

PROFESSIONAL DEGREE POSTGRADUATE EDUCATION REFORM PRACTICE BASED ON CDIO

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ABSTRACT

In order to educate engineers with strong ability in engineering practices and comprehensive multi-disciplinary qualities, college of mechanical engineering, Yanshan University, attempt to attach the practice concept of CDIO into professional degree postgraduate education. The paper introduce mechanical engineering professional degree graduate education practice from the cultivating scheme, course system, cultivating mode, practice base and teaching staff construction and etc.. To strengthen the innovation consciousness and practice ability and embody discipline characteristic, the cultivating scheme is revised; with professional skill and engineering practice ability as the guidance, the curriculum system with the discipline characteristic is build; the detailed measures of the teaching staff and practice teaching base are proposed; and the follow-up work plan as the dissertation diversification, construction of teaching material system and case database are also put forward. This paper explores the CDIO engineering education idea in solving the role of practical problems in educating professional degree graduate students, which can provide certain reference to the cultivation of practical engineering masters under complex requirements.

KEYWORDS

Professional Degree Postgraduate Education, CDIO, Mechanical Engineering, Cultivating Mode Reform, Standards: 3, 5, 6, 9, 11

INTRODUCTION

With the increasing needs of engineering applications and multi-disciplinary skills, the main emphasis of our postgraduate education work shift from nurturing the academic talent to the applied talents, which achieves the strategic adjustment and historic transformation of the structure of postgraduate education. The professional graduate degree is set up relative to the academic graduate degree and for the needs of a specified career field, and designated for special professional practice. The ability of engineering practice is a major goal of full-time professional degree graduate education, which has become an important indicator of the quality of professional graduate degree. CDIO engineering education model provides us with a new educational ideas and methods. It helps largely us solve the widespread problem which current domestic full-time engineering master confronts with, and meets the demand for the cultivation in practices ability and comprehensive multi-disciplinary qualities. CDIO engineering educational philosophy not only applies to cultivate outstanding undergraduate engineers, but also has a great reference to educate master engineers under the new situation.

To implement the "Long-term Education Reform and Development Plan (2010-2020)", and improve the quality of professional degree education, the Ministry of Education launched the "Comprehensive Reform Experimental Project of Professional Degree Postgraduate Education ". As one of the pilot institution, Mechanical Engineering College of Yanshan University has carried out exploration work on graduate education comprehensive reform since 2011. Taking "to strengthen the sense of innovation, enhance the ability of engineering practice, and reflect the subject characteristics" as the goal, we revise the cultivation scheme; orientating professional skill requirements and engineering practice ability, the curriculum system is rebuild. The engineering quality of teachers is improved; the number of engineering practice bases is increased for developing practice ability. The quality of graduate degree in mechanical engineering can be improved.

1. CULTIVATION SCHEME

The cultivation scheme is revised to "strengthen the sense of innovation, enhance the ability of engineering practice, and reflect the subject characteristics".

1.1 Revise cultivation scheme

The cultivation goals of graduate professional degree in mechanical engineering of Yanshan University is that masters should possess solid theoretical foundation and broad professional knowledge in mechanical engineering, develop a strong ability of solving practical problems, be qualified for the mechanical engineering technology or management work, become the applied expertise talents with a better professionalism.

With the ideas of CDIO "project design", professional degree postgraduate can completely understand the conception of their research projects and how the solution program implement and process operation of the entire project plan. Thus, the CDIO concept is implemented into professional master's research organically. Under the guidance of the above ideas, Yanshan University revised its cultivation scheme of professional degree in mechanical engineering, and its main points are as follows:

(1) Apply the trinitarian model of "theory teaching + practice ability + thesis", namely 0.75 year of the theory teaching +0.5 year of practice ability + 1.25 year of thesis research.

(2) Adopt the methods of "subject-oriented learning", tutor is required to assign specific research directions for the professional degree students within two weeks after term beginning, and report to the graduate cultivation department to record.

(3) After the graduate completes their theory courses, they should write the "Courses Summary Report" combining with the course according to the proposed research, the specific meaning of a course is required to describe in basic theory, research methods and other aspects for future research work.

