

Reform and Application Exploration of the “AI + Civil Engineering Drawing” Teaching Model Based on Industry-Education Integration

Shuang Yao*, Liang Zhao, Huayin Sun, Weili Zhou

College of Civil Engineering and Architecture, Yangtze Normal University, Chongqing, China

**Corresponding Author*

Abstract: There are many problems in the traditional teaching of “Civil Engineering Drawing” course. For example, students have weak cognitive abilities in three-dimensional space, insufficient visualization of traditional two-dimensional plane drawings, and a disconnect between course content and industry demands. In order to strengthen students’ imagination of drawing space and engineering practice ability, this course reform has constructed a new teaching paradigm of “AI tool assistance + basic concept consolidation + engineering case driven”. Integrating real-life case drawings into teaching and deepening the mechanism of industry education integration. Firstly, create an AI-based 3D modeling tools link that can generate lines and planes, and convert two-dimensional drawings into three-dimensional models. This AI-based 3D modeling tools can solve the problem of combination drawing errors caused by students’ lack of imagination. Secondly, the concept of integrating industry and education is introduced to provide students with authentic architectural drawings of the enterprise for reading. Finally, create a 3D model in Revit software and use the model roaming function to show students the building. 3D model roaming can effectively enhance students’ understanding of architectural floor plans, elevation drawings, and sectional drawings. Practice has shown that this teaching model has increased students’ interest in the course of “Civil Engineering Drawing”, deepened their understanding of three views, and strengthened their spatial imagination of architectural drawings.

Keywords: “Civil Engineering Drawing”; Reform in Education; AI Tools; Integration of Industry and Education

1. Introduction

“Civil Engineering Drawing” is a fundamental core course for students in civil engineering and related majors, undertaking the mission of cultivating students’ spatial imagination, engineering graphic expression, and drawing interpretation abilities [1,2]. The teaching quality of this course directly affects students’ recognition of the major and their learning outcomes in subsequent specialized courses. However, in nearly eight years of actual teaching practice, three prominent issues have been identified: First, students exhibit a relatively weak ability to deconstruct three-dimensional components. Most of their prior learning in high school involved two-dimensional drawings, making it difficult for them to convert these into three-dimensional solid components [3]. Secondly, the traditional Engineering Drawing course relies predominantly on two-dimensional drawings and static PowerPoint presentations, particularly on Building Combination. The textbook primarily displays an isometric view from a single visual direction along with three orthographic views, offering limited visualization. For students first encountering three-dimensional solids, it is difficult to imagine the forms; the abstract nature of orthographic views fails to intuitively present the complex spatial geometric relationships among composite components [4]. Finally, the course content has remained relatively rigid. Over the past eight years, due to adjustments in the curriculum plan and reduction in class hours, Solids and Surface Intersections, Contour Projections, and Structural Construction Drawings have been removed from instruction, while the fundamentals and concepts of projection, projection of composite solids, and projection of architectural construction drawings have been retained. Overall, there exists a certain disconnect between the course content and the actual needs of the industry, resulting in students lacking practical application skills of this course

after graduation [5].

2. Teaching Status and Analysis of Core Problems

2.1 Teaching Status

The “Civil Engineering Drawing” course totals 32 class hours now and is offered as the first core foundational course for first-year students majoring in civil engineering, cost engineering, and related disciplines. The course consists of six chapters: Basic Knowledge of Drawing, Fundamentals of Projection, Solids and Surface Intersections, Building Combination, Representation Methods of Engineering Forms, and Architectural Construction Drawings. The specific teaching content is detailed in the Table 1 below.

Table 1. Teaching Content of Civil Engineering Drawing

Chapters	Teaching Content
Basic Knowledge of Drawing	Understanding engineering drawings; Mastering the basic provisions of drafting standards.
Fundamentals of Projection	Classification and basic concepts of projection; Common types of projection drawings in engineering; Concept of three-plane projection; Fundamental projection knowledge of points, lines, and planes.
Solids and Surface Intersections	Projection of plane solids; Projection of points and polylines on plane solids.
Building Combination	Concept of Combination; Interpretation of Combination drawings; Drafting of Combination.
Representation Methods of Engineering Forms	Concept of views; Reading and drawing of cross-sections; Reading and drawing of cutaway views.
Architectural Construction Drawings	Classification of architectural drawings; Reading of general design description and site plan; Reading of floor plans; Reading of elevations; Reading of sections; reading of details.

