Construction of College Engineering Training System Based on OBE—Take Aerospace Engineering University as an Example

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Abstract. This paper analyzes the OBE result-oriented education model, combines the implementation steps of OBE, and follows the teaching concept of the unity of knowledge and action. The construction structure, curriculum system, training management system and achievement evaluation system framework of the Engineering Training Center of Aerospace Engineering University are designed. And under the guidance of this system framework, it has been verified by practice: the trainees who have undergone engineering training innovation and practical ability training have obvious advantages in winning awards in various competitions, writing scientific papers, and evaluating graduation thesis. The construction of this system can provide reference for other similar higher engineering colleges to carry out engineering training construction.

Keywords: Newengineering · Aerospace Engineering Training · OBE Outcome Oriented · Innovative training

1 Introduction

In 2015, Premier Li Keqiang mentioned in the "Government Work Report" reviewing his work in 2014 that he should focus on cultivating new growth points and promoting the accelerated development of the service industry, support the development of strategic emerging industries such as mobile Internet, integrated circuits, high-end equipment manufacturing, and new energy vehicles. With the sudden emergence of Internet finance, new business formats such as e-commerce, logistics and express delivery have grown rapidly, many "makers" have come to the fore, and the cultural and creative industries have flourished.

In 2015, the "Made in China 2025" plan was proposed for industrial development, The introduction of this plan reflects the country's plan to actively respond to a new round of technological revolution and industrial transformation. The scientific and technological revolution and industrial transformation are based on talents, and talent training depends on education.

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In 2017, the Ministry of Education successively formed the "Fudan Consensus", "Tian Da Action" and "Beijing Guide". The "Notice on Carrying out New Engineering Research and Practice" and "Notice on Promoting New Engineering Research and Practice Projects" were issued, and the construction of new engineering was gradually implemented. As the main responsible unit of the new engineering construction, the major engineering and comprehensive colleges and universities, subsequently, a research and construction boom centered on new engineering disciplines was launched.

The aerospace industry is an emerging industrial sector in which human beings develop into space. It is an important part of the national defense technology industry. The aerospace industry level represents a country's economic, military and technological level, and is an important symbol of a country's comprehensive national strength and national defense strength. Aerospace engineering belongs to an emerging engineering specialty field that has only begun to develop in the past half century. The construction of engineering education in the aerospace field will become an important part of the new engineering construction. Under the background of national new engineering construction, how to continuously cultivate high-quality compound "new engineering talents" with strong engineering practice ability, strong innovation ability and international competitiveness for my country's aerospace industry iswhat we need to think about and research questions [1–3].

2 OBE Education Model

The full name of OBE is the output-based education model. American scholar William G. Spady explained OBE as follows: "Clearly focus and organize each link in the education system, determine a learning goal, around this goal enables students to achieve the expected results after completing the learning process" [4]. The OBE model emphasizes the main role of students in the learning process, and advocates students' autonomous learning, self-learning and mutual evaluation. Teachers are the managers, person who demonstrates and supervisors of the teaching process. Teachers play an exemplary and guiding role for students, and evaluate students' self-study and self-evaluation. Since it was proposed in the 1990s, the OBE education model has been widely used in basic education in the United States, Australia and other countries. It has become the mainstream concept of education reform in the United Kingdom, the United States, Canada and other countries, and has been fully adopted by the professional certification of engineering education. This educational model adopts the inverse method, reversely designs the students' educational structure and related evaluation system according to the expected results, and forms a closed-loop continuous improvement, in order to achieve the purpose of rapidly improving the quality of teaching [5–8]. It can be seen that educators need to have a clear understanding of the ability of students to work after completing their studies, that is to say, the needs of future positions for students' ability and quality are clear, this is completely in line with the graduation and appointment law of the University of Aeronautics and Astronautics. Therefore, it is of practical significance to use the OBE result-oriented education concept to guide the construction of the Aerospace Engineering Training Center system.

