

# Electronic Technology Teaching Practice Assisted by Information Technology--Taking Counter Design as an Example

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**Abstract.** The concept of electronic technology courses is abstract and has strong applicability. In response to the problem of weak foundation and learning ability among vocational education students, which leads to poor learning effectiveness in electronic technology courses, information technology methods are introduced to assist in teaching implementation. Using specific cases as carriers, from unit circuit design to fault phenomenon simulation, virtual simulation experiments are visually intuitive and have a thorough understanding; Using mind maps to build a knowledge network, with clear context and doubled efficiency. Within a limited time, students have a deep understanding of a series of theoretical and practical knowledge such as circuit principles, and their learning interest and effectiveness have rapidly improved, achieving good teaching results.

**Keywords:** Electronic technology; Virtual simulation; Multisim software; Synchronous counter; Mind mapping software.

## 1. Introduction

The electronic technology course is a crucial foundational course for vocational education in the electrical field. Given the short duration of vocational education and the limited study hours for this course, coupled with the typically weak learning abilities and foundations of vocational education students, it holds a significant position in the development of competence for their future roles. Under traditional teaching methods, the learning outcomes of the course are often unsatisfactory, leading to adverse consequences such as loss of interest for learners. This, in turn, makes it challenging for the demand for talent in professional positions to be effectively met from the outset. Therefore, vocational education teachers should innovate and optimize teaching methods based on traditional teaching models. Creative teaching approaches and strategic improvements in teaching methods are essential to transform abstract and complex technical principles into vivid, easily understandable instructional content. This approach aims to address the issue of poor teaching effectiveness in the electronic technology course within vocational technical education.

## 2. The Characteristics of Information Technology

Experimental operations can play a consolidating, assisting, and compensatory role in theoretical learning. In practical teaching, hardware experiments are often constrained by conditions, space, personnel, etc., rendering experimental teaching somewhat impractical. With the vigorous development of information technology, leveraging computer virtual simulation methods demonstrates its unique advantages in the classroom teaching of electronic technology. This is primarily manifested in three aspects: firstly, real-time interaction deepens the understanding of theoretical knowledge; secondly, it is safe and reliable, avoiding safety accidents in experiments; thirdly, it is convenient and fast, allowing for the adjustment of component parameters at any time for performance verification or innovative research. Similarly, the interaction between theoretical teaching and experimental experience needs to be integrated seamlessly anytime, anywhere. Information technology software can also excel in the organization and memorization of knowledge.

The use of mind map tools is ingenious, favored by educators and learners for its structural, systematic, and radiative characteristics.

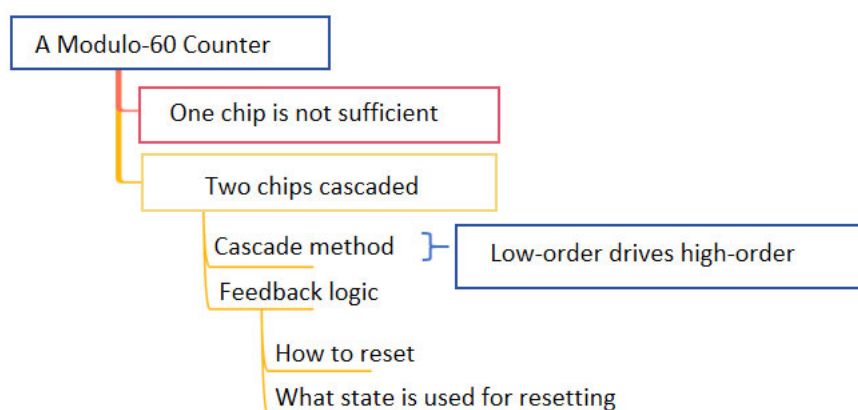
### 3. Information Technology Means Empowering Teaching Practices - A Case Study

