

Cooperating Innovation Makes Successful Education for Innovative Talents

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Abstract: There are big gaps compared with the top international level in industry technologies. Cooperating innovation based technology developing is the one solution way for local economy. It is of great significance to push the industry development of Liaoning province, to drive the revitalization of the northeast industry and boost the national industrial progress. Collaborative majors set up for manufacturing engineering has cultivated cross-disciplinary talents of various disciplines and promoted the cross-integration of relevant disciplines. In order to reform of training system for undergraduate students, the ways are adopted as follows. First, majors are set up according to industry needs and construct a new structure of engineering, courses are reformed according to technological development and update knowledge hierarchy of engineering talents. Education methods and means of schools and innovative engineering are reformed as changing teaching methods according to students' interests and explore the incentive mechanism of independent development of emerging engineering. Resources and an open and integrate ecology are created for engineering education. Standards are set up to apply for international frontier and enhance international competitiveness of engineering education.

Keywords: Cooperating Innovation; manufacturing; undergraduate students; engineering

1 Introduction

Cooperating innovation based technology making successful education for innovative talents is the one solution way for developing local economy especially of Liaoning province of northeast China^[1,2]. It is of great significance to push the industry development of Liaoning province, to drive the revitalization of the northeast industry and boost the national industrial progress^[3]. The Northeast area of China is a major industry base for many years. Liaoning Province is known as the biggest equipment manufacturing base across China. In recent years, its developing is blocked. One of the reasons is due to the lack of educated young students, especially of innovation talents^[4].

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There are big gaps compared with the top international level in industry technologies. The original innovations, key technologies for manufacturing are urgently needed. The well-trained workers, young talents are also required. Cooperating Innovation based technology developing is the one solution way for local economy. The key theory and technologies should be solved including compressor, pump, engine and machine tools, construction machine etc.. The course of mechanical engineering, materials science, engineering mechanics, control science, engineering, thermophysics and so on are needed to be synthesized. Then the key theory and technology including super high speed rotor dynamics, fluid transport hydraulic model, complicated surface manufacturing, performance driven design optimization, multi-system intelligent control, reliability and life assessment can be united together and developed quickly. This innovation based on technology should be cooperated with many universities and enterprises.

At the same time Collaborative Innovation based education is also very important to local economic developing. Collaborative Innovation center of major machine manufacturing in Liaoning (M³) is built by Dalian University of Technology in 2012. It is of great significance to push the industry development of Liaoning province to drive the revitalization of the northeast industry and boost the national industrial progress. It is supported by the government in a big scale. It also unites the important companies, research institutes and universities together.

These organizations, departments collaborate together can drive the majors including mechanical engineering, materials engineering, energy and power engineering develop fast. It has cultivated cross-disciplinary talents of various disciplines and promoted the cross-integration of relevant disciplines such as fundamental theories, key technologies, systematic majors and new educations and so on.

2 Description of the Collaborative Innovation organizers

2.1 Organizers of collaborative innovation

Collaborative Innovation based education is organized by Dalian University of Technology. Collaborative Innovation center of major machine manufacturing in Liaoning (M³) is built by Dalian University of Technology in 2012. The Cooperative units of universities include Northeastern University, Shenyang University of Technology, Dalian Jiaotong University, Xi'an Jiaotong University (XJTU). The Cooperative units of companies includes Shenyang blower works group corporation which is famous for its compressor output in the world's top three. North Heavy Industries have a full face tunneling machine State Key Laboratory. Dalian Huarui heavy industry group CO.,LTD is famous as China's large offshore lifting equipment of the top three. Wafangdian bearing group Corp is about China's largest bearing enterprises. Taiyuan heavy industry co. Ltd is the largest heavy machinery manufacturing companies of China. Shenyang aircraft industry (Group) Co., Ltd is the largest aviation hosting and parts manufacturing enterprises of China. Changhe aircraft industry (Group) Co., Ltd is famous for China Helicopter Research Base.

