Design and Practice of Case Teaching Method in Fieldbus Principle and Application Course

Xiaoxia Chen

School of Electronics and Information Engineering, Dalian Jiaotong University, Dalian 116028, Liaoning Province, China

cxx@djtu.edu.cn

Xiaoxia Chen

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Abstract. Fieldbus Principle and Application is an optional course for graduate students majoring in Control Science and Engineering. In order to stimulate students' interest in learning, improve students' practical ability, and cultivate students' sense of teamwork and innovation, case teaching method is introduced into the teaching of this course. This paper expounds the necessity and feasibility of introducing case teaching method, the implementation process of case teaching method and the results achieved.

Introduction

Fieldbus technology, as the technological frontier in the field of industrial control, leads the development direction of industrial control system, and its application field and scope are expanding rapidly. As a postgraduate course of control science and Engineering in our university, "Principle and Application of Fieldbus" has attracted more and more attention of students.

Case teaching method began at Harvard Business School in the 1920s and became a successful education model which is considered to represent the future direction of education. The introduction of case teaching method in China began in the 1990s, but its application in higher education teaching is still rare. [1]

The teaching method of Fieldbus principle and application is implemented with the concept of case teaching. The fieldbus technology is integrated into the design of intelligent node and the case of project configuration, so that students can directly contact the application of technology and intuitively feel the advanced nature. Use interest to guide their self-study of theoretical knowledge, achieve twice the result with half the effort, and truly put them into action.

Necessity and Feasibility of Case Teaching Method in Field Bus Principle and Application Course

The course "Principles and Applications of Fieldbus" aims to enable students to master the generation, development and architecture of fieldbus; gain proficiency in PROFIBUS-DP and PROFIBUS-PA protocol structure, communication model, transmission technology and bus access technology; master the application of PROFIBUS-DP and PROFIBUS-PA protocol chip; understand other fieldbus, such as CAN bus communication protocol, CAN controller and transceiver, and CAN application. There are 32 hours in this course. The ideal curriculum is 20 hours of theoretical teaching and 12 hours of experiment. However, due to the limitation of school hardware conditions, the experiment cannot be carried out. So at present, 32 hours are all theoretical hours.

The traditional teaching mode is centered on teachers and textbooks, with inculcation method. It only pays attention to how much knowledge is inculcated into students, but ignores the method of acquiring knowledge and the potential of self-study. It is difficult to stimulate students' learning enthusiasm and initiative by using this teaching mode, and it cannot meet the training objectives of postgraduates. Therefore, there is an urgent need to improve teaching methods and introduce
case-based teaching method into this course, so as to lay a foundation for improving students' ability of integrating theory with practice and engineering application.

The students who choose this course mostly come from automation major and other similar majors, such as measurement and control, electrical automation and so on. They have studied Programmable Logic Controller, Single Chip Microcomputer, Process Control and other related courses at the undergraduate stage. Many students' graduation designs are related to the design of single chip microprocessor or PLC. Therefore, students have a certain basis for control system integration and embedded system development, which makes the implementation of case teaching method feasible.

**Implementation of Case Teaching Method**

**Case Selection**

To make good use of case teaching method, case selection is the key. Because the research team of the author has many years of working foundation in the field of industrial control and has the experience of fieldbus control system integration, there are two main types of case sources. One is the actual project developed for the enterprise in the past, and the other is the case specially designed for this teaching. The criterion of case selection is comprehensive function and advanced technology. Each case provides functional requirement document, design proposal document, hardware circuit diagram, control program and upper computer monitoring interface, etc. There are many kinds of fieldbus, which has not formed the only international standard. In our country, PROFIBUS and CAN bus are the most widely studied and applied. Accordingly, the cases used in this course include three bus system integration cases and two bus node development cases, including:

- Case 1: System Integration of PROFIBUS-DP Bus.
- Case 2: System Integration of PROFIBUS-PA Bus.
- Case 3: System integration of CAN bus control system.
- Case 4: Development of PROFIBUS-DP bus intelligent node.
- Case 5: Development of CAN Bus Intelligent Node.

Taking Case 1 as an example, the case is briefly introduced.

(1) Functional requirements. The whole automatic control system is roughly divided into two parts, one is the centralized monitoring part, the other is the field control part. The centralized monitoring part adopts industrial computer and configuration software for centralized management. The field control part is shown in Fig. 1, which mainly includes temperature detection, liquid level detection and alarm, PH value detection and control (adding acid or alkali), dissolved oxygen detection and control, fan frequency converter, water pump and sludge pump control.
(2) Control scheme. Considering the system cost and advanced technology, fan inverter and pump are controlled by PROFIBUS-DP bus while others are controlled by PLC. The system control structure is shown in Fig. 2.

(3) Hardware design. The hardware design related to PROFIBUS is highlighted here. CPU315-2DP is used as DP master station, MCC motor controller and frequency converter are used as DP slave station. The hardware configuration is shown in Fig. 3.
(4) Monitoring interface of PC. The monitoring system is designed by WINCC, which provides the monitoring, recording and alarming of all process parameters, setting of automatic control parameters and manual control functions of all equipment. The main control interface is shown in Fig. 4.

**Case Teaching Process**

The case teaching process of this course is arranged as follows: (1) Case issuing: In the course of teaching background knowledge of industrial control system and fieldbus, case materials are sent to students, and 20 students are divided into four groups, each group chooses at least one case, requiring students to look up the data themselves and familiarize themselves with the case first. At the same time, provide application software for students. (2) Case explanation and assignment:
After the background knowledge is finished, one class is arranged to explain the case, including functional requirements, hardware design, control software design and monitoring software design. After that, each team will be assigned the same type of project design tasks as the previous selected cases, providing detailed functional requirements documents, and the team leader will be responsible for the division of labor, requiring that the design work be completed within 2 weeks. (3) Group report and discussion: 2 weeks after assigning the task, one class will be arranged. Each group will send representatives to show the design results of the group through PPT. Team members jointly answer the questions from teachers and classmates and discuss together. (4) Teacher's summary and evaluation: After each group of demonstrations and discussions, the teacher corrects and summarizes the errors, scoring according to the performance of each student, and counting into the normal performance of the course (accounting for 30% of the total score).

**Implementation Effect**

Case teaching method is implemented in Grade 2017 and Grade 2018 graduate students majoring in control science and Engineering in College of Electrical Information Engineering, Dalian Jiaotong University. Through the reference cases explained by teachers, self-referencing materials and group cooperation, the students jointly completed field bus equipment selection, AUTOCAD software wiring drawing, STEP7 software control program design, PC monitoring software design, Altium Designer circuit design, PPT, achievement display and reply, etc. They have a deeper understanding and mastery of the field bus technology and its application, which lays a good foundation for the later graduation design and employment. To a certain extent, case teaching method improves students' practical ability, application ability and speculative ability, strengthens students' scientific research topic selection, team cooperation, innovation and entrepreneurship consciousness, and enhances students' professional and employment self-confidence. Statistical results show that the course and teaching methods are 100% approved by students and their tutors.

**Conclusion**

Case teaching method has the characteristics of student subjectivity, teaching enlightenment, highlighting application and dynamic process [2]. With classical cases, it can upgrade students' passive acceptance to active pursuit and knowledge education to ability training. After two rounds of teaching practice, good results have been achieved. In the future, we will continue to study and research, further optimize teaching methods, further optimize teaching cases, and better serve the talent training of science and engineering specialty.

**References**
