
Exploration of Revit Software Aided Architectural Design Education Based on Computer BIM Technology

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Abstract: The development of BIM technology is an amazing trend for the construction industry. The production capacity upgrade with a new technology has inevitably become one of the most important topics of the construction industry. Therefore, the further promotion and application of new computer technologies such as BIM technology have affected the Chinese construction industry to an unavoidable critical juncture. In this paper, we show the Revit software-based experiments, their results based on the college education level. At such a moment, the architectural design major of higher vocational colleges has undergone tremendous changes. The school's teaching goals are not consistent with the new development of the architectural design industry. In the paper, we present the current studies of the BIM based architectural education. We compared the types of applications such as CAD, SketchUp, Revit we use in education field. In this paper, we show that BIM experiment is the advanced technology, and everyone can work together to contribute to efficient transformation of the construction industry with computer BIM technology. We get BIM skill certificate as a result of the Revit software-based experiments and projects in the teaching. The paper presents the results of experiments, tests, performance, and BIM effects on trainings. In applying BIM in an education, a visualization tool is used to enrich the body of knowledge of BIM education.

Keywords: BIM, Revit, Architectural Design Major, Teaching Reform

1. Introduction

Nowadays step by step all companies are moving to BIM technology. It forms one of the main demands of the labor market, influencing the principles of specialist's preparation in the construction industry higher education institutions [1].

China's current architectural industry is developing rapidly. We have transformed from onsite concrete pouring to on-site assembly of factory preset pouring to the new BIM technology integration. BIM technology is of great significance to construction in China because it can shorten time, cooperate with China's architectural design and management style, and it can standardize the process of construction. It is so important that the government has

started requiring companies to use BIM technology to popularize it [2]. The nearest example is the use of Autodesk Revit. This program has many functions but the most important feature is to check if the inner building materials coincide together with no friction. Another example of government aid in the popularization of BIM technology is to have colleges and universities upgrade their material to include BIM technology as well as train students to get the 1+X certificate of BIM skill [3, 8]. Due to this the reform of the architectural design profession is imminent. Glodon and Revit software have been popular among the vast number of engineering cost users by virtue of their powerful parametric modeling and visualization functions. Meanwhile, they have

further accelerated the development of construction industry in an effective combination with other technologies. Regarding the research, the BIM Glodon software saves unnecessary troubles for cost personnel and improve the efficiency [3].

2. Research Background

In 1973, the world's first oil crisis broke out. Due to the increase in oil demand from the United States, the largest oil consumer at the time, as well as the global oil shortage and price increase caused by untimely domestic oil exploration. In 1975, all industries in the United States were exploring energy conservation and efficiency [4].

Several pilot studies have focused on a range of relevant areas, including enhancing the incorporation of BIM concepts as part of interdisciplinary teamwork that architectural engineering students engage in; introducing guidelines for the integration of BIM topics into construction engineering and management curriculum; applying integrated BIM in the education of structural engineering and building technology students; and proposing a process framework for the planning of BIM project execution to enhance student competencies in BIM-focused education [13-16].

According to the "Building Information Model Professional Skill Level Standard" issued by the Ministry of Education of China. The building information model is the process of creating and managing building information in the entire life cycle of planning, design, construction, completion, use, and maintenance using a three-dimensional, real-time, and dynamic model to truly simulate the design and construction of a project. The building information model includes building volume information, spatial interaction information, geographic and landform information, component engineering quantity information, and material information of each components of the building.

In 2002, Autodesk acquired Revit Technology, a three-dimensional software company, and for the first-time interpreted BIM and became the "BIM" that all architects know.

Popular BIM software in China

Autodesk Revit is one of many software developed by Autodesk. Autodesk Revit is specifically developed for how to create building information models. Revit helps architects and designers to create three-dimensional building plans and use plug-in software, which is secondarily developed through the Revit software platform. It can simulate construction, maintenance, and design with better efficiency.

Revit is one of the most widely used BIM software systems in China's construction industry. Other software such as NavisWorks, Fuzor, Lumion, Bim5d are also called BIM series software, but the single software with the most comprehensive functions in Revit. In addition, various software like SJMS, THS WARE, Revit, Glodon, Lubansoft and PMS all can realize the high-quality cost management of engineering projects, effectively improve the working

efficiency, reduce the error rate of cost treatment and achieve highly efficient information fusion and sharing [1-6].