2.2 Collaborative majors

Collaborative majors set up for manufacturing engineering includes mechanical engineering, materials engineering, energy and power engineering and other majors related. It has cultivated cross-disciplinary talents of various disciplines and promoted the cross-integration of relevant disciplines. The cross-integration research work include such as high-end turbine compressor unit and large diameter hard rock tunneling equipment, heavy duty bearings, main pump of megawatt nuclear power plant and giant ocean floating crane.

2.3 Recent achievements of research activity of innovation

The partners of the Collaborative Innovation center of major machine manufacturing in Liaoning (M^3) include DUT、NHI、ZWZ. Collaborative innovation center of major machine manufacturing in Liaoning (M^3) has achieved many rewards these years. A large-diameter tunneling equipment (TBM) and high-performance bearing are developed as shown in figure 1 and figure 2. The TBM and the largest main bearing are successfully used in a coal mining. Advanced mechanics, measurement and control technologies are adopted in manufacturing engineering of high-performance material producing and connection technologies as shown in figure 3 and figure 4.

In recent years, the Collaborative Innovation center of major machine manufacturing in Liaoning has received many rewards such as Second prize of China Machinery Industry Science and Technology Awards, First prize of Science and Technology Progress Award of Liaoning province and Technology Invention Awards of China and Technology Invention Award of Education Ministry of China, etc..

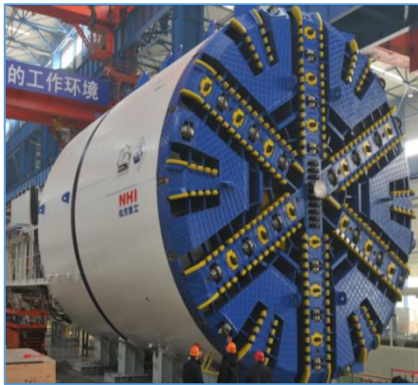


Fig. 1. TBM



Fig.2. Main bearing in TBM

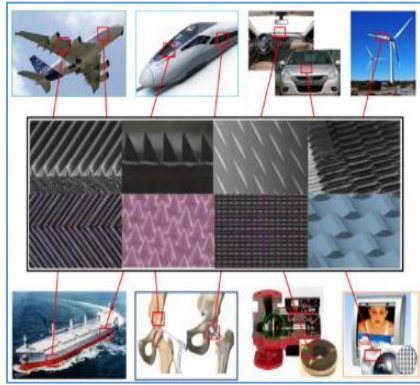


Fig .3. Bionic functional surfaces manufacturing **Fig .4.** High-speed railway contact lines with CuCrZr alloy

3 Collaboration education for students

3.1 Reform of training system for undergraduate student

The teaching and practical contents are out of line with the enterprise of current problems of the training system. On the other hand, practice bases are not enough. Many teachers are lack of practical experiences. Students' innovative training and international activity are not enough. Students cannot solve complex engineering problems. Many manufacturing companies are not satisfied with the students. Improving the shortage of training system and setting up a training model for advanced manufacturing, exploring the comprehensive utilization of the education resources through cooperation between school and enterprise resources are firstly to be solved.

Consensus in the new engineering education (Fudan U, 2017.4)^[5], the national needs a lot of emerging engineering talents as Innovation-driven Development, Made in China 2025, Internet Plus, Cyber power^[6,7]. Majors according to industry needs and construct a new structure of engineering are needed to meet the need of the strategy of Emerging Engineering Education (3E). Reform courses are adopted according to technological development and update knowledge hierarchy of engineering talents. The teaching system are reformed to improve engineering education. Changing teaching methods are used to attract students' interests and explore the incentive mechanism of independent development of emerging engineering. An open and integrate ecology for engineering education are created for engineering education. International frontier and enhance international competitiveness of engineering education are set up to meet the teaching target.

