

Exploration of the Curriculum Construction for Traditional Engineering Major under the Background of New Engineering

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Abstract: The new round of technological revolution and industrial transformation worldwide has posed new challenges to the reform and development of engineering education, and the proposal of the construction of new engineering disciplines is a positive response to this challenge. Under the Background of the development of new engineering disciplines, this paper focuses on the traditional engineering major of Measurement & Control Technology and Instruments. By studying the reform of curriculum system construction, it explores the transformation and upgrading of traditional engineering majors and innovative changes in talent cultivation models. Based on the core concept of Outcome Based Education (OBE), starting from the characteristics of measurement and control technology and instruments, combined with the positioning of the school and the needs of local economic construction, this paper explores the establishment of a curriculum system that is suitable for the new economic era.

Keywords: Higher Education, New Engineering, Curriculum System, Measurement & Control Technology and Instruments

1 Introduction

The new round of scientific and technological revolution and industrial transformation worldwide, as well as the booming development of the new economy sweeping across the world, have posed new challenges to the reform and development of engineering education. The proposal of the construction of new engineering disciplines is a positive response to this challenge. In "New Engineering", "Engineering" refers to the discipline of engineering, and one of the three meanings of "New" is "New type", which refers to the transformation, reform, and upgrading of traditional and existing (old) disciplines, including the expansion of connotation, transformation or improvement of training objectives and standards, reform and innovation of training models, and the formation of new disciplines [1]. The discipline of Instrument Science and Technology, as an engineering discipline in the high-tech field, involves knowledge from multiple disciplines such as physics, biology, materials science, chemistry, mechanics, optics, electronics, automation, communication, and computer science. It is a scientific and technological discipline that specializes in researching, developing, manufacturing, and applying various organs that extend human thinking, sensation, and physical abilities. With the rapid development of science and technology, especially information technology, as well as intelligent technology in recent years, measuring

instruments and systems that carry various physical, chemical, and biomass information have developed into a system that integrates various high-tech elements. The characteristics of multidisciplinary integration and multi system integration are becoming increasingly evident.

The development of science and technology not only greatly increases the demand for professionals in major of Measurement & Control Technology and Instruments in more and more fields of research and application, but also, with the accelerating speed of knowledge updating, the knowledge economy era urgently needs talents with high comprehensive quality, practical ability, and innovative ability. This puts forward new requirements for the cultivation of professionals in measurement and control technology and instruments [2-4].

The major of Measurement & Control Technology and Instruments is a traditional major in the undergraduate major catalog issued by the Ministry of Education of China. It is a meaningful research topic to focus on the needs of traditional major transformation and upgrading and the cultivation and development of emerging industries in the new era of social development, promote the deep integration of knowledge, ability, and quality requirements of high-tech and engineering majors, and explore the implementation path of engineering major upgrading [5-7].

This article takes OBE (Outcome Based Education) as the core concept to explore the establishment of a curriculum system that is suitable for the new economic era under the background of the construction of "New Engineering" for the major of Measurement & Control Technology and Instruments.

2 Major of Measurement & Control Technology and Instruments in Tianjin University of Technology

The next subsections provide Measurement & Control Technology and Instruments (formerly Precision Instruments) is one of the traditional advantageous major of Tianjin University of Technology, founded in 1979. Adhering to the professional positioning of serving local economic construction and social development as the main focus, setting professional training goals, and cultivating applied engineering and technical talents who can adapt to the needs of local economic construction and social development, and engage in scientific research, technological development, enterprise production management, and other work in the field of instrumentation engineering.

After the professional adjustment in 1996, the professional scope was expanded to form a comprehensive major that integrates multiple disciplines such as electronics, optics, precision machinery, computer technology, and information technology. After the revision and adjustment of the curriculum system in 2010, the professional direction of information technology testing, measurement, and application was determined. In 2018, the major passed the China Engineering Education Certification, achieving international mutual recognition of graduate academic qualifications. Through the new engineering construction project, it sorted out its characteristics and established a new engineering construction direction with intelligent testing. In 2019, the major was approved as a national first-class professional construction major.