China is also strongly supporting and promoting the introduction of prefabrication methods into all sectors of the AEC industry, which further encourages BIM-based workflows [6]. Besides software industries marketing BIM tools, the Chinese government has emerged as a major force promoting BIM adoption in China recently [7], with a guideline by the Ministry of housing and Urban-Rural Development aiming ambitiously for a national BIM adoption rate of 90% by the year 2020 [8]. In addition, the research presents the status of industry application of BIM and present situation and problems of BIM in school education, practical teaching and learnings [9]. In general, another key component of an accelerating the renovation process and improving the quality and impact of buildings is the development of BIM, which can help to identify improvement interventions [10].

The combination of BIM technology and engineering quantity is compared, and it is considered that the software strength on BIM design software is more obvious, but is not for other categories.

3. Current Status of Computer-Aided Architectural Design in China

3.1. The Use of Autodesk CAD to Draw 2D Designs Is Still the Mainstream Method That China's Major Companies Use

The 2D&3D representation computer applications discipline is the most integrated application both in world level. Autodesk REVIT and Autodesk 3Ds MAX are being mostly used in the international architectural profession [11].

This method is very inefficient. Designers need to draw detailed drawings, elevations, floor plans, cross-sections, and each drawing one by one. A relatively independent workload is very large. For example, the clover shape in the Mercedes-Benz Museum in Germany, the complex interior, and a large number of split-level slopes without clear floors require hundreds of Autodesk CAD two-dimensional design drawings, which require a large number of designers to participate in the drawing and are extremely inefficient. If the design plan needs to be modified, such as modifying one of the building components. Every drawing must be checked for contradictions, and all the drawings related to it must be checked for errors and updated one by one. The workload is high.

3.2. Comparison of Traditional Autodesk CAD Software-Assisted Architectural Design and Autodesk Revit-Assisted Architectural Design

Autodesk CAD is a design software developed by Autodesk (Autodesk CAD hereinafter referred to as CAD). It is mainly used to draw architectural design and construction drawings. The drawings and design files drawn in CAD are

mainly in two-dimensional planes. If you need to modify the design, CAD requires a drawing, which is very inefficient. Although CAD is inefficient, the early launch, marketing strategy, simplistic design, and easement of learning have allowed CAD to make it popular.

Autodesk Revit is a design software developed by Autodesk (Autodesk Revit hereinafter referred to as Revit). Revit is designed for building information modeling. At present, Chinese architectural design and construction drawings are still two-dimensional. The difference between Revit and CAD is the different drawing ideas. CAD is drawn from 2D, and Revit needs to draw 3D architectural models directly from a 3D perspective. Once the Revit 3D architectural model is drawn, you can immediately observe the slices of the 3D model. Each slice of the model is actually a single two-dimensional architectural design drawing, originally it may take an hour or more to draw a floor plan with CAD.

However, Revit can generate a two-dimensional plan within one second, which greatly improves the efficiency of drawing two-dimensional architectural drawings. At the same time, based on the uniqueness of the building information model in the project, if a component in the building model is modified, the corresponding floor plan will also be modified at the same time.

Therefore, Revit has quickly become the most widely used software in the BIM series of software in the global construction industry. Revit has also become the core modeling software of BIM technology.

3.3. Application of CAD and Revit in Design Institute

In general, all design institutes in China are using CAD to

draw their designs. More large-scale projects and firms ought to apply BIM technology and maybe even establish their own BIM. Revit is used widely as the core modeling software under BIM technology.

3.4. The Status Quo of Software Used in Architectural Design Majors in China's higher Vocational Education

The simplified Chinese version of CAD is commonly used in schools and almost all schools of architecture offer related courses. Revit 2018 is also the version commonly used in China. Not all schools of architecture have opened BIM technology application courses.

3.5. Expression of CAD and Revit

When CAD represents the plane, elevation, and section of an object, it mainly uses two-dimensional lines to draw architectural designs (Figure 1). When we edit a single element like an elevation, there is no connection between this modification to the other correlated elements. This means that if the designer is to edit a single element, they must also change the other correlated drawings and elements manually.

Revit is to design buildings in 3D. After the 3D model is drawn, various 2D plans are extracted from the same 3D model by slicing. Since they are all extracted from the same model, the contents of different views are essentially related to each other (Figure 2).

Therefore, once the model changes, the views in the east, west, south, and north directions will also change accordingly. In the same way, if an object in one view is changed in each direction, this change will appear immediately on all views and 3D models.

