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Teaching Research and Practice of Reading Assembly Drawing

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Abstract: Reading assembly drawing is one of the crucial teaching contents in engineering drawing courses. This article emphasizes the steps and methods for reading assembly drawing. It suggests initially reading the title block and item lists to gain a preliminary understanding of the assembly, rather than focusing on the front view at the very beginning. Subsequently, the views should be analysed. The approach to interpreting the drawing starts with the front view, the assembly main line is then identified, the three-point specified representation is used, and finally dimension and projection relation is used to "dissect" the assembly drawing. Once the assembly relation and the structures of each part are clarified, it becomes easy to analyse the working principles and disassembly sequence of the assembly. The incorporation of ideological and political education into the teaching content emphasizes that only by maintaining a proper learning attitude can better learning outcomes be achieved.

1. Introduction

The core task of the engineering drawing course is to cultivate students' ability to read and draw detail drawing and assembly drawing [1]. Therefore, the ability to interpret assembly drawing is one of the essential teaching contents [2,3]. To comprehend assembly drawing, students should master common expression methods, the specified representation for standard and commonly used parts, the reading and drawing of detail drawing, and the ability to assemble drawing from detail drawing. However, in the initial stages, some students have a superficial understanding of the content, lack drawing and reading skills, and experience difficulty and anxiety when it comes to reading assembly drawing. Additionally, some students read drawing without a systematic approach, which results in a sense of impatience.

In response to the aforementioned issues, this paper emphasizes the steps and methods of reading assembly drawing. Firstly, students should preliminarily understand the assembly by reading the title block and item lists, rather than immediately focusing on the front view. When examining the drawing, they should start from the front view, identify the assembly main line, use the three-point specified representation as a reference, and, in conjunction with dimension and projection relation, "dissect" the assembly drawing.

2. Teaching Objectives for Reading Assembly Drawing

The knowledge objectives for reading assembly drawing are to master the steps, methods, and essentials of reading assembly drawing, and to review and consolidate knowledge of expression methods and specified representation for assembly drawing. The skill objectives are to cultivate students' ability to correctly interpret various information in assembly drawing, including assembly relation, working principles, disassembly sequences, and the structures of each part, thereby possessing the ability to read assembly drawing. The value objectives are to cultivate students with rigorous and meticulous work ethics and a spirit of craftsmanship that seeks perfection.

In light of these three teaching objectives, the analysis of the focus and difficulties of the teaching content is crucial. The focus of teaching is to enable students to master the methods and essentials of reading drawing, while the difficulty lies in how to quickly understand the assembly relation between parts and the structures of each part. The teaching methods employed include lectures, case-based teaching, PowerPoint (PPT) animations, and SolidWorks model demonstrations [4,5]. The entire teaching process is divided into six stages: course review, course introduction, new lesson instruction, course summary, extended reading, and post-class reflection. Teaching feedback is obtained through homework corrections, exam results, and student evaluations. Continuous improvement and reflection are conducted to enhance teaching effectiveness, ultimately benefiting the students. The following section provides a detailed explanation of the teaching process using the example of reading the assembly drawing of the "Mechanical Tiger Pliers."

3. Teaching Process of Reading Assembly Drawing

3.1 Course Review and Introduction

Firstly, students are guided to review the previously learned content: the definition of assembly drawing; the functions and content of assembly drawing; the specified representation and special expression techniques for assembly drawing; dimension and technical requirements, the references of items, the filling of the detail lists; the introduction to assembly structures and the method of assembling drawing from detail drawing. Next, the requirements for understanding assembly drawing are explained: the ability to recognize the names and parts of assembly drawing, the ability to understand the assembly relation between parts and the structures of each part, understanding the working principles, and disassembly sequence. Finally, students are asked to examine the assembly drawing of the "Machine Tiger Pliers" and consider two questions. The first question: What do you see at first glance? Are you looking at the front view? The second question: What is the approach to viewing the drawing? Will you focus on the front view first, then look at the top view, and finally turn to the left view? As shown in Figure 1. With these two questions, students are guided to actively follow the teacher's methods and steps for learning how to read assembly drawing.

