Exploration and Practice of BIM Technology Teaching Faculty Development from the Perspective of Industry-Education Integration: Postprint

Authors: Jin Yan

Date: 2018-10-26T00:00:00+00:00

Abstract

With the widespread adoption of BIM technology, cultivating application-oriented BIM professionals has become a broad consensus among architecture and construction universities. However, insufficient faculty development remains the primary factor constraining BIM talent cultivation. This paper focuses on BIM faculty cultivation in application-oriented undergraduate institutions: first, it analyzes the competency system required for application-oriented BIM professionals; second, it proposes, in a demand-driven approach, the knowledge and abilities that BIM faculty in such institutions should possess; and finally, it presents practical measures for BIM faculty cultivation from an industry-education integration perspective, aiming to improve the quality of application-oriented BIM talent development.

Full Text

Exploration and Practice on the Training of BIM Technical Faculty from the Perspective of Integration of Industry and Education

JIN Yan
School of Urban Construction, Xi' an Siyuan University, Xi' an 710038, China

Abstract

With the widespread application of Building Information Modeling (BIM) technology, cultivating BIM application-oriented talents has become a broad consensus among architecture and construction universities. However, faculty shortages represent the primary constraint on BIM talent development. This paper

focuses on BIM faculty training in application-oriented undergraduate institutions. First, it analyzes the competency framework required for BIM technology application talents. Second, it proposes the knowledge and capabilities that BIM faculty in application-oriented undergraduate programs should possess, guided by market demand. Finally, it presents practical measures for BIM faculty cultivation from the perspective of industry-education integration, aiming to improve the quality of applied BIM talent development and provide a valuable reference for similar institutions.

Keywords: integration of industry and education; BIM (Building Information Model); faculty training; practice

Introduction

Following the Ministry of Housing and Urban-Rural Development' s release of the "2016-2020 Construction Industry Informatization Development Outline," BIM technology has been more extensively applied in large and medium-sized construction projects than ever before. In October 2017, the Ministry explicitly designated "BIM-based site construction management information technology" as one of the ten new information technologies in the construction industry. Consequently, cultivating BIM technology application talents has become a widespread consensus among architecture and construction universities. Currently, some civil engineering and architecture universities in China have launched undergraduate and graduate education programs related to BIM, gradually forming diverse education and training models that include curriculum instruction, campus professional associations, and research centers.

However, relative to current industry and enterprise demands for BIM professionals' capabilities in software application, technical expertise, and comprehensive coordination, Xie Yunfei et al. note that Chinese architecture and construction universities still face deficiencies in BIM talent cultivation, including lack of systematic curricula, teaching materials, qualified faculty, and hardware infrastructure. Among these, inadequate faculty development is the primary factor restricting BIM talent cultivation. Many scholars have explored solutions for faculty training. Zheng Yingjie et al. propose establishing BIM technology development centers, selecting backbone teachers for training, encouraging teachers to obtain professional certifications, and introducing BIM production projects. Zhang Weiqi et al. suggest establishing BIM training laboratories and teaching-research teams to enhance faculty capabilities. Zhang Yingchun et al. recommend building a school-enterprise collaborative education mechanism based on BIM technology. Bai Shu et al. advocate encouraging professional teachers to work temporarily in enterprises or directly recruiting BIM professionals from industry. Bai Quan et al. propose encouraging teachers to participate in advanced BIM training to improve their theoretical knowledge and application skills.

Building upon this research, and considering that university talent cultivation—constrained by limited resources—tends to emphasize theoretical teaching while

practice remains limited to single software operations or fragmented knowledge application, there remains a significant gap with enterprise demands for whole project lifecycle management and integrated project optimization. This paper focuses on BIM faculty training in application-oriented undergraduate institutions. It first analyzes the competency framework required for BIM technology application talents, then proposes the knowledge and capabilities that BIM faculty should possess based on market demand, and finally presents practical measures for BIM faculty cultivation from the perspective of industry-education integration. These efforts aim to improve the quality of applied BIM talent development and provide a valuable reference for similar institutions.