(4)The graduate student is required to submit "Internship Summary Report" and report specific work that what they did during the internship and describe the relevance between the work and research topics when complete the 0.5 year practical internship.

(5) To meet the demand of diversity and personalization for the professional degree graduate, the self-taught course with 1.5 credits is set when enrolled in the second semester. Graduate should learn some professional course under tutor's suggestion which is necessary to the research, but not offered by school, and then the tutor decides the score by learning effect.

(6) To improve professional competence "project-based" education reform is carried out, and also an additional 1.5-3 credit courses in engineering practice. Graduate students complete the course arranged by teacher which is a small task with specific engineering background. It includes design, the actual operation or computer simulations, run the demo, PPT defence and others. Through the training of "conceive", "design", "implement" and "operate", graduates can fully experience the learning in practice.

(7) Emphasizes the practice-oriented of professional degree graduate program, requiring theses must be derived from the actual production of mechanical engineering or with specific background.

(8) The proportion of the dissertation which helps new product development and technological innovation with a specific engineering background should be increased year by year. And uniform writing specifications and format standards are developed.

(9) A sound evaluation system of dissertation should be established, which develop a reward system of outstanding dissertation, enact special evaluation criteria of outstanding dissertation in mechanical engineering and select the outstanding dissertation in accordance with the standard system.

(10) The review and defense methods of thesis which embodies the professional degree and engineering features fully are innovated. The proportion of the enterprise experts in thesis defense group is increased.

1.2 Rebuild Curriculum System.

The "curriculum development" in the CDIO emphasizes interpersonal skills that is concrete, consistent with professional goals and validated by the stakeholders, the system constructing ability and disciplines knowledge of product, process, the importing course concerning products, process and the system framework of engineering practice, as well as teamwork knowledge consistent with the goal and team members..

In the above revised cultivation scheme, the curriculum structure of mechanical engineering professional degree graduate is divided into four basic modules, namely degree courses, non-degree courses, practice teaching and the compulsory part.

In the new curriculum system, the non-degree courses include public electives and specialized elective. The public elective covers that the basic theory of modern applied mathematics and others required by engineering graduate student, and also involves humanistic quality courses. The specialized elective is opened according to seven main research directions of Mechanical Engineering College. It also opens an additional 1.5 credits of professional self-taught. The purpose of professional self-taught courses is that to provide graduate students necessary knowledge. Under the guidance of tutor, the students select the course required by the subject research, and finally the tutor gives the score of the course based on learning effect.

The biggest distinguish between full-time professional degree graduate education and academic graduate is the different teaching methods of practical ability. Within the new teaching plan (Table1) the credits of practical teaching that includes curriculum practice and professional practice is added from the original 6 to 8 credits. Learning from the successful experience on the reform of CDIO engineering undergraduate education, the “project teaching mode” is introduced into the teaching methods of practical ability. Two CDIO projects that “application the test technology of mechanical system” and “integrated application of CAD / CAE” are open up. The project covers the various aspects of the life cycle of the project, namely conceive, design, implement and operate. The teacher layouts task and the students form a team freely and complete the tasks in the form of team.

Table 1 Steps of Practice Teaching

Category	Course name	Period	Credit
Practice teaching	Application the test technology of mechanical system	one week	1
	Application of CAD and CAE	two weeks	2
	Practice of mechanical engineering	twenty weeks	5

In Table 1, twenty weeks of professional practice is the half year internship of the first item in revised cultivation scheme. Under the guidance of enterprise tutor, the postgraduate participate the forefront of production and rotation training according to the production processes of life cycle. At the end of the internship, the graduate submits training summary reports and makes a defense reply; the results will be given by the school and the enterprise tutor together.

2. ENGINEERING QUALITY OF TEACHER STAFF

The following are the main abilities of teachers in CDIO: the skill of learning experiences, interpersonal relationships skills and the abilities of products, production processes and system- constructing skills, providing comprehensive learning experience and using active learning, experiential learning methods; and the ability of evaluating students' learning.

The basic condition for postgraduate degree education is to establish a team of professional teachers with a solid engineering practical foundation, professional knowledge and well cultured in humanities and social sciences. The following are main measures of Mechanical Engineering Collage of Yanshan University to improve the faculty.