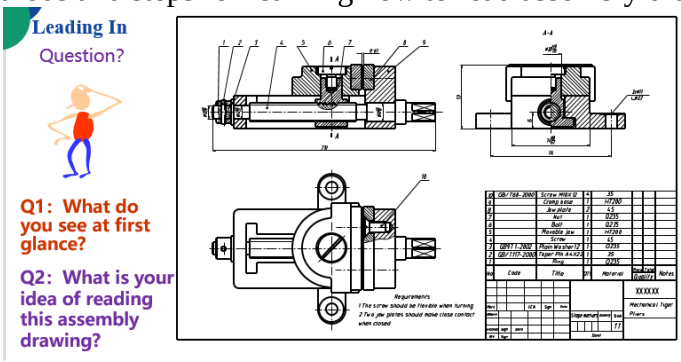

Figure 1: Encourage students to learn with questions.

3.2 Reading Methods and Steps for Assembly Drawing

3.2.1 Step One: Read the Title Block and Item Lists to Gain Initial Understanding of the Assembly

The first step in interpreting assembly drawing is to read the title block and item lists, rather than focusing on the structures. Upon reading the title block, students should examine the name of the assembly, "Machine Tiger Pliers," with a focus on the word "pliers". When "pliers" are mentioned, students may associate them with the pliers at home, which are used for gripping. Similarly, machine tiger pliers also serve a gripping function. Next, students should examine the item lists and determine the total number of parts, including the various standard components and their quantities. For machine tiger pliers, there are a total of ten different parts, with three of them being standard parts. Apart from four screws and two jaw plates, all others are singular. Then, students should determine the structures of standard parts based on the national standard codes provided in the item lists. Part number 2 is a standard part taper pin; part number 3 is a standard part plain washer, and part number 10, the screw, is a standard part slotted countersunk head screw. Step One is illustrated in Figure 2.

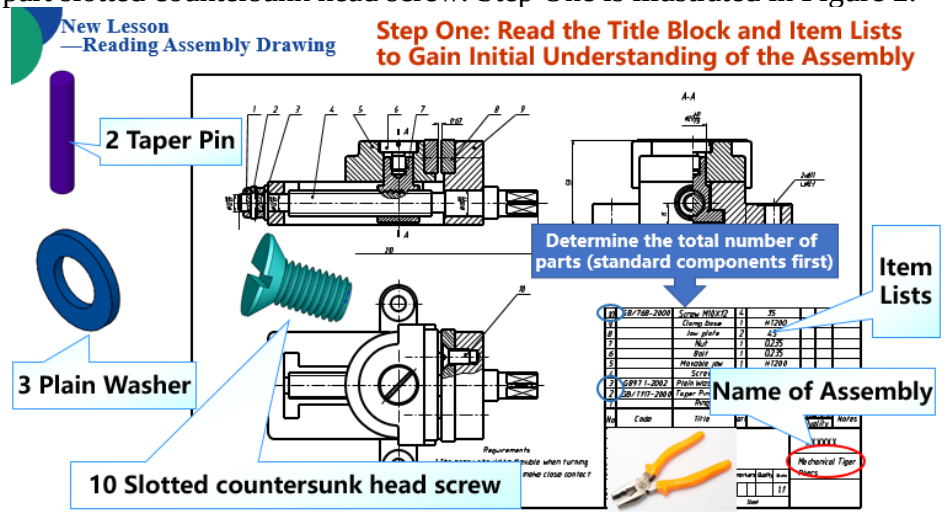

Figure 2: Read the Title Block and Item Lists

3.2.2 Step 2: Examine the views to clarify assembly relation and the structures of each part.

(1) Approach to Reading Drawings

Firstly, the approach to reading drawing is discussed: Starting from the front view, the assembly main line is identified. Then the three-point specified representation is used as a starting point, and the assembly drawing is "dissected" based on dimension and projection relation. Secondly, the three-point specified representation for assembly drawing is reviewed: The first point involves specifying the contact surfaces, mating surfaces, non-contact surfaces, and non-mating surfaces. The second point involves specifying the section lines, and the third point involves handling the non-sectioned areas. Finally, ideological and political education is incorporated into the curriculum, emphasizing the importance of constant review and practice by quoting a proverb. As shown in Figure 3. Students should remember the approach to reading drawing and review the three-point specified representation for assembly drawing. Students should also understand the principle that “Without accumulating small steps, one cannot travel a thousand miles.”