Counters are the most widely used circuits in digital circuits. The 74LS161 counter is a commonly used medium-scale sequential circuit capable of performing modulo-16 addition counting. It can realize functions such as measurement, counting, frequency division, and control, and has a wide range of applications in digital circuits and microcontroller systems. In vocational technical education electronic technology courses, students are required to design counters with any modulo value using this chip. Due to the asynchronous clear function of the chip, clearing in cascaded designs becomes a challenging aspect to comprehend. To enable students to quickly understand the logic of circuit design and observe faults caused by logical design errors, practical analysis and demonstrations using Multisim simulation were introduced during the design phase. Concurrently, incorporating mind maps facilitated the penetration of design ideas. By approaching the logic of design and the dimension of knowledge-to-skill comparison from a logical height in theoretical experiments, theoretical and practical experiments complemented each other, and innovative thinking training was elevated through immersive experiences, ultimately enhancing teaching quality and effectiveness.

#### 3.1 Design Analysis

The task requires the utilization of a 74LS161 chip, gate circuits, and displays to create a 60-second timer for a basketball game. Evidently, this task involves constructing a 60-second counter circuit. The design approach begins with the analysis of a single 74LS161 chip to achieve a sexagesimal counter. One chip alone is insufficient for a 60-second timer; therefore, two chips need to be cascaded. The choice of cascading method and the design of feedback logic are crucial aspects of the overall design.

To organize the design thoughts, a mind map is used, as depicted in Figure 1.



**Figure 1.** Design Concept

Combining the design concept, determine the modulus for the low-order counter and high-order counter. Starting the count from 00, the final state should be 59. When the low-order counter reaches 9, a control signal should drive the high-order counter to start counting on the next incoming pulse, simultaneously resetting the low-order counter. Therefore, the counting modulus for the two counters is 10 (low-order) and 6 (high-order). The clearing logic involves resetting to 0 when the high-order counter reaches 5 and the low-order counter reaches 9. The counter and feedback logic circuit diagram can be designed as shown in Figure 2. The key difference between the high-order and low-order is the feedback state, using 9 for the low-order and 5 for the high-order.

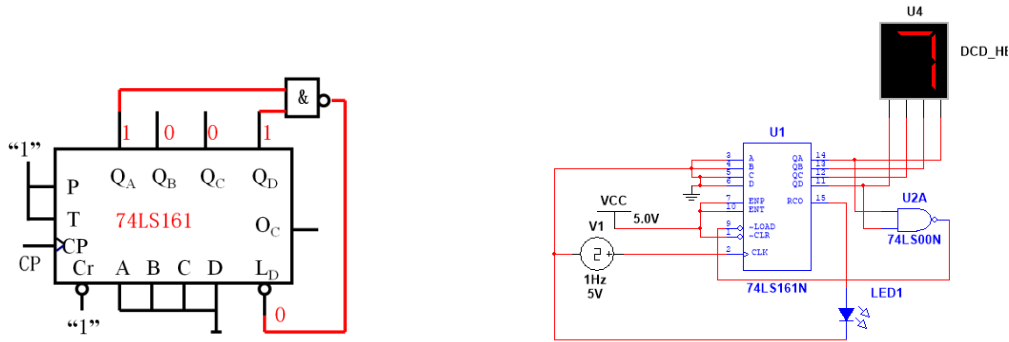


Figure 2. Low-Order Counting and Feedback Logic

### 3.2 Model Construction

Combining the design logic and analysis, the low-order and high-order sections are designed. The next consideration is how to cascade them. The key to the design is to use the low-order section to control the initiation of counting in the high-order section, meaning that when the low-order section completes one cycle, the high-order section starts running once. This cycle repeats 60 times, achieving a 60-base counter. Two methods, asynchronous cascading and synchronous cascading, can be employed. To validate the correctness of the design, simulation experiments are conducted using simulation software.

#### 3.2.1 Asynchronous Cascading

When the low-order section completes counting up to 9, it generates a counting pulse for the high-order section. This model uses the preset terminal to restore the initial state, leaving the chip's clear terminal for other control purposes. The experimental simulation is shown in Figure 3.

