

Analysis and Consideration of Construction Project Management Course on Building Information Modeling

Yunxia Jiang^{1,*}

¹*Shanghai Sanda Institute, Shanghai, 201209, China*

**Corresponding author Email: april2002@126.com*

ABSTRACT

In order to adapt to the wide application and rapid development of Building Information Modeling in the construction industry, we do some research on Construction Project Management course based on Building Information Modeling in this paper. According to the characteristics of the course, combined with the advantages of Building Information Modeling, the application status and difficulties of Construction Project Management course based on Building Information Modeling are analyzed. Then through literature research methods and interviews with some teachers and some students, some suggestions about how to apply Building Information Modeling into Construction Project Management course are put forward in this paper. It is hoped that these suggestions can provide some references for the teaching reform of Construction Project Management course with the emergence of Building Information Modeling.

Keywords: *construction, project, management, course*

1. INTRODUCTION

BIM is the abbreviation of building information modeling, which is well known in the construction industry in recent years. BIM is a digital expression of the characteristics of construction projects. It is a technology and management method that uses information technology to simulate the process of design, construction and management in construction projects [1]. The full application of BIM will greatly improve the production efficiency of the construction industry. It will enhance the integration of construction projects. It will make the quality and efficiency of construction project design, construction and operation significantly improve and reduce the cost of construction project.

With the rapid development of today's economy, China's government's demand for public project construction is increasing, which makes construction projects more and more common in today's society[2]. In recent years, with the rapid development of information technology in the construction industry, there are more and more documents that require the application of BIM in construction projects in China. BIM is actively promoted and applied in the construction field from the government to the owner. However, there is a shortage of BIM talents at present. The development trend of BIM in the construction industry provides a good opportunity to explore the development and application of BIM in Engineering Management major. Construction Project Management course which can be abbreviated as CPM course in this paper is one of the core professional courses of Engineering Management major. The mastery of this course knowledge is an important embodiment of the professional ability of Engineering

Management major students. The course involves a wide range of knowledge and strong practicality. Traditional classroom teaching has always been used as the main teaching method, so it is difficult to combine the teaching with the actual construction management. At present, the teaching of CPM course mainly focuses on theoretical explanation, supplemented by a case study. The learning effect is far from meeting the actual work requirements of employers for Engineering Management major graduates. Through BIM, the whole process of construction projects can be simulated, so as to help students understand the operation and management of construction projects more easily, and further deepen their mastery of professional knowledge. Therefore, the research of CPM course based on BIM has important theoretical and practical significance.

In this paper, BIM advantages will be briefly analyzed. Then, the application status and difficulties of CPM course on BIM will be analyzed. Through literature research methods and interviews with some teachers and some students, some suggestions for CPM course on BIM will be put forward. It is hoped that these suggestions can give some reference and help to relevant teachers. It is also hoped that this research can arouse more attention to BIM teaching in Engineering Management major.

2. ANALYSIS OF BIM ADVANTAGES

BIM has some advantages: visualization, coordination, simulation, optimization and drawing ability [3].

2.1. Visualization

BIM displays the components in the form of three-dimensional physical drawings in front of people. BIM visualization is to form interactive and feedback visibility among components. In the building information model, all processes are visible.

2.2. Coordination

BIM can coordinate the collision problems of various disciplines in the early stage of building construction, and it can generate reports to help designers modify the scheme. This kind of collision problem can be solved before the construction stage of the project.

2.3. Simulation

BIM can not only simulate the design of the building model, but also it can simulate things that will not be carried out in the real scene.

2.4. Optimization

Optimization is usually constrained by information, complexity and time. BIM and its various optimization tools provide optimization services for complex projects. The optimization method based on BIM can complete the optimization of project scheme and the design optimization of special project.

2.5. Drawing Ability

BIM can not only provide common building construction drawings, but also it can provide construction drawings formed after visualization, coordination, simulation and optimization of buildings.

3. APPLICATION STATUS ANALYSIS OF CPM COURSE ON BIM

The application status of BIM in the construction industry and the application status of BIM in the curriculum construction will be analyzed in this part. Then the difficulties of CPM course on BIM will be analyzed and summarized in this part.