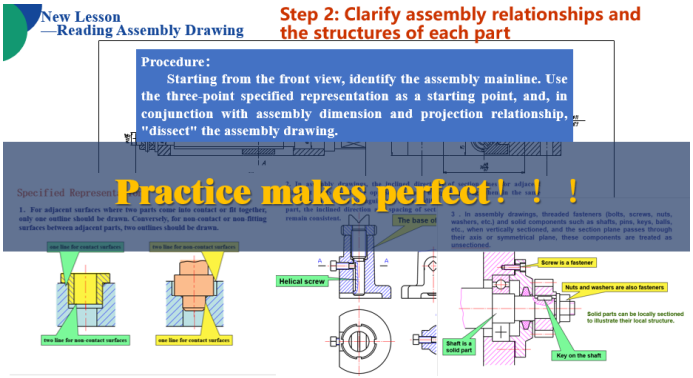

Figure 3: Explain the procedure and incorporate ideological and political education

(2) Starting from the front view, the assembly main line is located

Analyse the front view. According to the expression requirements of the assembly drawing, the front view most effectively reflects the assembly relation. The front view of the Tiger Pliers is a complete sectional view, with an assembly main line in the horizontal direction, and part number 4 is the main focus. To determine what part number 4 is, students should immediately refer to the detail lists. Part number 4 is a screw and is appropriately represented without sectioning.

(3) Along the assembly main line, following the specified representation of the assembly drawing and combining dimension and projection relation, each part and its assembly relation is illustrated.

With part number 4 as the main focus, the assembly is further "dissected". As shown in Figure 4, when looking from right to left, the mating dimension of "φ18H9/f7" axis hole is observed. It is essential to consider assembly dimension when interpreting the drawing. Only one line is drawn for the mating surface of the axis hole, reaching from part number 4 to part number 9 (illustrated by an orange background). After checking the detail lists, it turns out that part number 9 is a clamp. Based on projection relation, section line, and the specified representation of the assembly drawing, the section lines of the same part are consistent in multiple views. The lines belonging to part number 9 are found in the top view, as shown in the top view in Figure 4. The section lines of the part in orange in the left view match the section lines in the front top view of part number 9, but it seems like the projection relation is not aligning correctly. Here the question is raised but not answered, leading students to overcome any reluctance, and to continue reading.

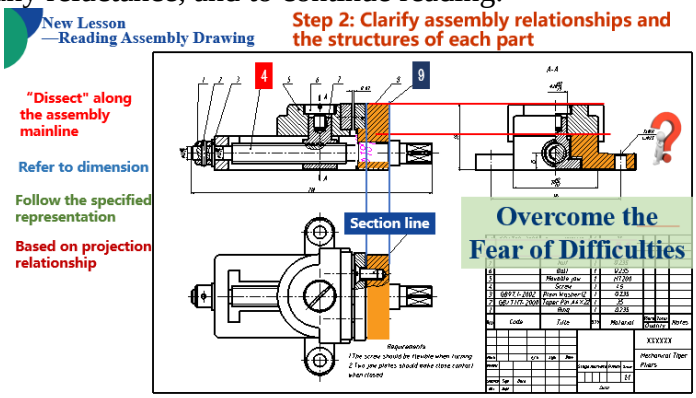

Figure 4: Read along the assembly main line

Continuing along, when observed to the left of part number 4, the presence of part number 7 is indicated based on the differences in the section lines. The section lines serve as indicators to differentiate between various parts. Referring to the item lists, Part 7 is identified as a nut. When it comes to nuts, one should immediately think of internal threads. Parts 7 and 4 are in a state of threaded engagement, both internally and externally. Now, examining the left view, it is a semi-sectional view.

Based on the projection relation of heights alignment, and based on the consistency of profile lines, the lines in the left view that belong to the nut are identified. Look at the dimension, "φ20H9/f9" represents a shaft hole fit, with the upper part of the nut serving as a shaft, forming a cylindrical shape. The structure of the nut is illustrated in Figure 5.

