the same time research background, and master the multi-disciplinary field of expertise. By changing the previous teaching mode that emphasizes theory over practice, it can not only lay a solid foundation for BIM teaching, but also enhance students' ability to understand theoretical knowledge and practice. Schools should also actively introduce advanced technicians from enterprises and institutions outside school, train teachers and students, encourage teachers to learn, communicate and discuss with each other, integrate BIM into professional teaching and carry out research on BIM teaching reform.

Set up specialized BIM institutions, integrate resources, and conduct multi-specialty and multi-department collaborative teaching. The establishment of specialized BIM collaborative teaching institutions in colleges and universities is a key step to deepen the construction and research of BIM teaching in colleges and universities. On the one hand, it provides a platform of communication and cooperation for teachers who want to develop BIM education reform; on the other hand, the way of collaborative cooperation can improve the overall education level of teachers. The traditional single teaching mode is changed to the collaborative teaching of different majors, which increases the opportunities for students to learn different professional skills, enables them to enjoy higher quality educational and scientific research results, and learns to communicate and solve problems from all angles of the whole major when participating in the design of engineering projects.

Implement the three-stage drawing course system and conduct the school BIM skill appraisal. Popularize and apply "manual cartography - CAD cartography -BIM cartography" three-stage cartography education. Engineering drawing has developed from traditional 2d manual drawing to 3d drawing and 3d design, and the teaching of computer 3d drawing technology has become the main teaching line of engineering drawing course. In the past, the teaching form of drawing was that the teacher taught the theoretical knowledge in class and then sent the students to the laboratory or computer room for operation [8]. At present, teachers teach directly in the computer room. By using three-dimensional building software to draw three-dimensional models, teachers teach students to conceive and design a building from a three-dimensional perspective, help students develop their overall spatial thinking ability, and provide great help for students in future design work. School regularly organizes students to BIM professional skills training, arranges teachers to

appraise students' academic achievements in professional skills, by conducting the national nature of BIM skills examination work related certification, issued by the relevant authority certification, this will save the time cost for students work in the future, and lay a certain foundation for the students' career.

IV. ESTABLISHMENT OF BIM SUBJECT CURRICULUM SYSTEM

The construction of BIM teaching needs hardware, software and talents, and one of them is indispensable. It should not be rushed, or it will lead to overinvestment in hardware, limited application of software and shortage of talents. Therefore, a transition period must be set, which can be greatly alleviated by introducing the teaching mode of BIM course selection. The setting of BIM quality general course selection can break through the boundary between the original disciplines and other disciplines, and build a new cross-disciplinary and cross-field curriculum system in the form of multi-disciplinary integration. Offering BIM quality general elective courses in colleges and universities can not only help students save the funds required by training in training institutions, but also build a common learning platform for teachers and students who are interested in BIM, and at the same time, broaden the road for students' future employment development.

By offering the course of "BIM public theoretical basis", students of all majors can have a preliminary understanding of the concept and application of BIM. In the past, teachers only impart knowledge to students unilaterally, and students are naturally lack of subjective initiative in feedback, which makes it difficult to apply all the knowledge learned to their own learning and work. Compared with the traditional setting of compulsory courses, the setting of BIM quality general elective course reflects the characteristics of people-oriented development. From the starting point, it is determined that this is a course that starts from the perspective of students, and students take the initiative to choose and take the leading position.

By setting drawing courses such as "basis of BIM modeling" as compulsory courses, students can master basic knowledge of BIM modeling, become proficient in drawing basic building types, and further understand the application of BIM in related fields and preliminary design. By offering professional courses such as "modeling of BIM intermediate MEP equipment system", the teaching mode from simple to deep and from basic to intermediate enables students to deepen the application understanding of BIM in this major, and mainly teaches students how to use Revit MEP software and Navisworks equipment system that are widely used in practical engineering. The new teaching mode that combines elective courses and compulsory courses can enable students to systematically learn relevant knowledge, abandon the previous narrow thinking mode of solving and treating problems, and learn to design, think and solve problems from a new perspective.