The course operates on the “Xuexitong” online teaching platform. To date, a relatively comprehensive knowledge graph for the course has been established, and the course has been delivered for three consecutive teaching cycles. In terms of supporting teaching resources, the course has accumulated well-developed auxiliary teaching materials, including 7 assignments, 1 examination paper, and 360 course discussion threads involving 190 participating students. The

accompanying instructional videos for the course are incomplete, and some knowledge points still lack systematic video explanations. This situation affects the effectiveness of students' after-school review, self-directed learning, and previewing.

2.2 Difficulty in “Drawing–Object” Transformation in Combination

In the past 8 years of teaching, the Building Combination chapter has always been a common difficulty reflected by students. This chapter requires students to be able to imagine the three-dimensional spatial form of a combination based on its elevation drawing, plan view, and side elevation. Conversely, this chapter requires students to be able to draw elevation drawing, plan view, and side elevation of a combination based on its three-dimensional spatial form. This process requires strong spatial imagination [6]. In early teaching arrangements, this chapter usually consists of 6 class hours. Teaching mainly focuses on the axonometric projection of a combination in one direction, and draws three views based on the axonometric projection diagram. The teacher decomposes the combination using different colors on the blackboard. Transform the combination into individual plane-surface solid and then proceed with drawing. However, due to the oral descriptions in teaching and the lack of dynamic and intuitive demonstrations, it is difficult for students to establish a clear spatial cognition of the combination in a short period of time. In recent years, the class hours have been adjusted to 4, making it difficult for teachers to provide personalized guidance for each student in the classroom, and teacher can only provide unified explanations of common problems. At the same time, the teaching videos provided on the “Xuexitong” Learning Platform are incomplete, and students lack effective review methods after class, further exacerbating this difficulty.

2.3 Disconnection in “Learning–Application” Transition in Architectural Construction Drawing Instruction

Architectural construction drawing teaching is an applied chapter of the course “Civil Engineering Drawing”. This chapter involves the reading of various types of drawings such as building elevation drawing, plan view, and sectional drawing, and architectural detailed drawings [7]. Compared to geometric shapes or combinations, identifying architectural drawings is more

difficult. Real architectural drawings have large dimensions, abundant information, complex structures, and strong professionalism. Especially in the plan view and architectural detailed drawings, there are a large number of building construction nodes, dimension annotations, material symbols, and legends of specifications. Students often feel unfamiliar and unsure where to start the drawings when they first encounter them.

In teaching, in order to prevent students from being intimidated by overly complex drawings, the course book selects simplified drawings that are relatively easy to understand. The buildings in course book usually have a relatively small building area, simple functions, and are convenient for students to read. However, there is a significant gap between this type of drawing and actual engineering drawings. The actual drawings have more complex engineering information, and many details need to be found by themselves. The difference between these two drawings make it difficult for students to quickly adapt to the actual reading requirements of enterprise positions, even though they have mastered the basic principles of drawing [8]. In addition, students lack imagination about the correspondence between “drawings” and “building entities”, especially their understanding of sectional drawings, which often goes against the actual architecture.

3. Overall Framework of the Teaching Reform

3.1 Theoretical Basis

Constructivist learning theory holds that knowledge is not passively imparted to learners from the outside, but is actively constructed by learners based on their existing experience [9]. In the teaching of “Civil Engineering Drawing”, this means that “spatial imagination” and “drawing reading ability” cannot be transmitted solely through teacher teaching. This ability must be gradually formed through students’ careful observation, comparison, and reflection.

The “AI tool assistance + basic concept consolidation + engineering case driven” model proposed in this educational reform is guided by constructivist theory and creates a condition for students to actively construct knowledge. AI tools provide an instant and interactive “Drawing–Object” transformation environment. Students gradually enhance their understanding of space through repeated “observation–imagination–verification–correction”. Real engineering cases

provide rich and authentic learning materials, allowing students to build a deep understanding of construction drawings through “recognition–comparison–understanding” [9].

3.2 Deep-Level Logic of AI-Assisted Instruction

AI technology is mainly used in teaching reform to compensate for students’ cognitive ability towards three-dimensional shapes [10]. Specifically, AI tools play two important roles in the course of “Civil Engineering Drawing”.