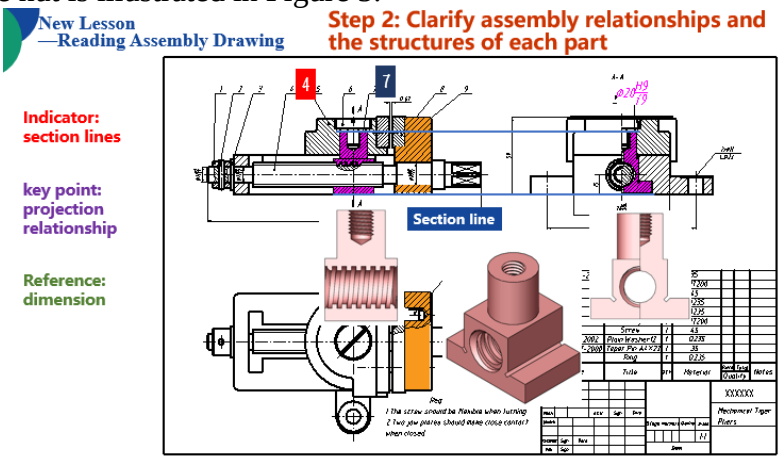

Figure 5: Understand part 7 based on section lines, projection relation and dimension

Continuing along the assembly line where part 4 is located, moving to the left, another set of dimension for the hole and shaft is observed, denoted as "φ12H9/f7." The screw serves as the shaft, and the corresponding part is the hole. The cross-sectional profile matches that of part 9, and it cannot be any other part. Therefore, it is confirmed to be part 9. Based on the projection relation, the lines belonging to part 9 on the top view are identified.

The left view is a half-section view along line A-A direction, with heights aligned. The part that was not fully determined earlier (denoted by the question mark in Figure 4) belongs to the clamp base of part 9. The structure of the clamp base is illustrated in Figure 6.

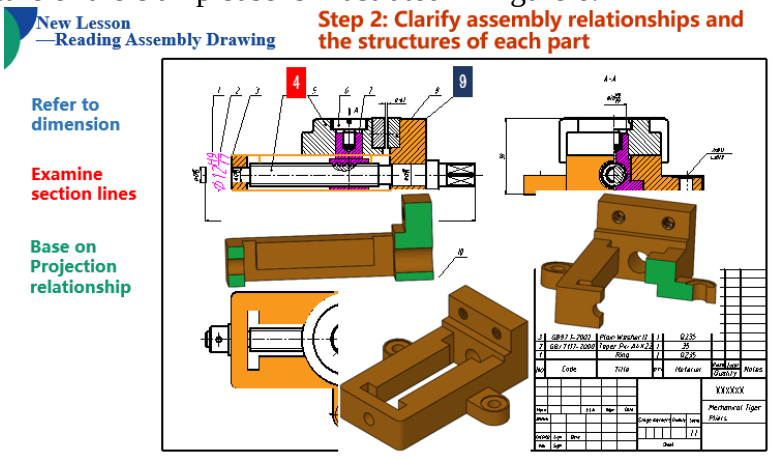

Figure 6: Understand the structure of the clamp seat (part 9)

In the same vein, based on the profile lines and projection relations, and combined with dimension, the structures of other non-standard parts are understood. The assembly relations between parts are clarified based on axis hole fits, threaded connections, or contact/non-contact surfaces.

(4) Finally, the expressive intentions of each view are understood.

For the assembly drawing of the Machine Tiger Pliers, a total of 3 views were utilized for representation. The front view is a full-section view, primarily reflecting the assembly relations between parts; the left view is a semi-section view, further illustrating the structures of the nut and other parts; the top view is a partial cross-section view, depicting the assembly relations around the

outline and screws.

3.2.3 Step 3: Clarify the Working Principle and Disassembly Sequence.

Finally, all the technical requirements in written form in the entire drawing should be examined. The statement "Rotating the screw should be flexible, neither too loose nor too tight" indicates that the working principle of the machine tiger pliers involves using a wrench to rotate the screw, driving the nut to move linearly along the screw, thereby opening and closing the jaw plate of the pliers. The disassembly sequence involves first removing the screw of part 6, then taking out the movable jaw, knocking off the pin, removing the retaining ring, and pulling out the screw. Conversely, the assembly sequence is reversed. Teachers can use animations to illustrate the working principle and disassembly sequence, as shown in Figure 7. Up to this point, three steps have been employed to fully understand the machine tiger pliers.