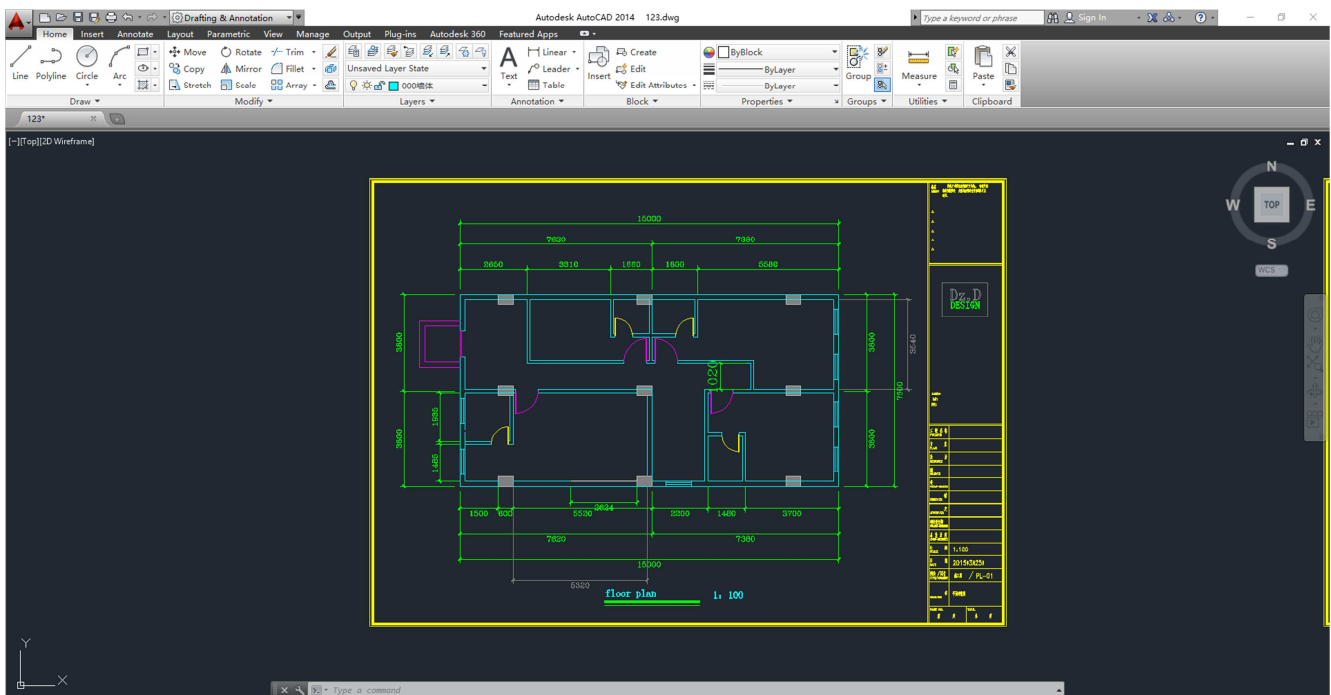


Figure 1. Autodesk CAD-assisted architectural design two-dimensional architectural plan.