Firstly, it is cognitive construction. The team has developed their own web-based AI tool. Through the 3D modeling technology of AI tools, straight lines, planes, common solids and other shapes can be directly reflected on web pages. The interweaving of lines, planes, and solids, and their projection relationships can be displayed on web pages. The 3D models created by AI tools can be adjusted in both line and plane, providing students with an “interactive 3D space”. Students can first use AI tools to generate models and establish preliminary spatial concepts when facing problems of intersecting straight lines and planes, as well as combination problems, and then draw their three-view diagram. This learning method of “looking before thinking, verifying before drawing” reduces the initial difficulty of spatial imagination.

Next is instant feedback. The biggest challenge for students when drawing a combination of three-view diagram is not knowing if they are drawing correctly. The interactive function of AI tool systems makes “instant verification” possible. Students input their three-view diagram into the AI system, and the system automatically generates the corresponding one. By observing whether the three-view diagram generated by the system are consistent with their own, students can immediately determine whether their drawing is correct [10].

3.3 Curriculum Reform of Industry-Education Integration

The integration of industry and education emphasizes the integration of the real development status of the industry and practical engineering cases into curriculum teaching, so as to accurately match talent cultivation with industry demand [11]. After the teaching reform, real engineering drawings were used in the Architectural Construction Drawings chapter to replace the 3-story simple villa in the course book.

The engineering drawings adopt a dormitory building of about 3000 square meters, which is close to the living environment of students and allows them to adapt to the real engineering drawings as soon as possible. While reading engineering drawings, students can also review knowledge points such as drawing frames and title blocks in Chapter 1 Basic Knowledge of Drawing. Complete engineering drawing teaching can also help students adapt to the real pace of the industry faster.

In terms of software, industry-standard tools such as Revit 2025 is introduced. Revit serves three primary functions in teaching: First, the models built in Revit can display the building's exterior elevations from all angles, facilitating students' comparison with the drawings. Second, Revit allows section cuts at any position within the building, which also deepens students' understanding of sectional drawing. Third, Revit features a walkthrough function that enables students to virtually enter the modeled building and observe it from the interior, thereby enhancing their comprehension of floor plans.

4. Specific Implementation of the Teaching Reform

4.1 AI-Based 3D Modeling Tools of Three Views in the Building Combination Chapter

In the chapter on Building Combination, students face two primary challenges. The first is the difficulty in interpreting drawings—being unable to imagine the shape of a combination from given three-view diagram. The second issue is the frequent occurrence of missing or multiple lines when drawing three-view diagram of a combination. This teaching reform introduces AI-based 3D modeling tools to enable students to independently construct combination and observe their corresponding three views.

On the AI platform, students can combine desired lines, planes, and simple planar solids, rotate them, and the platform automatically generates the corresponding 3D model while projecting it from the front, side, and top directions to produce three orthographic views. Students can rotate, zoom, and manipulate the model to observe the spatial structure of the solid from any angle. This process transforms abstract solids into interactive models, enabling students to gradually establish the concept of three-view diagram through hands-on observation and practice.

Through the three-view projections generated by

the platform, students can reversely verify the accuracy of their own three-view drawings, identifying issues such as improper projection relationships, redundant lines, or missing lines.

AI-based 3D modeling tools provides students with a “reference frame” and “validator”. Students can independently try, repeatedly draw, modify, and observe, gradually mastering the essentials of the three-view diagram. This interactive tool is particularly effective for students with poor spatial imagination ability. The AI-based 3D modeling tool is shown in Figure 1 and Figure 2 below.

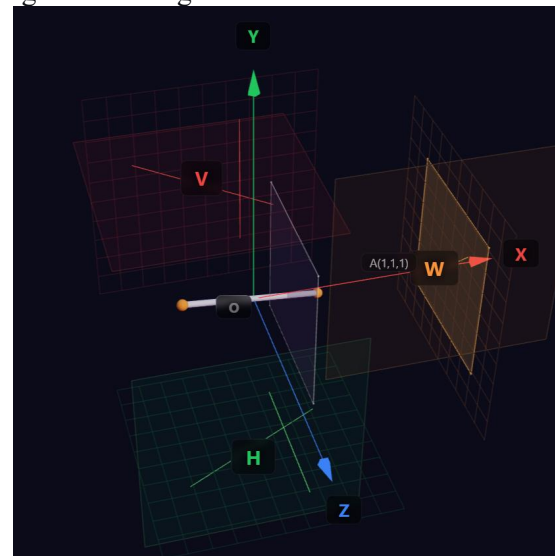


Figure 1. Three-Plane Projection of a General Position Straight Line on AI-Based 3D Modeling Tools