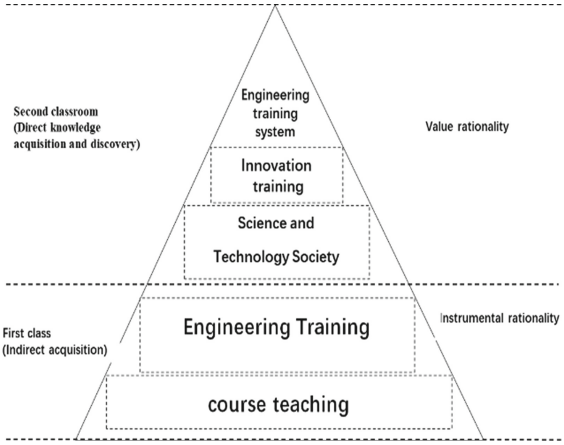

Fig. 1. System Framework of University Engineering Training Center

3 Construction of Aerospace Engineering Training Center System

Engineering training is a necessary process for the training of engineering professionals, and the engineering training center is an effective platform for improving the engineering literacy and innovation ability of undergraduates. Other local higher engineering education institutions at home and abroad have built specialized engineering training environments, such as: Tsinghua University, Zhejiang University's College Student Innovation and Entrepreneurship Practice Center, Wuhan University's Student Innovation Center, Harbin Engineering University and Nanjing University of Aeronautics and Astronautics Engineering Training Center, Engineering Workshop of Xi'an Jiao tong University, etc. In order to improve students' engineering practice and innovation ability. Drawing on the successful experience in the construction of existing engineering training centers in China, combining the characteristics of university aerospace engineering training and the background of new engineering construction, taking Aerospace Engineering University as an example, the engineering training center system is constructed.

3.1 Architecture of Engineering Training Center

The University of Aeronautics and Astronautics is a comprehensive institution specialized in cultivating advanced aerospace engineering and technical personnel. According to the functional orientation of the university and the training tasks of aerospace engineering and technical personnel, the expected learning outcomes of undergraduate and postgraduate students in the engineering training center are integrated, and in accordance with the education and teaching concept of "integration of knowledge and action" [10], The system structure of the engineering training center with the characteristics of aerospace engineering culture, the cradle of outstanding engineers, the scientific and technological innovation of students, and the transformation of teachers' achievements has been constructed, as shown in Fig. 1:

The Engineering Training Center is mainly for two levels of students, undergraduate and postgraduate. The training of undergraduates is mainly based on the cultivation of engineering practice ability, supplemented by the cultivation of innovative thinking and innovative ability; the training of graduate students is mainly based on innovation ability, supplemented by the consolidation of engineering practice ability. Based on this, the whole framework is divided into two stages: The first classroom stage is the stage of indirect knowledge acquisition, which mainly carries out classroom principle verification teaching and basic engineering technology skills training; The second classroom stage is the advanced stage of direct acquisition of knowledge, discovery of problems and attempts to solve them, mainly carrying out scientific research work such as scientific and technological community activities and project principle verification. Undergraduate students need to learn general basic knowledge in the first and second year of university. The Engineering Training Center can provide these students with a platform for knowledge verification of common basic courses, as well as a platform for these students to carry out basic training in cognitive and engineering skills. In order to cultivate students' engineering literacy and basic engineering skills; Sophomore and third-year students can carry out the training of innovation ability and comprehensive thinking ability through the training center, such as participating in extracurricular experiments, competition teams, interest groups, etc.; The third and fourth grades focus on the comprehensive application of engineering and the cultivation of students' innovative ability. On the basis of the original interest group or the second classroom, they will move forward to the cutting-edge or practicality of technology, and provide a training platform for this. The engineering training center can be fully opened to provide them with a scientific research platform for the postgraduates of master and doctoral degree, whose research results become practical and carry out in-depth research on cutting-edge technology.