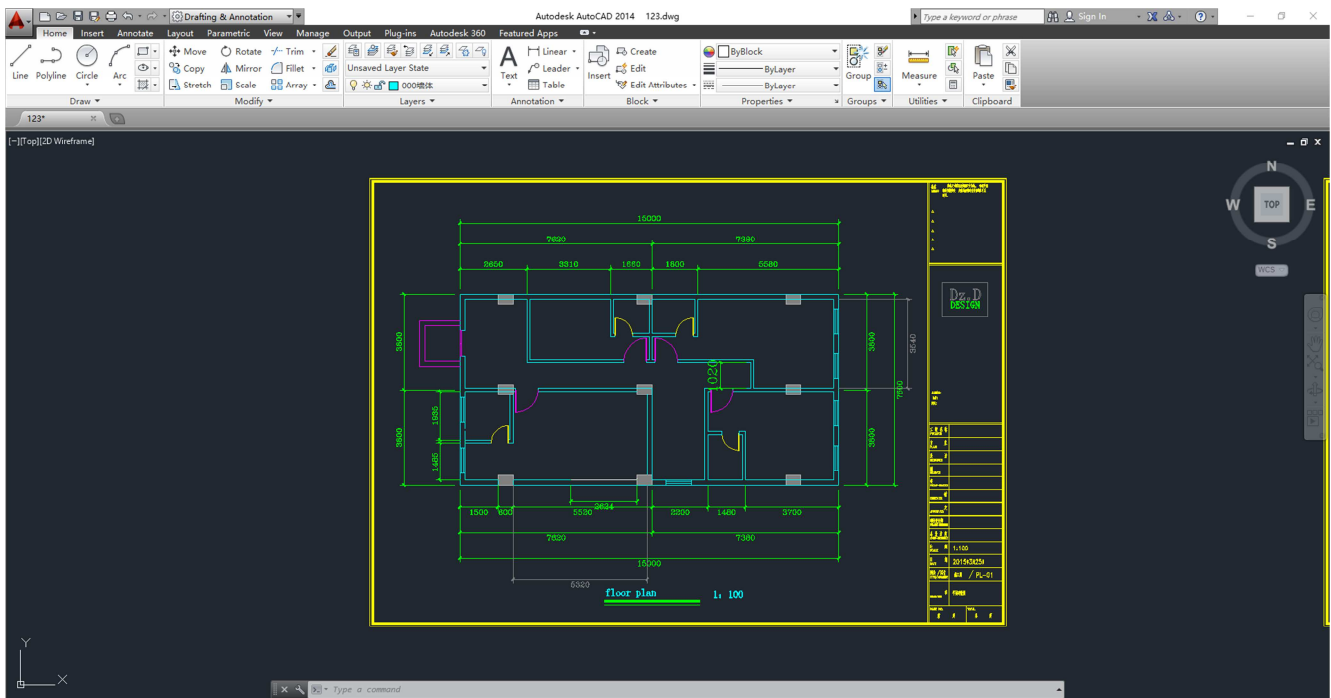


Figure 2. Revit building information model drawn by students.

3.6. CAD and Revit Secondary Development

CAD can use plugin software, but this plug-in software requires computer programming capabilities. This plug-in software can speed up the processing of points and lines. Improve drawing speed. These developers need to have strong computer programming skills. Development is difficult.

The secondary development of Revit is mainly for the "family" model library. The process of establishing the "family" model library does not require programming and is no different from the normal modeling process, and is easy to master. The process of using Revit is very similar to the process of defining blocks in CAD. It's just that CAD blocks are two-dimensional, and Revit's "family" is three-dimensional. For example, to draw a "door", CAD inserts a "door" block in a two-dimensions. The "family" that Revit inserts into a "door" is three-dimensional. CAD can only insert a flat door. The "door" inserted by Revit can see both the plane and the elevation, and if you want, you can also see the section. So as long as this "family" can meet the needs, future work will become very easy. Compared with CAD, Revit has a better secondary development environment, lower requirements, wider scope, and more flexible methods.

3.7. CAD and Revit Collision Detection

CAD cannot achieve collision detection. Revit can be used in conjunction with BIM series software to perform collision checking (based on Revit modeling and implemented by NavisWorks software). Therefore, schools must teach Revit software and BIM technology integration for it is the industry demand.

4. Problems in Higher Vocational Colleges

4.1. Insufficient Connection Between the Requirements of Teaching Norms and the Requirements of Corporate Job Needs

With the industrial upgrading of the construction industry and the widespread promotion and application of new BIM technologies, companies in the construction industry need a large number of employees who have mastered new technologies. Prior to 2018, higher vocational colleges rarely offered courses such as "BIM Technology Application", "Building Energy Efficiency Design", "Prefabricated Building", "Building Intelligence" and other courses. Graduates cannot well meet the needs of employers in the construction industry. Talent training cannot meet the needs of the construction industry. It is necessary to open relevant courses or increase the proportion of class hours to make up for the talent gap.

4.2. Less Use of BIM Technology in Training Courses

BIM technology is rarely used in training courses such as curriculum design and graduation design. Since there is no special BIM course, teachers can only briefly introduce the basic knowledge of BIM when teaching related courses. For the application of BIM-related software, teachers can only teach introductory applications, such as CAD, tangent, SketchUp, etc. Most applications rely on students' self-study, and students only master lesser modeling software, such as CAD. Therefore, in the training courses, most students still use CAD or tangent for the design of two-dimensional drawings and use SketchUp for three-dimensional

visualization of buildings. SketchUp's three-dimensional visualization can only display the three-dimensional effects of buildings, and cannot display the buildings themselves.