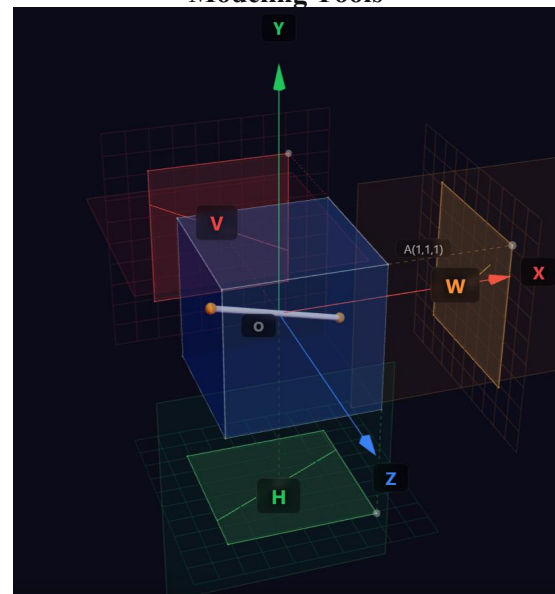


Figure 2. Three-Plane Projection of a Cube with Straight Lines Interspersed on AI-Based 3D Modeling Tools

4.2 Industry-Education Integrated Teaching Module for Architectural Construction Drawings

4.2.1 Introduction of authentic architectural blueprints

Based on the concept of integrating industry and education, this educational reform has contacted enterprises to obtain 5 complete sets of real construction drawings for building projects. The types of drawings include common engineering types such as dormitory buildings, high-rise residential buildings, office buildings, and small public buildings, ensuring that students are exposed to diverse architectural drawings during the learning process [12].

In terms of teaching content arrangement, the focus is on teaching in dormitory buildings. This type of building is closer to students' lives and easier for them to accept. The teaching sequence follows the order of the architectural drawings, including the building description, floor plan, elevation, section, and detailed drawing. Based on the content of the drawings, help students master basic architectural drawing standards and legend expressions, while consolidating the basic concepts in Chapter 1. When students have a certain foundation, they transition to more difficult public building drawings to train their ability to read engineering drawings and understand building structures.

In the teaching of sectional views, some students find it difficult to understand the corresponding positions. The teacher can open the Revit 3D architectural model corresponding to the architectural drawings, and the plan view layer, elevation view layer, and 3D view layer can be activated simultaneously, guiding students to observe the building's overall structure and elevation composition from the exterior. From the 3D view, students can observe the cutting positions and logical relationships of walls and door frames; from the roof level, they can examine the building roof and parapet walls, facilitating their comprehension of the drawing content. This "drawing-model-reality" teaching resource enables students to find corresponding relationships in the 3D model for every line and every symbol they see on the drawings.

4.2.2 Application of Revit 3D modeling and walkthrough functionality

This teaching reform also employs the walkthrough functionality of Revit software to transform construction drawings into navigable 3D architectural models. In Revit, walkthrough

paths can be created through the View-Walkthrough function to generate walkthrough videos. Students can use the walkthrough function to "enter" the building depicted in the floor plan, from the lobby on the first floor to the stairwell, and then explore the various floor plans. This immersive experience makes students no longer just daydream when reading construction drawings. Students are able to project every line on the architectural drawings into a complete and perceptible architectural space. This method improves students' understanding of drawings and their perception of spatial volume size.

4.2.3 Project-driven comprehensive training

After completing the teaching of construction drawings, students can be assigned a group assignment. Students work in groups of 6-8 to open Revit building models and complete the following tasks: (1) Read the architectural drawings and locate the entrance hall on the first floor. (2) Establish a walkthrough path in Revit based on the architectural drawings. (3) Create roaming animations and record videos. (4) Upload recorded files on "Xuexitong" platform.

This project-driven comprehensive training organically integrates four interconnected stages—"drawing interpretation-walkthrough-expression-presentation". In the process of completing the project, students naturally acquire authentic engineering drawing interpretation and drafting skills. This training model effectively mobilizes students' initiative, and the training approach equips students with preliminary engineering drawing interpretation capabilities and practical Revit operational skills, thereby shortening the adaptation period after graduation and entry into professional practice.