For over 40 years of professional construction, we have been catering to the talent needs of local socio-economic development and adhering to characteristic development. After years of accumulation, we have formed a high-level professional teaching team based on photoelectric detection, covering fields such as machine vision, artificial intelligence, and embedded systems. Based on the needs of teacher reserves, student ability cultivation, and local economic construction services, a student training and research construction direction with "photoelectric detection technology" and "embedded measurement and control system design" as distinctive advantages has been formed. The professional team has achieved numerous excellent results in teaching and research, scientific research, and student technology. The team also adheres to scientific research feedback teaching, integrating scientific research with talent cultivation, cultivating students' innovative spirit and engineering practical ability, and cultivating excellent professional talents with innovative spirit and practical ability for Tianjin and surrounding areas.

The major has undergone years of development, and its undergraduate training program has also undergone multiple revisions, striving to solve problems such as outdated knowledge content taught in certain courses, large credits, overlapping content between certain courses and several courses, low rate of elective courses, unclear cultivation of students' core abilities, and weak practical teaching links, and so on. It is imperative to change the problems existing in the traditional curriculum system, introduce new generation information technology contents to meet the needs of the times, and explore a new engineering transformation curriculum system suitable for interdisciplinary integration of the major of Measurement & Control Technology and Instruments.

3 Curriculum System Construction under the Background of New Engineering

3.1 Establish a curriculum system structure that aligns with the professional training objectives, and taking into account local characteristics and school positioning

Based on the positioning of Tianjin University of Technology, which focuses on information science disciplines and serves the development of local economic construction, the training objective of our major of Measurement & Control and Instruments is proposed: to cultivate technical engineering talents who with a sense of social responsibility, good professional ethics, engineering literacy, and humanistic literacy, as well as the comprehensive application ability of basic knowledge in natural sciences, basic theories in the field of instrumentation engineering, and professional knowledge. The talents are with rich engineering practical experience in the field of instrumentation engineering, innovative consciousness, self-learning and practical ability, adapting to the needs of local economic construction and social development, and able to engage in scientific research, technological development, enterprise production management, and other work in the field of instrumentation engineering.

Based on the positioning of the school and the training objectives of our major of Measurement & Control Technology and Instruments, there are three main guiding principles for revising the training plan:

- ① Reflect the cultivation of basic knowledge and abilities in mathematics, natural sciences, engineering, as well as mechanical, optical, electrical, and computational disciplines required for the measurement and control profession;
- ② Based on the school and professional positioning, clarify the core competencies of the students being trained;
- ③ Reflect the characteristics and advantages of our school and our major, and condense the talent cultivation plan with professional characteristics.

3.2 The core concept of Outcome Based Education (OBE) is to cultivate the core abilities of students; supporting the cultivation of core competencies with "core courses" and constructing a core curriculum group

Following the concept of engineering education and implementing the Outcome Based Education (OBE), starting from the student-centered approach, this article proposes the concept of cultivating students' "core abilities", establishes a curriculum system supported by "core courses", and carries out the construction of core course clusters [8-11].

Establish a course system structure as shown in Fig.1 and explore the construction of professional course systems.

The cultivation of basic abilities in disciplines such as mechanics, optics, electronics, computing, and control in this major is supported by Subject Based Courses; and the cultivation of core professional abilities is supported by Professional Courses. In the Professional Elective Course system, establish course groups in different directions to support the distinctive training direction of the major. Based on the employment ability needs of students, local economic construction needs, as well as the history, development, teaching staff, and research characteristics of this major, we will condense the talent cultivation direction of intelligent optoelectronic testing technology and embedded measurement & control system design.

Classify core courses with the same ability development needs and form a course group. Design and integrate relevant courses for classmates or interdisciplinary subjects, using logical connections such as knowledge, methods, and problems between courses as a combination point, so that they complement each other and permeate each other, reflecting the significance of one course within the group to another. Build a curriculum system with the goal of cultivating abilities and the curriculum group as a relatively independent unit.