2. Competency Framework for BIM Technology Application Talents

Chinese enterprises primarily demand three types of BIM talent: BIM standard specialists, BIM tool specialists, and BIM application specialists. Application-oriented undergraduate institutions should focus on cultivating BIM application specialists—practitioners who use BIM to support and complete tasks throughout the building lifecycle, including design, construction, procurement, and cost management personnel for clients; architecture, structure, MEP, HVAC, and electrical professionals in design and construction enterprises; operations management personnel; and specialized BIM application professionals in various related organizations.

Through investigation and interviews, our research team concludes that BIM technology application-oriented talent cultivation in newly established undergraduate institutions should enable students to complete fundamental training as BIM engineers during their university studies. The knowledge and capabilities in BIM technology should follow a progressive hierarchical relationship: software operation skills form the foundation, modeling and model application constitute the two main tasks, and project integrated management represents the extended objective. We propose a "one foundation, two main tasks, one extension" competency framework for application-oriented undergraduate BIM talent cultivation, illustrated in Figure 1 [Figure 1: see original paper].

Further detailing this competency framework yields the specific competency system that application-oriented undergraduate BIM talents should possess, as shown in Figure 2 [Figure 2: see original paper].

3. Knowledge and Capabilities BIM Faculty Should Possess in Application-Oriented Undergraduate Universities

Based on the above analysis of the talent demand competency framework, we propose that BIM faculty in application-oriented undergraduate institutions should possess the following professional knowledge and capabilities:

(1) Mastery of architecture and construction professional knowledge, including building construction, structures, construction technology, budgeting,

bidding, and project management; familiarity with BIM fundamental theories; and proficiency in operating and applying at least one BIM-related software.

(2) Capability to apply BIM software to establish engineering models (including architecture, MEP, steel structures, and transportation engineering), integrate and maintain models, and apply BIM5D platforms for project integration and comprehensive management.

(3) Minimum three years of work experience in engineering design, construction, supervision, testing, or site management at relevant enterprises such as design institutes, construction companies, supervision firms, or real estate enterprises.

(4) Possession of intermediate-level or higher BIM professional certification issued by industry authoritative organizations.

(5) Mastery of modern educational information technology, with the ability to guide students in participating in various BIM professional competitions and completing comprehensive BIM technology application training and graduation projects.

(6) Capability for exploration and research in BIM technology application, with innovative spirit, and the ability to complete BIM-related research projects and enterprise BIM technical services.

4. Practical Exploration of BIM Faculty Training from the Industry-Education Integration Perspective

4.1 Project Services Under the BIM Studio Model BIM technology application can be regarded as an educational innovation behavior in architecture and construction universities, with faculty teaching capability being the key to implementing BIM information technology education innovation. Establishing a BIM studio represents an effective approach to stimulating faculty BIM educational innovation and enhancing teaching capabilities.

(1) Establish a BIM studio, form a BIM team composed of teachers from different specialties, select outstanding students to join, and concurrently establish a BIM professional association. Our school' s BIM studio comprises teachers from architecture, MEP, transportation engineering, and other specialties. For two consecutive years, team members have undertaken internships and project services at a large design institute, a state-owned construction enterprise, a steel structure company, and a construction consulting firm. Through these project services, teachers have enhanced their practical abilities in BIM modeling software such as Revit, Tekla, and Bentley, as well as their capabilities in solving engineering technical problems for enterprises. Simultaneously, teachers can use actual BIM technology application projects from their project services as teaching carriers, with the completion of productive BIM technical services for enter-

prises as teaching objectives, making the teaching process oriented toward production practice and teaching resources derived from real cases, which greatly improves teaching effectiveness.

(2) Through project services, team teachers maintain long-term close contact with enterprises, gaining in-depth understanding of BIM technology' s application value at various project stages, the demand status for BIM technology talents, job tasks for BIM technology positions, salary levels, and development prospects. This provides first-hand information for optimizing and adjusting application-oriented undergraduate talent cultivation programs and teaching reforms. Project services feed back into the teaching process, stimulating students' learning interest and improving talent cultivation quality.

