

# Development and Application of Simulation Teaching Project of "Intelligent Electric Apparatus Principle and Application"

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**Abstract.** "The principle and Application of Intelligent Electrical apparatus" is a new technology application course, with strong practicality and knowledge points, in order to enable students to quickly grasp the relevant content in the process of practical operation. Based on the HT600 control system, a comprehensive simulation teaching project is designed. In the actual teaching process, the simulation teaching project can make part of the content which is difficult to understand become intuitionistic and easy to understand through the simulation operation, and achieved a good teaching effect.

**Keywords:** HT600; Simulation controller; Simulation debugging; Intelligent electrical apparatus.

## 1. Introduction

"The principle and Application of Intelligent Electrical apparatus" is a highly practical new technology application course for electrical appliances, automation and related majors. The intelligence of electrical apparatus is the result of the crossing and amalgamation of many subjects, such as traditional electrical apparatus, microcomputer control technology, power electronics technology, digital communication and network technology, etc. It is a new developing field of electrical apparatus discipline. The teaching purpose of this course is to enable students to make full use of HT600 control system of ABB to set up DCS project quickly and complete configuration control after learning PLC application technology, frequency converter application technology and bus technology and so on. The ultimate goal of the course is to apply a variety of intelligent technologies to all kinds of electrification equipment, so that students have a better ability to apply intelligent electrical appliances.

The course is based on HT600 control system and involves knowledge points including control system structure, project tree construction, process station programming, operation station and HMI configuration, flow chart configuration and system debugging, etc. Typical knowledge and skill points are introduced in the course. Practice training to rely on the theory, part of the theory has been training for the purpose, so that the two rely on each other.

## 2. Simulation Project Design

The course "principles and applications of Intelligent Electrical Appliances" has a lot of knowledge and novel contents, and some abstract contents are not easy for students to understand. In the actual teaching, there are more than 40,50 students in a class of higher vocational education, and the training space is limited. If all the training items are placed in the training console, each student will have less opportunity to practice, and the training effect will be greatly reduced. The HT600 control system has a soft controller, and the function of the simulation controller can be realized by the PC machine. Without the hardware controller, the student can download the application program to the simulation controller resource, so as to complete the running logic quickly.

In the course of teaching this course, we make full use of the simulation controller. A typical comprehensive training project "liquid level control engineering configuration based on HT600" is designed, which enables students to download and simulate the application program of process station on PC. Through the project, students can master variables, operation screen, flow chart add configuration operation steps; can grasp the monitoring screen view, system detection screen view and other monitoring operation methods; can master the basic knowledge of process station

programming. There is an engineer station and an operator station in the project, in which the engineer station is also the operator station. The contents and teaching difficulties of the integrated practical training simulation project based on the design of knowledge points are shown in Table 1.

Table 1. The Teaching content, emphasis and difficulty of Simulation Project and the Distribution of Teaching hours

Class hours	content of courses	Key points and difficulties in teaching
3	Task 1 Use of Simulation Controller	Key points: the difference between variable and label; troubleshooting method of simulation controller.
	Task 2 Static process flow chart drawing	Difficulties: the familiarity of graphical editing interface and the basic method of picture editing.
3	Task 3 Implementation of dynamic flow Chart	Key points: alphanumeric display methods; correct use of bar drawings.
	Task 4 Development of manual control procedures	Difficulties: precision adjustment; online debugging FBD program; the realization of panel control.
3	Task 5 Programming of automatic interlocking program	Key points: display reasonable use of numerical window; historical alarm data recording steps.
	Task 6 alarm configuration	Difficulty: to be able to display instrument alarm data on the WinMI screen.
3	Task 7 Trend configuration	Key points: fast search trend chart; the realization of general appearance display. Difficulties: the building steps of the trend server; the implementation of the "Unit" parameters.
	Task 8 Basic operations of the trend server	
	Task9 Implementation of Graphics Macros	

### 3. Typical Simulation Training Task Teaching

This paper introduces the practical teaching application of the simulation control item with the example of "the compilation of the manual control program of task 4". At the beginning of class, the learning materials of this lesson are presented in the form of "answer + practice", part of which is shown in Fig. 1. Students must firmly grasp this information in class in order to successfully complete the practical training task. The study material inside has the knowledge point to fill in the blank content, also has the knowledge point which the concrete must practice the operation, like "the activity 1" and so on. After the students get the information, they will do each task in the classroom.

(1) **IDF\_1 function block** ( )

Role: \_\_\_\_\_

※※※"Emulator" must be placed first※※※

Activity 1 ---- The process water pump P201 is started and stopped by IDF\_1.

---- IDF\_1 is used to start and stop the process tank mixer M101.

First, create a new Manual Control Program (FBD).

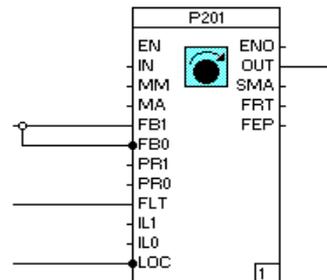
@P201\_FT

Then use WinMI to "Open the Panel."

