

# The Reform Research and Practice of Quality Course of “Automatic Control Theory” Based on CDIO Educational Philosophy

Yue Chunxia

Institute of Electrical and Control Engineering  
Xi'an University of Science & Technology  
Xi'an Shaan xi, China  
Elegant1976@sina.com.cn

**Abstract**—CDIO, namely, the conceive, design, implement and operate, it is the carrier of the life cycle which from the development of product to its running, and it enables students to take the initiative, practical and organic link way to learn project. This paper selects of a main automation professional course "Automatic Control Theory" as the research object, using CDIO educational philosophy to study and explore the teaching and learning of this course, which has formed a teaching mode including active classroom, actively practice, academic research , project research and network learning , after years of teaching practice, it has achieved a good teaching results and reform achievements, and make students improve in practical ability, independent innovation ability, teamwork ability, meanwhile building a broad stage for innovation of talents.

**Keywords**—CDIO; engineering education; automatic control theory; educational philosophy

## I. INTRODUCTION

The engineering education training model of CDID is to clearly and concisely give a introduction of relative conception via teacher and then the students are divided into groups each includes five to six people. Each group designs their own experimental program, determines the operational process, selects equipment, and completes the experiment by work in cooperation with a due division of labor. Through analyzing the results, students present the existing problems, and teacher begins to analyze the concept, explain the principle, and explore with students together. This mode can train students' skills in analyzing and solving problems, and it is able to enhance students' ability of self-learning, coordination and cooperation and running large-scale systems, and stimulate the enthusiasm and creativity of students. Automatic control theory is to guide people to achieve certain methodology for the design and analysis of complex systems in the engineering background, it is highly theoretical, and the essence of CDIO engineering education model—the conception, design, implementation, and operation of CDID are the concrete manifestation of the thought of automatic control theory, it regards life cycle which from the development of product to its running as the carrier, which aims to develop students' ability,

is a new higher engineering educational mode. It includes the ability in personal scientific project, technical knowledge, lifelong learning, communication, coordination and other aspects of large-scale systems. Obviously, the teaching goal of CDID is in accordance with applied undergraduate training, which combines theory with practice, engineering technology with market demand for high-level talent. It regards personnel training as the goal, teaching reform as a guide teaching innovation as the core, scientific research as basis, and reforms automatic control theory curriculum to adapt to the rapid development of domestic industrial areas of automation personnel requirements.

## II. TEACHING PHILOSOPHY TRANSFORM

### A. Teaching Mode Reform

"What kind of talent we should cultivate, how to cultivate talent" is always the basic problem of higher education, "what to teach, how to teach, what to learn, how to learn" is always a process of teaching basic contradiction. Many teachers think the most important is "what to teach" , as for "how to teach" and "how to learn" belong to the individual. They think that "how to teach" is teachers' thing, "how to learn" is the students' thing so that making "teaching" and "learning" separate. Inadequately considering in teachers' leading and the interaction between teacher and student. Not fully realizing in the grasp of the curriculum and the achievement of teaching target. Some people thinks that textbook, handouts and Internet information can be freely used, actually, these teachers' behavior is irresponsible. They have no completely knowing of regular curriculum and the training of learning ability, some teachers overemphasize teaching all the aspects, "spoon-fed" teaching method delays the creation of training and developing student thinking. So we propose the following idea.

a) The amalgamation of the main body of students and leading of teachers. Teachers consider each teaching as a show, they are both actors and directors, and the student is audience. So teachers should work hard in how to play wonderfully an how to be attractive, when teaching, teacher-led activities and student body activities continue to integrate to achieve dynamic

conversion, with the unconsciously influence of knowledge, students' learning activities gradually expand, teachers' teaching activity conditionality gradually reduced, and finally student can completely learn by themselves, and truly become the masters of learning.

b) The integration of key point of open studying and teaching. Information Age offers numerous ways to obtain knowledge, classroom and teacher are no longer the only channel to acquire knowledge, we should make full use of the network, authoritative teacher, materials, experiment, discipline, professional, other quality resources, environment and academic atmosphere, extend the place of study from classroom to large laboratories, libraries, forums and so on. Independent research study, development training, thinking and creating began to expand a more relaxed environment for students' knowledge creation and building capacity, which is the core of the current teaching mode reform.

