Reflections on the Cultivation of Civil Engineering Professionals based on the Construction of New Engineering

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Abstract: New engineering construction is a new engineering education paradigm proposed by the country in response to technological revolution and industrial transformation, and it is a major strategy for the country to achieve a strong engineering education. Based on the enlightenment of the construction of new engineering, local undergraduate colleges and universities should actively explore new paths for the training of civil engineering professionals, keep up with the development trend of local industries, actively meet the talent needs of enterprises, and build a cross-disciplinary integrated curriculum system, so as to train a group of innovative engineering talents with solid professional knowledge, strong engineering practice ability and adaptability to future positions.

1. Introduction

With the arrival of the fourth industrial revolution, revolutions with artificial intelligence, robotics, virtual reality, quantum information technology, controlled nuclear fusion, clean energy, and biotechnology as technological breakthroughs are rapidly unfolding. New industries, new formats and new technology are constantly emerging, and the development of new industries requires a large number of innovative engineering and technical personnel. Engineering education and industry development are closely related and interdependent. The level of education development is an important indicator of a country's development potential. In response to the new situation of scientific and technological revolution and industrial transformation, the reform and development of higher engineering education in China has stood at a new historical starting point.

On February 8, 2017, the Ministry of Education reached a Fudan consensus on the construction of "new engineering" at Fudan University [1]. On April 8, the Ministry of Education issued an action plan for the construction of "new engineering" (Tianda Action) at Tianjin University [2]. On June 9, the Ministry of Education reached a new engineering construction guide (Beijing Guide) in Beijing [3]. The Fudan Consensus, the Tianda Action and the Beijing Guide constitute the "trilogy" of new engineering construction, clarify the new path of engineering education reform, and play the main melody of talent training reform. In fact, the reform of international higher engineering education has begun from the end of the 20th century, and has put forward new concepts such as "output-oriented", "returning education to engineering", and "student-centered". In the past 10 years, China has also carried out a series of explorations in the reform of engineering education. The proposal for the construction of "new engineering" has presented a new perspective for the exploration of engineering education reform, providing the "Chinese experience" and "China Mode" of engineering education. It is the national response to industrial change and international higher engineering education reform [4].

2. The Connotation and Characteristics of "New Engineering"

The new engineering is relative to the traditional engineering. On the one hand, it is necessary to actively set up a group of emerging engineering majors. On the other hand, it is necessary to actively carry out the reform and innovation of traditional engineering majors. The construction of

new engineering is not just about establishing a group of new majors. There should not be an absolute boundary between "old engineering" and "new engineering". New majors cannot be completely equivalent to new engineering. Broadly speaking, new engineering is a new engineering education paradigm and a synonymous for engineering education innovation [5]. The "new" of new engineering is mainly reflected in: new concepts of engineering education, new structure of disciplines, new model of talent training, new quality of education and teaching, new system of classification development. Its connotation is: to cultivate diversified and innovative outstanding engineering talents in the future by taking the lead of cultivating people with morality, the concept of coping with changes and shaping the future, and the approach of inheritance and innovation, intersection and integration, coordination and sharing [6].

The connotation of new engineering determines its following characteristics. 1. Leading, new engineering majors should not only serve the existing industry, but also play a supporting role for the future new technology, new industry and new economy, and cultivate a group of innovative talents who actively explore unknown fields for the society. 2. Forward-looking, "new engineering" and "old engineering" are relative and dynamic. With the development of society and the reform of industry, the construction of new engineering should keep pace with The Times, the education and teaching content should be constantly updated, and the new technology and new knowledge in the industry should be increased, so that the major can be kept alive forever. 3. Cross-cutting, the construction of new engineering emphasizes the intersection between existing engineering and the integration between engineering and other disciplines. Cross-cutting and integration are the focus of innovative engineering and technical personnel training, and the breakthrough point of major engineering innovation. 4. Openness, the construction of new engineering must strengthen international exchanges and cooperation, strengthen the deep connection with enterprises, and promote the opening of disciplines and the opening of engineering education resources, and form a deep integration of co-construction and sharing. 5. Practicality, engineering education is inseparable from practice. New engineering must focus on practical teaching links, focus on training students' ability to solve complex engineering practical problems, actively build a school-enterprise cooperation platform, and actively build a group of dual-teacher faculty [5].

