

The Reform and Practice of Training Model of Innovative and Entrepreneurial Talents in the Concept of "the Combination of Specialization and Creation"

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Abstract—Emerging engineering education advocates for the talent training concepts of "character shaping," "integration" and "continuous innovation." In this paper, the author reformed the teaching methods used in five undergraduate programmes at Tianjin University's School of Mechanical Engineering. The author integrated resources from both the school and various enterprises in order to build an integrated platform connecting innovative and entrepreneurial practices from a core professional first classroom and a second classroom. In this way, the author aimed to construct an ecosystem that integrates professional education with innovation and entrepreneurship. Based on strong continuity, deep interaction and the curriculum's high quality "specialty and innovation integration" training, this will enhance students' recognition, participation, and sense of achievement in innovation and entrepreneurship education.

Keywords—integrates professional education, innovation and entrepreneurship education, second classroom

I. INTRODUCTION

Emerging engineering education consists in system engineering, which designs a complete program for education, research, practice, innovation and entrepreneurship from the perspective of the system [1]. In this paper, the author mainly focuses on degree programmes at Tianjin University's School of Mechanical Engineering (mechanical design, manufacturing and its automation; engineering mechanics; energy and power engineering; industrial design; intelligent manufacturing engineering). Considering the characteristics of these degree programmes, the author suggested advocating for the talent training concepts of "character shaping",

"integration" and "continuous innovation", and to integrate resources from both school and businesses, to create an integrated platform for innovative and entrepreneurial practices that connects a core professional first classroom with a second classroom.

The platform mobilises teachers and professors, entrepreneurial alumni, cooperative businesses and social subjects from all fields to participate in the design and teaching of the degree programmes. The education elements in first and second classrooms are integrated and reconstructed by revising the syllabus, optimising the assessment and evaluation systems, and improving the incentive mechanism, then constructing an ecosystem that integrates professional education with innovation and entrepreneurship education. Through "project-based" teaching, in-depth school-enterprise cooperation, and improvement of policy support, this system gives full play to the "specialty and innovation integration" advantages of the curriculum's system (strong continuity, deep interaction, and high quality training). It aims to improve students' recognition, participation, and sense of development in innovation and entrepreneurship education, and strives to enhance the overall quality of how we train future talent [2].

This paper addresses three important long-standing issues in innovation and entrepreneurship education:

- The students' poor comprehensive capabilities when applying professional knowledge and practices. It is difficult for them to accurately analyse complex engineering problems, conduct effective reasoning or control project costs.
- The training model's inaccurate target positioning of innovative and entrepreneurial

talents, and insufficient investment. These degree programmes fail to take full advantage of the available high-quality teaching resources and high-level scientific research, and fail to arouse the enthusiasm of teachers, students, alumni or other subjects.

- The coordination mechanism for innovation and entrepreneurship education needs optimising. Exploring how to construct an effective innovation and entrepreneurship ecosystem composed of policies, honours and curriculum systems is of great importance.

II. METHODS FOR REFORM

A. *Improving Student Engineering Quality*

Taking into account student realities, these degree programmes should construct a "product-oriented" project-based curriculum system. In the main classroom, the main line consists in the whole machine's design of the product, and it coordinates the teaching content and practical case studies [3]. In the second classroom, professional knowledge is taught through an analysis of business cases, thereby realising an organic integration of classroom teaching and entrepreneurial practices. For this integration, students are required to review the design of parts and components under the guidance of the "whole machine design concept".

At the same time, they have to consider the full life-cycle of the products, as well as focus on the system mode, design type and basic methods used in the design. In order to cultivate innovative design thinking and the overall views on entrepreneurship, it is necessary to condense the core literacy outlines required of future outstanding engineering talents [4]. In the long run, students will put into practice what they learn, further improve their engineering problem analysis and solution abilities, and stimulate their spirits for practical problem exploration in the industry.

B. *Carrying Out In-depth School-Enterprise Cooperation*

Degree programs should make full use of the educational resources available to them, such as having the entrepreneurial alumni establish a new faculty team. Social practices can be conducted at the industry's front line by inviting corporate tutors to give lectures on campuses, student internships or placements within businesses, and entrepreneurial practice simulations [5]. Provided that there are no first-line industry problems in the textbooks, under the guidance of corporate instructors, students can gradually master the core working principles, and the motion and dynamic characteristics of common components.

