The Educational Reform of the "Fundamentals of Mechanical Manufacturing Technology" for the "Education and Training Program of Excellent Engineer"

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ABSTRACT: This paper proposes the educational reform for the teaching content and method, the experimental teaching, the practice teaching and the examination of the "Fundamental manufacturing technology", according to the highlights, objectives and principles of the "Education and training program of excellent engineer"(Excellent Program). The students have gotten a better understanding of the FMT course, and their practical and innovative ability have been enhanced, through the reform measures.
KEYWORD: Excellent Program; Fundamentals of Mechanical Manufacturing Technology; Educational Reform

1. INTRODUCTION

The "Education and training program of excellent engineer"(Excellent Program, EP) is a major reform project for implementing the "National long-term education reform and development program (2010-2020)" and "National long-term talent development program (2010-2020)"，it aims to aims to train a group of high-quality engineering and technical talents, who are high qualities , strong innovation ability, and can adapt to the economic and social development in China. Jilin University became the first batch of the training colleges for the "Excellence Program" since 2010, the first group students of "Excellence Engineer Class" (EC) begin to learn the course of "Fundamentals Mechanical Manufacturing Technology (FMT)" in 2013. The EC students are major in mechanical engineering and automation, automobile engineering, agricultural machinery and automation. The Course group has done the reform for the teaching method, assessment methods, experiment and practice teaching of the FMT, according to the training characteristics, the main objectives and basic principles of the EP, and also by considering the characteristics of different majors.

2. THE REFORM FOR THE CLASSROOM TEACHING

EP should develop the compound talents with solid engineering foundation, broad knowledge, innovation ability and comprehensive ability, so the course group has reformed the teaching content, and encourages the diversification of the learning. In the classroom, the "Fundamentals of Mechanical Manufacturing Technology"(Junyi Yu, Qing Zou, Mechanical Industry Press) has been chosen as the teaching material, we provided EC students with a great many multimedia material about "Non-conventional Machining", "The process Planning of Group Machining", and "Computer Aided Machining Process Planning", they can watch and learn after the class, they were also required to learn the "Grinding" and the "Mechanical Vibration" by themselves. In the spare time, we invited some experts to give the EC students special lectures about advanced manufacturing technology, such as "Ultra-precision Machining", "Nano-processing Technology", "Rapid prototyping technology", and "green manufacturing", which were the new content for the course, since these contents are so fresh to the junior students, the lectures should be not only comprehensive and easy to understand, but also be innovative and interesting, enable the students to have some interest in some fields. The EC students have been expanded their knowledge, their interests have been inspired by the reform, and this can lay a foundation for future learning and research work.

In order to let EC students learn the course content linked more closely, and quickly understand the knowledge, the convergence of the course content has been reformed. For example, make the "setting element" as the core of knowledge, the "clamping and positioning" of Chapter I and "the fixture design of machine tool" of Chapter VI have

been taught together. Thus, the students can easily understand the concept of freedom, and the freedom that should be restrict and needed setting elements when processing a surface, after that the "analysis and calculation of positioning error" in Chapter IV, which is closely related to above information. In this case, the EC students can understand and grasp the knowledge systematically, such as freedom, fixture and position error.

In order to cultivate the comprehensive ability of the EC students, we borrowed ideas from foreign teaching methods, encourage the students to give a lecture about the course content. Because Chapter III "Machine Tool" is easy to understand for the students, we decide they talk about this content. After the lecture of each student, the teacher or the students will ask some questions about what he/she introduced, and finally the teachers will give a summary speech about the lectures that given by students, we will explain and supplement the key points, the part that is difficult to understand for the students, and the part that the students lecture had missed. Preparing and giving lecture by the students not only enable them to understand the course content more clearly, but also make them gain the ability of self-study, the expression ability, the ability of reviewing literature, and the ability of analyzing and discussing questions, it can also arouse their interest and enhanced their self-confidence.

3. THE REFORM FOR THE EXPERIMENTAL TEACHING

As the high-quality engineering and technical people of China in the future, the EC students must possess the innovative and practical ability. The experimental section of this course offers three types of experiment, they are the cognitive experiment, practical experiment, and design experiment, the cognitive experiment is "the measurement of tool angle", the practical experiment includes "the measurement of the cutting force and its empirical formula", "the effect of process system stiffness on machining accuracy", and "the methods of ensuring the assembly accuracy", and the design experiment is " the design of process and modular fixture". We also purchased new laboratory equipment, such as machining center, cutting tool, force sensors, speed sensors, torque sensors and modular fixtures.