First, the diversified appraisal system of equivalent teaching workload performance is formulated, and the level of theory and engineering practice ability of teachers is treated equally. The implementation rules of teacher performance assessment that provides each teachers the equivalent marks of the basic teaching, teaching research effect and scientific research result (including research projects, identification or award, scientific papers, books, patents, etc.). Among them, the equivalent marks of teaching research effect and scientific research result can be balanced by twice of the remaining two equivalent marks. The teacher performance appraisal system guides teachers to pay attention to engineering practice, and promote the comprehensive development of teachers, reverse the non engineering tendency of graduate education faculty.

Second, the interim measures of appraisal and appointment for master tutor is formulated, and hires more than 40 senior engineers with extensive experience in engineering practice to serve as enterprise tutor of professional degree postgraduate in mechanical engineering in a flexible and pragmatic way from cooperative enterprises and practice teaching bases of our school. Every enterprise tutor is required to participate in postgraduate's teaching and guidance each semester. On the one hand, it is helpful for tutor to teach experience and knowledge of production and practice systematically to students. It helps students to understand the characteristics of the production and research, and also facilitates enterprise to select students who have excellent talent in engineering.

Third, the two-stage policy of college and school is issued which encourage teachers to train in well-known foreign universities, outstanding enterprises and large domestic enterprises.

3. ENGINEERING PRACTICE BASE

The design and implementation experience of CDIO is the engineering education mode that takes training engineering ability as the goal, and orients project design. The above includes two or more curriculums of design and implementation experience. One is the basic level, the other is advanced level. Establishing and increasing the engineering platform and laboratory will support and encourage experiential learning for products, production process, system construction, team cooperation and socialization.

In recent years, under the opportunity of "Mechanical Engineering National Key Discipline Construction" and "Professional Degree Graduate Education Comprehensive Reform Pilot Construction", Mechanical Engineering College of Yanshan University consolidates and expands the school practice teaching bases combining with professional teachers' ongoing major scientific research project, and the engineering practice bases are shown as Figure 1.

(1) Laboratory and practice base in school

At present, College of Mechanical Engineering owns ten of various technology research center and key laboratories and several the basic specialized laboratories as shown in Figure 1. Based on the above experimental teaching, the needs of engineering practice for professional degree graduate in academic research stage are basically satisfied, and also lay the foundation for subsequent internship.

(2) Practice bases outside school

Mechanical engineering major in Yanshan University has a long history in heavy machinery. Cooperation relationships have been established between our university and many large machinery manufacturing enterprises as shown in Figure 1. And engineering practical bases in these enterprises are established.

At the same time, major research cooperation projects between teachers and industry leading enterprises encourage professional degree graduate enter directly into the cooperative enterprises in the 0.5 year internship, take experimental verification and optimization analysis work of their research, which can test the results in the practice, so as to shorten the time between research projects and productivity.