In addition, they can train their analysis and design capabilities for common components, and obtain basic knowledge on component selection and assembly [6]. Through their designed products and engineering

progress, the instructors will intuitively understand how the students best grasp a basic understanding of working principles, and selection and calculation of common parts. Following this, the instructors should teach quality courses, and explore the practical curriculum method of "interdisciplinary + project teamwork".

C. *Perfecting the Policy Support System*

It is imperative to accelerate top-level designs, build complete supporting policies and institutional mechanisms, and create strong entrepreneurship and entrepreneurial culture and atmosphere. Professionals, professors and senior engineers will be invited to form a student innovation and entrepreneurship working group responsible for overall planning and work. Targeted competition incentive policies will be issued, with the awards won by students in competitions at different levels converted into direct bonus points when they are exam-free recommendation postgraduate candidates.

At the same time, the improved competition guidance and workload will be included in the teacher performance appraisal system. They must give full play to the resources available from the alumni's entrepreneurial businesses, offer 6 extracurricular educational courses, and introduce the second classroom into a training plan for each degree programme. The transcripts of the extracurricular practice education will be recorded in the student files. In order to cultivate the innovative and entrepreneurial engineering talents who will adapt to the new economy and new technologies, a policy system that meets student needs to grow should be formulated [7].

III. REFORM METHODS

A. *Improving Assessment Standards*

Emerging engineering education practices that incorporate "specialty and innovation integration" in education teaching methods are achieved through an organic integration of professional education with innovation and entrepreneurship education [4]. These new practices are built based on the major channels of inheritance and innovation, crossover and integration, and coordination and sharing. So as to boost the training quality of innovative and entrepreneurial talents, first-line industry cases are introduced into main classroom teaching, and students are encouraged to learn core knowledge through innovative practices [8].

These degree programmes should analyse the abilities and requirements of outstanding engineering talents over various disciplines, revise the syllabus, adjust the class schedule and curriculum requirements, and enrich classroom teaching by implementing second-classroom practices. These adjustments are made in the hope of stimulating students' innovative and entrepreneurial thinking, expanding subject horizons, and forming a benign interaction model

characterised by "core knowledge + industrial training". Moreover, scientific research should also play a role in education, thereby continuing to create the full-chain "creation-innovation-entrepreneurship" talent training model. A complete innovation chain of personnel training ecosystem is presented in Figure 1.



Fig. 1. A complete innovation chain of personnel training ecosystem

B. Deepening Cooperation, Inside and Outside of School

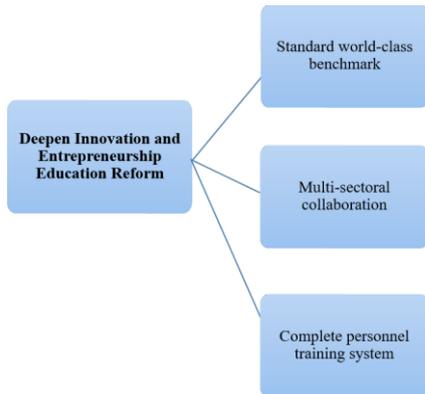


Fig. 2. The multi-level personnel training ecosystem

The university should explore a new method of talent training that includes school-enterprise collaboration and full-staff education, as well as broaden training channels so as to allow students to participate in innovation and entrepreneurship practices, in accordance with the goal of "innovation driving entrepreneurship, entrepreneurship back-feeding innovation, and promotion of students' all-round development". In light of students' professional needs and characteristics of discipline, the university should cultivate entrepreneurial practice abilities, adjust the evaluation system for students, and highlight personalised and flexible teaching policies [9].

In order to carry out high-quality innovation and entrepreneurship education and employment guidance, a corporate project pool can be established, and students

can be provided with open horizontal training topics and part-time internship positions. Students will be stimulated to strengthen their understanding of professional theoretical knowledge, exercise practical skills, develop a hard working ethic, cultivate a sense of cooperation and team leadership, and grow into outstanding engineering talents [10]. The multi-level personnel training ecosystem is shown in Figure 2.

