

Faculty Development for BIM Technology under the Industry-Education Integration Framework: Exploration and Practice (Postprint)

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

Abstract

With the widespread application of BIM technology, cultivating application-oriented BIM talents has become a broad consensus among architecture and construction-related universities. However, inadequate faculty development remains the primary factor constraining BIM talent cultivation. This paper focuses on BIM faculty development in application-oriented undergraduate institutions. First, it analyzes the competency framework required for BIM technology application-oriented talents. Second, guided by these demands, it proposes the essential knowledge and capabilities that BIM faculty in application-oriented undergraduate programs should possess. Finally, it presents practical measures for BIM faculty development from an industry-education integration perspective, aiming to enhance the quality of application-oriented BIM talent cultivation.

Full Text

Preamble

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

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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, insufficient faculty development remains the primary constraint on BIM talent cultivation. This paper focuses on BIM faculty training in applied undergraduate institutions. First, it analyzes the competency framework required for BIM technology application talents. Second, it proposes the essential knowledge and

abilities that applied undergraduate BIM faculty should possess, guided by market demands. Finally, it presents practical measures for BIM faculty cultivation from an industry-education integration perspective, aiming to improve the quality of applied BIM talent development.

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

1. Introduction

With the release of the “2016-2020 Construction Industry Informatization Development Outline” by the Ministry of Housing and Urban-Rural Development, BIM technology has been more extensively applied in various 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-oriented talents has become a widespread consensus among architecture and construction universities. Currently, some civil engineering 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 center cultivation.

However, relative to the multi-faceted competency requirements of the industry and enterprises for BIM professionals—including software application skills, technical expertise, and comprehensive coordination abilities—Xie Yunfei et al. note that Chinese architecture universities still face several deficiencies in BIM talent cultivation: lack of systematic approaches, teaching materials, qualified faculty, and hardware infrastructure. Among these, inadequate faculty development is the primary factor restricting BIM talent cultivation. Regarding faculty training, numerous scholars have conducted beneficial explorations. 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 as faculty development strategies. Zhang Weiqi et al. suggest establishing BIM training laboratories and teaching-research teams to enhance faculty competency. Zhang Yingchun et al. propose creating a school-enterprise collaborative education mechanism based on BIM technology. Bai Shu et al. recommend encouraging professional teachers to work temporarily in enterprises or directly recruiting BIM professionals from industry as faculty. Bai Quan et al. advocate encouraging teachers to participate in advanced BIM training to improve their theoretical knowledge and practical application abilities.

Building upon this existing research and recognizing that universities, constrained by their own conditions, tend to emphasize theoretical teaching while offering only single-software operation or fragmented knowledge application in

practice—which falls significantly short of enterprise demands for full project lifecycle and integrated project management and optimization—this paper focuses on BIM faculty training in applied undergraduate institutions. It first analyzes the competency framework required for BIM technology application talents, then proposes the essential knowledge and abilities for applied undergraduate BIM faculty guided by market demands, and finally presents practical measures for BIM faculty cultivation from an industry-education integration perspective. The aim is to improve the quality of applied BIM talent development and provide valuable references for similar institutions.

2. Competency Requirements for BIM Technology Application Talents

Enterprise demand for BIM talents in China primarily falls into three categories: BIM standard talents, BIM tool talents, and BIM application talents. Applied undergraduate universities should position their BIM talent cultivation toward BIM application talents. BIM professional application talents are 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, water supply and drainage, HVAC, and electrical personnel in design and construction enterprises; operations management personnel; and various professional BIM application personnel in related organizations.

Based on research and interviews, our project team concludes that BIM technology application-oriented talent cultivation in newly established undergraduate institutions should enable students to complete basic training as BIM engineers during their university studies. The knowledge and abilities related to 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 goal. We propose a “one foundation, two main tasks, one extension” competency framework for applied undergraduate BIM talent cultivation, as illustrated in [Figure 1: see original paper].

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

3. Essential Knowledge and Abilities for BIM Faculty in Applied Undergraduate Universities

Based on the above analysis of the talent competency framework, we propose that BIM faculty in applied undergraduate universities should possess the following professional knowledge and abilities:

- (1) Mastery of architecture-related professional knowledge, including build-

ing construction, structures, construction technology, budgeting, bidding, and project management; familiarity with and mastery of BIM fundamental theories; and proficiency in operating and applying at least one BIM-related software.