To make each student has a variety of skills and talents, lots of independent, comprehensive and designing experiments should be strengthened, the engineering practice, curriculum design, project training and exercitation should be placed importance on them. To expand the learning of the students to the form of cooperative learning, to improve the coverage and participation of various extra-curricular learning activities, through the research groups, seminars, clubs, salons, clubs and other carriers,. The key point of teaching is to teach students a thinking method, we can check the book when forgetting the specific details of some of the problems of knowledge, but the way to think about the problem, once understood and applied, it is the ability to solve more problems and realize more new knowledge, which is the key to teach and learn. Fully utilizing Internet to expand students' online learning, teachers' online questions, students' online assignments, and new ways of correcting teachers' online.

c) The integration of teaching evaluation and transparency. Since the lecture is performing, the audience have the right to evaluate actor's level, students take anonymous online review system, to give the teaching quality evaluation in accordance with the unified evaluation index, teachers can look at any time, if have problems then change it, have no then add it to encourage. This way can effectively improve the teachers' teaching level.

d) The integration of the diversity and flexibility of students' performance evaluation. Take the usual assessment (20%) + test (10%) + term examination (70%) as a student's final grade, so to fully mobilize the enthusiasm of the students' learning autonomy and initiative, to avoid that a test set for one life and the phenomenon of playing truant.

### *B. The Connotation of the Quality of the Course*

The quality course is a kind of demonstration course which has the characteristics of first-class teachers, teaching content, teaching methods, teaching management and so on. The provincial quality course "automatic control theory" is a course of school level platform which is open by automation system, it is a theoretical and practical course and difficult to understand. It is characterized by a large number of concepts, abstract content, theoretical analysis and mathematical calculation. In

the practice of curriculum reform, we give an introduction of CDIO mode, consider the small control subjects as the guide, lead students to deepen the theoretical study, successively complete control system modeling, controller design, simulation, training students' innovation ability, practical ability and research ability, stimulate students' learning interest. Therefore, teachers should have a purpose, plan, and combine the specific content in steps to guide and train students' thinking mode so that they can understand and grasp of the typical, linear and other processing methods and significance, to experience the importance and interest of math, which is a tool to deal with the problem, so that we can make students become passive to active learning, improve learning enthusiasm, not only consolidate the knowledge system, but also set up a project.

### III. TEACHING REFORM BASED ON CDIO EDUCATION IDEA

To study the teaching mode of the CDIO concept, the teaching mode based on the actual physical object background to control system modeling, design controller, achieve simulation, reform teaching content, teaching methods, examination methods corresponding.

#### *A. The construction of teaching material*

Teaching material is the carrier of the teaching idea, and it is the core of the reform of the curriculum system. In order to fully implement the reform of the curriculum, play the characteristics of the team, the team pays close attention to the construction of teaching materials, published the corresponding theoretical materials in 2012, : "automatic control theory" (Coal Industry Press), "automatic control principle on the experimental guidance" (Xi'an University of Science And Technology press). Formed a system which includes theoretical teaching, experimental teaching, learning guidance, and CAD to achieve a series of teaching materials to laid the foundation of effective dissemination of knowledge .

#### *B. A good beginning is the key to success - the importance of the introduction.*

In the introduction, we mainly introduce the development history of automatic control theory, the object, method, main content, the characteristics and development trend of automatic control theory and its important role in the field of industrial production, aviation, spaceflight and so on. In order to enhance students' interest in the course, use a multimedia technology to produce a number of video data, including the Apollo moon, China's Shenzhou seven manned space flight, the United States NASA rover, the international robot competition and the behavior of people in the brain, and give a brief introduction to the automatic control theory knowledge, curriculum focus and learning methods, students have a strong interest in learning and a strong desire for knowledge, to promote students from "to me" to "I want to learn".