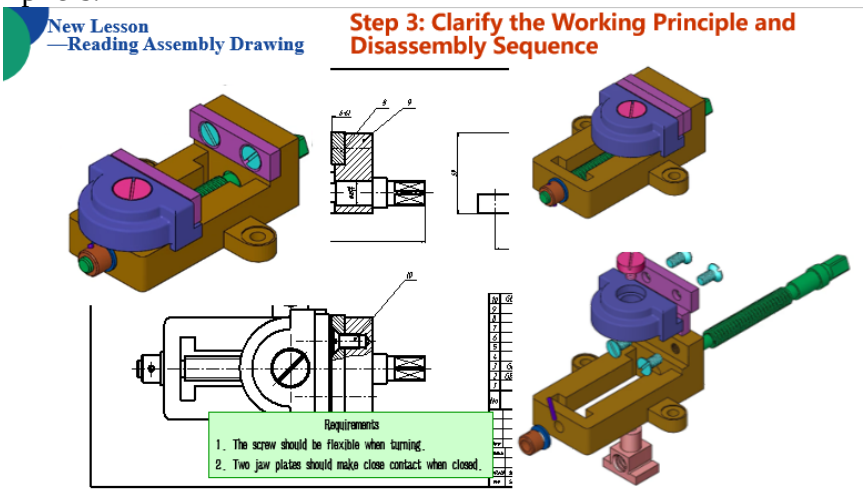

Figure 7: Animations of working principle and disassembly sequence of the Machine Tiger Pliers

3.3 Course Summary and Reflection

The teacher summarized the steps of reading assembly drawing and the essentials of interpreting drawing, answering the two questions raised at the beginning of the course. The first step in reading a drawing is to read the title block and item lists, rather than focusing on the structures. The approach to reading the drawing starts from the front view, identifying the assembly main line, using the specified representation for assembly, and combining assembly dimensions with projection rules to interpret the drawing. Reading assembly drawing requires the comprehensive application of many previously learned concepts. A down-to-earth, step-by-step approach, without fear of difficulty, and avoiding impatience is required in the process of learning. All advanced machineries of the nation are inseparable from drawings, the spirit of craftsmanship that seeks perfection, and the responsibility and sentiments for the nation and home.

After class, students can read the brief history of the development of engineering drawing uploaded by the teacher on the online teaching platform. They can also explore excellent drawings from various times and places, and contemplate whether they can disassemble and draw part number 9, 7, and 5. This will be the focus of the next class – learning detail drawing from assembly drawing. Detail drawing from assembly drawing will be the final content of the engineering drawing course.

4. Conclusions

This article explores methods for reading assembly drawing, highlighting three teaching

characteristics. The first point involves clarifying the three steps of reading drawings, organizing thoughts, and quickly and accurately understanding assembly drawing. The approach begins by reading the title block and item lists, then proceeds from the front view, identifying the assembly main line. The drawings are "dissected" by leveraging the three specified representations and combining dimension and projection relation.

The second point involves raising questions in the course introduction to encourage students to learn with questions, which is beneficial for focusing their attention and enhancing teaching effectiveness. Finally, through class summaries, the steps and essentials of reading assembly drawing are reinforced. Students answer the questions raised in the introduction, creating a cohesive and responsive learning experience.

The third point involves incorporating ideological and political education into the teaching content. Emphasizing the importance of maintaining a proper attitude towards learning is crucial for achieving better learning outcomes.

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References

[1] Zhu Wenbo, Ji Haihui, Li Haiyuan. Reform and Practice of Mechanical Drawing Teaching Integrated Theory with Practice [J]. Journal of University of Shanghai for Science and Technology 2019; 43(2): 185-195.

[2] Sun Shaoni, Huang Ying, Li Xiaohao, etc. A Method Reading Assembly-Drawing Based on Recognition of Characteristic Drawing [J]. Journal of Graphics 2015; 36(1): 123-127.

[3] Xiao Guohua Lu Yinghua Liang Bei. Drawing Method Based on Classification Logic and Analysis [J]. Journal of Zhejiang Business Technology Institute 2021; 20(3): 48-51.

[4] Wang Yan, Cao Hongna, Sun Liming, etc. Teaching Design for Reading Assembly Drawings under the Condition of Smart Classroom [J]. Machine China 2023; (11): 108-112.

[5] Zhao Xinyue, He Zaixing, Liu Zhenyu, etc. Design of Immersive Teaching Experimental Platform for Assembly guidance of Engineering Graphics Based on Augmented Reality [J]. Experimental Technology and Management 2022; 39(3): 195-199, 213.