Reform and Practice of Building Equipment Automation Course in the Context of New Engineering Disciplines

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Abstract. In the context of the new engineering, talent cultivation should be oriented towards the needs of the new era, and the future transformation of education system. It is important to emphasize research and exploration in new industrial disciplines, and systematically reform the traditional engineering talent cultivation mode to improve the quality of talent cultivation work. The teaching reform and education practice have been carried out, taking the course building equipment automation as an example. The current status of this course has been analyzed. Measures for the reform of course, key issues and solutions to be addressed have been proposed under the background of the new engineering. The reform measures include improving the teaching content and methods, introducing online teaching tools, promoting the integration of scientific research and education. These reform measures can effectively improve the quality of teaching for building equipment automation courses, and contribute to the cultivation of high-level applied talents.

Keywords: New engineering · Teaching reform · Building equipment automation · Research-based learning

1 New Engineering Disciplines Courses

Compared with traditional engineering, "new engineering disciplines" emphasizes the practicability, intersectionality and comprehensiveness of disciplines, especially the close integration of information technologies such as communication, electronic control, and software design with traditional industrial technologies. New engineering disciplines [1] is a dynamic developing concept proposed for the construction of the new economy and new industrial system. The core idea is to promote the reform and innovation of existing majors, cultivate high-quality engineering talents that meet the requirements of engineering professional certification and the needs of talents in the new era, and contribute to the development of our country.

New engineering disciplines is mainly a new talent training reform that revolves around the new structure, new quality, new model [2] and new concept in the field of

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engineering education. Under the background of new engineering disciplines, the talent training work must face the needs of the recent economic development and the future education system. Reform, focusing on the research and exploration of new industrial majors [3], can systematically innovate the traditional engineering professional talent training mode, and improve the quality of talent training. In the process of developing talents in application-oriented undergraduate colleges and universities in the new era, strengthening the active leading role of new engineering will promote the reform and innovation of the engineering education professional certification system, improve the teaching quality of new engineering majors, and the quality of engineering education. The professional teaching quality evaluation system shall be adjusted and optimized, so that the organizational development efficiency of personnel training work could be significantly improved.

In the process of building equipment automation course reform in the new era, grasping the influence of the new engineering disciplines background, constantly exploring the design and optimization of the teaching system, can guide the development of teaching activities with new educational ideas and concepts, and can promote the development of new courses. The construction of the teaching system will train students to become high-quality engineering professionals with sustainable competitiveness and innovation abilities, who could be well prepared for the world and for the future.

2 Current Status of Building Equipment Automation Course

In the course system of building environment and energy application engineering, the course that is most closely integrated with information technology is《Building Equipment Automation》. Professor Zhu Yingxin, chairman of the National Construction and Environmental Discipline Professional Steering Committee of Colleges and Universities, has clearly pointed out: the building equipment automation course is the top priority of the new engineering construction of the building environment and energy application engineering major [4]. This course cultivates students' knowledge structure and ability literacy of interdisciplinary integration, and this course shall actively responds to the urgent needs of teaching reform under the situation of "carbon 3060 goals" and the development of informatization and intelligence.

Building equipment automation is the core course of the new engineering construction of building environment and energy application engineering. It mainly enables learners to master the composition and working principle of building intelligent systems, and cultivate students' interdisciplinary integration of ideology, knowledge structure and associated capacity. It is the key for students in Building Environment and Energy Application Engineering major to unlock the door to the world of information and intelligence. The course content could be roughly divided into two categories: the fundamentals of control systems and applications of control systems. The foundational part includes the principles and functions of sensors, controllers, actuators, and their communication systems [5]; The application part includes control of air handling processes; monitoring and automatic control of chiller plant, boilers, heat pumps; control of hot water heating systems, fire monitoring and control systems, control of intelligent community/house systems, etc. This course focuses on cultivating students' ability to

independently analyze and solve problems, laying a solid foundation for their future technical and managerial work, and enabling them to analyze and solve complex engineering problems in a practical context.

The specific content of the building equipment automation course teaching is shown in Table 1.

Table 1. Specific Content of Building Equipment Automation Course Teaching.

Number	Teaching Content	Expected Learning Outcomes for Students	Allocation of Teaching Hours
1	Course Introduction	Clarify the course positioning, objectives, assessment methods, etc.; Distinguish basic concepts such as smart buildings, building equipment automation systems, and building equipment control systems based on the Internet of Things.	2
2	Controller	Learning controller hardware: concept CUP, chip, PLC, etc.; learning controller hardware: concept CUP, chip, PLC, etc.; The software algorithms of controllers can be explained, including on-off control, PID (Proportional-Integral-Derivative) control, model predictive control, intelligent control, etc.	4
3	Actuator	Clarify the flow characteristics of the valve/damper, the working principle of the frequency converter, etc., and can perform type selection calculations;	2
4	Sensor	Understand the processing and input of sensor signals.	2
5	System Architecture and Communication	Upper computer and configuration; PLC, DDC field control; Recognize communication systems based on their communication characteristics; List wired communication protocols and wireless communication protocols common communication protocols in the field of building equipment automation and intelligence.	2

(*continued*)

Table 1. (*continued*)

Number	Teaching Content	Expected Learning Outcomes for Students	Allocation of Teaching Hours
6	Subsystem Optimization Control	Implement control optimization of cold and heat source machine room, heat station, water system, and wind system; Residential Intelligent System.	10
7	Actual Control Engineering Case Study and Course Summary	Comprehensively grasp the actual engineering control cases of HVAC systems; Final summary, review and improvement.	2

At present, the building equipment automation course has accumulated complete daily teaching materials, including course syllabus, course teaching plans, high-quality courseware, teaching videos, etc., With the support of the pervious education reform project, this course has been taught twice with the help of Modelica simulation demonstration system, and has been broadcasted with demonstration experimental excises during online education period. A preliminary exploration has been carried out.

