INNOVATION AND PRACTICE ON EDUCATION FOR ENGINEERING TRAINING*

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ABSTRACT
Engineering training centre is an important intra-campus practicing base. It differs in function, methodology and human resource structure with the traditional metalworking practice. The former single-purpose training mode is transformed to multiple-purpose mode that based on modern industry. Hence, the center brings forward four transformation concepts under the issue of educational reform. Based on the four transformations, the following four combinations in methods have been presented. In order to enhance the education on engineering knowledge, practical ability and innovation spirit, the modularized educational system for engineering training with 6 platforms and 3 layers is constructed.

KEYWORDS
innovation; practice; engineering training; talent cultivation

1. INTRODUCTION

In November of 2000, the Engineering Training Center (ETC) of Guangdong University of Technology (GDUT) was established on the former Metalworking Practice Base. The foundation of this center is in accordance with the booming development of economy in Guangdong Province, and with the consequently eager demanding on personals with creativity and practical ability. Thanks to the support from the University on all aspects, we thus have the confidence to set our goal to "educate high qualified persons with versatility, creativity and practical ability for the development of local economy, aiming on the pillar industry with a broad vision on great engineering and great manufacturing".

The development of GDUT is very rapid in recent years. Now the University becomes the largest undergraduate education institute in Guangdong Province. The number of newly enrolled undergraduate students each year is more than 10,000, which is the highest among the universities in Guangdong. To date, the total full time students in campus (secondary schools are excluded) reaches a number of about 42,000.

ETC is responsible for the training and education on the subjects including manufacturing engineering, electronic/electrotechnic engineering, computer basis, engineering software application, management technology, industrial engineering, innovation design and practical operation etc for the 43 specialism departments of the university. It becomes a practical education base to elevate the comprehensive quality and engineering operation ability of the students. Now the floor space of ETC is about 20,000 square meters. The equipments hold reaches 1,400 suites, and the total value of fixed assets is up to ¥50 million. The standard of the hardware as well as the software of ETC is the first class in China mainland.

ETC locates at the University City of Guangzhou. It is the only engineering training center among the 10 universities in the city. In recent two years, thousands of students from several institutes have practiced in the center. ETC is now the share base of training for the high educational institutes in University City and in the vicinity of Guangzhou.

2. THE CONCEPTION AND IDEOLOGY OF EDUCATION REFORM

Guangdong University of Technology is a provincial key university with well sets of science and engineering specialisms. The university bears the glory duty to educate talented persons in the field of science of engineering for Guangdong economy. In a long time, GDUT always put high premium on experimental teaching, and persist to the idea of reformation that is practically oriented, ability preferred and innovation encouraged. Relying on the demands

of high level engineering and management talents for Guangdong economy, and taking the totally improvement of students' knowledge, ability and quality as guideline, GDUT seeks to construct a regionally characterized teaching system facing the Guangdong-Hong Kong-Macau area with the object to educate comprehensive qualified and skilled persons with innovation spirit. After years of teaching practice, ETC has formed its special teaching conception and ideology on engineering training as follow. (1) In considering the educational object, self definition and regional characters of the university, build a featured teaching system of engineering training with a broad vision on great engineering and great manufacturing. (2) Concentrate on practice, ability, quality and innovation in the education. Besides the elevation of technical quality, put premium on the development non-technical quality as well. (3) Guide the set up of experimental project with student-oriented idea. Emphasize on initiative practicing mode. Encourage the engineering thought, practical spirit and innovation spirit of student. (4) Provide a platform for scientific research, product creation and extracurricular technical activities. (5) Construct and develop the center with the idea of open, union, share and service. In more detail that is: Open-Open the center in all aspects not only interiorly but also exteriorly, so as to provide an excellent environment of initiative study and practice for student; Union-Unite the industrial enterprise in Guangdong-Hong Kong-Macau area, so as to take dominance in the target field, and construct a educational base with characterizations; Share-Share the sources with educational institutes in University City, in Guangzhou and even in the whole Guangdong province. Service-Serve the society in providing vocational training for the area.

ETC is an important intra-campus practicing base of GDUT. It differs in function, methodology and human resource structure with the traditional metalworking practicing or electronic/electrotechnic practicing base. The former single-purpose training mode is transformed to multiple-purpose mode that based on modern industry. Hence, the center brings forward four transformation concepts under the issue of educational reform. First, transforms the training object from the single purpose of the improvement of practice ability to the multiple purposes of the development of engineering thought and innovation spirit. Second, transforms the target field from traditional manufacturing technique to advance manufacturing technology. Third, transform the computational method from the training with independent single computer to the training under intranet environment. And last, transforms the issue from pure education to the complexness of production, education and research. Based on the four transformations, the following four combinations in methods have been presented: combination of reality training and virtual training, combination of fixed training and flexible training, combination of traditional training and innovative training and the combination of engineering training and skill training.

