

Optimal Path of Student Engineering Practical Ability Training for Mechanical Engineering Profession-oriented Master's Degree Education

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Abstract—The lack of engineering practical ability is the main disadvantage of graduates holding a research-oriented master's degree. To compensate for this disadvantage, the profession-oriented master's degree program started in 2011 at Jiamusi University. However, the current profession-oriented education of master's degree still has not met the industrial requirements due to the dependence of profession-oriented educational methods on the traditional research-oriented educational methods. In this research, Jiamusi University developed an optimization model for the training of mechanical engineering profession-oriented master's degree education. The necessity and characteristics of the training of full-time profession-oriented master's degree education were analyzed in this article. This model improved the effectiveness of training objectives, efficiency of curriculum arrangement system, diversification of practical teaching methods, construction of school-enterprise practice base, and tutor's practical engineering ability and accuracy of assessment methods. This model is helpful to enrich the relevant theories about profession-oriented master's degree education, better define the training objectives and methods of application, improve the training quality of profession-oriented master's degree education, and provide a possible future reference for the reform and practice of full-time profession-oriented master's degree education in universities.

Keywords—mechanical engineering; profession-oriented master; engineering practical ability; training model; path optimization

I. INTRODUCTION

The rapid development of China's economy urgently requires many a high-level professional in applied science. As the main way to train professional personnel, the profession-oriented master's degree education plays an important role and

is receiving more and more attention from the education system. The full-time Profession-oriented Master of Mechanical Engineering (PMME) education aims to train mechanical engineering professionals, so as to meet the urgent needs of economic and social development for mechanical engineering professionals. Therefore, it is necessary to improve the professional training system through optimizing the training model of mechanical engineering master students and improving the quality of mechanical engineering master students training^[1]. Profession-oriented master's degree education in mechanical engineering has its particularity, which emphasizes the perfect combination of theoretical teaching and engineering practice. This imposes higher requirements for the arrangement of PMME courses, and thus puts forward the setting of some new courses. By providing a scenario of knowledge accumulation and exploration, engineers can gradually build a connection between abstract knowledge and real-world application; as a result, engineers are able to enhance their practical engineering ability^[2]. The rapid development of our country's economy urgently requires a large number of high-level professionals. As the main way to train professionals, the profession-oriented master's degree education is gaining more attention in the education system. However, compared to the traditional research-oriented master's degree education, the profession-oriented master's degree education is aiming at training high-level professionals, which has always been in the "non-mainstream" field. The reasons why these happened are as following^[3-4]:

A. Late starting

The research-oriented master's degree education started in 1902, while the profession-oriented education began in 1984.

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B. Small scale

The training scale of the research-oriented master's degree is tremendous, while the scale of the profession-oriented master's degree is insignificant, accounting for only 10% of research-oriented master's degree scale. At the same time, the available majors and occupational areas for profession-oriented master's degree are relatively few. What is a worse, part-time profession-oriented master's degree seeking student takes larger proportion than that of full-time students. Thus, economic developments in this area are seriously slowed.

C. Lack of characteristics of training methods

The profession-oriented master's degree teaching methods or curriculum arrangement was often imported from the research-oriented master's degree training model. Even though the research-oriented education system has been implemented in Universities for many years, there are some problems. Those problems include unsuitable teaching methods and contents for social development, unreasonable curriculum setting, and so on.

The existence of these problems causes conflict between master students education and real-world needs. The training model for master students, which mainly focuses on research training, is increasingly unable to meet the needs of the real-world for specialized talents in quantity and quality of society. And the demand for graduates with good practical ability has enormously exceeded the supply. In order to better meet to the urgent needs of the national economic and social development, optimize the classification of profession-oriented master's degree education, improve the training quality of profession-oriented master's degree education, and enhance the ability of graduate students to well serve at work, the Ministry of Education has carried out a major reform in the structure of profession-oriented master's degree education since 2009. It has decided to train full-time profession-oriented master's degree master students with current undergraduate students together. The Ministry of Education has been intensifying the training efforts year by year so as to promote the transformation of master students' education from the model of training research-oriented talents to the model of training profession-oriented talents. This indicates that profession-oriented master's degree education will play a more and more significant role in the future development of higher education in China. The whole higher education system in China has made huge progress and entered a new stage of profession-oriented master's degree education. The profession-oriented master's degree education has formally stepped into the track of full-time training.

In this study, according to the special research on the training model of full-time professional master's degree education, the theories about degree obtaining and master students education in our university are abundant. This facilitates the understanding to the essence of degree obtaining and postgraduate education, and thus to promote the development of degree system and master students education. According to analyzing and learning from the necessity and characteristics of the training of full-time professional master's degree education [5-7], an optimization model for the training of mechanical engineering profession-oriented master's students in our university was constructed. It is helpful to

enrich the theories of degree obtaining and master students education, define the training objectives and methods of application, improve the training quality of profession-oriented master's degree education, and provide a certain reference for the reform and practice of full-time profession-oriented master's degree education in our university.