By applying BIM to the course design of professional

courses, theoretical knowledge can be well applied to practice. For example, traditional water supply and drainage, air conditioning and heating design all use CAD for two-dimensional plane design, which cannot clearly show the system composition and pipeline distribution. The introduction of BIM into the course design can help students more intuitively see the pipeline layout and placement in the actual site. Under the guidance of professional BIM teachers, BIM technology is used for collaborative graduation design of multiple majors, which not only has important practical significance for improving students' practical application ability, professional level, student innovation and team cooperation, but also fully demonstrates the intersection between disciplines and professional collaboration. The premise of BIM collaborative design is that all majors use the same standard system under the same platform environment. In collaborative design, work content should be stored and information sharing centrally, and work environment should be managed centrally, and work process should be controlled centrally.

V. MULTI-SPECIALTY COLLABORATIVE DESIGN BASED ON BIM

The construction of BIM laboratories and training bases in colleges and universities can not only meet the needs of enterprises for BIM talents under the new situation, but also improve and exercise students' ability to learn BIM independently through practical engineering projects. In the teaching process, real project cases are introduced, and the teaching mode is complementary to the teaching content [9], let students participate in the construction management and simulation exercise of BIM engineering project, contact and understand the various stages of the actual project, and exercise and improve students' practical ability [10]. Provide a real environment for students to work in BIM in the future. Guiding students to participate in the BIM competition, establishing a design team, and making students feel real and get practice are the only criteria to test the truth. It not only allows students to check and find their deficiencies in learning in competitions, but also allows them to learn more professional knowledge and understand how to combine theory and practice in practical engineering. To train and improve students' ability to actively research, design, create, learn from each other and make progress together, so as to train students to be well-rounded and high-quality talents. Compared with the previous talent training model, it not only broadens students' professional fields, but also lays a solid foundation for students' future career development. It enables students to learn and master BIM technology in advance in college, and prepare for the role transformation social work in the future.

A. BIM theory teaching

With BIM technology application in the field of construction engineering more and more, in response to the national energy conservation and emissions reduction,

and green building construction industry, conform to the trend of the development of construction industry, make broad graduate more quickly and accurately in the social practice and work, domestic colleges and universities also gradually will BIM course planning into their school curriculum. At present, the application of BIM technology in teaching has not reached the national promotion, only some universities have included it in compulsory courses, and some universities have not opened BIM courses.

Colleges and universities add pre-software courses related to BIM. Changchun College of Engineering, for example, in order to make students contact as soon as possible, to learn, master BIM technology, the school will set up course selection, which not only saves the set as required to the cost of time consuming, but also lets the students learn by the courses truly interested in BIM course, in the process of learning, through mutual communication between students and draw lessons from and work together, let the students can really take the initiative to go to understand the fun of learning, and explore the BIM technology and truly master the BIM technology, the application of BIM technology in their field of study, strengthen the BIM mainstream software operation,

B. BIM practice

BIM technology involves the complete practice process of all links in the whole life cycle of construction projects, which is of great importance to the HVAC industry. In the HVAC design of all kinds of buildings, by means of parameterization and modeling, targeted design can be realized for the internal pipeline of buildings under preset conditions. Students learn the professional knowledge in the school under the condition of limited, through the use of BIM software can clearly understand and observe the whole building life cycle, including design and construction and operation of the process, overcome the limit of cross major basic knowledge, and can be very convenient access to all information inside the building, so BIM is using digital model of project design and construction and operation of a process. Through BIM technology, energy saving, land saving, water saving, material saving, environmental protection and pollution reduction can be emphasized in green building, and reliable information technology support can be provided.

Currently our domestic equipment is more commonly used professional RevitMEP this software. Students can use this software to intuitively observe the spatial position relationship of various pipelines and the spatial relationship between pipelines and civil structures to ensure the normal arrangement of pipelines when doing graduation design and modeling of related buildings or structures. Specifically, it can be used for pipeline collision inspection, program simulation, optimization design, 3d disclosure assistance, and engineering quantity calculation. The software can also be used to analyze the running status of each device and the running status of the fluid in the pipeline connecting these devices to ensure the

normal operation of the whole system. BIM technology can accurately plan, track and control the construction progress, dynamically allocate various construction resources and sites, timely analyze the influence of deviation on the construction period and the causes, and take effective measures to control the project progress and ensure the timely completion of the project.