3. THE REFORM SCHEME FOR ETC

(1) Reconstruct and optimize the project of engineering training, and select the education course elaborately. Based on the demands on talented person of Guangdong-Hong Kong-Macau economy and the requirements on knowledge structure, survey the detailed demands of enterprises and related industries broadly. Analyze the knowledge and skill for education, and organize the training courses carefully, such that the key points will be emphasized, the broad fields will be covered and the characterizations will be distinguished.

(2) In accordance with the tendency of modern industry, set up the training equipments appropriately and arrange the training projects reasonably. Based on the requirements of Guangdong economy and the specialized enterprises, in the selected training courses, set up the training equipments appropriately and arrange the training projects reasonably. On the consideration of the assurance of basic training courses, keep increasing the portion of issues on advanced manufacturing technology, modern electrical technology and modern computational technology, so as to guide the students to thorough knowledge of modern technology and its tendency. Meanwhile, emphasize on the features of different specializations, and arrange training courses accordingly. Pay attention to the formation of characterization. Add characterized training projects on different layers and modules. Give a special eye on elevating the standard of training courses. Construct the projects of synthesization, excogitation and innovation in special.

(3) According to the characters of ETC, establish a talented engineering trainer team and enhance the construction of the team. Increase the quality of teacher by import, external employment and further training. Optimize the structure of faculty team. Along with a good age, certificate and qualification structure, emphasize on the cultivation of dual-teacher style staff. Pay especial attention to the development of young teacher. Make them to have a high theoretical standard and a high practical ability as well. Enhance the training of skilled technician so as to keep their technical grade increasing. Appoint the experienced specialists and technicians from related enterprises and the Hong Kong Vocational Training Council as externally employed teachers.

(4) Develop and innovate educational strategy and method continuously. The development of modern computer technology and web technology has provided us a solid base for the application of advanced educational approach and strategy. Construct a comprehensive educational system of engineering training, so as to provide a platform for mod-

ular selection, virtual training and device exhibition. Take a full advantage of modern educational technique. Keep replenishing the training course and developing virtual training system that is web-based. The operation of realistic equipments, especially the precise and expensive ones could be finished under the virtual web environment.

(5) Enlarge the extent of opening and share. Deepen the inner-campus share through extracurricular research activity, supervised research, competition, free optional course and opening booking. On the other hand, share the ETC to all the institutes in University City. Raise the social and economical benefit of center, and make ETC a model in the area.

(6) Construct and complete a characterized base of engineering training and a base of innovation. An innovation base will be built in the training center, so as to provide a foundation for the student to participate in various design and operation competitions.

4. CONSTRUCTION OF THE EDUCATIONAL SYSTEM FOR ENGINEERING TRAINING

In order to enhance the education on engineering knowledge, practical ability and innovation spirit, the modulized educational system for engineering training with 6 platforms and 3 layers is constructed. Hence the training course could be continued throughout the undergraduate academic year.

The training platform of mechanical engineering, which is set up for the training on the mechanical processes and the operation of machine tools, includes courses of conventional manufacturing and advance manufacturing technology. The training platform of electronic engineering includes the courses of electronic technology and electrotechnic technology. The purpose of this platform is to train student on circuit design and install method of popular electric facilities, so as to understand the basic theory and method for circuit design, manufacture and detection. The training platform of basic computer technology includes the courses on the application of general software and engineering software, and the courses on the installment and adjustment of hardware. The objective of this platform is to make the student familiar with basic applications of computer. The training platform of management technology includes the courses on ERP and manufacturing management technology. This platform is set up so as to guide the student to a thorough knowledge of modern management technology. The training platform of comprehensive engineering includes several large scale training projects on engineering, electronics and computer technology to educate the comprehensive application ability and engineering application ability of student. The training platform on innovation design is based on the technology innovation projects and specialism competition for student, and assisted by the scientific research of the teacher, so as to provide a initiative, independent and well equipped innovation space for student.

The training issues are divided into three layers. The first layer is basic engineering training. As compulsory course, this layer primarily faces to first form and sophomore students. The training issue as well as class hour will be decided according to the specific requirements of different disciplines. The basic layer contains training issues on four primary aspects: fundamental numerical control, conventional mechanics, traditional electronics and basic computer technology. This layer will make the student to have a first knowledge of the corresponding fields, and to learn the basic manipulations of certain equipments. The processing knowledge, engineering thoughts and practice ability will be excised on this layer as well.

