Predicaments in BIM Practical Ability Teaching for Civil Engineering Specialty Group and Countermeasures

Zhihua LUO, Jiejun XIE
College of Architecture and Urban Planning, Guangzhou University

Abstract: As an emerging national strategic industry technology, BIM poses a huge demand for talents. However, the current BIM talents have problems such as narrow knowledge, weak engineering practice ability and mismatch with the needs of multiple jobs. This paper analyzes the current situation and causes of BIM practical ability teaching from the perspective of colleges and universities, and puts forward new training methods and ideas through curriculum reform, extracurricular measures and the establishment of social coordination mechanism.

Keywords: Civil engineering; BIM; Practical ability; Teaching reform

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Building Information Modeling (BIM) is a kind of information carrier technology taking the construction body as the main description object, which has been applied horizontally in smart cities, municipalities, buildings, the Internet of Things and relevant new infrastructure facilities, and vertically throughout the whole life cycle of construction project design, construction and operation. It has become an emerging national strategic industrial technology with a huge demand for talents. Owing to its wide application and diverse use scenarios, BIM poses demanding requirements on the knowledge and practical ability of industrial talents. Currently,

About the author: Zhihua LUO (1976-12), Male, Han Nationality, native place: Panyu, Guangdong province, Master, associate professor, research direction: Architectural informatization.

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the teaching organization system and mechanism of colleges and universities is obviously not competent enough to cultivate such talents, and new coping ideas and solutions are in urgent need. A series of training on BIM practical ability have been carried out at home and abroad: B. Becerik-Gerber and other scholars believe that the traditional separate training of various specialties in civil engineering education is no longer suitable for the current situation of engineering application, but BIM and Integrated Project Delivery (IPD) with multi-specialty cooperation are required [1]. American scholar JD. Adams and others mentioned the connecting role played by Industry–University Cooperative Research Center (IUCRC) in the research activities of universities and enterprises [2]. BIM technology in China started later than that in western developed countries and is relatively weak in personnel training, but which, in recent years, has caught widespread attention due to the strong industry demand. In 2015, Bai Shu et al. put forward countermeasures such as increasing investment in professional teaching facilities, combining teaching with practice, and training professional BIM teachers in view of the lack of BIM talents [3]. In 2018, Dai Chunquan et al. introduced the OBSE teaching concept and CDIO engineering education mode into BIM personnel cultivation [4]. However, up to now, the current situation of BIM personnel training in the university system, which focuses on software operation and lacks engineering practice ability, has not been improved. This paper attempts to explore approaches to improve BIM talents’ engineering practical ability through curriculum reform, extracurricular measures and the establishment of social coordination mechanism from the perspective of the overall orientation of personnel training.

1. Analysis of the Current Situation and Problems of BIM Practical Ability Teaching

BIM is an interdisciplinary applied technology, and the related practical ability is based on abundant subject knowledge and is constituted by the integration of technical operation ability and communication and cooperation ability. At present, the training process of practical ability realized in the form of independent courses in colleges and universities has the following problems.

(1) Lack of top-level design and teaching innovation

In the current collegial teaching, BIM is mostly positioned as a software operation course, lacking top-level design and planning for the training relationship and division between BIM and internal courses of specialties, as well as between various specialties. Students are constrained by professional boundaries and cannot
understand and practice BIM technology from the perspective of the whole specialty and the whole process. There is no integration of knowledge and ability across various professional courses, teaching activities are independent from each other, and communication is rare. In terms of teaching organization, the current practical ability teaching often exists in the form of experimental courses, and the content is mainly based on software operation verification, which is less connected with vivid practical scenarios. The teaching content and form are rigid, students have narrow knowledge, weak practical ability, insufficient communication and cooperation ability, limited development potential, and can barely adapt to the diverse job requirements of engineering practice.

(2) Shortage of teachers and limited teaching resources

BIM is included in a series of software technologies, while teachers acquiring both engineering practice experience and software operation ability are very few, which leads to the vast majority of classroom teaching being limited to software instruction and lack of actual project application scenarios. At present, the vast majority of BIM tutorials or exercise resources are oriented to software command explanation, and there are relatively few comprehensive and practical cases. In addition, as scientific research and teaching units, colleges and universities have very limited opportunities to provide practical project exercises, which also leads to narrow space for students to expand their practical ability.

(3) Lack of curricular-extracurricular interaction and on-campus-off-campus coordination

Based on current school resources, there is obvious limitation in BIM practice ability teaching solely depending on either curricular activities or extracurricular activities, while taking curricular activities as the main body supplemented with effective extracurricular or off-campus expansion is currently a commonly recognized form of training in the education sector. However, at present, extracurricular and off-campus activities in colleges are mostly carried out spontaneously by students, with low connection with the curricular activities, absence of overall planning, limited available resources, thus making it difficult to substantially carry out on-campus-off-campus collaborative cultivation.

2. Curriculum Reform

BIM practical ability is a type of comprehensive quality ability, which requires multidisciplinary participation in the training process from different angles. First of all, in the aspect of overall structure design, the training specifications and objec-
tives of this ability should be explicitly defined, top-level design should be performed from the perspective of overall quality of talents, and the application orientation and training methods of BIM should be clearly defined for each specialty of civil engineering specialty group. Moreover, the specialty courses should be reasonably divided into sections based on the cultivation of BIM practical ability within the specialty, and the division and the design of teaching contents and methods should be clarified. Through the above-mentioned work, BIM will be substantially integrated into the teaching of various specialties, and dialogues will be formed between specialties. While students form a solid professional general foundation and basic quality, BIM application scenarios will be activated to enhance the multi-angle application ability of engineering practice.