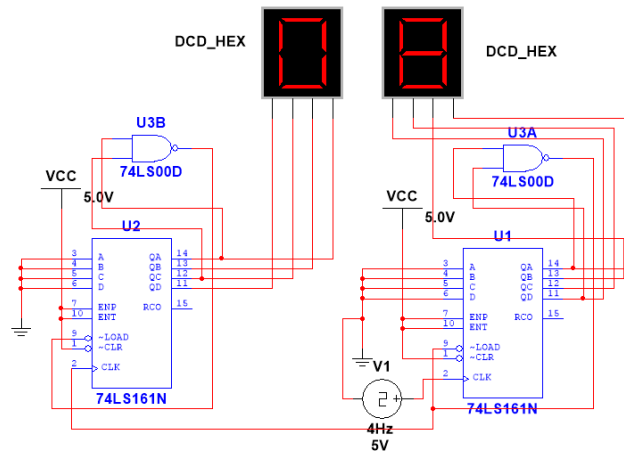


Figure 3. Asynchronous Cascading

#### 3.2.2 Synchronous Cascading

The synchronous cascading design is verified by students. Synchronous pulses are used for counting. When the low-order section reaches 9, the control signal for high-order counting is activated, allowing counting when the next pulse arrives. Simultaneously, the low-order chip resets, and the high-order chip enters a latched state. For every cycle of the low-order section, the high-order section counts once. The final state of the high-order section can be set to 0101 for feedback preset or 0110 for feedback clear. Regardless of the feedback method chosen, another feedback terminal will be available for other requirements. The model simulation for synchronous cascading is shown in Figure 4.

