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Reform and Practice of Engineering Training Course for Cultivation of Innovative Talents

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***Abstract*-The 'Engineering training' course plays an important role in cultivating the innovative spirits, practical abilities and engineering consciousness of college students. This paper introduces the reform and practice of the 'Engineering training' course for 'Innovative talents Class' in mechanical engineering at Guangdong University of Technology, China. Explorations on the teaching mode, teaching method and teaching content of the 'Engineering training' course have been carried out, and as an outcome of these explorations, the spirits of innovation and practical abilities of our students in the 'Innovative talents class' have been enhanced effectively.**

Keywords: Engineering training; Innovative talents; Teaching reform

I. INTRODUCTION

Innovative spirits and creative capabilities are considered important attributes for outstanding engineers/scientists to solve various engineering and technical problems. For engineering education, one of the most important tasks is to foster innovative talents with innovative capabilities through a large amount of training practices. Therefore, as the engineering practice education base in campus, the engineering training center plays a very important role in cultivating innovative talents.

"Engineering training" course is an essential technical fundamental course during engineering learning period, which shoulders the task of comprehensively improving the engineering quality and practical abilities of college students, cultivating engineering talents with compound knowledge, applied technology and high creativity. This course helps to enhance the engineering consciousness, spirits of innovation and practice abilities of college undergraduate students. The students are expected to build up a solid foundation for engineering and improve their abilities in solving engineering and technical problems.

Various colleges and universities conducted many reforming activities in the field of engineering training, ranging from the research of teaching mode, teaching methods, teaching content, infrastructure construction and equipment development [1-8]. Progresses have been made and a large amount of experience has been obtained, which lay good foundations for innovative talents fostering [9-11]. High-quality students with good spirit of innovation, engineering consciousness and practical abilities were trained through the way of their practical work of products design and making from practical engineering training.

As one of the important step to implement *College Students' innovative action plan*, Guangdong University of Technology enrolled the "Innovative talents Class" from 2012 and started its exploration on innovative talents cultivation. This paper introduces the reform and explorations on the teaching mode, teaching method and teaching content of "Engineering training" course for cultivating innovative talents in the major of mechanical engineering at Guangdong University of Technology. The reform results show these reforming activities improve the practical abilities and spirits of innovation of our students effectively.

II. TEACHING MODE REFORM

Almost all college students are enrolled from high school without any engineering training experience. Therefore, they are always lack of engineering awareness and have little knowledge of engineering. For these students, the basic training should be emphasized firstly to build up their basic understanding of engineering. The traditional engineering training is a one-stage process, i.e. all the teaching contents are required to be completed within one semester, and every training content is independent from each other. However, this kind of teaching mode is not suitable for the innovative talents cultivation because of higher skills requirements for students of "Innovative talents Class", which cannot be obtained from individual unrelated operation skills study and short period of learning time. According to the characteristics and training objectives of the innovative talents training project, a customized training plan for the "innovative talents class" in mechanical engineering was established, which includes three training stages, i.e. Basic skills training, Innovative design ability training and Engineering practical ability training. These three stages are organically linked together and is arranged to be completed within one academic year.

A. Basic Skills Training

The first training stage is basic skills training, which mainly involves the operation training of various instruments

and equipment for different processes. During this stage, students improve their practical skills through the way of learning how to operate relevant instruments and equipment, thus lays the foundation for the subsequent two stages of innovative design ability training and engineering practical ability training.

The training mode in this stage is still the traditional engineering training mode, i.e., students learn various kinds of unrelated manufacturing techniques respectively, and the training content of each technique is almost independent and unrelated. This kind of training mode is that at first, instructor operates equipment under specification and demonstration on-site, and then the students operate the equipment according to the given drawings and process under the guidance of the instructor beside them. This level of teaching is teacher-centered, and the training content and training methods are determined in advance by teachers and instructors, focusing on the training of basic skills of operation.

B. Innovative Design Ability Training

To further improve the innovative spirits of students in "Innovative talents Class", the second stage named innovative design ability training is specially designed. During this stage, the project-based learning (PBL) mode is adopted, which enables the effective transform of engineering training from teacher-centered to student-centered, with the transforming of the training content from the preassigned operation learning task to project-centered problem solving. The students are divided into several groups and each group includes 3-4 students. Each group performs innovative design based on the problems assigned by the teacher or related to the topics of their own idea. To accomplish the project, all students in the same group should work together to finish all the designing work with the consideration of product functions, structures, manufacturing processes and assembly methods by themselves. This kind of training mode can greatly initiate the students' passion in active learning, therefore a more in-depth understanding of the manufacturing process is achieved, and the spirits of innovation and teamwork capabilities of the students can be enhanced effectively.