C. BIM multi-professional collaborative design

When BIM technology has not been widely applied and promoted in the construction industry and various universities, it is difficult for technicians from different majors and design and construction units to carry out technical communication and collision inspection, which leads to a large part of unnecessary rework and resource waste. The emergence of BIM technology solves this contradiction in a timely manner. And combination of BIM technology to today's students' graduation design in the field of construction engineering related, can give students a good experience to BIM technology into their own professional design brings convenient, feel the blend each other mutual infiltration between disciplines system, through their learning professional knowledge, also learned other professional knowledge, learning through the skills they need to understand the various stages of construction projects.

In the application of BIM technology in ring as an example, BIM software integrated in the HVAC line, can set the level of the pipeline position and vertical position, the size of the pipeline, and the size of the elbow, the size of all kinds of valve parts, and more specific show each line position, can at any time by the three-dimensional display of pipeline relative position adjustment, more accurate pipeline avoiding collision, achieve the purpose of control is clear, save a space for the owners, convenient to construction. In the wind system design, make it a system with BIM, can use RevitMEP to simulate the actual operation, can clearly indicate the new wind in each pipe speed and friction resistance, until the end of the tuye. And in the unreasonable place will be marked with the set color, so that the designer can re-choose the size of the duct through the logo, or re-design the system pipeline direction. In water system design, by establishing the model selection of equipment and pipe system, can be simulated by the software running, shows the running state of each device, the velocity of fluid in pipe and resistance, unreasonable area will be expressed with set color, designers can use these data for equipment selection, the determination of water pipe diameter can also through the analysis of the model, using the software auxiliary piping system designers to design more reasonable.

VI. CONCLUSION

With the steady development of today's society, people more and more is also high to the requirement of the building, higher and larger, more complex buildings

emerge in endlessly, the existing building technology already cannot satisfy emerging engineering, which has given rise to the birth of BIM technology, and from the BIM technology available to popularize is also done in the high speed development, now of BIM technology is widely used in the design, construction, operations, solved the difficult problems in many traditional building technique has injected new vitality to the development of construction industry, can let JianZhuRen bolder, more innovation to achieve building a dream. Corresponding BIM professional talents becomes more scarce, so to train talents for the society with BIM use technology is particularly important, schools as a place for national transportation talents for the society will have to shoulder responsibility for personnel training, school must apply the theory teaching and practice of BIM organic union, let the students to consolidate the theoretical knowledge in practice, in practice to explore the balance of theory and practice, so as to cultivate professional skills of graduates, plus always pay equal attention to integrating theory and practice of teaching concept, the teacher will lead the students to explore, study and progress together in the field of practical engineering, and apply the theoretical knowledge of BIM to the practical application, so that students can more clearly understand the knowledge and BIM.

REFERENCES

- [1] Guiding opinions on promoting the application of architectural information model [J]. *China survey and design*, 2015, (10): 22-26.
- [2] He Guan-pei. China BIM standard personal thinking (ii) [J]. *Civil engineering information technology*, 2013, 5 (2): 107-112.
- [3] Chen Yonggui, Wang Guiyao, Huang Shengwen, et al. Thoughts on practical teaching reform of geotechnical engineering in civil engineering major [J]. *Higher architecture education*, 2009, 03: 104-107.
- [4] Marzouk M., Abdelaty A. BIM-based framework for managing performance of subway stations [J]. *Automation in Construction*, 2014, 41: 7-77. (in Chinese)
- [5] Wu Yiliang. 2007 national survey and design industry information development technology exchange BBS speech [D]. Beijing: China survey and design, 2008, (01): 16-17.
- [6] China construction industry informatization development report (2014): BIM application and development [M]. Beijing: China city press, 2014.
- [7] Liu Xiaoyan, Chen Liqiang, Zhang Jianren. Research and practice on construction of structural design course group for civil engineering major [J]. *Contemporary education BBS (second half of the month)*, 2009, 05: 64-65.
- [8] Meng Jie, He Gaofa, Wu Rui. Mechanical CAD/CIAM course teaching reform based on CDIO mode [J]. *Journal of lanzhou education university*, 2014 (7): 94-95.
- [9] Liu Wenyong, Dong Suqin, Sun Wenru. *Architectural CAD* [M]. Xi'an: Xi'an Jiaotong University press, 2012: 1.
- [10] Liu Hongyong, He Weitao, Huang Qiushuang. Exploration of BIM practical teaching path in ordinary colleges and universities [J]. *Civil and architectural engineering information technology*, 2013 (5).