3.1. Application Status of BIM in the Construction Industry

Many countries have promoted the application of BIM in their own country, and they have achieved certain results. In the construction industry of the United States, BIM has

been used by more than half of the companies. In the UK, the government has formulated a series of BIM strategies and plans to promote the development and application of BIM in the UK. The emergence of BIM is changing the cooperation mode of all participants in construction projects. In China, many construction projects have used BIM technology in different stages of construction projects. Shanghai Center Tower project is a typical case of BIM technology in the whole life cycle.

3.2. Application Status of BIM in the Curriculum Construction

BIM not only brings new requirements to the construction industry, but also it brings new requirements to the talent training of civil engineering majors in colleges and universities. Many universities in the United States have incorporated BIM into a series of undergraduate and graduate construction management courses. In addition, they also hold BIM meetings regularly or irregularly. At the same time, some universities offer BIM courses, such as the University of Salford offering BIM master courses[4]. The academic and business circles in Japan have taken the initiative to study BIM and held BIM related competitions for many times[5].

In China, with the in-depth application of BIM, more and more colleges and universities realize the importance of BIM and make various attempts. For example, Yu Liu added BIM contents into the teaching of Architectural CAD Drawing course. Shang Zhang introduced the mode of BIM education reform of the United States and discussed the specific problems such as the goal, mode, setting time and method of using BIM in Engineering Management major. Jiangyong Tian explores the teaching method of BIM in the Building Construction Technology course[6]. Yue Qi discussed the teaching reform of building architecture course combined with BIM. Keda Chen discussed some problems about the application of BIM in the reform of the Construction Engineering Computer Application course[7]. Among them, there is not a lot of systematic research on BIM applied to CPM course.

3.3. Difficulties of CPM Course on BIM

Through comprehensive analysis of teachers' and students' understanding about the CPM course and with relevant literature research, some difficulties of CPM course on BIM are analyzed and summarized.

3.3.1. Difficulties in setting up teaching objectives

At present, some colleges and universities have added BIM content into the course of CPM course. However, there is no consensus on what BIM knowledge should be included

in the curriculum and how to determine the teaching objectives after it is included in the curriculum. Because there is no unified standard, it is difficult to set teaching objectives in the CPM course based on BIM.

3.3.2. Difficulties of adding BIM into the original CPM course contents

CPM course has the characteristics of complex knowledge system and strong practicality. The original contents of CPM course are formed after years of practice and constant revision. It is a challenging task to integrate BIM knowledge into the original CPM course content and form a new organic knowledge structure system. The new knowledge structure system will not only bring great impact on the original curriculum system, but also it may be a challenge for teachers and students to learn BIM course content.

3.3.3. Difficulties of BIM resource investment

To integrate BIM into CPM course, we need to make use of BIM software and hardware facilities. It is necessary for colleges and universities to build corresponding BIM laboratories. But the construction cost of BIM laboratory varies from several hundred thousand yuan to several million yuan. Such a huge investment increases the difficulty of introducing BIM into the course.

3.3.4. Difficulties of lack of BIM teachers

At present, we may face the problem of lack of teachers when we integrate BIM into CPM course. The teachers of the original CPM course may not be willing to learn BIM technology because they need to spend extra time and energy. Some teachers may lack the ability to master the new information technology, and they may be resistant to the learning of BIM technology. Lack of teachers who are skilled in using BIM tools will be one of the difficulties in the construction of CPM course based on BIM.

4. SUGGESTIONS ABOUT CPM COURSE ON BIM

As a new teaching method and tool, BIM plays an active role in improving the teaching quality of CPM courses. In order to promote the implementation of CPM course teaching more effectively, and further improve the comprehensive ability of students, the following suggestions about CPM course on BIM are summarized,

combined with the results of literature research and interviews of some teachers and students.