II. REFORM AND OPTIMIZATION OF TRAINING MODEL

The enrollment of mechanical engineering profession-oriented master's students in the mechanical engineering institute where the author works at in the past five years was shown in Table 1. With the increase of enrollment year by year, problems such as weak curriculum pertinence, single practice model (lack of various practice model), lack of tutor practice and single assessment index are highlighted in the training process of the profession-oriented master's degree education. Based on the analysis of the problems during the process of training the profession-oriented master's students of mechanical engineering in our institute, the training model of profession-oriented master's students is taken as the starting point in this research. The training model of profession-oriented master's degree students majoring in machinery, who are looking for the best practical engineering ability, is reformed and improved from the following aspects: accurate orientation of training objectives, optimization of curriculum setting system, diversification of practical teaching methods, and construction of school-enterprise practice base, increase of tutor's practical ability and improvement of assessment index.

TABLE I. SUMMARY OF RECRUITMENT OF MECHANICAL ENGINEERING PROFESSION-ORIENTED MASTER IN COLLEGE OF MECHANICAL ENGINEERING IN RECENT FIVE YEARS

Year	2014	2015	2016	2017	2018
Enrollment Number	4	3	1	10	15

A. Accurate Orientation of Training Objectives

The training goal of the profession-oriented master's degree education is to build applied, multi-functional and high-level engineering technological and engineering management professionals and emphasizes the application and skills to carry out technological innovation. It is required that master students with the profession-oriented master's degree in mechanical engineering have stricter professional ethics and dedication, scientific and rigorous learning attitude and work style, and more devotion to teamwork and strong communication ability. At the same time, the master students are required have a good command of the basic theories and advanced technology methods in the field. What is more, they are also required to be able to independently engage in engineering design, implementation, research, development, and management in a certain area of the field. Besides that, they need to be able to undertake professional technology or management work and then be a high-level application-oriented professional.

B. System Optimization of the Curriculum Setting

The curriculum setting was very close to the course setting that is the most suitable to achieve the goal of master students training. The application was emphasized, and the proportion of professional and engineering practice courses was increased

in order to optimize the profession-oriented master's curriculum setting. The experienced enterprise management personnel were invited to give talks about the skills and abilities required by the job market. Meanwhile, the teaching methods of case study, field study, simulation training and discussion teaching were adopted to improve the ability of master students to analyze and solve engineering problems.

C. Diversification of Practical Teaching Methods

High-quality practice is an important enhancement for the quality of profession-oriented master's education. The practice methods of combining school laboratory practice, enterprise practice of tutor project, and base practice of master students training are adopted. The diversified methods of practical teaching are as follows:

Firstly, based on the "Experimental demonstration teaching center of Mechanical engineering-agricultural engineering and Key Laboratory of Heilongjiang Province", scientific research achievements were transformed into experimental teaching links. Besides that, master students laboratories were established, and a multi-level training environment for practical ability was created.

Secondly, master students whose tutors have many horizontal subjects were encouraged to practice directly in relevant enterprises.

Thirdly, the practice bases for graduate students in schools and enterprises were established, so that enterprises can directly participate in the training of graduate students. As a benefit of the participation, the software and hardware of better conditions would be provided to master students to carry out practice.

D. Construction of School-Enterprise Practice Base

Establishing practice teaching base is not only conducive to promoting the transformation of scientific research achievements in schools, but also beneficial to enterprises on the scientific research to overcome technical problems and improve core competitiveness by adopting the research results from schools. More importantly, master students can not only apply what they have learned, but also have insight into the latest developments in related technical fields by digging into practical cases. To formulate a series of rules and regulations, such as supervision system for master students training, responsibility and rights of base supervisors, ownership of property rights of master students scientific research achievements and enterprise technology secrecy, will facilitate the standardization of the master students training and promote the development of school-enterprise practice bases.

E. Improvement of Tutors Practical Ability

There must be a team of professional and experienced tutors to train the profession-oriented graduate students. At present, most of the school tutors have profound theoretical

knowledge, but lack practical experience. The "double tutoring" system of school-enterprise cooperation is gradually being adopted. And the team of enterprise tutors outside school is being expanded into our mechanical engineering system. In order to further expand the team of out-of-school tutors, on the one hand, a group of senior engineers with remarkable achievements in production and engineering practice were selected from the school-enterprise practice base as out-of-school tutors. On the other hand, the enterprise engineers with strong professional skills who are having been in charge of key project construction were selected as outside tutors.

F. Improvement of Assessment Indicators

Profession-oriented master's degree education emphasizes the application of knowledge and skills to carry out technological innovation, which requires diversified assessment methods. For assessment and evaluation, they not only need to take classroom performance, peacetime evaluation and theoretical knowledge assessment into consideration, but also to take the practical ability into account. Practical ability mainly refers to the ability to solve practical problems by combining engineering cases and scientific research projects, focusing on the application of theories. Graduation thesis is an important index showing practical ability of master students. Therefore, besides general theoretical calculation and analysis, the thesis should emphasize the process of solving practical engineering problems. In the new training program, it is advocated that the dissertation can take many forms, such as preliminary design report, feasibility study report, planning and engineering design, product development, case analysis, etc.