In terms of overall positioning, BIM curriculum teaching should serve as not only the main carrier for BIM software learning and practical operation ability training, but also the leading curriculum for students to clarify the training division of various professional courses. The teaching content should be divided into general part and professional part. The general part should not only reflect the main application situation of BIM in the whole life cycle of horizontal specialties and vertical projects, but also guide students to focus on accumulating relevant knowledge throughout the whole process consultation system in the process of professional learning. In addition to reflecting the routine operation content of BIM software in combination with professional application scenarios, the professional part should also properly introduce the system architecture and principles of BIM and comprehensively interpret BIM technology from the surface to the inside. Through the above contents, students will obtain a multidisciplinary view and BIM-based knowledge. In terms of teaching and assessment methods, more group discussion should be introduced to strengthen students’ autonomous learning and problem-solving ability and weaken the teaching method of conventional software command learning and large-area coverage of small exercises. Professional simulation engineering examples should be adopted as large homework topics, and real project topics and exercises should be used to guide the whole teaching interaction process, so that students can simulate various scenarios of actual projects in class and improve their whole-process consultation and practice ability. In terms of teaching environment creation, the teaching faculty allocation, supporting teaching materials and teaching scenario creation of BIM technology practical teaching should be clearly defined to establish an open and self-organized teaching environment, and the methods and strategies to realize the above supporting contents should be proposed from the perspective of specific implementation.
3. Extracurricular Measures

Various extracurricular learning and practical scenarios are an indispensable and important part of BIM practical teaching, which should be planned and arranged in accordance with the requirements of ability cultivation to form teaching linkage with the curricular part. Specific measures include:

(1) Construction of teaching resource database

During the finite time in class, only the knowledge framework construction and application guidance can be achieved. Extracurricular situation is the main scenario for practical ability cultivation. Therefore, it is necessary to configure various resource databases convenient for students to use, such as massive open online course (MOOC), software operation integrable ware library, practical case library, etc. BIM involves a large amount of knowledge and application scenarios, which can be freely obtained by students.

(2) Establishment of on-campus practice scenarios

Relying on laboratories or teachers’ studios, students can be provided with extracurricular interest-oriented activities in the form of association-defined topic exploration, participation in teachers’ projects, industry competitions, etc., through which students can be promoted to awaken, correspond and deepen their impression of in-class learning contents in extracurricular practice scenarios. Guangzhou University has a student association to organize the Building Information Society, which has been carrying out extracurricular practical activities for a long time.

Figure 2 Extracurricular Practices
(3) Construction of school-enterprise collaborative cultivation platform

Currently, most of the school-enterprise cooperation bases are limited to providing internship positions for students before graduation and in a low degree of connection with curricular activities, and should be further upgraded to school-enterprise collaborative cultivation platforms. First of all, the cooperation should not be limited to a single enterprise, but should be constructed according to practical ability required, enterprises in different industries such as design, construction, project cost, supervision, operation and maintenance, BIM consultation and development should be selectively introduced to form a diversified ecology. In addition, in terms of coordination, two-way linkage should be strengthened, namely, enterprises should participate in the customization of the school’s personnel training syllabus, and schools should also regularly visit enterprises to carry out new technology promotion and research on personnel’s practical ability, so as to strengthen the frequency and intensity of communication.

4. Establishment of Socialized Cooperative Cultivation Mechanism

Based on the characteristics of BIM’s inter-discipline and diversified application scenarios, the cultivation of BIM practical ability cannot be completed independently by the universities. It is necessary to mobilize all social parties to participate and form a four-party socialized cooperative cultivation mechanism involving the government, industry associations and enterprises. In this mechanism, the government provides macro-policy support and creates a good industry environment, enterprises offer practice platforms and motivation for talent demand, universities are the main carriers of talent cultivation, and the associations provides the most important link and bridge function for the connection of the above three parties, forming a “four-coupling linkage system model”, as shown in Figure 1. It can be seen from the figure that the four main bodies of “government, industry, university and enterprise” are the main axis of the system operation, and the association is located in the information center, through which the government, universities and enterprises can form effective connections. Through this mecha-
nism, all parties can participate in the cultivation of students’ BIM application ability stably. In the past, specialties in universities, as the leading party and application party in the establishment of this socialized cooperative cultivation mechanism, were independent and weak, making it difficult to establish this mechanism. The relationship between civil engineering specialty groups should be organic and homologous, and stable contact across various specialties should be maintained for a long time. Therefore, universities should take the responsibility to carry out joint teaching reform through the contact between curriculum leaders and external parties, relying on the school-enterprise cooperation base to gradually establish social cooperative cultivation mechanism to jointly promote the cultivation of BIM talents’ practical ability.

5. Achievements and Conclusion

Since the implementation of BIM practical ability teaching reform in 2016, in addition to innovating teaching forms and introducing plentiful practical contents, our college has also organized students to participate in 11 extracurricular project exploration through the Building Informatization Society, the resulting achievements have been publicized in 4 public briefings and 2 exhibitions, which have received positive feedback from the industry. Students’ BIM application ability has been greatly improved. In the 2019 GUYU Cup National Sustainable Building Design Competition (dominated by BIM technology), our college won a total of fourteen awards, accounting for 10% of the total awards, including one first prize, two third prizes, seven participation prizes and three digital technology awards. Employing units have maintained a long-term high evaluation on the BIM application ability of our students. For a long time, BIM talents are narrow in professional knowledge, weak in practical ability and communication and cooperation ability. This paper proposes to improve the comprehensive quality and practical ability of BIM talents through curriculum reform, extracurricular measures and the establishment of social coordination mechanism, so as to meet the increasingly urgent talent demand in the industry.
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