4.1. Setting Up Teaching Objectives on BIM

In the environment that BIM has been widely used in construction industry at home and abroad, we should make full use of the characteristics and advantages of this new technology to optimize the course objectives of CPM. The teaching objectives of CPM course based on BIM can be set up as follows:

- Understand the principle, function and value of BIM.
- Be familiar with the basic application and related value of BIM in the whole life cycle of the construction project.
- Master the content and method of cost management and quality management of the construction project based on BIM.
- Master various measures of progress control based on BIM and progress optimization control methods based on BIM.
- Be familiar with the basic contents and methods of resource management, information management, data management and risk management based on BIM.
- Be familiar with the methods and contents of BIM project collaborative application.

4.2. Modular Design of Course Contents

The contents of CPM course have the characteristics of complex knowledge system and strong practicality. The contents of CPM course on BIM mainly include the introduction of construction project management system, construction project planning, construction project organization, progress management, cost management, quality management, resource management, communication management, information management and BIM knowledge, etc. It is suggested that the course teaching content system can be set as follows: basic theoretical knowledge module, case topic module, simulation module, site visit module, course design module. Reasonable use of BIM knowledge in the above modules and contents can make students more intuitive and clear to master the knowledge system of CPM course. After interviewing 8 teachers who have taught CPM course, we designed the course hours of the curriculum system module and BIM hours of the whole hours as shown in Table 1.

Table 1 Module Design

Module Design	Module Contents				
	<i>Basic theoretical knowledge module</i>	<i>Case topic module</i>	<i>Simulation module</i>	<i>Site visit module</i>	<i>Course design Module</i>
Course hours	32	8	16	8	32
BIM hours	8	4	16	4	32

4.3. Course Contents Optimization on BIM

In the course optimization, BIM should be used reasonably to optimize the relevant teaching content according to the characteristics of CPM course. One of the biggest advantages of BIM is the application of 3D visualization model. Using this advantage, we can simulate the building through professional BIM software, and we can bring the project into the classroom, so that students can come to the scene in person in the classroom. Taking the construction stage of the project management as an example, the core contents of the project management in the construction stage are the progress management contents, quality management contents and cost management contents.

4.3.1. Optimization of construction progress management course contents

In the past, when explaining progress management, we will find out that various bar charts and network plans were boring and tedious. It was very difficult for students to master them completely and to connect them with the actual project progress management. If we adopt the 4D virtual simulation construction technology based on BIM and add a time dimension to the 3D building information model completed in the engineering design stage, we can constitute the 4D simulation construction animation. Then we can build the model on the computer and use various 3D visualization equipment to describe the construction project. In the classroom teaching, according to the construction plan of the project, the whole construction progress of the real project is simulated. This method of using BIM to simulate the progress plan of the construction project is much better than explaining the formulation and implementation of the progress plan with a piece of text and chart.

4.3.2. Optimization of construction quality management course contents

We can add material information into BIM. Through the modeling process of the model, the building components in the project can be gradually built up according to the actual construction sequence. With the help of BIM, the

construction process can be fully reflected. This method can make students understand the relationship among the various components of a building. Then with the teacher's explanation of the construction points of the major components, it is easy for students to find the quality control difficulties in the construction process.

4.3.3. Optimization of construction cost management course contents

Through BIM with material information attached, we can directly see what building components are completed and what materials are consumed in each period. Through the demonstration of the construction process displayed by BIM and through the demonstration of the process of converting material consumption into construction cost, students can have a more intuitive and comprehensive understanding of the process of construction cost formation, so as to grasp the control points of construction cost management more easily.

4.4. The suggestion on Teaching Organization Form on BIM

After introducing BIM into CPM course, we can adopt three kinds of course organization forms.

4.4.1. BIM classroom teaching

We can teach students design, schedule, cost management, quality management and other content based on BIM in the traditional teaching method. Through BIM classroom teaching, students can understand the basic knowledge of BIM and be familiar with BIM software.

4.4.2. BIM practice teaching

Students use BIM software to solve practical engineering problems. In particular, project management sand table simulation practice course based BIM can enable students to experience the process of project management of construction enterprises in the simulated environment, and enable students to think about the essence of construction project management.

