Application of 3D Modeling Technology in Engineering Graphics

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Abstract. With the development of technology and the progress of the times, the application methods and expression methods (including teaching methods) of engineering drawings have undergone tremendous changes. This article analyzes the reasons that restrict the three-dimensional design method can not completely replace the two-dimensional drawing in the short term, and proposes the teaching reform direction that combines the three-dimensional modeling with the traditional graphics content. It clarifies the role of 3D modeling content in graphics courses at this stage, and explains the specific methods of introducing 3D modeling in different stages of graphics courses and the choice of teaching software.

Keywords: Three-Dimensional Modeling, Engineering Graphics, CAD

1. Introduction
With the development of technology and the progress of the times, the application methods and expression methods (including teaching methods) of engineering drawings have undergone tremendous changes [1-3]. From the perspective of technological development trends, 3D design technology will gradually become the main means of design expression. The rapid development of 3D CAD technology and the increasing popularity of its application have caused great changes in the theory and technology of design and manufacturing [4-5]. 3D CAD solid modeling and feature modeling software have been applied in some large and medium-sized enterprises and research institutes. With the intensification of market competition, the application of 3D CAD as a tool for engineering design and product development will surely become popular [6-8].

Before the advent of computer-aided three-dimensional modeling technology, due to technical limitations, designers could only express their design ideas through two-dimensional projections. This is actually a "three-dimensional conception-two-dimensional engineering drawing-three-dimensional entity (manufacturing)" process. The development of computer-aided design (CAD) technology eliminates the conversion link between two-dimensional and three-dimensional, making "three-dimensional concept-three-dimensional model-three-dimensional solid processing" a reality [9-10].

Relying on 3D modeling technology, this paper analyzes the reasons that restrict 3D design methods from being able to completely replace 2D drawing in the short term, and proposes a teaching
reform direction that combines 3D modeling with traditional graphics content, aiming to explore the 3D modeling technology. application.

2. The status quo and thinking about the introduction of 3D modeling into the graphics course

Judging from the teaching practice of drawing courses and the development status of 3D design technology, the traditional drawing content still has the need to continue to reform and develop. 3D modeling tools cannot completely replace 2D drawing in a short time as people originally expected. The main reasons are as follows: ① The digitalization level of the national manufacturing industry is very unbalanced, and only some large-scale backbone enterprises and design units have popularized 3D design technology. Even so, these units still need the assistance of two-dimensional drawings in the manufacturing process of parts and components. There is still a long way to go for the popularization of three-dimensional design in our country; ② If the role of descriptive geometry and the learning of two-dimensional drawing knowledge are weakened, it will be out of touch with subsequent courses. Take aircraft manufacturing engineering as an example. In the textbooks of mechanical design courses used by students and other engineering courses (such as aircraft assembly technology), the drawings appear in the form of two-dimensional engineering drawings. If you rely too much on 3D modeling tools in the drawing course, it will inevitably reduce the student's ability to read drawings, which will affect the learning of subsequent courses. It involves the synchronization with these curriculum reforms; ③ Due to the high technical threshold, most of the 3D design software market is occupied by foreign software, and its internal standards are not consistent with my country's current standards. In addition, there is no national standard for 3D design; ④ At present, the portability of computer 3D models is still incomparable with drawings; ⑤ Excessive emphasis on training in 3D modeling methods will result in complete reliance on computer tools, reducing students' manual drawing and hand-drawing. The learning interest of sketches will also put forward higher requirements for teaching conditions.

In summary, in engineering design, two-dimensional design and three-dimensional design will coexist for a long time. It is unreasonable to ignore the development of three-dimensional design technology and ignore traditional two-dimensional design methods. In the reform of the content system of the graphics course, it is necessary to carefully grasp the relationship between the two and determine the best combination of three-dimensional modeling and traditional graphics content. This is also the key to the reform of the content system of the graphics course.

3. Combination of 3D modeling and traditional cartography course content

Comprehensively comparing the existing combination methods, the segmented introduction is to set up a 3D modeling course in addition to the original drawing course. Its advantage is that it does not change the original teaching content of the cartography course, and it is easy to implement; the disadvantage is that it takes up long hours and is not closely integrated with the cartography course to achieve the fundamental purpose of reforming the course content. The fusion introduction method can integrate the methods and skills of 3D geometric modeling into the engineering drawing course, forming new teaching theories and content, and can fundamentally reflect the influence of technological updates on the drawing course, and achieve the desired goal. Therefore, when determining the specific combination method, a fusion introduction method can be used. On the basis of retaining the original content structure of the drawing course, according to the needs of different stages of learning of descriptive geometry and drawing course, the 3D modeling content can be steadily introduced to form Complete teaching content system.

The course will introduce 3D modeling training in the following stages.

3.1. The introduction of 3D modeling in descriptive geometry

(1) Perform body modeling exercises in the basic three-dimensional part of descriptive geometry. Basic three-dimensional is the foundation for the establishment of complex shapes. Therefore, the introduction of three-dimensional modeling training at this stage can enable students to initially grasp
the methods of three-dimensional solid modeling, and at the same time have an intuitive understanding of three-dimensional concepts.