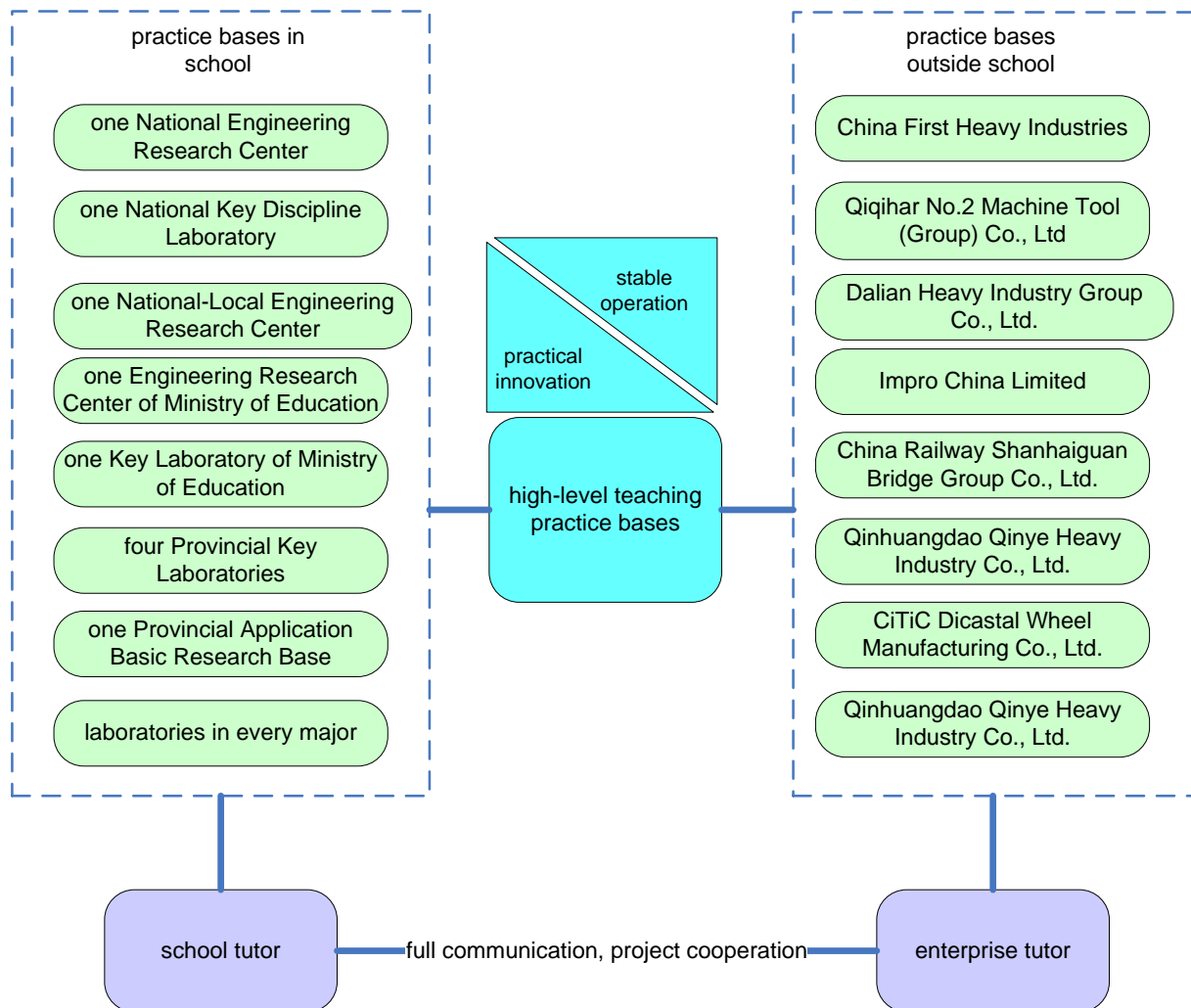


Figure 1. The environment of engineering practice teaching of high level

4. SUBSEQUENT PLANS

4.1 Evaluation mechanism and management work

How to manage graduates in internship period, how to assess the result are an inevitable and practical questions. Therefore, it is necessary to conduct the research on the supporting system under the background of deep cooperation between schools and enterprises and large engineering education. Through these efforts a relatively complete and practical method can form to manage, operate and monitor engineering teaching bases.

The evaluation of CDIO ability for full-time engineering master, the members not only include the teachers and students. But more importantly judgments come from industry because they are relatively objective and accurate. They can give the graduate students an objective and comprehensive assessment at graduation.

4.2 The diversified system of dissertation

The existing assessment standard pays too much emphasis on dissertation. It has an obvious academic tendency and monotonous form. Against this malady, we plan to establish a diversified system of academic dissertation, which specifically includes:

① The practice-oriented problem of topics and how to ensure project background and practical application value in thesis. ② The format and evaluation standards of dissertations in product development, engineering design, applied research, technological innovation, project management and other forms. ③ Improve review and defense institutional in academic dissertation; ④ Carry out contest to select outstanding dissertations.

4.3 Teaching material system

The current mechanical engineering graduate textbooks have heavy theory and light engineering. And case teaching is lack of supporting materials. So it is urgent to promote the teaching material reform which specifically includes: ① Set up the teaching material project; ② Develop selection norms of teaching materials; ③ Establish the teaching typical case library in mechanical engineering.

4.4 Further promoting of the case teaching reform

To improve "professional competence", we continue to carry out case teaching and teaching reform. The vivid projects and teaching programs enable students to understand the engineering background of the course content as soon as possible, cultivate the students' engineering quality, improve the ability to solve practical engineering problems.

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