3.2 Curriculum System Construction

The construction of a scientific training course system is the core of the core of the engineering training center's effectiveness and the realization of its goals. According to the system framework of the engineering training center in Fig. 1, combined with the results-oriented, student-centered, and future-oriented training concepts, fully respect students' personality, interests and hobbies, stimulate students' initiative and enthusiasm for learning and training, and gradually complete the transition from low-level training to high-level training, Based on the principle of continuous improvement of students' engineering practice ability and innovation, the curriculum system is divided into two categories and four layers. The two categories refer to compulsory courses and elective courses, Compulsory courses include general basic courses of aerospace engineering, professional foundations of various disciplines and professional core courses. That is, the engineering training center covers the experimental and practical training courses of all required courses in the talent training program; Elective courses include basic courses in aerospace engineering technology, as well as other subject courses closely related to aerospace engineering and cutting-edge technology courses. The four layers include general basic and professional courses, engineering technology basic training elective courses, science and technology association-related elective courses, and cutting-edge

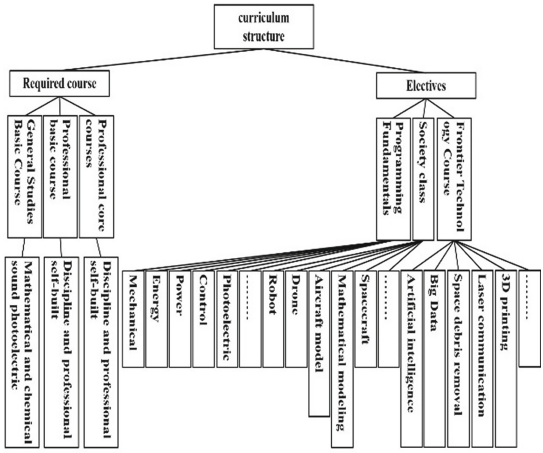

Fig. 2. Training Course System

technology elective courses. General basic courses mainly include verification experiment courses such as mathematics, physics, chemistry, mechanics, electromagnetism, circuit analysis, digital electronic technology, and analog electronic technology; The experimental and practical training courses of professional basic courses and professional core courses are determined by the professional talent training plan of each discipline; The elective courses related to the scientific and technological community mainly include technical courses provided by the activities carried out by the scientific and technological community or related to the design of various competitions; Frontier courses also adopt the form of electives to introduce forward-looking, pioneering and exploratory major technologies in aerospace-related fields into the curriculum system. The two types of four-tier curriculum systems are shown in Fig. 2.

3.3 Construction of Training Management System

According to the theory of organizational structure, there are two organizational structure models for engineering training centers in colleges and universities. The first is affiliated with a certain engineering discipline unit in the university, and the second is the independent establishment of the university. According to the characteristics of personnel in university, that is, the staffing is relatively fixed, the teaching and scientific research tasks of teachers and managers are heavier, and the engineering training center is a common teaching and scientific research innovation platform for all engineering majors in the university, involving many self-built contents of disciplines and majors, etc. The engineering training center adopts an independent system and is under the direct management of the university. According to the engineering training center structure, personnel setting and ease of management, The Engineering Training Center can set up the General Management Office, the Engineering Basic Training Office, the Engineering Skills Training Office, the Engineering Innovation Training Office, Office of Management of Scientific and Technological Societies. The General Management Office is mainly responsible

for the management and daily management of the full-time staff of the center; The Engineering Basic Training Office is mainly responsible for the training management of general basic and professional experimental training courses; The Engineering Skills Training Office is responsible for the training of engineering technicians and the training management of engineering skills courses; The Engineering Innovation Training Office is responsible for the training management of cutting-edge technology courses; The Science and Technology Association Management Office is mainly responsible for the management of the discipline associations. The construction of the engineering training center personnel team is based on the combination of teaching and scientific research and engineering technology, and full-time/part-time teachers and combined with external employment. The personnel are divided into four categories, consisting of managers, experimental instructors, practical training technicians/engineers, and scientific research community instructors. Among them, the leaders of management positions are concurrently held by the deputy leaders of the dominant disciplines, or full-time by the leaders of the dominant disciplines, and other management personnel are recruited by the non-staff employment system; The experimental instructors shall be the experimentalists assigned by various disciplines and majors; Among them, the leaders of management positions are concurrently held by the deputy leaders of the dominant disciplines, or full-time by the leaders of the dominant disciplines, and other management personnel are recruited by the non-staff employment system; The experimental instructors are appointed by the experimentalists assigned by various disciplines; the practical training technicians/engineers can be selected from the skilled senior non-commissioned officers of the basic units. Retired skilled senior non-commissioned officers can be re-appointed, and engineers from relevant local enterprises and institutions can also be employed concurrently; the instructors are concurrently held by teachers with high scientific research level and rich engineering practice experience in various disciplines.