To cultivate the students' international vision, training agreements are signed with 9 abroad institutes, including the University of California at Irvine, University of Edinburgh, University of Queensland, etc.. An international class has been built with English courses. A full-bilingual mechanical class teaching by Chinese and Japanese

including 39 foreign students at present. More than 100 students every year go abroad to communicate for more than one month.

3.2 Construction of the new training system

In order to solve above problems, Collaborative Innovation center set up a new training system for undergraduate students by the way of school-enterprise cooperation which focuses on Collaborative Revision of Training Programs, Cooperative Construction of Practice Bases, Coordinated Perfection of Teachers' teams, Collaborative Development of International activity.

3.2.1 Revision of training programs

A collaborative innovation experimental class is adopted to develop the training program. For the major equipment design and manufacture, we have developed the training plan of strengthening innovation and engineering practice ability in cooperation with enterprise experts based on the course of "mechanical design-manufacture and automation". For the freshman year, the students are introduced to understand mechanical innovation (innovation Group of 2-3 students).

The remarkable characteristics of the training program is listed as follows. Innovation capacities are enhanced for four years. Taking the open innovation project and the typical major equipment innovation project as the carrier, it runs through the whole course of four years' course and practice teaching. Practical ability training with project guidance as individualized cultivation of students' essential abilities and thinking modes such as autonomous learning, creative thinking, solidarity and integration of theory and practice are carried out through the students four year.

Freshman year: Introductory Courses Enlighten Innovative Thinking

The special teaching model with Teachers plus School experts and Enterprise experts on introduction of mechanical innovation are used in the frontier knowledge of mechanical engineering and project examples to stimulate students' enthusiasm and interest. At the same time, 2-3 students are set up to form an innovation group. Each group is equipped with an innovative design instructors then choosing innovative projects independently.

Before the end of freshman year, the innovation group should submit the design conception and research report of the innovation project according to the market orientation, the development foreground and the technical economy of the project.

Sophomore year: Science and technology competition traction training

Each student needs to complete the whole process from mechanical structure design, software and hardware control to car production, and exercise students' mechatronic design capability and hands-on practical ability. In recent year, an opening course of "Basic Mechanical and Electrical Practice" with the goal of making smart cars is in service. At the end of sophomore year, all innovation groups participating in the selected items in the introductory class can benefit from the "University Students' Innovation and Entrepreneurship Program".

Junior year: Typical products throughout the knowledge system

In order to enable students to master and comprehensively use the basic knowledge of mechanical engineering, a number of typical products or cases are selected and carried out through the entire knowledge system in the course of design, manufacture,

measurement and control to let them realize the whole-case teaching of professional basic courses.

For example, in the mechanical design related courses of the design of typical equipment "Cooling fin stamping machine" as the main line, the process run through mechanical design and it's course design of all chapters and knowledge system.

Through the newly established Mechanical Product Design and Mechanical Product Design Practice course, the motion scheme of the fin press, structural, performance and control system can be achieved evidently.

Senior year: Innovative task-driven capacity reached

To enhance students' ability to solve complex engineering problems, a new course of Theory and Practice of Innovative Design of Critical Equipment Critical Systems that meets OBE and new engineering concepts is established. A scalable and innovative task library of practical engineering issues in the design and manufacture of typical and major equipment such as tunnel boring machines, high-end compressors, giant cranes, new energy vehicles, and more is built.

The task-driven and self-learning and group co-guided teaching methods are adopted. A diverse team of tutors from college teachers and business mentors and multi-venue integration of classroom and lab and business are operated. During the graduation project, major equipment innovation experiment class students should choose the subject from the actual project of the enterprise with the centralized guidance and individual counseling of enterprise mentors. A graduation design evaluation system in line with professional certification system is established. NI technical director is involved in graduation design include intensive guidance for 8 hours and individual counseling. Chief designers of NHI also participate in graduate design guidance and defense.