3 Course Reform in the Context of New Engineering

3.1 Reform Goals

The course objectives has been redefined based on the new engineering talent training goals, then teaching examples have been redesigned based on the course objectives to meet industrial needs, and cultivate innovative engineering and technical talents. Taking a problem-oriented approach, the concept of "research-based learning" is integrated into classroom teaching activities, guiding students to engage in scientific exploration and innovation. Some essential education modules have been polished as key node modules and based on those carefully arranged education activities, students are equipped with the knowledge structure and literacy ability of "new engineering", and could actively respond to the "carbon 3060 goals" and the development demand of informatization and intelligence: real practice forces education reform urgently.

3.2 Reform Content

Based on a comprehensive and multi-angle analysis of student learning and teaching situations in the early stage, the following key teaching modules that require special attention have been identified for further refinement. It is required continuously improvement and strengthen of key education nodes, such as On/Off control, double-level hysteresis characteristics in temperature control or liquid level control; PI and PID control, mechanism and their applications in temperature and pressure control; Flow characteristics

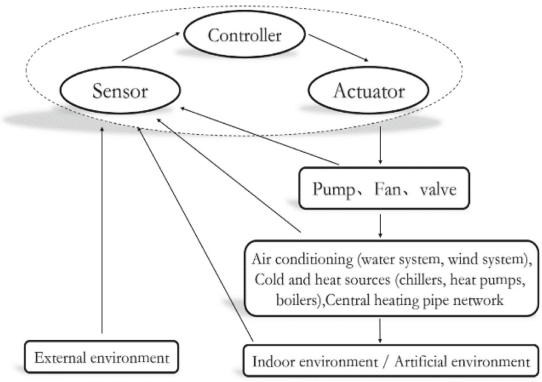

Fig. 1. Course content diagram.

and control effects of valves and pumps; on-site communication and configuration of HVAC systems; High-efficiency chiller plant; and whole year air conditioning operation regulation (enthalpy difference control); Smart mixing water heating module. The relationship between the contents of each part is shown in Fig. 1.

The specific reform includes the following aspects:

(1) Development of complete model library for HVAC control systems based on the Modelica language. The multi-physics property of the Modelica simulation language perfectly matches the interdisciplinary property of building equipment automation course, full coverage of the course content could be achieved by Modelica. In the process of course construction, programming based on the Modelica language can be started from scratch to demonstrate control mechanism, and the teaching module can be developed independently by teacher in an flexible and unlimited way, which makes the content setting of the Modelica teaching module fully meet the teaching needs of the course, with this most intuitive, most authentic way, it is much easier to show students the obscure control algorithm and control feedback process.

(2) Development of a dynamic demonstration experimental teaching system based on enthalpy difference testing system for fan coil units.

Existing fan coil enthalpy difference test system needs to be upgraded, modular configuration software is used to develop the human-computer interaction interface in the upper computer, communication connection with the PLC is established, and project practice and theoretical teaching will be integrated, so that in the process of establishment the actual project, students could study in an result-oriented, deeply participating, constantly discovering and solving process. The currently displayed static control system will be transformed to real-time dynamic demonstration teaching system.

(3) Introduce online teaching methods. With the advent of the information age, in order to improve students' enthusiasm for independent learning, network teaching methods can be introduced in the teaching process. Before class, students can learn about relevant Chinese and foreign literature related to the course content in advance to gain basic understanding. During the class, real practice examples can be employed

to facilitate teaching, and operations can be explained in real time. If there are any doubts, students can also use the internet as a resource. After class, students can watch online tutorial videos to consolidate their understanding of the topics that were not fully explained during class.

3.3 Key Issues to Be Addressed and Their Solutions

The students majoring in building environment and energy application engineering normally do not have strong foundation and find it difficult to understand related content in control and information-related courses, it is necessary to strengthen key education modules, fill in the knowledge structure from points to chain. Modelica teaching modules library shall be expanded, further development and improvement of the optimized control modules for HVAC systems based on the Modelica language is with extreme importance, especially for key and difficult modules such as the heating station and distribution system. Improvements and enhancements will be made to the existing air conditioning system enthalpy control module based on the current fan coil enthalpy testing system. The teaching module will be transformed from a static demonstration to a real-time operating system. This will shift class from pure theoretical explanations to actual real time control optimization in practice.

Relevant laboratories in universities will completely open to students, encouraging them to participate in teachers' research projects or apply for college student innovation and entrepreneurship projects, it can help students develop their practical skills and professional abilities. Involving students in the research projects of their teachers is a way to combine classroom learning with practical experimentation, ensuring the continuity of engineering education. Moreover, unlike traditional teaching, research experiments are subject to a lot of uncertainty, which can encourage students to consider carefully and critically.

4 Conclusion

The formation and development of the new engineering disciplines have already had great impact on the innovation of the engineering education model and the cultivation of engineering talents in higher education institutions. In the context of the new engineering disciplines, it is important to accurately position the needs of talent cultivation in engineering education in the new era. We need to explore the re-selection of curriculum content and the design of teaching modes scientifically in the teaching activities of building equipment automation course, to ensure that students can meet the requirements of the new engineering disciplines. Therefore, in the context of educational reform in the new era, it is important to focus on the reform of teaching models under the background of the new engineering disciplines. This involves analyzing the construction of a completely new educational organizational system and promoting students' practical exploration of the contents of building equipment automation course.

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