C. Achieving Full Support

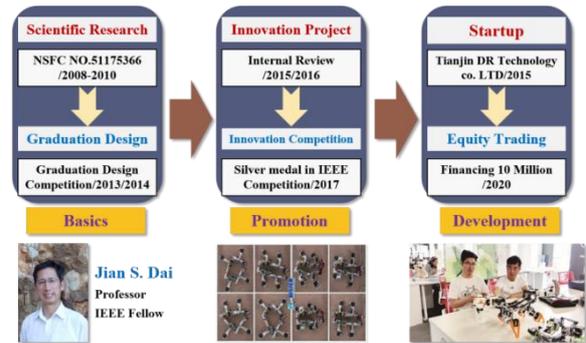


Fig. 3. Typical case: the world's first META robot

There is a necessity to continuously iterate and improve upon support systems, organise a working group for innovation and entrepreneurship, strengthen organisational leadership and overall coordination, provide comprehensive services through policy support, and cultivate outstanding students so as to establish a model to follow [11]. For lower-grade students, the university should make more than 50 laboratories available in its laboratory opening month, improve department-level innovation project systems, and achieve a steady increase in the proportion of scientific research projects which have undergraduate student participation.

Senior students should be informed of the guiding role of key competitions so that they can fully explore the available resources for various disciplines. In this way, a vivid scene of interdisciplinarity and co-creation between teachers and students can be established [12]. With regards to the mechanical students in universities specifically, 14 consecutive undergraduate graduation design competitions have been held, and the "enterprise-academy" dual tutor project has been implemented so as to expand the scope of innovation and entrepreneurship activities from one point to a broader area [13]. Teachers and students have both been mobilised to initiate and participate in innovation and entrepreneurship activities and create an innovation and entrepreneurship culture and atmosphere in the classroom and on campus. Figure 3 presents typical case: the world's first META robot.

IV. RESULT AND DISCUSSION

A. *Effectively Promote The Transformation of Teacher and Student Achievements and Significantly Enhance The Level of Innovation and Entrepreneurship Education*

After six years of construction and four years of practice, as many as 76.7% of undergraduate students are now participating in scientific research. More than half of the graduates work in large state-owned enterprises and institutions, such as China Aerospace Corporation, China National Aviation Corporation, China National Nuclear Corporation, and China State Construction, or assume important positions or serve as technical backbones in manufacturing, power, energy, aerospace and other fields. Professor HUANG Tian leads the "ATOM-High Speed Handling Robot" team, which is committed to the design and industrialisation of parallel robots. After seven years of development, his team has finally broken the foreign domination of China's industrial robot market and has created products whose precision is superior to similar international products. Their accumulative shipments have exceeded 1,000 units, with annual sales of RMB 50 million, and their market share continues to rise.

B. *Build a Professional Charismatic Practice Platform and Construct a Diversified Assessment and Evaluation System for Students*

The university regularly organises for students to embark on internships at key businesses, which closely connects them with leading global scientific and technological innovation, as well as the development of national strategic needs [14]. At the same time, five corporatized operating societies have been set up (robot team and the racing team, etc.) at the university, which include independent and complete organisation methods for project management, cost analysis, and financial budget management. Additionally, incentive policies and evaluation systems have been improved, and scientific research achievements, such as competition awards, can now be applied as practice credits, exemptions from courses and exam-free candidate bonus points [15]. In 2020, after a review and confirmation from expert groups, a total of 11 students received extra points for exam-free postgraduate recommendation through their award-winning performance in the competition.

C. *Strengthen the Construction of a Practical Teaching and Open Sharing Platform, and Enhance Collaborative Innovation Service Abilities*

In accordance with the integration system of the first and second classrooms, a robot team run by students has been established. In order to participate in the ROBOTAC, they independently design and manufacture applied robot groups every year, and actively carry out technical exchanges and industry-university cooperation activities with related key

businesses. In summary, nearly 300 entrepreneurial engineering talents with practical experience have been cultivated. Relying on the advantages offered by entrepreneurial alumni, the university has worked with them to open a number of second-classroom practical courses, such as Robot R&D and Innovation. Furthermore, corporate horizontal innovation projects have been launched, with 31 teams and more than 100 students signing up in the first phase, and going on to successfully accomplish their projects.

V. CONCLUSION

Tianjin University's new engineering program is committed to training talent by strengthening moral education and cultivating its people. Through integration with new liberal arts education, and multi-disciplinary and interdisciplinary engineering education with personalized professional education, it aims to provide comprehensive education for its students, and to train the outstanding engineers and entrepreneurs of the future in fields of scientific discovery, technological inventions and industrial applications.

Reflecting on the reform and practices implemented over the last 9 years, the author understands that within emerging engineering education, this paper advocates for the talent training concept of "character shaping," "integration" and "continuous innovation". An integrated platform is established that connects a core professional first classroom and second classroom, after which a curriculum system is constructed that combines professional core education with innovation and entrepreneurship education. This is done in order to comprehensively improve the training quality for the innovative and entrepreneurial talents of the future.

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