#### *C. Strengthen practical teaching, improve engineering practice ability*

Foster the goal around engineering practice and innovative spirit, practice teaching is constructed in a three tier system,

which highlight the comprehensive, design, research training, strengthen the orderly convergence of practice of the experiment, curriculum design, graduation design and. Put forward a teaching mode of "active class, active practice, academic research, project research, network education", which considers students as core. The teaching reform is based on the academic discussion and the project research. The teaching is divided into three stages: classroom teaching, curriculum design, and graduation design. A complete set of three level programs is designed to promote students' learning in the core curriculum, and design professional course as the two projects to develop students' ability to construct and use the knowledge. Graduation design as the first project module in order to cultivate students' ability to design complex systems and products with professional knowledge. In order to explore the CDIO teaching mode, we make a Organic fusion based on the team's three level project and the experimental teaching which is refined from research project so that students can independently set up a system to determine the program, design and simulate for the main content. In the end of three projects, students are required to write project report and make PPT report for research project, changes the previous concept. With the characteristics of different sections, the teaching backbone has developed the multimedia courseware for all courses, such as the full animation multimedia courseware for drawing Root locus, which is popular in the students. This teaching mode provides an autonomous, investigative and various stage for the development of innovative talents, which promotes the improvement of students' innovative practical ability and comprehensive quality. The students from Xi'an University of Science And Technology have achieved very good results in the national robotics competition, Challenge Cup national college students extracurricular academic science and technology work, and the national electronic design competition and many other important events.

#### D. Develop research-based study

In the teaching of engineering example, the inverted pendulum is a complicated and unstable nonlinear system. It is an ideal experimental platform for controlling theory teaching and carrying out various control experiments. Through the control of the inverted pendulum, checks the new control method whether have the ability to deal with the problem of nonlinear and instability. At the same time, the control method in the military, aerospace, robotics and industrial process field has a wide range of use, such as robot in the process of balance control, rocket verticality control and satellite flight attitude control. In teaching, the inverted pendulum is an engineering example which throughout the course, after the stage theory teaching, complete inverted pendulum system modeling, analysis and design of the controller, it improve the confidence of the students' engineering application ability and apply what they have learned.

Research learning is divided into three stages: (1) to lead students make a full use of library and internet to collect relevant information; (2) to divide the students into research group. In 6 weeks, course learning progress is to complete the modeling and performance analysis of the controlled object. Then the simulation model of the control system is established

with Matlab/Simulink, and complete the design of controller.(3)to make students write a research report in groups, and to study in the form of group. All the members are required to participate, teachers and other groups of students score at the same time to study the case of the evaluation. Through reporting, not only the research atmosphere can be active, the exchange between students in each group can be strengthened, the students' perspective can be opened, but also the degree of participation of each student in the subject research can be test. Finally, on the one or two and three level inverted pendulum experiment platform, students can achieve system verification that is designed by them. In the classroom, the teachers also take part of the project as a teaching case to the students, pay attention to the organic combination of knowledge teaching and project practice. After the class, teachers take students to actively participate in scientific research project development or professional competitions, and train a number of students who have professional foundation, practical ability. Using the existing laboratory and practice base to explore a effective engineering education model, so that improve students in the practical ability, independent innovation ability, teamwork ability.

#### IV. CONCLUSION

Teaching practice shows that the teaching mode based on CDIO education philosophy can greatly improve students' learning enthusiasm and initiative, promote students to change from "want me to learn" to "I want to learn", it is conducive to the cultivation of students' practical ability, comprehensive application ability and innovation ability. Students like this kind of teaching model, and puts forward a lot of good advice, it always strengthens communication and exchanges between teachers and students, obtains the effect that teaching benefits teachers as well as students. As a kind of teaching mode of engineering education, CDIO has advanced idea and good reference function. This kind of engineering education thought runs through various aspects, such as the reform of personnel training program, curriculum system construction, teaching staff construction, practice teaching and so on. Making the combination of theory and practice, the combination of technology and market application oriented personnel training system, training qualified senior professionals for country and local place is the tireless pursuit of education workers.

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