4.3. There Is Currently a Lack of Teacher Qualifications Related to BIM Technology

There are only two teachers in the architectural design major of our school who hold BIM skills certificates. Few teachers learn BIM software systems, and most teachers do not have the ability to independently complete BIM technology teaching.

5. The Reform of Computer Software in the Teaching of Architectural Design

5.1. Establish a Professional Curriculum System with BIM Application as the Core

Offer BIM application courses. Introduce the basic knowledge of BIM technology into the design principle

course of the first-year university students to improve students' perceptual understanding of BIM; the second-year university offers the "BIM Technology Application" course using Revit software for teaching. Integrate BIM theory and software practice into teaching, focusing on project teaching. This allows for Revit mastery. For example, through the combination of Revit courses and architectural drawing, materials, and construction technology, architectural design and other courses, comprehensive study and practice, students can use BIM technology to learn and integrate other course knowledge.

Revit software has the characteristics of visualization, interaction, simulation, optimization, sharing, and integration. Incorporate design theory into the teaching of Revit architectural design practice. For example, Figure shows the homework by students learn the course "Architectural Drawing and Recognition of Drawings" through Revit. Students can use its visual characteristics to directly understand the knowledge of three-dimensional projection and use the three-dimensional view.

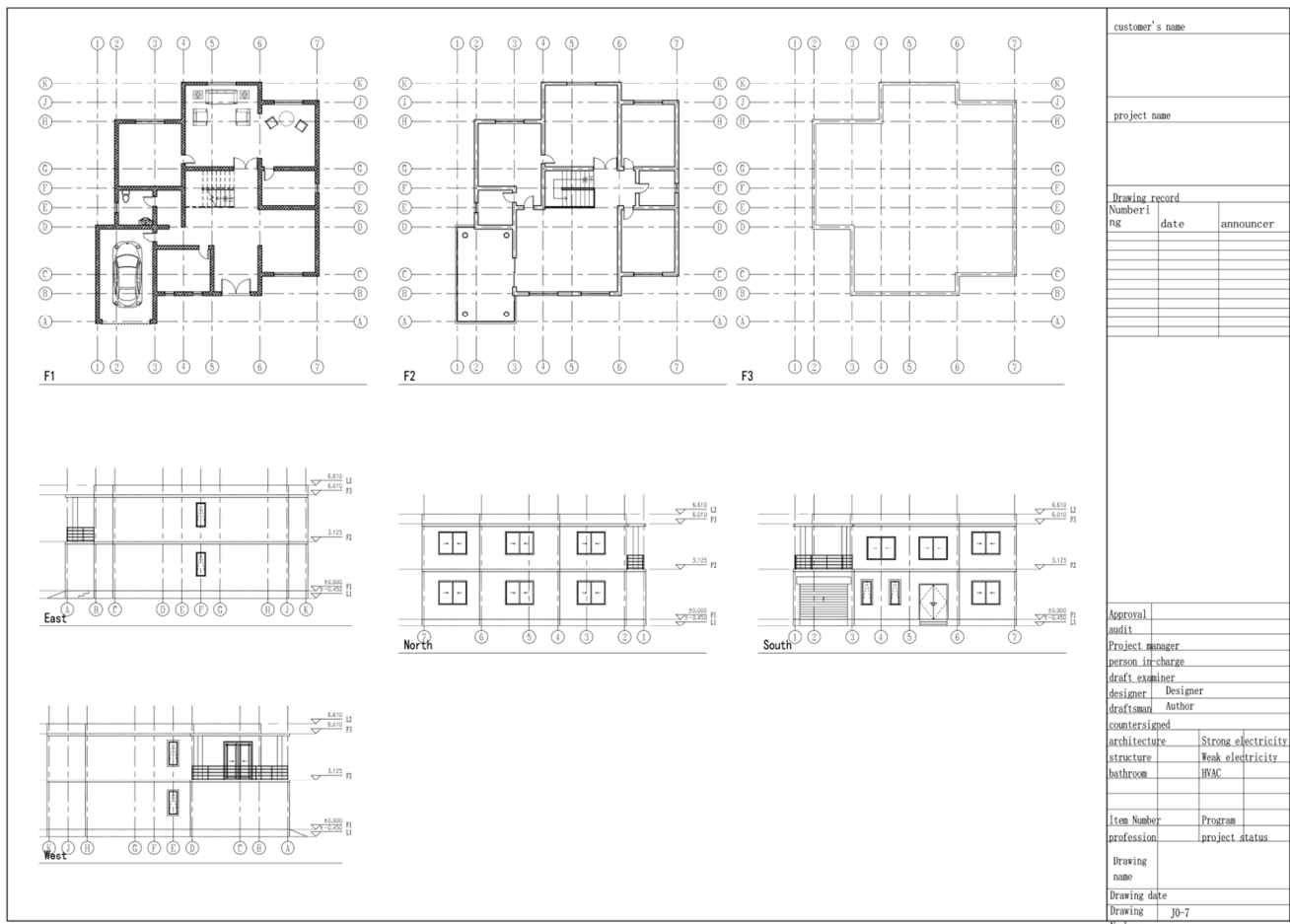


Figure 3. The initial student's usual homework: Integrate the Revit building plan, elevation and door and window statistics on the A3 drawing.