The second layer is promotion training. The courses included cover the fields of advanced manufacturing technology, management technology, software application and comprehensive training. This layer is designed for sophomore and junior students. After the study of certain theoretical course, the students will be trained on this layer with specific projects according to the different specialism. Comprehensive training projects, including assembly training (assembly and measurement of automobile and motor), reverse design, fast prototype manufacturing, numerical control practice, device and measurement practice, PLC control training, computer system maintenance and integration of mechanics & electrics training. The engineering application ability, comprehensive practice ability and innovation spirit of student will be enhanced on this layer. With a further training on some projects, the student will be enabled to pass the examination on professional skill, and acquire the national certificate of profession consequently. The employing competitive of student hence could be promoted.

The top layer is innovation training, which primarily faces to junior and senior students. Innovation courses of mechanical design, electrical design, robot design and integration of mechanics & electrics design are included in this layer. The training courses on the standard bear mainly the forms of elective course, competition and innovative research project. The training projects will be finished under the guidance of supervisor. In the design of this layer, the emphasis is put on the introduction of newest results on education reform, on the combination of innovative project and research project, on the innovative activities in enterprise project and on the encouragement of initiative study,

initiative practice and fancy ideas. The objective of this layer is to cultivate the practical ability, innovation spirit, team spirit, mental power and the comprehensive quality of the students.

The training courses on different layers can be combined modularized and the training platform is composed of several training projects. The projects can be combined to form a serial of educational modules according to the requirements of certain specialism. The modules are characterized into compulsory module and elective module, each with different course and class hour. The elective module can be selected freely according to different disciplines.

5. ACHIEVEMENTS AND FEATURES OF ETC

The training center insists on supporting the Guangdong economy. Improve the practical ability, engineering application ability, innovation ability and comprehensive quality of student in accordance with the requirements of industry and information technology, so as to achieve the objective of "cultivating talented persons with practical ability and comprehensive ability". After years of practice and investigation, the following achievements and features have been formed.

(1) An advanced training system has been constructed, and several characterized experimental projects have been introduced. By choosing the training issues and projects carefully, a modulized educational system for engineering training with 6 platforms and 3 layers has been constructed facing to the foundational industry of Guangdong province. Serials of training modules with characteristics have been designed. Students of different grades or from different specialism can be trained efficiently on the three layers.

(2) A large-scale center with well set training projects has been formed. ETC is established under the background of great engineering and great manufacturing. The training issues cover the whole undergraduate school years, which include numerical control manufacturing, electronic/electrotechnic engineering, computer install, web configuration, software application, management technology, industrial engineering and conventional mechanical engineering. Special emphasis is put on the advanced manufacturing technology and innovation training. The innovation base established on ETC has provided a platform for a serial of competitions including Challenge Cup Competition, Innovative Mechanical Design Competition and Electronic Design Competition. ETC is the only engineering training institute in University City. In 2007, the center has been nominated as the national model of experiment education. Besides the training of about 20,000 students in GDUT, ETC also share the courses for more than 10 educational institutes in University City and in the vicinity of Guangzhou.

(3) ETC has become the training base of talented person for Guangdong-Hong Kong-Macau area. ETC has signed compromises with the Hong Kong Vocational Training Council (VTC). The two sides have been devoted to establish the Guangdong-Hong Kong Vocational Training Union, with the purpose to cultivate skilled engineering persons for the area. VTC has bestowed equipments valued HK $ 12 million to ETC, and moved the mechanical and mould training base to our center. In the future, the union will extend the training courses to related fields. A number of experts from certain enterprises and from VTC have been employed as the external teacher of the center so as to enhance the teaching team. A training plan called "United Training of Guangdong and Hong Kong" has been agreed by VTC. According to the plan, some vocational training will be finished in the center for Hong Kong related enterprises, including the enterprises in Hong Kong and the Hong Kong capitalized enterprises in Guangdong. On the other side, the VTC will provide chances for the students in GDUT to acquire professional certificates of Hong Kong.

(4) ETC has become the base for the transformation of research achievements. Radio Frequency Identification technology (RFID) has been applied to the visualization and transparency of workshop. Adopting the RFID technology and the idea of transparent workshop, a comprehensive education platform for engineering training based on RFID technology has been developed. The platform uses RFID card (campus card) to identify administrator, teacher and student, such that information collection and dynamic interaction can be achieved through the intelligent terminal system. The student can obtain the educational schedule, process document and guiding document from the terminal. On the other hand, the information of equipment status and training process will be provided to the teacher. Meanwhile, the teacher can also monitor the device condition and material consumption through the terminal. The application of this system will integrate the educational management, equipment management, material management and human resource management tightly, so as to maximize the potential of dynamical information collection and visualized management, and to optimize the utilization of resource and management standard.

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* *This research is funded by Guangdong undergraduate higher education teaching reform project(BKJGZZ2008034).*