C. Engineering Practical Ability Training

The third stage is the engineering practical ability training. The task of this stage is to turn the designing at the second stage into real product. Firstly, specific manufacturing process should be made according to the designed product structure, which includes determination of manufacturing and assembly processes, proper sequence of processes, selection of proper machining equipment, tools, jigs and fixtures, etc. Then students are required to complete all the operation work by themselves, ranging from manufacturing, assembly and adjustment. As various processes and machines are involved, the comprehensive abilities of the students can be trained during this stage.

III. TEACHING METHOD REFORM

Besides the teaching mode reform, flexible teaching methods and various means should be adopted according to the characteristics of different training stages.

A. Centralized Training

At the first stage, a centralized training method is adopted for basic skills training. Three weeks' centralized training within one semester is arranged. On the one hand, for students without practical experiences, the effectiveness of centralized training is better than that of decentralized training according to our teaching experiences. On the other hand, this kind of arrangement will make few influences on other theoretical courses.

B. Individual Training

To ignite the initiative of the students, the teaching method adopted for the second stage is individual training. The training during this stage is arranged to require students to complete in their spare time themselves. The college students in lower grade are impelled to do excessive researches to complete their designing task as they are lack of basic professional knowledge, including the searching and collection of literatures such as books, references and other related documents, discussions in group and communications with others. This kind of individual training can greatly inspire the students' initiative, enhance their abilities of independent learning and help to build teamwork consciousness.

C. Free Open Training

As different products are designed by different groups, the teaching method during the third stage is free opening training. The engineering training center is open for all groups. Each group can make an appointment for their manufacturing and assembly tasks in different site and at different time according to their respective product designing. As the students are still not so skilled and not so familiar with the equipment operation, instructors are required to stay with them for guidance and safety operation, but there is no strict time limit during their operation, therefore the students can have enough time to finish their respective work more freely.

D. Introducing Advanced Education Technology

Traditional engineering training is performed using physical equipment at a fixed site. However, for certain kinds of expensive or high precise equipment, especially for those machines used in advanced manufacturing technologies (AMT), it is usually difficult for every student to have sufficient time of training. To solve this problem, modern education technologies are introduced and virtual operation software of CNC machine tool was self-developed. Students can easily operate the virtual CNC machine tool using this software in computer on internet. Therefore, the

constraints of time and space were broken. Students can not only get training at their workshop time in schedule, but also can practice in their spare time with the utilization of virtual operating software. Virtual operating software can not only save the cost of equipment and increase the students' practice opportunity, but also can help to adjust the training contents to keep pace with the development of science and technology.

IV. TEACHING CONTENT REFORM

In addition to the scheduled compulsory engineering training listed in the teaching plan, extended training content were arranged to further improve the innovative abilities and engineering practical abilities of the students in 'Innovative talents class'.

A. Elective Course

It is difficult for students to master all the training content arranged in the teaching plan only during their limited workshop training time. Several relevant elective courses are therefore set up in curriculum, which are designed for the enhancement of the practical abilities in a certain aspect of operation, including the courses of *CNC Lathe Programming and Operation Training*, *CNC Milling Machine Programming and Operation Training*, and *Comprehensive Practical Ability Training, etc.* After the successive training of these courses, the students can accomplish the NC programming and machining of simple parts interpedently, which shows they have the skills of programming and operation of CNC machine tools.

B. Extracurricular Science and Technology Activities

For those students taking part in extracurricular science and technology activities, since they are more sophisticated with skills of machine tools operation after elective course learning, the engineering training is completely open to them. All the content of the engineering training is completely determined by the students themselves. Usually, these kinds of training are much related with tasks of various contests or projects. Through the way of establishment of innovative group teams and innovative bases, the students work together with little constraints of sites and equipment. They are provided with good conditions. Almost all the machines and equipment in engineering training center and innovative bases are free to them. They have greater opportunities to enhance their innovative capabilities during their product-making since contest-driven training is adopted. In recent years, students in 'Innovative talents class' participating in contests such as the "Challenge Cup", "Mechanical Innovation Designing Competition" and "Project of Comprehensive Ability Training and Competition" have obtained good grades through this way of engineering training.

V. CONCLUSION

The 'Engineering training' course is a basic compulsory practical course for students of 'Innovative talents class' in mechanical engineering. With the reform and explorations on the teaching mode, teaching methods and teaching contents of the 'Engineering training' course, the students in the 'Innovative talents class' are provided with good engineering training conditions and environment, and the spirits of innovation and practical abilities of our students have been enhanced effectively.

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