@P201\_RD

@P201\_ST

@P201\_RN



Q: why "reverse" on LOC?

Fig. 1 teaching materials handed out before class

Teachers in the teaching process, the first to clear the focus of the class and difficult content, and then combined with the information distributed to students, flexible layout of tasks. Taking into account the actual situation of vocational students, generally in 1 ~ 2 important theoretical knowledge points after the completion of explanation, it is necessary to combine the actual situation of the layout of practical training tasks. Because of the convenience of the simulation controller, the flexibility and maneuverability of the simulation controller are greatly improved when the tasks are arranged. For example, when students find it difficult to understand the feedback signals of "FB1" and "FB0", they can consciously strengthen this knowledge in "activity 1" and set up a manual control program FBD in the HT600 control system. The simulation controller is used to make the program run, and the students observe the running phenomenon of the program directly. "FB1, FB0" a total of four states, let the students to the four states are simulated again, the corresponding phenomenon of each state are recorded, the students will naturally understand the function of these two terminals.

Due to the convenience of simulation teaching, as long as the PC machine does not break down, students can complete the related training tasks in the computer room, and the requirements for training venues are greatly reduced. In addition, the class students can be divided into groups. A class can be divided into an average of 8 to 10 groups, each group of 4 to 5 people. Teachers can use the operation of short video, animation and other resources to assist in the teaching process. A specific task to achieve what procedures, the team leader to fully understand. Teachers send part of the relatively easy simulation training tasks, let the group leader to coordinate the division of labor within the group, teachers mainly play the role of defining the task, distributing related resources, process coordination, task summary and so on. Put the main body of the practical training class on the students or group leader, train the ability of the group students to coordinate the completion of various practical training tasks. The students designed FBD program to operate and monitor the process object through D-OS. After using simulation controller to make the process station and operator station in the running state, they directly opened WinMI to carry on operator station configuration. Students can be very intuitive to see the trend display, flow charts and so on, whether to complete the training requires students to be able to quickly self-judgment.

Every completed an activity, the teacher can carry on the induction summary of the knowledge point, at the same time carry on the unified answer to the typical question in the training process, let the student grasp the important knowledge point quickly. Each task has an activity design and each project has an assessment requirement. Students in the completion of various tasks, teachers comment and score, students in the classroom can know how much practical training score, students' enthusiasm for practical training will be greatly improved.

#### **4. Curriculum Evaluation**

Highlight the process evaluation, combined with classroom questioning, practical testing, homework and other means, strengthen the assessment of practical teaching links, and pay attention to the usual adoption of points. Strengthen the assessment of each training project link, and pay attention to the peacetime adoption of points. Suggested peacetime results account for 20% of the total score, reference work, attendance, peacetime performance to the points. At the same time, it is suggested that the final exam results account for 40% of the total results, and the peacetime practical training results account for 40% of the total results. In order to facilitate the peacetime practical training assessment scoring, the total value of the training project points for 40 points, as shown in Table 2, the score of each project can be slightly adjusted in accordance with the actual situation.

**Table 2. grading criteria for practical training items of courses**

Serial number	Project name	Evaluation criteria	Reference score
1	Design of water level control system	The ability of students to construct real-time database, to establish and edit the picture, to establish the graphic object in the user window and the data object to establish the correlation connection in the real-time database, to make the report form and the curve and so on, were evaluated.	8
2	Design of Monitor and Control system for Electric Gate	To evaluate the students' comprehensive application ability of communication interface, configuration, PLC technology and so on.	6
3	Design of liquid mixing and stirring system	To evaluate the students' comprehensive application ability of complex picture, script program, timer, PLC technology and so on.	6
4	Configuration of liquid level Control Engineering based on HT600 (Comprehensive training Project)	To evaluate the students' mastery of the structure, composition, configuration mode and basic algorithm of the HT600 control system.	20

## 5. Conclusion

The main goal of the course "principles and applications of Intelligent Electrical Appliances" is to enable students to be proficient in using HT600 to implement typical DCS projects and to carry out system configuration control through HT600. Finally, students can analyze problems and propose ways to solve the problems through product manuals, case materials and so on. The introduction of simulation tools can help students quickly grasp some important knowledge points, and reflect the concept of integration of teaching, learning and doing. Students build various application models through the simulation controller of HT600.

The use of FBD function blocks, flow chart operation, trend operation and other functions that need to be achieved through hardware control can be achieved quickly, greatly reducing the threshold of intelligent electrical applications. Teachers for the signal feedback, the general appearance of the introduction of knowledge points have become easier, students listen to the interest has been enhanced, play a good teaching effect.

## Acknowledgements

Project support: Wenzhou Vocational & Technical College "Thirteenth Five-Year" Education and Teaching Reform Project, the project number: WZYzd201715.

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