4.4.3. BIM course design

BIM course design can test BIM teaching effectiveness. According to the construction project case, the project team is formed and the division of labor and cooperation is carried out. Then the team will use BIM to complete the course design tasks in the design stage, bidding stage, construction preparation and other stages [8].

4.5. Suggestion about Case Teaching on BIM

The case teaching method is a heuristic and practical teaching method. Teachers can use BIM to analyze the case of project management. Teachers can simulate the real situation of "Internet plus" with BIM to guide students to establish a correct attitude towards learning. Teachers should have a class after combining the theoretical content with the actual content with BIM, so that students can clearly understand the project management system.

4.6. Suggestion on Offering Course Lectures about BIM

In addition to teachers' teaching, we can give corresponding guidance to students in the form of BIM lectures[9]. We can invite BIM industry experts with rich experience to introduce BIM in the form of special lectures. In the lecture, the application of BIM can be told to students in detail, so as to continuously improve students' cognition and application ability of BIM.

4.7. Suggestion on Offering Simulation Training Course Based on BIM

We can introduce BIM electronic simulation sand table of project management, and we can organize students to simulate team creation, planning process and execution process in project management by using BIM electronic sand table. This new teaching form can ensure that students have a deeper understanding of the specific work content and process of each cycle of the project. This teaching content can allow students to further understand the nature

of capital flow, material flow and information flow, and the students can also choose to play the role of production manager, operation manager, financial manager, procurement manager, project manager and so on. Then the students can complete the practice from the experience of a different division of labor and cooperation in different departments, so as to enhance the students' active participation and interest in the learning process. According to the survey of 8 universities offering CPM courses, 6 universities among them have used this kind of sand table simulation training module.

4.8. Suggestion on Course Assessment Mode

After the integration of BIM teaching process, the original assessment mode should also be changed. We will adopt diversified assessment methods. Through the diversification of assessment methods, we can not only strengthen students' ability to solve practical problems, but also improve their innovative consciousness. Students will have a stronger grasp of theoretical knowledge. And some examinations will not become a burden to students. The following suggestions are put forward to improve the assessment mechanism. The design of course assessment score distribution is shown in Table 2.

- We can set the score of theoretical knowledge including BIM knowledge to 30% of the total score. There are subjective questions and objective questions in the test paper of the theoretical knowledge module.
- We can set the usual assessment score to 20% of the total score. We can examine students' performance in case discussion and on-site visits combined with BIM.
- We can set the assessment score of the project sand table training module based on BIM to 30% of the total score. In the form of group assessment, each student's mastery of project management knowledge and skills in the sand table training process will be assessed.
- We can set the examination score of the course design module based on BIM to 20% of the total score. Students can choose or draw up appropriate topics based on BIM according to their interests with the teachers' help.

Table 2 Assessment Mode

Assessment Mode	Assessment Contents			
	<i>Theoretical knowledge scores</i>	<i>Usual Assessment scores</i>	<i>Training module scores</i>	<i>Paper or course design module scores</i>
Scores Percentage	30%	20%	30%	20%

4.9. Suggestion on Strengthening the Construction of Teaching Staff

In formulating and implementing teaching methods and activities, teachers' guidance and practice can not be separated. The level of teachers not only determines the overall quality of teachers, but also it is the most important factor in the expected influence of educational objectives[10]. In the construction of CPM course based on BIM, teachers are required not only to have rich basic theoretical knowledge and rich engineering practice experience, but also they should be proficient in BIM software operation. It is suggested that colleges and universities should encourage teachers to participate in BIM related seminars and training courses, and cultivate a team of teachers with strong innovative application ability. Colleges and universities should formulate corresponding policies to encourage teachers to improve their ability and level of using BIM.

4.10. Suggestion on Students' Participation in BIM Competition

We should actively encourage students to participate in some large BIM competitions organized by the state and provinces. We should encourage students to take part in competitions to improve their abilities of using BIM. We can stimulate students' interest in learning BIM by participating in the competition. BIM competition can help students master BIM skills systematically. To a certain extent, students' participation in BIM competition can promote students' learning in class. This is what we often say: competition promotes learning.