3.4 Construction of Evaluation System

Evaluation is the last link of the outcome-oriented teaching model. It is not only a verification of the expected learning results, but also the original driving force for optimizing the entire engineering training system. It is also one of the essential links of the OBE outcome-oriented teaching model. This is precisely one of the weak points of domestic colleges and universities. According to the theory and experience of student learning assessment practice in American colleges and universities, the expected learning output assessment can be divided into the following aspects. According to the level, the learning output assessment can be divided into classroom level, professional level and school level; according to the content of the assessment, it can be divided into direct assessment and indirect assessment; according to the main body, it can be divided into teachers, students, alumni, employers, managers etc. [5]. Germany is an old industrial power, his engineering professional certification body ASIIN (The Accreditation Agency for Study Programs in Engineering, Informatics, Natural Sciences and Mathematics), establish corresponding evaluation systems and standards in terms of the reasons for setting up courses, organizational requirements for courses and teaching content, teacher material security, and teaching-related projects. Accredited experts are composed of university

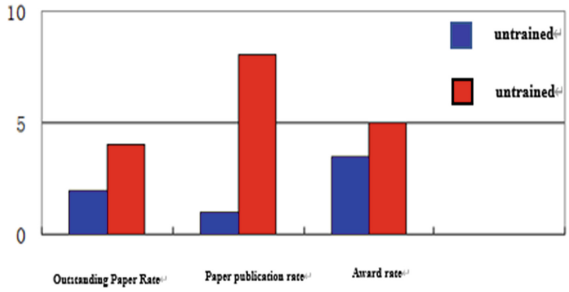

Fig. 3. Comparison result graph

members, senior professional and technical members, and industrial and business people. University engineering degrees certified by ASIIN are recognized in the European Union, the United States, Canada and other countries, and their graduates are qualified to work as engineers in the above-mentioned countries [9]. At present, my country has established a Chinese industrial engineer grade certification body, and has designated the implementation rules for the qualification certification of industrial engineers (for trial implementation) and the implementation rules for the selection of industrial engineering experts (for trial implementation), which are being continuously revised and improved. At present, my country has established a Chinese industrial engineer grade certification body, and has designated the implementation rules for the qualification certification of industrial engineers (for trial implementation) and the implementation rules for the selection of industrial engineering experts (for trial implementation), which are being continuously revised and improved. For the construction of the evaluation system of the engineering training center, it can be carried out in the form of a combination of hierarchical, multi-subject combined evaluation and qualification certification with reference to the United States.

4 Practice and Effect Analysis

In the past three years, under the guidance of the framework of the aerospace engineering training system, the university's communication engineering and related majors have continued to cultivate students' innovative ability. A total of more than 100 undergraduate and postgraduate students in communication, control and other majors have participated in engineering training innovation practice activities. Among them, in international and national university competitions or 1 international silver award, 3 national special prizes, 3 first prizes, 5 s prizes, 2 third prizes and other outstanding achievements. Statistics of graduates in the past three years show that after the training of engineering training innovation ability, the ratio of students' papers rated as excellent is 20%, which is double that of students who have not passed engineering training innovation and practical ability training. The cultivation of innovative ability in engineering training has obvious advantages for students in terms of graduating with excellence, publishing papers and winning awards, as shown in Fig. 3.

5 Conclusion

With the development of aerospace engineering technology, especially in the context of new engineering, the knowledge system of aerospace engineering tends to be systematic. If undergraduate students in the aerospace field want to adapt to the needs of future work tasks and improve their technological innovation capabilities, they urgently need to supplement the relevant engineering knowledge that is missing or necessary in their majors, improve the aerospace engineering knowledge system, and understand the development of cutting-edge technologies. Aerospace Engineering Training Center plays an increasingly important role in cultivating students' engineering awareness, creativity awareness and innovation ability in the education process of colleges and universities. It is an important means to improve the comprehensive engineering education quality of students, laying a solid foundation for the improvement of engineering practice and innovation ability for cultivating engineering and technical talents related to aerospace missions in the future.

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