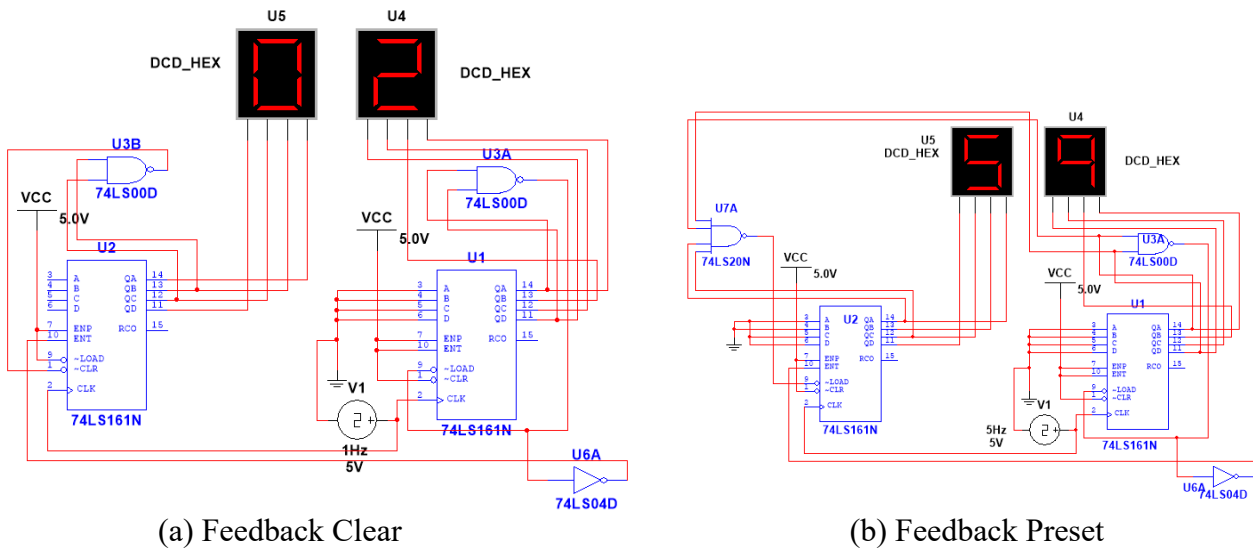


Figure 4. Synchronous Cascading

### 3.3 Fault Simulation and Analysis

Synchronous cascading design is undertaken by students in groups, and various faults emerged during the process. Fault phenomena include erroneous displays such as the sequence 0-1-4-5-6-7, counting feedback at 49, low-order counting without high-order counting, and clearing starting at 51, among others. The fault phenomena observed in the simulation experiments will be accurately reflected in physical experiments. Students systematically analyze and troubleshoot each fault based on the chip's functionality. Using mind maps, they organize the fault phenomena, solutions, and corresponding knowledge points, facilitating an iterative process of learning through doing. The fault phenomena encountered in the design process are recorded in the form of a mind map, as shown in Figure 5.

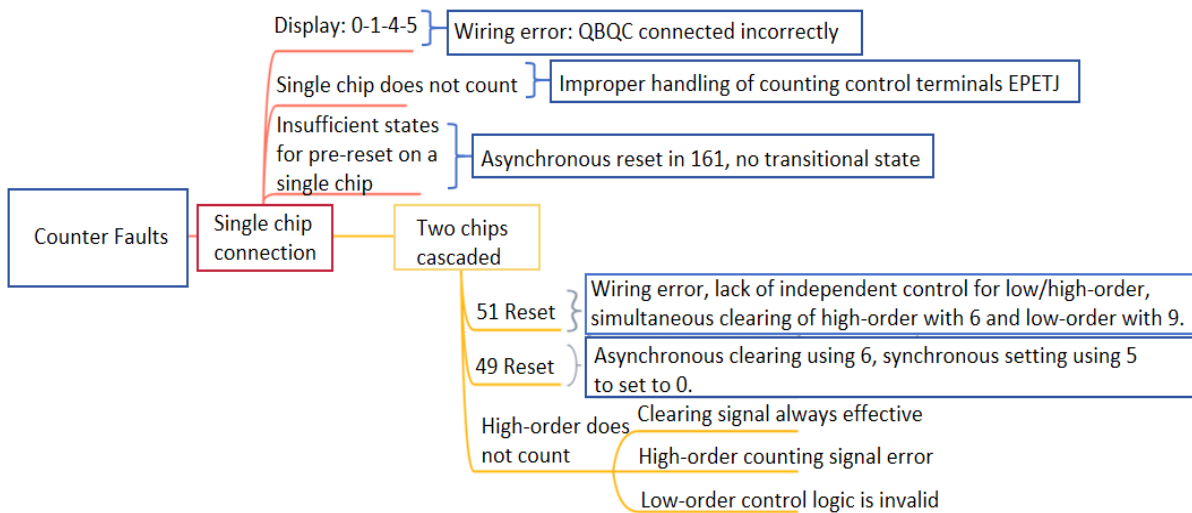


Figure 5. Fault Resolution Knowledge Graph

In the teaching case of counter design, virtual simulation experiments are utilized for demonstration, correcting common faults and errors. Throughout the design process, mind maps are integrated to promptly organize and reinforce relevant knowledge and skills, enhancing students' sense of relevance in circuit design and the satisfaction of successful experimentation. Additionally, various solution validations are efficiently conducted within a limited time frame, bridging the gap between theoretical learning and experimental verification. This approach encourages an

understanding of the scientific and philosophical aspects inherent in different design solutions. Fault compression and elimination have proven remarkably effective in a single class, cultivating a spirit of inquiry and skepticism among students.

#### 4. Conclusion

The widespread application of virtual simulation technology and various specialized software, along with other information technology tools in teaching, has ignited students' interest and enthusiasm for learning. This has made abstract and complex theoretical knowledge more vivid and engaging, creating a relaxed and enjoyable learning atmosphere. Students find knowledge acquisition, experiential learning, skill development, and intellectual cultivation more accessible. This signifies a return to the original intention of teaching and education. Therefore, in practical teaching, educators should closely follow the forefront of information technology developments, actively explore various strategies for leveraging information technology in subject teaching, and ensure optimal teaching effectiveness. This lays a solid foundation for students' learning and growth.

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