The cultivation of new engineering talents plays a supporting role in China's industrial development and international competitiveness. It is both an urgent task and a long-term strategy, and its important role is self-evident. The Tianda Conference of New Engineering Construction put forward the "Core Quality Standards for Engineers Facing 2030", which requires students to strengthen their national feelings, global vision and rule of law awareness, cultivate students' design, engineering, critical and digital thinking, and enhance students' innovation and entrepreneurship, interdisciplinary integration, independent lifelong learning, communication and negotiation skills and engineering leadership [2]. Different from the traditional engineering education that only focuses on the transmission of theoretical knowledge, the requirements for new engineering talents are more diverse and more in line with the needs of social development. In the process of education and teaching, the new engineering department not only emphasizes the transfer of basic knowledge, but also pays attention to the cultivation of students' practical skills, the cultivation of students' engineering logical thinking ability, the cultivation of students' innovation ability and independent learning ability, and the cultivation of students' humanistic quality and social responsibility. These core qualities are in line with the qualities and abilities of future engineers described by the American Academy of Engineering, World Economic Organization; ABET Engineering Professional Certification Standards, etc., all aiming to cultivate a group of innovative talents with sustainable competitiveness that meets the needs of the industry for the society.

3. Exploration of New Paths for Training Civil Engineering Professionals

Facing the rapid development of society and the profound changes in science and technology, the civil engineering major as a traditional old engineering major must carry out its own reforms and innovations, explore new ways of education and teaching, optimize course content, and build a curriculum system that meets industry needs. Due to the different conditions of Chinese universities,

the construction of new engineering will be carried out in three different universities, namely, engineering superior universities, comprehensive universities, and local universities. Local colleges and universities should take the initiative to meet the needs of local economic and social development, clarify the direction of industry needs, make full use of local resources, give full play to the characteristics of self-sponsored school, deepen the integration of industry and education, school-enterprise cooperation, enhance students' innovation and entrepreneurship capabilities, so as to cultivate a group of application-oriented and technical-skilled talents with solid engineering basic knowledge, engineering practice ability and competent industry positions for the society [1].

Taking Xi'an Peihua University as an example, it is a privately-run local undergraduate university. The training objective of civil engineering major is to train high-quality applied technical professionals with all-round development of morality, intelligence, physique and beauty, who are oriented to northwest China and meet the needs of civil engineering industry and regional economic development. The professional direction is the direction of housing construction engineering. After graduation, students are mainly engaged in housing construction, structural design, civil engineering construction and project management. In order to respond to the national policies on engineering education reform and the construction of "new engineering", the major has carried out a series of reforms, focusing on the combination of theoretical knowledge transfer and practical ability, successively established soil mechanics laboratory, materials laboratories, engineering measurement laboratories, virtual simulation training rooms, and the corresponding centralized practice and decentralized practice courses have been set up. At the same time, school-enterprise cooperation platforms have been established with many enterprises.

However, the construction of new engineering is not accomplished overnight. It takes a long time of exploration and practice to form a systematic theory and method. Although we have made a series of reforms in professional construction, they are still in the initial stage, and systematic reform and innovation are urgently needed. First of all, we should change old ideas from the ideological point of view, change the traditional engineering science orientation to demand orientation, pay attention to the interdisciplinary integration, deeply understand the practical nature of engineering education, find out the problems of traditional education, look at the essence through phenomena, and find good road of professional development, so as to cultivate a group of high-quality innovative engineering and technical personnel that can be used immediately after graduation, to achieve a seamless connection between education and industry, and to avoid the waste of educational resources and the low professional matching rate. Based on the enlightenment of the construction of new engineering, the new path of training civil engineering professionals in local universities can be considered from the following aspects:

3.1 Based on local industry needs, deepen school-enterprise cooperation to educate people.

The construction of new engineering in local undergraduate colleges and universities must implement the principle of “based on locality, targeting applications, and close to the industry”, actively understand the strategic direction of national emerging industries and the development trend of local industries, and actively explore the direction of professional construction adapted to local industries and economic development [7]. The key to the construction of new engineering is to carry out in-depth supply-side structural reforms to meet the needs of social and economic development. In this process, we must firmly grasp the needs of enterprises for talents, update the new professional direction in a timely manner, deepen the cooperation between schools and enterprises to educate people, and schools and enterprises jointly shoulder the responsibility of educating people.