III. RESEARCH METHOD AND OPTIMAL PATH

Through a detailed investigation into the training bases of high-level universities, both their remarkable achievements in exploring the training model of engineering practical ability and the difficulties they encounter in operation and the specific measures to solve them were understood. According to the comparison and analysis between the training of the practical ability in traditional and current profession-oriented master's degree projects, taking the training model of mechanical engineering profession-oriented master's degree as the starting point, the training model of profession-oriented master's degree from three aspects: history, reality and comparison was systematically analyzed in a similar fashion as the starting point. As a result of the careful comparison and analysis, a new model of training the student engineering practice ability for the full-time profession-oriented master's degree could be explored in our college.

Focusing on the training of student engineering practice ability, and from the perspective of meeting the urgent need of national economic and social development for applied, multi-function and high-level talents and innovative education, an optimized full-time postgraduate training model of our college was established as shown in Fig. 1.

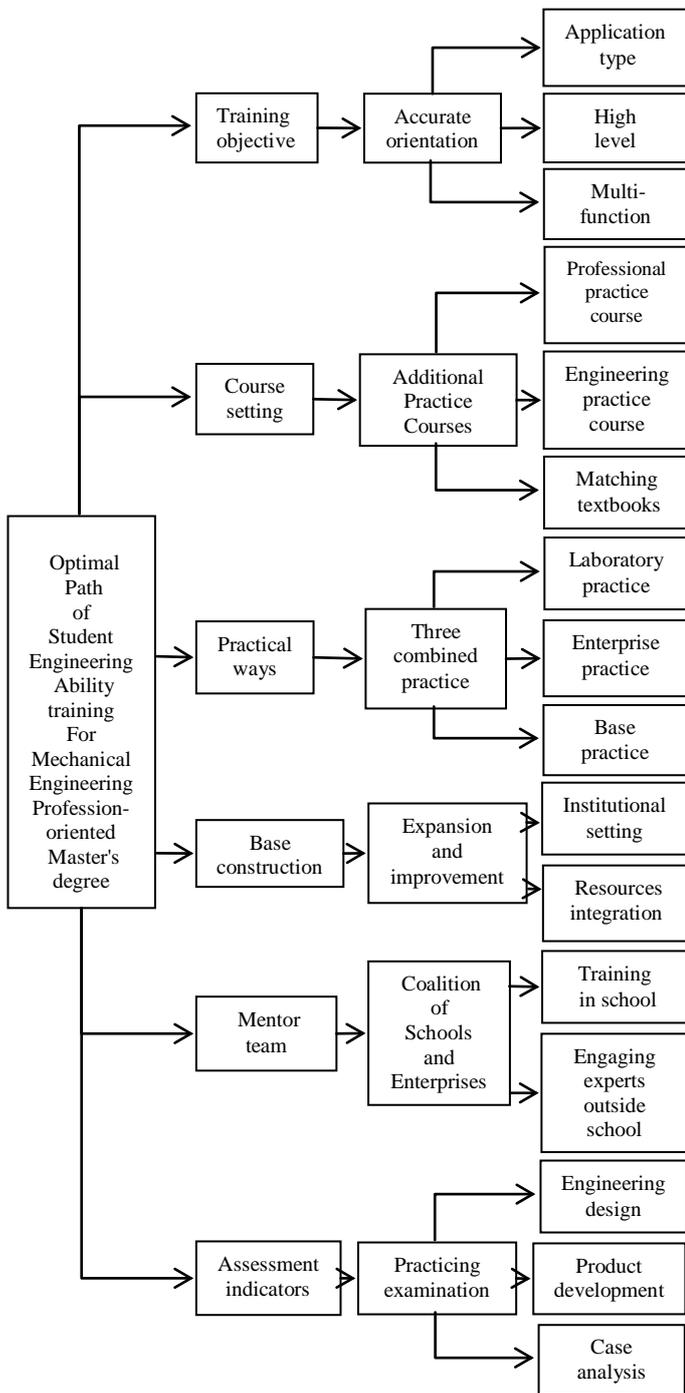


Fig. 1. Optimal path of student engineering practical ability training for the mechanical engineering profession-oriented master's degree education

IV. CONCLUSION

Based on the analysis of the problems existing in the current training process of the mechanical engineering profession-oriented master's degree education in the College of Mechanical Engineering of Jiamusi University, such as, weak curriculum pertinence, single practice model, lack of tutors engineering practical ability, and single assessment method, etc., the training model of engineering practical ability of master students majoring in mechanical engineering was reformed and improved by the aspects of accurate orientation of training objectives, system optimization of curriculum arrangement, diversification of practical teaching methods, construction of school-enterprise practice base, increasing tutor's engineering practical ability and improvement of assessment methods. The optimal training path was obtained by gradually applying the developed training process of the mechanical engineering discipline profession-oriented master's degree education.

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