3.2.2 Construction of Practice Bases: New mode of students practice

Relying on major equipment manufacturing enterprises, Dalian Lifting Heavy Industry, North Heavy Industry, XCMG and other off-campus practice base were established. So as a mentor-led and project-led are adopted in producing practice teaching mode. For example, during the internship at Dalian Heavy Industry, enterprises proposed a number of projects such as "Optimization of Crane's Efficiency" and "Manufacture of Wind Power Gearboxes". Each group of students is equipped with an enterprise mentor. At the end of the internship, everyone should be graded by teachers based on their diaries, reports and the performance of oral defense.

Relying on collaborative enterprises and two state-level experimental teaching demonstration centers (Engineering Training Center, Mechanical Engineering Experiment Teaching Center), a school practice base in line with "Industry 4.0" and "Made in China 2025" is built. A teaching module based on FMS Flexible Island was built according to intelligent manufacturing as shown figure 5. Real-time distance transmission teaching system of mold casting is shown as figure 6. Virtual Welding Training Teaching System based on virtual reality is shown as figure 7.



Fig .5. Teaching module based on FMS Flexible Island



Fig .6. Real - time distance transmission teaching system of mold casting

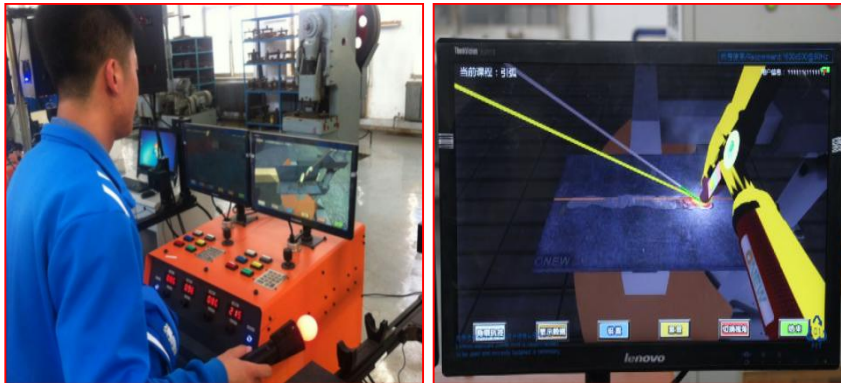


Fig .7. Virtual Welding Training Teaching System(Based on Virtual Reality)

3.3 Perfection training of teachers team

The school-enterprise coordinated training enhances the teachers' engineering practice ability. In the basic condition of the application of senior professional title, it is necessary for applicants to have more than half a year's experience in enterprise practice and to arrange the short-term practice study of young teachers. 66.4 percent of full-time faculty members should work in enterprises or have more than half a year's internship experience.

Young teachers in Dalian Machine Tools participate in practical ability training, then introduce the enterprise experts and build the integration courses as the diversity of lecturers of the synergistic enterprise with the construction of the integration of innovation and practice courses. In the past three years, 22 business experts have been invited to participate in the teaching of 14 courses.

In order to improve intercollegiate cooperation to improve teachers ability, the center cooperates with Xi 'an Jiaotong University, Northeastern University, Shenyang University of Technology and other domestic universities to realize the intercollegiate collaborative education activities, which will be carried out through the form of teaching research and curriculum construction.

To development of Global outlook, and introduce and cultivate international teaching staff, there are 17 foreign teachers from the University of California at Irvine, Ryerson University in Canada, and other well-known colleges and universities are invited to participate in curriculum construction and teaching. In recent three years, 120 teachers have been sent to be engage in teaching training and exchange visiting abroad. The ratio of full-time teachers with degree or experience of long-term work or studying abroad account are about 56.9%, and the internationalized teaching team are formed successfully.

4 Conclusion

Cooperating innovation is of great significance to drive the revitalization of the northeast industry and boost the national industrial progress. In order to reform of training system for undergraduate students, collaborative innovation are adopted. Education methods and means of schools and innovative engineering are reformed as changing teaching methods according to students' interests and explore the incentive mechanism of independent development of emerging engineering.

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