5.2. Establish a BIM Practice Teaching System Aimed at Design Projects

At present, BIM teaching in China's higher vocational

colleges is still in the exploratory stage. The BIM basic courses should be set up reasonably and BIM technology should be combined with professional courses. The project goals should be the graduation design, subject competitions,

and "1+X" skill level exams to enrich BIM teaching and form a variety of project-oriented practical teaching.

In this graduation project, we used BIM technology to demonstrate our architectural design plan, simulating the physical characteristics of building energy-saving, ventilation, sunshine, and achieving the dual improvement effect of BIM technology application level and professional skills. Figure 4 presents model performed by students' usual homework in the middle of learning based on Revit architectural model.

Especially during the current Covid-19 period, it is not suitable for students to go out to the market to buy handmade building model materials. Using BIM technology to simulate building models is obviously a better solution.

At present, there is a very fierce BIM skill competition in China. For example, the "Luban Cup" National Colleges and Universities BIM Technology Competition, "National Colleges and Universities BIM Graduation Design Innovation Competition" and other competitions are fierce, and college students can participate. Among them, the "Luban Cup" also has a track for higher vocational colleges,

encouraging college students to form teams to participate in competitions to promote learning and improve professional practice capabilities.

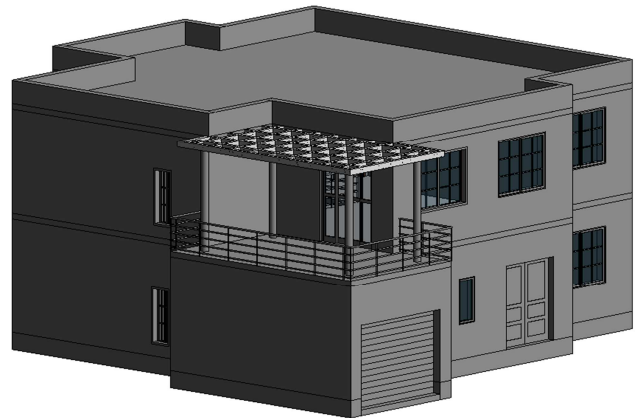


Figure 4. Students' usual homework in the middle of learning: Revit architectural model.