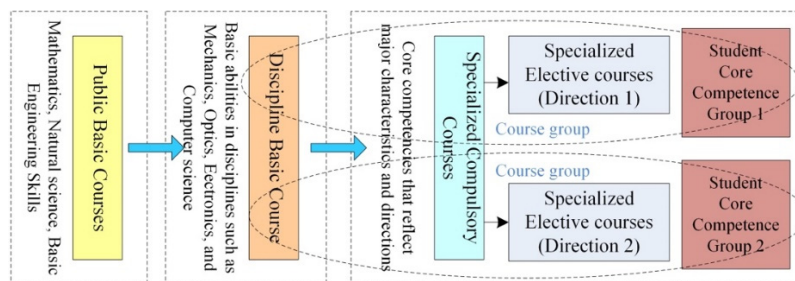


Fig.1. Construction of course system structure for major of Measurement & Control Technology and Instruments

3.3 In the background of the construction of "New Engineering", improving the professional course offerings and establish a curriculum system that is suitable for the new information and economic era

In this study, curriculum construction is used as a carrier to transform, transform, and upgrade the existing curriculum system, organization, and content in response to the current and future industrial development needs, and establish a curriculum system that is suitable for the new information and new economic era [12].

Taking the advantage and characteristic direction of "Optoelectronic Testing Technology" in the early stage of construction as an example, in the past decade of development, the major has shifted from a traditional course system mainly based on geometric measurement to an information-based measurement and control direction mainly based on mainstream technologies such as optics and electricity, with a focus on researching the theory and technology of information acquisition, processing, and control of relevant elements. However, in the fourth industrial revolution characterized by the Internet of Things and information physical systems, the curriculum system also needs to be developed accordingly to meet the needs of talent cultivation in the new economic era. As shown in Fig.2, it is planned to add Internet of Things, Internet plus, intelligent computing and other contents on the basis of traditional photoelectric testing technology, reorganize the curriculum system, and construct the characteristic training direction of intelligent photoelectric testing technology.

The specific curriculum system is shown in Fig.3.

In the Professional Elective Course module, two strengthening direction groups are set up, namely "Application of Optoelectronic Detection Technology" and "Design of Embedded Measurement and Control System", to support the development of professional characteristics. At the same time, in the context of the construction of new engineering disciplines, based on core capabilities such as information acquisition, information processing, algorithm design, and data analysis, new engineering capabilities such as "Intelligent Perception and Testing" and "Internet of Things Construction (Distributed Measurement and Control System Construction)" are proposed.