- (2) Ability to apply BIM software to establish engineering models (including architecture, mechanical and electrical systems, steel structures, and transportation engineering), integrate and maintain models, and apply BIM5D platforms for project integration and comprehensive management.
- (3) More than three years of work experience in engineering design, construction, supervision, inspection, or site management at relevant enterprises such as design institutes, construction companies, supervision firms, or real estate enterprises.
- (4) Possession of intermediate or higher-level BIM 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) Capacity for exploration and research in BIM technology application, innovative spirit, and ability to complete research projects related to BIM technology and provide enterprise BIM technical services.

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

4.1 Project Services Through BIM Studios

BIM technology application can be regarded as an educational innovation behavior in architecture universities, with faculty teaching capability being the key to implementing BIM information technology education innovation. Establishing a BIM studio is an effective approach to stimulating faculty BIM educational innovation and enhancing teaching capacity.

- (1) Establish a BIM studio to 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, mechanical and electrical engineering, 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. Simul-

taneously, teachers can use actual BIM technology application projects from their project services as teaching carriers, with the completion of productive BIM technical services for enterprises as teaching objectives, making the teaching process oriented toward production practice and deriving teaching resources 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, BIM talent demand conditions, job tasks for BIM technical personnel, salary levels, and development prospects. This provides first-hand information for optimizing and adjusting applied 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 relevant policy support. For instance, the studio should have full discretion over the 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 capacity.

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 our association to win awards in various BIM professional competitions multiple times and successfully applied for Shaanxi Provincial College Student Innovation and Entrepreneurship Projects with BIM themes, all receiving provincial-level project approvals.

4.2 Flexible Expert Introduction Through Enterprise Mentor 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 a combined full-time and part-time faculty team. Enterprise BIM experts can be invited to give lectures at the university periodically, or expert master studios can be established. Our school has appointed 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 teachers lack practical experience and have weak capabilities in project integration management and op-

timization 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; conducting visual drawing review and three-dimensional site layout.
- (2) Detailed design phase: creating accurate models, integrating mechanical and electrical systems across specialties, conducting clash detection, and performing model deepening design; calculating support and hanger stresses and issuing prefabrication drawings for supports and hangers.
- (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 accurate quantity calculation based on BIM models.

Implementing the off-campus mentor 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 Capacity Enhancement

- (1) Currently, school-enterprise cooperation and industry-education integration remain effective models for applied undergraduate talent cultivation. In recent years, our school has signed a 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 management, 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 on-campus training base, we provided BIM modeling training for the enterprise's employees. Currently, our school has completed the construction drawing review for this project and is completing BIM modeling for various specialties, laying the foundation for subsequent project integration management and optimization using BIM technology.
- (2) Deepen school-enterprise cooperation by regularly dispatching teachers for on-site project services. Long-term arrangements can utilize winter and summer vacations, while short-term arrangements can use daily teaching free time. Actively organize backbone teachers and enterprises to jointly

establish research teams to complete enterprise BIM technology application projects or jointly apply for various vertical research projects.

- (3) Invite enterprise experts to join professional teaching guidance committees to participate in developing applied 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 are the main channels for enhancing BIM faculty capacity. Through actual project practice, teachers' BIM technology application capabilities are greatly improved, and valuable experience is accumulated for practical teaching reforms in BIM technology application-oriented 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 applied undergraduate talent cultivation program for civil engineering majors integrating BIM technology and completed BIM curriculum standards. We have established three-dimensional model libraries for various building components and structures and systematically developed course resources for "BIM Technology Application" and "BIM5D Platform Comprehensive Training."

The practical teaching ability of applied undergraduate faculty is the key determinant of teaching capacity. School-enterprise cooperation and industry-education integration remain the essential path for enhancing BIM faculty capacity. 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 studio systems and off-campus mentor systems to ensure effective project services and guaranteed faculty capacity enhancement. Future work plans include developing high-quality online open courses for BIM to accelerate 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; and cooperatively building "dual-qualification" BIM faculty training bases with enterprises to normalize and institutionalize regular faculty practice at enterprises as a necessary condition for faculty evaluation and professional promotion. Through policy combinations and deepening reforms, faculty capacity enhancement can be more purposeful, planned, and guaranteed, with greater autonomy and enthusiasm. BIM faculty capacity enhancement oriented toward the entire project construction process will be more effective, and talent cultivation quality will be significantly improved.

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