(2) Introduce body modeling training in the section of intersection, intersection and combination. The learning of intercept and intersecting content has always been one of the difficult points of the course. Through three-dimensional modeling, students can clearly understand their concepts and the forms of intersecting and intersecting lines in various situations. Combined body modeling can enhance students' mastery of the combined body configuration method, and establish a good foundation for mastering the three-dimensional solid modeling method.

At this stage, 3DMAX software can be used as a learning tool. It is currently the most widely used three-dimensional modeling and animation production software, suitable for three-dimensional and film and television animation advertising design, product modeling, architecture and interior decoration design and other fields. 3DMAX is powerful and the production process is very simple and efficient.

Although 3DMAX is not a dedicated engineering design 3D modeling software, it is more suitable as a learning tool at this stage than other engineering 3D solid modeling software. First of all, the 3DMAX software interface provides basic three-dimensional modeling commands. Students can use this function to quickly create three-dimensional models such as quadrangular prisms, cylinders, and spheres in the scene. In contrast, solid modeling software needs to draw a two-dimensional sketch first to complete such a work, and then perform operations such as stretching and rotating to build a model. Secondly, the 3DMAX drawing interface provides a way to display three-sided projection images and three-dimensional images at the same time, as shown in Figure 1. The drawing area of the software consists of 4 view windows, 3 of which are basic orthographic projections and one is a perspective three-dimensional view. This window layout enables students to combine the three-sided projection theory they have just learned with the three-dimensional modeling method, which is intuitive. Experience the corresponding relationship between projection and stereo, which strengthened the previous learning about basic projection knowledge. Third, as a modeling software for animation and rendering, the three-dimensional model in 3DMAX has rich colors and strong sense of reality, which is easy to arouse students' interest in learning and improve learning effects.

3.2. Introduce the way of 3D modeling in the drawing part
The purpose of introducing 3D modeling in the drawing part is to replace some parts drawings and assembly drawings with 3D models and model assemblies, so that students can basically master the 3D modeling methods of parts and components.

(1) Based on the idea of taking into account the two-dimensional drawing and three-dimensional modeling methods, two-dimensional drawing and three-dimensional modeling are trained at the same time in the learning of the part drawing to reduce the manual drawing work of the part drawing. Use the three-dimensional modeling software to complete part of the part model. Generate two-dimensional drawings from the model.

(2) In the assembly drawing part, use three-dimensional modeling software to complete the assembly of parts. Due to the limitation of school hours, the practice of assembly drawing can take a bolder idea and complete the assembly with a three-dimensional model instead of drawing a two-dimensional assembly drawing. This is also based on practical considerations, because under the trend of continuous popularization of 3D design technology, the processing of parts in a short period of time cannot be separated from the assistance of 2D drawings, but the demand for 2D drawings for product assembly expression is relatively weak.

SolidEdge software can be used as a learning tool at this stage. SolidEdge is a three-dimensional solid modeling software developed by UGS. It uses the universal Parasolid core, which is widely used in product solid modeling, mechanical assembly design, engineering drawing output, professional sheet metal design, etc. SolidEdge provides a complete design environment. The software consists of part modules, sheet metal modules, assembly modules and engineering drawing modules. Each design
module has an independent and integrated design environment. Figure 2 shows the part design module interface.

SolidEdge has the same design ideas as other 3D solid modeling software. Compared with large software systems such as UG, SolidEdge is easier to operate and easy to master, so it is suitable for students to learn. After the students master the basic operations in the drawing course, they can quickly become familiar with UG, Pro/E and other software in the work.

3.3. The "Machine Surveying and Mapping" course introduces 3D modeling
The "Machine Surveying and Mapping" course is a comprehensive application and inspection of the cartography courses learned earlier, and is also an important practice link, generally for second-year students. The previous surveying and mapping tasks required students to complete the sketches of all the parts in the surveying and mapping components, and then complete their two-dimensional assembly drawings and two-dimensional parts drawings. Combined with the introduction of three-dimensional modeling methods in the drawing course to complete some parts and assembly drawings, the assembly drawings of surveying and mapping components will also be completed using three-dimensional modeling software. This can serve as a link between the previous and the next. On the one hand, it can be connected with the subsequent course design and graduation design. On the other hand, it can also consolidate the three-dimensional modeling skills learned in the drawing course, so that students can master the four-year undergraduate study. The use of 3D modeling methods and software will not be forgotten and wasteful, and can directly play a role in design, scientific research and production after graduation.

4. Application of 3D CAD software and modeling technology
From the perspective of three-dimensional design in developed countries in the world, my country's three-dimensional design has a long way to go. Three-dimensional and two-dimensional design will coexist for a long time. Engineering drawing cultivates drawing ability and spatial imagination. The difficulty lies in the continuous conversion process between three-dimensional objects and two-dimensional engineering drawings from "three-dimensional to two-dimensional" and then from "two-dimensional to three-dimensional". The reason why the content of the combination is considered difficult in learning. Under the circumstance that the existing teaching content and the number of hours remain unchanged, how to not only cultivate everyone's spatial imagination but also let everyone know as much as possible about 3D CAD modeling technology, this is the problem that graphics workers should consider at present.
In application, three-dimensional CAD software should be used as much as possible, and the real-time nature of three-dimensional modeling software and the characteristics of multi-window operation should be used to generate three-dimensional models from two-dimensional views, and two-dimensional views can be generated from three-dimensional models, which is conducive to training Image thinking ability and spatial imagination.