5. CONCLUSION

To improve the teaching effect of CPM course and to ensure that students can better master the knowledge of construction project management is an important content in the teaching reform of Engineering Management major. In the environment that BIM has been widely used in the construction industry at home and abroad, we should make full use of the characteristics of this new technology to improve the teaching effect of CPM courses.

At present, there are some difficulties in the construction of CPM course based on BIM, such as how to set the teaching objectives of CPM course integrated with BIM, how to organically combine BIM knowledge with the original CPM course content, how to increase BIM teachers, and how to solve the problem of a large investment in BIM laboratory construction, etc.

With the results of literature research and through interviews of some teachers and students, there are some suggestions about the construction of CPM course based on BIM in this paper, such as trying to set up the teaching goal based on BIM, adding BIM into the original course contents and designing the course module, trying to

optimize the course contents based on BIM, proposing three teaching organization forms based on BIM, proposing to carry out BIM case teaching and BIM course lectures, trying to put forward diversified assessment mode after adding BIM knowledge into the original course, trying to put forward the methods about how to motivate teachers and students to learn BIM of CPM course, etc.

It is hoped that some research in this paper can arouse more attention to BIM teaching in Engineering Management major. It is hoped that more people will join the research team to speed up the pace of teaching reform, so as to improve the quality of teaching to cultivate professional and technical talents suitable for market demand.

REFERENCES

- [1] Zhong Luo, "Discussion on teaching practice of BIM technology in construction project management," Shanxi Architecture, vol. 41, pp. 249-250, November 2015. DOI: <https://doi.org/10.3969/j.issn.1009-6825.2015.27.137>. (In Chinese)
- [2] Zixuan Zeng, "Application of BIM simulation in teaching reform of Construction Project Management course," Education Circle, vol. 9, pp. 87-88, June 2017. DOI: <https://doi.org/10.3969/j.issn.1674-9510.2017.09.043>. (In Chinese)
- [3] Wenlong Lu, "Application of BIM in project cost management," Architectural Engineering Technology and Design, vol. 12, pp. 910, June 2016. DOI: <https://doi.org/10.3969/j.issn.2095-6630.2016.12.867>. (In Chinese)
- [4] Wei Zhong, Xinwen Zhang, Tengting Jiang, "Educational Reform in the Course of Engineering Project Management based on BIM," Journal of Information Technology in Civil Engineering and Architecture, vol.5, pp. 494-496, June 2013. DOI: <https://doi.org/10.3969/j.issn.1674-7461.2013.06.002>. (In Chinese)
- [5] Yanhuan Chen, "Teaching Reform and Practice of Building Engineering Project Management Course Based on BIM," Journal of Juamjusi Education Institute, vol.8, pp. 494-496, August 2018. DOI: <https://doi.org/10.3969/j.issn.1000-9795.2018.08.327>. (In Chinese)
- [6] Jiangyong Tian, "Exploration of BIM Technology in the teaching of Building Construction Technology course," Science & Technology Information, vol.12, pp. 172-174, October 2014. DOI: <https://doi.org/10.3969/j.issn.1672-3791.2014.22.148>. (In Chinese)

[7] Keda Chen, "From CAD to BIM--Reform of Construction Engineering Computer Application Courses," *The Guide of Science & Education*, vol.35, pp. 68-69, December 2014. DOI: <https://doi.org/10.3969/j.issn.1674-6813.2014.35.032>. (In Chinese)

[8] Bin Zhao, Meng Zeng, "Education Reform and Practice Exploration of Construction Project Management Course Based on BIM," *City & House*, vol.25, pp. 61-64, May 2018. (In Chinese)

[9] YanLin Luo, "Teaching reform and practice of Construction Project Management course based on

BIM," *Sciences & Wealth*, vol.9, pp. 86, May 2018. (In Chinese)

[10] Jiarong Wang, Yuzhu Long, Wenbin Zhao, "Application of simulation in teaching reform of construction project management course," *Journal of Information Technology in Civil Engineering and Architecture*, vol.7, pp. 2390, May 2013. DOI:<https://doi.org/10.3969/j.issn.2095-6630.2015.07.2287>. (In Chinese)