5. Conclusion and Prospects

This educational reform mainly focuses on the chapter of Building Combination and Architectural Construction Drawings that students find most difficult to understand in the course of Civil Engineering Drawing. The educational reform proposes a teaching reform plan that integrates industry and education, consisting of "AI tool assistance + basic concept consolidation + engineering case driven". In the teaching of Building Combination, AI-based 3D modeling tools are introduced to achieve autonomous assembly and projection of 3D models. AI-based 3D modeling tools effectively solve the dual dilemma of students' difficulty in reading and drawing of combination. In the

teaching of Architectural Construction Drawings, real building drawings from enterprises in the past two years are introduced. With the help of Revit 3D modeling and roaming functions, dynamic comparison of “drawings model reality” is achieved, effectively solving the problem of students’ difficulty in understanding and drawing architectural section drawings.

These teaching reform plans have increased students’ classroom enthusiasm and integrated course content with industry demands. At the same time, the teaching reform plan provides an operable and promotable implementation path of the course “Civil Engineering Drawing”, hoping to provide some reference for the digital transformation of this course.

Acknowledgements

The present work was funded by the 2025 Education and Teaching Reform Research Project of Yangtze Normal University (JG2025320).

References

- [1] Zhan Mengsi. "Intelligent Drawing" Space: Integration Practice of 3D Construction and 2D Expression in AI-Assisted Civil Engineering Drawing Course. Teacher AI Application Cases 2025, Center for Educational Technology and Resources Development, Ministry of Education, 2026.
- [2] Zhang Shiyu. Digital Intelligence Empowerment, Learning-Oriented — Exploration of SC Teaching Reform in AI-Empowered Architectural Engineering Drawing Course. Harbin Huade University, 2026.
- [3] Wang Qing, Zheng Yizhou, Zhong Yuping, Zhang Yongzhou, Xie Shaotian. Research on Teaching Reform of Virtual Simulation Training for Spatial Interpretation Ability in Civil Engineering Drawing. Journal of Higher Education, 2024(20): 145-148.
- [4] Liu Jingjia, Luo Hua, Gao Yansheng. Case Study of Virtual Simulation Technology in Teaching Descriptive Geometry and Civil Engineering Drawing. Automation Applications, 2023(16).
- [5] Zhang Mingfang, Zhao Xiaofan, Wang Li, Wang Pangwei. Construction of Case Library for Professional Courses in Application-Oriented Universities under the Background of Industry-Education Integration — Taking Transportation Majors as an Example. Education and Teaching Forum, 2026(04): 27-30.
- [6] Xu Wensong, Zhao Guangming, Yan An, Chen Yi'an, Cheng Xiang. Research on the Construction of Teaching Case Library for Professional Degree Postgraduate Courses in Safety Engineering under the Background of Industry-Education Integration. Journal of Heilongjiang University of Technology (Comprehensive Edition), 2025, 25(08): 5-9.
- [7] Zhao Hui, Zhang Hui. Curriculum Reform and Practice of Building Structure and Construction Drawing Interpretation. Residence, 2019(35): 188-189.
- [8] Zhang Ziyang. Reform Practice and Research of First-Class Undergraduate Courses under the Background of Industry-Education Integration. Beijing Science and Technology News, 2026(07): 1-4.
- [9] Zhang Baoqing, Sun Lihua, Wu Xing. Research on the Application of Constructivist Learning Theory in Engineering Graphics Teaching. Journal of Graphics, 2022, 43(2): 345-350.
- [10] Qian Qiuying, Hu Xuran. Research on Flipped Classroom Teaching Reform and Practice Based on the Smart Vocational Education Cloud Classroom Platform — Taking the Course of Architectural Drawing and Interpretation as an Example. Guangxi Urban Construction, 2021(09): 103-105.
- [11] Li Qingxiang, Zhang Youming, Ding Shifeng, Hu Yuntang, Tan Haiyan. Project-Based Teaching Reform of Hydraulic and Pneumatic Transmission Course for Applied Talent Cultivation under Industry-Education Integration. Hydraulics Pneumatics & Seals, 2026, 46(07): 48-53.
- [12] Chen Yuqin, Yang Xiaoyong. Form Analysis of Composite Solids by Reductio ad Absurdum and CAD 3D Modeling for Drawing Interpretation. Journal of Hunan Industry Polytechnic, 2023, 23(01): 14-19.