Use 3D CAD software to illustrate spatial geometry problems.

The relative positions of geometric elements (points, lines, surfaces), such as intersections, intersections, distances, angles, and other quantitative problems are solved. This is the main line of descriptive geometry and the difficulty of learning descriptive geometry. Because I'm just new to descriptive geometry, I don't have a certain space imagination ability. At this time, you can use the 3D CAD software to graphically illustrate the space model of geometric problems, intuitively and vividly express the plane geometry problems that were difficult to understand before, and cultivate everyone's space imagination in a subtle way. Ability and ability to think in images.

The calculation form of two-dimensional geometric elements is:

$$Y_j^l = f\left(\sum_{i \in M_j} W_{ij}^l * Y_{j+1}^l + B^l\right)$$

(1)

Among them, l represents the number of layers; $Y_j^l$ is the j-th feature map of the l-th layer; W is the convolution kernel; B is the offset corresponding to the j-th feature map; * is the convolution operation. The convolution kernel W is equivalent to nl filters, and the filter size is kl×kl, and kl is generally 1, 3, 5, etc. The f(·) function is the activation function, and the Rectified Linear Unit (ReLU) activation function is adopted in the form:

$$f(x) = \max(0, x)$$

(2)

Among them, x is an arbitrary neural unit in the feature map, and ReLU is a nonlinear activation function.
4.1. The expression of the three-view and three-dimensional model of the combined body
The drawing and viewing of the composite body is the focus and difficulty of engineering drawing. The process of continuous transformation from plane view to three-dimensional model, and then from three-dimensional model to plane view is the main method for cultivating everyone's ability to think in images and space imagination. The 3D CAD software has the feature of multiple windows. You can draw the main, top, and left views while displaying the generated 3D model in real time. This helps you to establish the correspondence between the 2D view and the 3D model.

There are other advantages of multiple windows:
(1) The 3D model is generated from a 2D sketch through operations such as stretching, rotating, scanning, and lofting. The drawing is also carried out on a two-dimensional reference plane. Multiple windows can simultaneously see the different directions of the sketch, and select and add positional relationships. The modification and operation of other feature attributes are very convenient, and it can avoid visual misjudgment and cause operation errors, especially when generating 3D models from 2D sketches, it is easier to select 2D sketch features.

Figure 2. Production process of three-dimensional renderings

(2) The three views can be linked, mainly based on the main, tilt, and left views each representing the size in two directions. Dimension labeling has always been a difficult point in engineering drawings. In addition to lack of engineering practical experience, the reason for not understanding the
positioning dimensions in the three views is also one of the reasons. This function can subtly cultivate the sense of direction in viewing the views and understand the positioning dimensions in the drawings.

(3) For the completed model, move the mouse to a certain part of the assembly view, and the corresponding projection view and the corresponding part of the 3D model are highlighted, which can clearly express the one-to-one correspondence between the 2D view and the 3D model.

4.2. Expression of complex assembly
The assembly relationship and working principle of the various parts expressed by the plane assembly drawing are abstract and not vivid, and it is impossible to clearly express the installation sequence of the parts. With the aid of the animation function of the 3D CAD software, the installation sequence and assembly relationship of the parts can be expressed intuitively and vividly.

4.3. Thinking about the application of 3D CAD modeling technology in engineering graphics
Three-dimensional CAD modeling technology in the application of engineering graphics overemphasizes three-dimensional modeling technology, thinking that two-dimensional drawing technology does not need to spend too much time to understand, the reason is that two-dimensional drawings can be directly generated from three-dimensional models through three-dimensional CAD software, but many people New to descriptive geometry, many concepts and principles are new to them. If there is no systematic explanation and introduction, without a lot of subtle exercises, 3D CAD modeling technology itself is also difficult to understand and accept.

When designing and drawing with 3D drawing software, there are no unified standards and regulations on how to mark the dimensions and technical requirements of the drawing. The advantage of 2D drawings is to accurately express the technical requirements such as size, shape tolerance, surface treatment and surface roughness.

![Course teaching content system after the introduction of 3D modeling content](image)

**Figure 3.** Course teaching content system after the introduction of 3D modeling content

5. Conclusion
The goal of introducing 3D modeling content into the graphics course is to establish a complete set of practical ways and methods to integrate 3D modeling technology and traditional graphics course content to form a new content system that meets the needs of the market and the requirements of talent training. Through the current operation, let everyone understand and be familiar with 3D CAD software, and have a preliminary understanding of the principles and methods of 3D modeling technology, and cultivate everyone's innovative thinking, 2D drawing and 3D drawing ability.

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