Deepening the integration of industry and education and strengthening the deep cooperation between schools and enterprises is the only way for applied undergraduate education. Due to its own characteristics, the civil engineering major has high requirements for students' practical ability and innovative ability. Education that deviates from the actual engineering simply cannot meet the social requirements for the quality of engineers. We must run through the entire process of talent training with the needs of society and the expectations of enterprises, so as to truly realize the

collaborative education of schools and enterprises. First of all, in the early stage of the revision of the talent training program, it is necessary to conduct in-depth research on the enterprise, invite industry experts to the school to conduct a talent training program demonstration, determine the theoretical courses and practical courses that students need to learn, and fully implement the "demand-oriented" in talent training program. Secondly, in the process of implementing the talent training program, the communication between teachers and enterprises will be deepened, and teachers will be regularly placed in the company to exercise on duty, so that new knowledge and new technologies will continue to be integrated into the classroom. And in the communication with the enterprise, it constantly finds problems, constantly improves and optimizes the talent training program, and enables the professional to achieve sustainable development.

3.2 Optimize the new model of talent training and restructure the curriculum system.

The new model of new engineering talent training must be based on the premise of facing the future and facing the development needs of the project, shouldering new tasks such as updating talent training concepts, reshaping the knowledge structure and training goals, and changing training methods [8]. First, we must transform the traditional discipline-oriented engineering education concept into a result-oriented concept, emphasizing the student-centered, reverse design of the curriculum system, and continuous improvement of the major. Secondly, the training goals of new engineering talents must meet the needs of engineering development, and pay attention to the comprehensive cultivation of students' "character + quality + ability", with a view to cultivating a group of new engineering talents who can adapt to the sustainable development of new industries and new economies. Third, according to the top-level design and reconstruction training method, promote the integration of industry and education, the integration of science and education, the cross-integration between disciplines, and cultivate innovative engineering and technical personnel.

We must focus on restructuring the curriculum system with professional characteristics, emphasizing social needs as the guide, reverse designing and combing the curriculum system according to the training objectives. Different from the traditional education that only focuses on solid theoretical foundation; application-oriented universities should pay more attention to students' comprehensive practical ability and innovation ability. In addition to the general courses, the establishment of each course should be able to contribute to the graduation requirements and serve the local economic development; the teaching content of the course should include the standard requirements required for engineering professional certification; specific methods and measures should be formulated in the teaching process; students must submit the corresponding learning results after study, so as to ensure that students can engage in related work immediately after graduation.

3.3 Improve the practical course system and build an engineering practice platform.

Practice teaching is an indispensable part of undergraduate teaching, an integral part of quality education in application-oriented universities, and an important prerequisite for the cultivation of new engineering talents. The construction of the engineering practice platform is crucial to the practical education of the new engineering department. Returning education to the project itself and focusing on cultivating a group of engineers suitable for the job for the society is also the focus of higher engineering education reform.

Practical education system refers to the relevant practice links established in the whole learning process of colleges, including: experiment, in-class training, independent training, off-campus internship, graduation design and some innovative practical projects. To build a perfect and effective practical education system, you can start from the following aspects. First, the choice of practical courses should be in-depth discussions and demonstrations with local companies and industries. The relevant practical courses should be arranged in time in a logical order. The practical projects should be cross-integrated to avoid curriculum isolation and knowledge fragmentation, To ensure that the practical courses offered can serve the industry and students can learn to apply them. Second, the practical training and practice should be separated from the virtual learning environment, and various ways of cooperation between schools and enterprises should be actively

explored. Real projects should be taken as the carrier to train students' ability to solve practical engineering problems. Third, we must actively explore ways to practice teaching reform, transform the traditional "cramming" teaching method, and take students as the center to guide students to think, work, and innovate independently. This is the basic way to cultivate students' practical ability. Fourth, a good practical education system is inseparable from the strong support of the school. We must improve various experimental equipment and virtual software, build a comprehensive training platform for schools and enterprises, and establish a group of high-quality "dual-teacher" faculty, so that good practice teaching methods take root.

