Teaching Reform and Practices of Civil Engineering Majors’ BIM-Based Comprehensive Graduation Design

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ABSTRACT

Great lack of talents has seriously restricted application and development of BIM technologies in the field of architecture. According to cultivation of BIM talents in universities, a practical teaching reform scheme is proposed to be introduced into graduation design of majors in civil engineering in this paper. Besides, problems with graduation design concerning BIM and corresponding solutions are summed up. Practices prove that it is helpful for rapidly enhancing students’ practical skills in BIM, strengthening students’ abilities in engineering practices and improving their knowledge about engineering by comprehensively using BIM in graduation design.

INTRODUCTION

With constant development of information technologies in architecture, it has become inevitable that BIM (Building Information Modeling) will be applied in that industry, and there is a growing demand for BIM talents in architectural market. Great lack of BIM talents has become a bottleneck for technological development of BIM[1].

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OBJECTIVES FOR CIVIL ENGINEERING MAJORS TO COMPLETE GRADUATION DESIGN WITH BIM

To respond to these needs, how shall universities deepen reaching reform, keep pace with the times and develop high-quality BIM talents for developing architecture as bases for training reserve talents for industries? In view of industrial urgent needs, it is still immature to rapidly provide talents by relying on systematic academic education, which is more impractical in China even in a short term[2]. For instance, this may be reflected from procedures developed for BIM. For majors in Civil Engineering, introduction of BIM technologies in the phase of graduation design may not only promote effective integration of these technologies with university teaching, rapidly strengthen students’ practical skills in BIM, make undergraduates majoring in Civil Engineering more adaptable to industrial needs and increase their employment competitiveness, but can also enhance university teachers’ skills in learning and utilizing BIM technologies, thus driving development of BIM teachers in universities.

SCHEME FOR EXECUTING COMPREHENSIVE GRADUATION DESIGN WITH BIM

Scheme for executing graduation design with BIM is practiced based on a module, which is mainly divided into design stage, tendering/bidding stage and construction stage. The design idea is primarily described as follows: In a project, graduation design with BIM is completed by a team, in which specific tasks are assigned to each member, in order to complete a complete engineering project and put BIM into practice. Graduation design results achieved with BIM belongs to project deliverables, including those gained from all stages like design, tendering/bidding and construction, which may finally be incorporated to compose a document concerning outcomes of virtual construction by BIM[3]. Design content and outcomes are required as follows in different stages.

Design Stage

In this stage, students are mainly asked to build three-dimensional solid models with 3D design software such as GMT, Magicad and Rviet based on given actual engineering cases. Software for structural design like GICD is used to arrange reinforcement and document deliverables from stage of structural design. Deliverables are specifically as follows: On one hand, three-dimensional architectural and electromechanical models are created; on the other hand, efforts are made to review drawings from a three-dimensional perspective and check collision. Finally, models are required to be smoothly imported into metric software for the next stage and no collision will be found.
**Tendering/Bidding**

Stage After the design stage, tender and bidding documents shall be respectively prepared for the engineering project. Concrete tasks are described as follows. Firstly, engineering quantity shall be calculated with Glodon metric software for reinforcement, civil construction and installation, etc. Bills of quantity and tender documents need to be prepared. Secondly, a tender offer shall be prepared with Glodon valuation software. Thirdly, three-dimensional floor plans for site and those for construction shall be developed with Glodon software for floor plan of three-dimensional construction to form bidding documents.

**Construction Stage**

In this stage, the whole project is mainly virtually constructed with 5D BIM software for construction simulation. The entire stage of construction is managed in combination with software for managing materials, data and projects. At last, documents about deliverables may be created. Details of this stage are introduced as follows. First of all, different professional models of the planning stage are loaded to integrate models of preparatory stage with progress and costs (5D), in order to simulate virtual construction before practical construction, avoid problems and confirm final scheme for construction. Next, progress and outcomes of construction stage are entered based on tasks, so as to actually control the project, complete final cost-related document for settlement, import them for 5D analysis, compare three costs (including engineering, pre-construction and quality costs) and adjust schemes.

**PROBLEMS IN GRADUATION DESIGN COMPLETED WITH BIM AND SOLUTIONS**

It is still unprecedented in China that comprehensive graduation designs are completed by majors in Civil Engineering with BIM, so many problems are inevitable in implementing a project, mainly including how to enable students to master skills in operating BIM software as quickly as possible, improve tutors’ abilities to apply BIM and coordinate multiple specialties. In view of these problems, major measures may be taken as follows[4].

**Training Skills in Operating Software**

In the process of executing a project, it is firstly necessary to learn how to operate BIM-related software and master them. Once design tasks are assigned, a training will be conducted in the form of online courses to train skills on how to use BIM software while working on graduation design. Such learning style is helpful for students to put them what they have acquired into practice while learning, so that
they can better acquire how to operate software and their problems encountered during design may be promptly solved.

**Tutors’ Incapacity for BIM**

Lack of tutors who are proficient with BIM is another difficulty in implementing a project. In light of this problem, a united BIM consultative agency trains all teaching staff instructing students before graduation design and assists tutors in performing the graduation design on a trial basis. In this way, it is possible to strengthen tutors’ practical skills in BIM and guarantee instructive effects.

**Coordinating Multiple Specialties**

Comprehensive graduation design completed by BIM covers three specialties, including Civil Engineering, Engineering Management and Construction Costs. Although different majors cooperate with each other and are responsible for different tasks in the course of designing, results of each stage may impact the design of the following stage during information exchange. Thus, multiple specialties are required to be coordinated. Students shall be not only proficient with the knowledge of the specialty they major in, but also need to have some knowledge about other specialties. To help students construct a professional knowledge structure necessary for graduation design, lectures on special topics are integrated with tutoring team’s successive instruction to train and instruct students. BIM professionals are invited from corresponding consulting companies to give lectures about special topics, for the major purpose of interpreting information exchange among BIM software and synergic relationships among tasks assigned to different majors. The tutoring team is made up of teachers of Civil Engineering, Engineering Management and Construction Costs. Meanwhile, software teachers are assigned to jointly instruct students with those of other majors, in order that students may form a complete and systematic knowledge system about graduation design[5].

**EFFECT AND MEANING OF BIM-BASED GRADUATION DESIGN**

BIM technologies are introduced into the design stage for comprehensive design by coordinating multiple specialties. The implementation of this project reflects closely following international “internet +” informatization strategies[6], carrying out system of the Ministry of Education for deepening reform of talent training model and improving teaching, intensively implementing universities’ reform projects for teaching and vigorously supporting employment-oriented universities’ reform and construction. It is ideologically correct and apparently effective for promoting informatization of architecture, increasing popularity of BIM and facilitating talent training, etc.
According to final implementation effect, BIM-based graduation design may greatly strengthen students’ abilities to solve problems about engineering technologies of civil engineering and related specialties by comprehensively applying specialized knowledge as compared with traditional graduation design. Effect of BIM for coordinating work and transformation of various perspectives may not only restore buildings and construction sites to the largest extent, but may also coordinate specialties concerning architecture, structure, heating ventilation, electric appliances, water supply and drainage. Enhancing students’ understanding and grasp of engineering, Revit’s three-dimensional perspective has also reinforced graduates’ concept of engineering, engineering practices and coordination skills.

REFERENCES