(3) Establishing a BIM studio as an incubator for industry-education integration and school-enterprise cooperation requires policy support. For instance, the studio should have full autonomy in allocating economic benefits generated from project services. Teachers participating in project services should receive recognition and support in terms of time allocation and teaching workload recognition. This fully mobilizes teachers' enthusiasm, expands the studio's influence, deepens school-enterprise cooperation, and enhances BIM faculty capabilities.

Since our studio' s establishment, project services have grown from small to large, from point to surface, with completed contract values reaching hundreds of thousands of yuan. We have completed curriculum standards, instructional designs, self-compiled lecture notes, and training project task books and guidance manuals for "BIM Technology Application" and "BIM5D Comprehensive Training." We have guided student associations to participate in various BIM professional competitions and win multiple awards, and have successfully applied for Shaanxi Provincial College Student Innovation and Entrepreneurship Projects with BIM themes.

4.2 Flexible Expert Introduction Through Enterprise Mentorship System Drawing on the construction philosophy of modern apprenticeship programs, we implement the integration of teaching processes with production processes to promote the development of combined full-time and part-time faculty teams. Enterprise BIM experts can be invited to give lectures at the university periodically, or expert master studios can be established. Our school has engaged the director of the BIM Technology Center of a large state-owned construction enterprise as an off-campus mentor for our studio and as a flexibly introduced expert to train BIM faculty and guide BIM practical teaching.

Addressing the current situation where internal faculty lack practical experience and have weak capabilities in project integrated management and optimization based on BIM platforms, we conducted faculty training using a petroleum research center project hosted by the off-campus mentor as a case study. The

main content included: (1) Preliminary preparation phase: developing optimal pipeline layout plans and establishing BIM models; visual drawing review and 3D site layout; (2) Detailed design phase: creating precise models, integrating MEP professional systems, conducting clash detection, and detailed model design; stress calculation for supports and hangers, and issuing prefabrication drawings; (3) Simulation and verification phase: 3D walkthrough and 4D construction simulation to determine construction sequences and workflows; (4) On-site implementation phase: precise pre-embedding based on BIM technology; factory prefabrication and on-site assembly based on BIM technology; product QR code positioning management; mobile terminal visual technical disclosure; and precise quantity calculation based on BIM models.

Implementing the off-campus mentorship system has greatly enhanced teachers' participation in actual projects and laid a solid foundation for BIM5D comprehensive application practical teaching.

4.3 School-Enterprise Cooperation for Capability Enhancement

(1) School-enterprise cooperation and industry-education integration remain effective models for application-oriented undergraduate talent cultivation. In recent years, our school has signed a school-enterprise cooperation agreement with a large construction enterprise to provide project services for its Silk Road International Art Center project. For two consecutive years, we have dispatched a faculty team composed of building construction, structural engineering, geotechnical engineering, construction technology, and cost estimation specialists to the enterprise for project services. The team has completed temporary structure design, foundation pit support construction plans, and pipe jacking construction plans. Simultaneously, using our school' s training base, we provided BIM modeling training for the enterprise' s employees. Currently, our school has completed construction drawing review for the project and is completing BIM modeling for various specialties, laying the foundation for subsequent project integrated management and optimization using BIM technology.

(2) Deepening school-enterprise cooperation, we regularly dispatch teachers for on-site project services. Long-term services can utilize winter and summer vacations, while short-term services can use daily teaching free time. We actively organize backbone teachers to establish joint research groups with enterprises to complete enterprise BIM technology application projects or jointly apply for various vertical research projects.

(3) Inviting enterprise experts to join professional teaching guidance committees to participate in developing application-oriented undergraduate talent cultivation programs based on BIM technology, compiling BIM curriculum standards, developing BIM course resources, and writing practical guides for BIM technology application.

Industry-education integration and on-site project presence constitute the main

channel for enhancing BIM faculty capabilities. Through actual project practice, faculty BIM technology application capabilities are greatly improved, and experience is accumulated for practical teaching reforms in BIM technology application talent cultivation. Currently, our school has completed or is conducting enterprise horizontal projects worth hundreds of thousands of yuan and has jointly applied for three vertical research projects with enterprises. We have compiled an application-oriented undergraduate talent cultivation program for civil engineering majors integrating BIM technology and completed BIM curriculum standards. We have established 3D model libraries for various building components and structures and systematically developed course resources for "BIM Technology Application" and "BIM5D Platform Comprehensive Training."