3.4 Strengthen the construction of the teaching staff and make full use of the resources of teachers inside and outside the school.

Teachers are the basic force for the development of universities, which directly affects the learning quality of students. In order to better serve the local economy, it is particularly important to establish a batch of "dual-teacher" faculty, that is, compound talents with both educational and teaching ability and engineering practice ability [9]. As for the construction of "double-qualified" teaching staff, there are the following ways. 1. Colleges and universities should cultivate the vocational ability of existing teachers, take temporary jobs in relevant enterprises in summer and winter vacations, get familiar with the operation mode of enterprises, visit and join the practice of actual projects, and master the advanced technology of the industry. 2. Employing engineering and technical personnel with practical experience within the enterprise to the school as part-time teachers, which has a better teaching effect for practical courses. In addition, outside the school, we must take the initiative to connect with scientific research institutes in key areas of local industry development, and focus on introducing high-level talents who can keep up with the frontiers of science and technology and have higher scientific research levels to lead the cultivation of new engineering talents [7].

Finally, a good system is the guarantee for the construction of the teaching staff. Colleges and universities should start from the construction of the system, improve and reform the employment mechanism and management mechanism of teachers, engineering and technical talents, and scientific research talents, so as to attract outstanding talents to teach on campus and stabilize the teaching staff. And according to the age, professional title, professional, full-time and part-time structure of the teaching team, "double-qualified" structure, etc., we gradually optimize the structure of the teaching team, so as to improve the construction of the teaching team.

3.5 Reinvent a new mechanism of quality evaluation and realize the diversified development of students.

The final goal of new engineering construction is the quality of talent cultivation. Strengthening the connection with the society, breaking the traditional closed mechanism of evaluation, deepening the integration of industry and education, and establishing a multi-faceted and multiple evaluation methods are the only way for the development of applied technology universities to achieve the diversified development of students. On the one hand, the evaluation system in the school should avoid relying entirely on the test results, and more attention should be paid to the evaluation of the process, such as: the student's operation level, the student's practical ability, the communication between the student and the teacher, and the student's completion of the assignment and so on. On the other hand, we should pay more attention to communication with industries and enterprises. The evaluation result of the third-party unit is a direct performance to measure whether the talent training meets the social needs, such as: the evaluation of the talent training program by the enterprise, and the evaluation of the students by the internship unit, discipline competition evaluation, etc. The talent training evaluation system should always run through the entire process of education and teaching, and continue to improve based on feedback.

Conclusion

The development of new industries and new economies has put forward new requirements for

engineering education, and the construction of new engineering subjects is a major reform and innovation of engineering education. Focusing on the training goals of new engineering talents, in addition to the basic qualities of traditional engineering and technical talents, civil engineering students also need to have new features such as compound, mastering new tools, independent learning and social responsibility [10]. To build a new path for the training of civil engineering professionals, we must first strengthen industry-university cooperation, integration of science and education, based on the school's professional characteristics; combine the needs of society and new technology to reverse design the curriculum system. Secondly, it is necessary to emphasize the cultivation of students' innovative ability, formulate a curriculum system of cross-disciplinary integration, break discipline barriers, and break through professional barriers, such as architectural 3D printing, bio-concrete technology is the cross-fusion of materials science, life science and civil engineering major. Third, we should emphasize the combination of general education and professional education to cultivate students' patriotism and humanistic qualities. Fourth, in the teaching process, we always adhere to the concept of student-centered and continuous improvement to achieve comprehensive development of students.

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