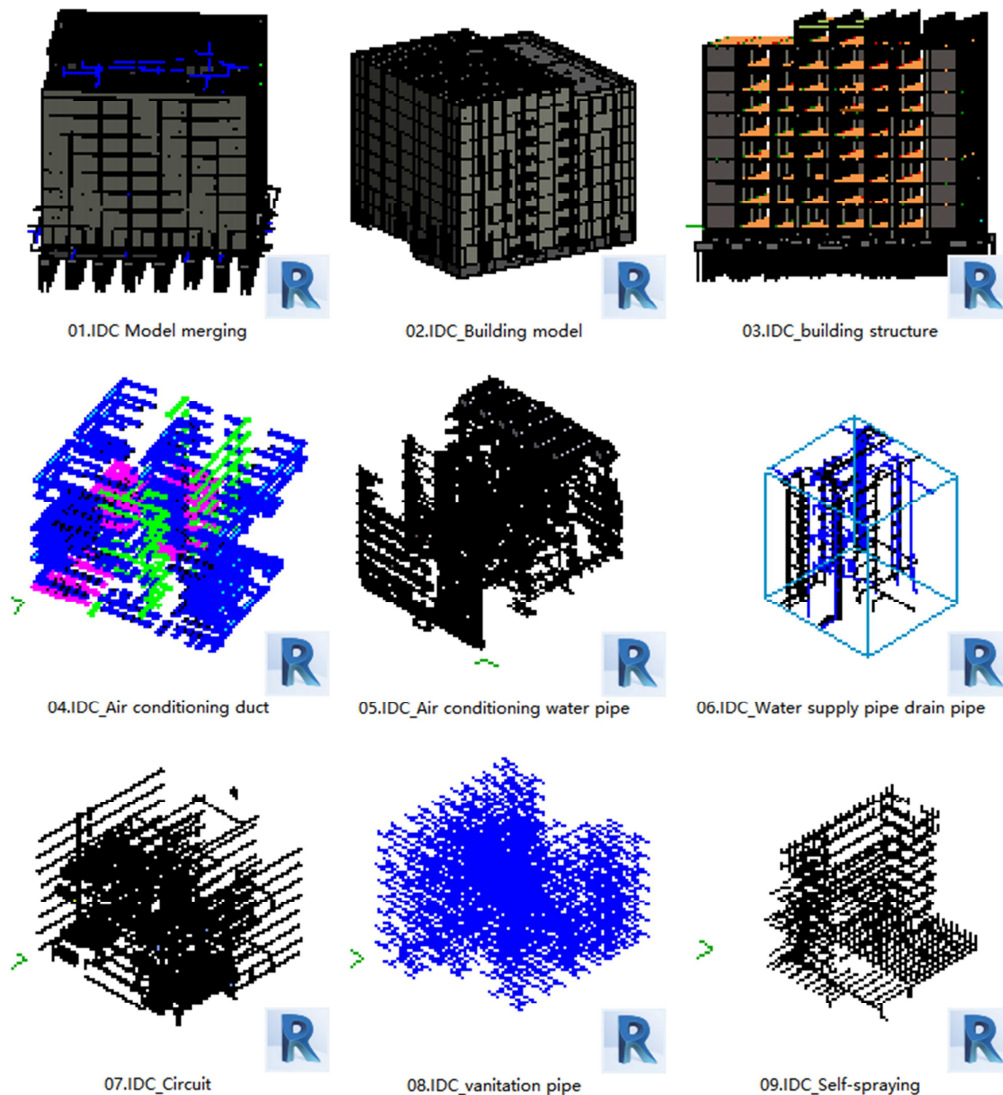


Figure 5. The second-year university students participated in the "Luban Cup" national college BIM competition. The building model, building structure, water supply and drainage, electric circuit, air-conditioning duct, air-conditioning water pipe, and the combination of all these models.

According to the "1+X" certification system, students must obtain a BIM vocational skill level certificate before graduation. Through classroom learning and pre-examination training after class, it is ensured that students successfully obtain skills certificates, so that students can truly gain professional knowledge from their studies and have a sense of accomplishment.

5.3. Strengthen the Construction of BIM Technical Teachers

At present, few teachers master BIM application technology and cannot complete teaching tasks. Schools can hire BIM modelers from companies as part-time teachers. A case study presents tests the course, evaluates the students' performance, and identifies improvements in software training, time schedule, technology connection, interoperability issues, as well as how BIM effects on teamwork [12]. There are several research describing objectives, methods and outcomes with regard to generating new knowledge in BIM oriented higher education in architectural design and studies. In research, case studies test the course, evaluates the students' performance, and identifies improvements in software training, time schedule, technology connection, interoperability issues, as well as how BIM affects teamwork [15-16]. In applying BIM in an interdisciplinary situation, a visualization tool is used to enrich the body of knowledge of BIM education.

At the same time, the school should formulate a plan to train a select group of young and middle-aged teachers, hire corporate BIM modelers to train teachers, and learn BIM software such as Revit, Lumion, Fuzor, Glodon, NavisWorks, etc. Make teachers have the ability to apply BIM technology. Establish a team of teachers who can understand and proficiently use BIM technology to provide a solid foundation for cultivating high-quality skilled talents.

6. Conclusion

Currently, BIM technology is rapidly being promoted all over the world, and China is entering the era of architectural BIM. The increasing demand for BIM technical talents requires that the teaching reform of architectural design majors integrate BIM technology into professional teaching, cultivate students' BIM technical capabilities, and promote the industrial upgrading of the construction industry. In future, the proposed technology-based experiment is promising, and everyone can work together to contribute to the energy-saving and efficient transformation of the construction industry with computer BIM technology.

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