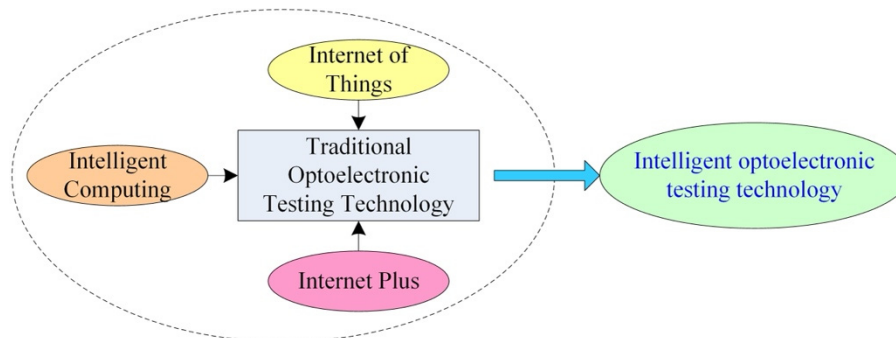


Fig.2. Transformation and upgrading of traditional training direction

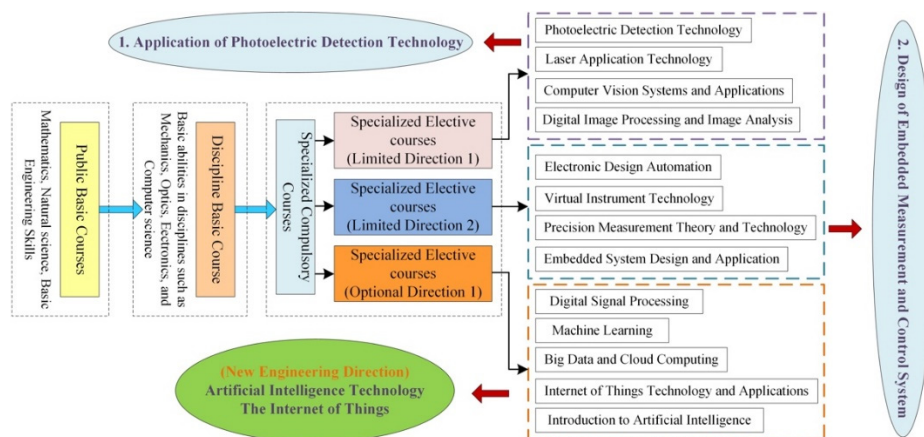


Fig.3. Curriculum System Plan

In the Professional Elective Course module, courses such as "Machine Learning", "Big Data and Cloud Computing", "Internet of Things Technology", and "Introduction to Artificial Intelligence" have been added to support the construction of new engineering factors in our major. Support the cultivation of "Intelligent Perception and Testing" abilities through courses such as "Machine Learning" and "Big Data and Cloud Computing", and support the cultivation of abilities in "Internet of Things Construction (Distributed Measurement and Control System Construction)" by the courses such as "Internet of Things Technology and Applications".

4 Conclusion

The 2021 version of the training program at Tianjin University of Technology was initiated in year of 2021. The research content of "Building a Curriculum System for New Engineering" is fully applied for major of Measurement & Control Technology and Instruments. At present, students in the 2021 cohort are the main target audience for curriculum reform, starting from their third year of college. During the implementation period of the project, the scope of implementation is for students in three grades: 2021, 2022, and 2023. The beneficiary students are students of major of Measurement & Control Technology and Instruments in the later stage, as well as students majoring in case promotion of training plans after the formation of research results.

In recent years, students have repeatedly achieved excellent results in competitions such as the "Challenge Cup" Chinese College Student Entrepreneurship Plan Competition, the National College Student Intelligent Automobile Competition, the "Creating Youth" College Student Entrepreneurship Competition, the North China Five Provinces Robot Competition, and the National and Tianjin Municipal College Student Innovation and Entrepreneurship Plan Training Project, and so on. In 2022, teachers and students of our major won National Second Prize in the 17th "Challenge Cup" National College Students Extracurricular Academic and Technological Works Competition.

In response to the construction of traditional engineering professional curriculum system under the background of new engineering, this article studies and obtains the following conclusive results.

(1) Based on the OBE concept of outcome oriented education and the student-centered concept of engineering education certification, the concept of cultivating students' "core abilities" is proposed, and it is proposed to support the cultivation of "core abilities" with "core courses", and to construct a professional curriculum system.

(2) Under the background the construction of "New Engineering", we are exploring new directions for the transformation and upgrading the major of Measurement & Control Technology and Instruments, focusing on new technologies such as Artificial Intelligence, Big Data, and the Internet of Things. We are improving the professional course offerings and establishing a curriculum system that is suitable for the new information and economic era.

(3) Adapt to the needs of knowledge innovation, technological progress, and disciplinary development, cultivate professional talents that meet industrial needs, and better serve the local economic development of Tianjin.

The major of Measurement & control Technology and Instruments is an important and traditional undergraduate major in the field of instrument science and technology. The research on the cultivation mode of applied talents in the major of Measurement & Control Technology and Instruments of our school still needs to be continuously improved and enhanced in practice, in order to promote quality education, improve teaching quality, keep up with the pace of the times, closely follow social needs as the guiding ideology, and increase the training of applied talents.

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