Practical professional technical capabilities are the key determinant of teaching ability for faculty in application-oriented undergraduate institutions. School-enterprise cooperation and industry-education integration remain the essential path for enhancing BIM faculty capabilities. According to the "Guiding Opinions of the General Office of the State Council on Deepening Industry-Education Integration," we should further improve the operational mechanisms and safeguard measures for the studio system and off-campus mentorship system to ensure effective project services and guaranteed faculty capability enhancement. Future work plans include developing high-quality online open courses for BIM, accelerating the informatization construction of teaching resources, refining new engineering discipline characteristics based on intelligent construction to promote deep school-enterprise integration, implementing task-based training models oriented toward real enterprise production environments to continuously improve talent cultivation quality, selecting outstanding students for productive internships at enterprises, and jointly establishing productive internship bases with enterprises. We will also cooperate with enterprises to build "dual-qualification" BIM faculty training bases, making regular enterprise practice for teachers normalized and institutionalized as a necessary condition for teacher evaluation and professional promotion. Through policy integration and deepening reforms, faculty capability enhancement will become more purposeful, planned, and guaranteed, with greater autonomy and enthusiasm. BIM faculty capability enhancement oriented toward the entire project construction process will be more effective, and talent cultivation quality will be significantly improved.

References

[1] Bai Shu, et al. Practice and Reflection on BIM Talent Training in Civil Engineering Undergraduate Institutions[J]. Journal of Information Technology in Civil Engineering and Architecture, 2015, 7(4): 99-102.

[2] Xie Yunfei, Li Chunxiang. Impact and Reflection of BIM on Talent Training in Civil Engineering Colleges and Universities[J]. Journal of Information Technology in Civil Engineering and Architecture, 2017, 9(5): 86-90.

[3] Zheng Yingjie, Gan Hui, Peng Zimao. Analysis on BIM Faculty Training in Higher Vocational Architecture Programs[J]. Education Modernization, 2017, 4(43): 88-90.

[4] Zhang Weiqi, Han Jun. Research and Exploration on BIM Faculty Capability Training Through School-Enterprise Cooperation in Higher Vocational Education[J]. Journal of Harbin Vocational & Technical College, 2017(5): 7-9.

[5] Zhang Yingchun, Du Ming, Li Weicheng. Research on School-Enterprise Collaborative Education Mechanism Based on BIM Technology[J]. Education Modernization, 2017, 4(52): 21-23.

[6] Bai Quan, Bian Jingmei, Yu He, et al. Research and Practice on BIM Teaching Reform for Civil Engineering Majors[J]. Journal of Information Technology in Civil Engineering and Architecture, 2017, 9(5): 90-93.

[7] He Guanpei. Thoughts on Career Development of BIM Application Professionals (II). http://blog.sina.com.cn/s/blog_620be62e0100v1za.html.

[8] Teng Jiaying, Wang Wan. Research on the Induction Mechanism of BIM Information Technology Education Innovation Behavior[J]. Higher Education in Architecture, 2017, 26(6): 123-128.

[9] Yao Qi, Li Chaoyang. Exploration of Modern Apprenticeship Pilot Projects in Higher Vocational Education—Taking the Architectural Engineering Technology Program (BIM Technology Application Direction) of Guangxi Construction Vocational and Technical College as an Example[J]. Guangxi Education, 2016(12): 99-101.

Author Biography

Jin Yan (1976—), female, from Hancheng City, Shaanxi Province, is an associate professor and Vice Dean of the School of Urban Construction at Xi' an Siyuan University. She holds a Master' s degree in Management. Her research focuses on construction project cost management.

Correspondence Address: School of Urban Construction, Xi' an Siyuan University, No. 28 Shui' an Road, Eastern Suburbs, Xi' an, Shaanxi Province
Postal Code: 710038
Mobile: 13772166408
Email: yan760418@126.com

Note: Figure translations are in progress. See original paper for figures.