Each experiment will be done by the hands-on operation of EC students, "the measurement of tool angle" experiment provides them with a variety of cutting tools, it enable them to understand the typical cutting tools that are commonly used. They will have a clearer understanding of the tool angles by measuring the tool angles of turning tool. Previously, when "the measurement of the cutting force and its empirical formula" experiment, "the effect of process system stiffness on machining accuracy" experiment, and "the methods of ensuring the assembly accuracy" experiment began, all the equipments had been adjusted and operated by us, the students just collected the data by the computer, but now the whole experimental process that includes the connection and adjustment of the equipments, the operating of the machine tool and the collection of the experimental data should be completed by EC students hands-on operate under our supervision. The students began to be able to solve the problem during the experiment, their practical ability and the ability of analyzing and solving problems have been also improved.

The purpose of "the design of process and modular fixture" experiment is making the students to obtain the abilities of innovative design and hands-on operation. Each group will be given a typical part, they should arrange the process specification for the part, and finally design a fixture for a working operation, so this experimental course involves Chapter I, V and VI, so it is very comprehensive. However, there were some problems, for example, the content of the experiment is very fresh to the junior students, it is difficult for them to arrange the process and design the fixture by themselves in the lab, because of the limited time, so most cases they need our help. Meanwhile, there are millions of different typical parts, such as shaft, shifting yoke, and housing parts etc., their structure and size are also different, so it is impossible to purchase all of the parts. So as to solve the existing problems, we build the database of typical parts and fixture parts in the computer, so the students can do this virtual experiment on line, and then go to the lad to finish the real experiment[1]. This reform not only can save the money and time, but also can enable the students to explore idea of how to research or working on a engineering project (Xu et al. 2012).

4. THE REFORM FOR THE PRACTICAL TEACHING

In order to cultivate the engineering ability and creativity of the students, EP requires schools to train the students by following the common standards and industry standard, the related companies should deeply involved in the training of EP, so we reformed the engineering internship and project laboratory of the course, meanwhile we also cooperate with some companies, send the EC student to take internship in the summer vacation.

The engineering internship and project laboratory are both the important practical teaching of the course. During the engineering internship, combining with the classroom knowledge, the EC students go to the workshop to visit the machining process of some parts and the assembly process of some typical

products or components. During the project laboratory, the EC students would be divided into several group，there are 6~7 students in each group. Each group would get a different typical part from us, they were required to plan the machining process for the part, and then each student should design a modular fixture for a working operation of the process.

We arrange a suitable content of the engineering internship and project laboratory for different majors of the EC students. For example, the engineering internship and project laboratory of the vehicle engineering students should more focused on the typical car parts machining and the assembly of components of vehicle, such as the machining process of the shifting yoke, the top head of the transmission, and the knuckle, and the assembly of the transmission, the front and rear axles and the entire vehicle. The engineering internship and project laboratory of the mechanical engineering students should more focused on the machining process of the typical parts of the machine tool, and the assembly of components of machine tool, such as the machining process of the gear, the spindle machine tool, the slide, and the assembly of the headstock of the machine tool.

During the engineering internship, the EC students visited the rigid automated production line and the flexible automated production line. The students can clearly understand the work of each working operation and the entire machining process by visiting the rigid automated production line, and they can also be easily to know that the characteristic of the rigid automated production line is extremely high efficiency and less production variety. Meanwhile, they can get familiar with the machining center and the CNC machine tools by visiting the flexible automated production line, and they can get that the characteristic of the flexible automated production line is various production and high efficiency, but lower than the rigid one.

In addition, we fully take advantage of the opportunities of the school-enterprise cooperation, we take the EC students to have a internship the FAW Group, Shenyang Machine Tool Group, XCMG for 4~6 weeks. During the internship, the technical staff in the enterprise will explain the relevant theoretical knowledge to the students, and the students also have plenty of time to deeply learn more about the processing and assembly process of different products or parts in the workshop. Meanwhile, we also take the students to visit some machine show, such as Beijing International Machine Tool Show. Through the visiting, the sight of the students can be broaden, and they can also get better understanding of the most advanced manufacturing technology and equipment, their interest and passion can be inspired, and their abilities of engineering practice and innovative thinking can also be training.

5. THE REFORM FOR THE EXAMINATION

We have change the examine method for the EC students, the final test result that was determined by the test paper has been abandoned, and current final result is including: 50% of test paper scores, 20% of the experiment result, 10% of the assignment, and they should also take the interview test, it occupies 20% of the final result. The interview test is very comprehensive, its content is not only about the course, but also involves in the other importance of mechanical engineering. The interviews way is also various, for example, the student can answer some questions, or some students make a discussion on a question, or the preemptive answer. The interview can give a periodic review about what they have learnt during the 3 years of the undergraduate, and their abilities of express and making a quick response.

6. CONCLUSION

The paper applies the idea into the FMT course reform, in order to foster the engineering accomplishment, and practical and innovative ability of the students, the classroom course content has been optimized, the experimental teaching paid more attention to the practical ability of students, various practical teaching and examine methods have been added, and all of the reform will lay the foundation for training the excellent engineer

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