

Exploration on the Reform Path of Undergraduate Talent Training Mode for Aircraft Control and Information Engineering in Application-oriented Regional Universities

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Abstract:

This paper centers on the talent cultivation of undergraduate majors in aircraft control and information engineering in applied local universities. Based on the analysis of the characteristics and drawbacks of the traditional engineering talent training model, the goals and principles of talent training reform in this major have been made clear. To cultivate high-quality professionals in aircraft control and information engineering with innovative practical abilities and the ability to adapt to the development needs of the regional drone industry. Adhering to the principles of application-oriented approach, integration of industry and education, student-centered approach, and continuous improvement, a series of targeted talent cultivation reform measures have been put forward, including optimizing the professional curriculum system, strengthening textbook construction, innovating teaching methods and means, deepening school-enterprise cooperation, enhancing the construction of off-campus practice bases, encouraging students to participate in subject competitions, strictly selecting and guiding graduation design topics, and improving the quality assurance system for talent cultivation. Through continuous exploration and improvement in recent years, the quality of talent cultivation in this major has been effectively enhanced, and the ability of teachers and students in this major to serve society has been continuously strengthened.

Keywords:

Application-oriented Regional Universities, Aircraft Control and Information Engineering, Talent Cultivation Mode, Reform

1. Introduction

1.1. Research Background and Significance

As the low-altitude economy increasingly emerges as a new engine for China's economic growth [1], the drone industry, as a crucial component of the low-altitude economy, is playing an increasingly vital role in military, agricultural, environmental protection, disaster relief, and logistics fields. To meet the talent demand in the drone industry for economic and social development, many universities have set up undergraduate majors related to drones.

In recent years, a new generation of technological and industrial revolution represented by big data and artificial intelligence has arrived. The demand for talent in the modern drone industry has shifted from a simple need for aerospace professionals to a requirement for composite talents. In response to the changing talent demand and to facilitate the construction of disciplines and majors that are in line with industrial transformation and upgrading, since 2016, universities have successively launched majors in Aircraft Control and Information Engineering, starting from Northwestern Polytechnical University. The Aircraft Control and Information Engineering major, as a typical "new engineering" major [2], integrates disciplines such as aviation, mechanics, electronics, and information technology.

The Sichuan-Chongqing region is a major hub of China's drone industry, boasting a relatively complete drone industry chain that encompasses design, research and development, production and manufacturing, as well as application services, and gathering a large number of drone companies. As an engineering college that has long served the local economy, Chengdu University of Technology has traditional strengths in mechanical manufacturing and electronic information. To utilize the school's existing advantageous disciplines, establish and develop aerospace disciplines, and better serve local advantageous industries, in 2016, the school established the Unmanned Aerial Vehicle Industry Technology Research Institute and launched a specialized program in Unmanned Aerial Vehicle Application Technology. In 2018, the university set up an undergraduate program in Aircraft Control and Information Engineering. From then on, as an application-oriented regional university, the exploration of the construction and talent training reform of the Aircraft Control and Information Engineering major commenced.

1.2. Research Objectives and Methods

Compared with traditional powerhouse universities, as an applied local university, Chengdu Institute of Technology has a relatively weaker disciplinary foundation in the aerospace field. The Aircraft Control and Information Engineering major, being an emerging field, has high levels of systematicness and integration. Consequently, it is challenging to draw upon existing talent cultivation models. Only by fully considering our own characteristics and the demands of the drone industry, continuously reforming the talent training mode, and effectively enhancing the quality of talent training, can we cultivate applied talents that meet the requirements of industrial development.

Since the major was established, we have stuck to the Outcome-Based Education (OBE) philosophy [3], promoted Project-Based Learning (PBL) [4], and concentrated on curriculum design, textbook construction, teaching methods, internships, subject competitions, and graduation projects. We have initially explored a talent cultivation model for the Aircraft Control and Information Engineering major that is suitable for the characteristics of application-oriented regional engineering universities.

2. Traditional Talent Cultivation Mode and Existing Issues

2.1. Traditional Engineering Talent Training Model

The traditional engineering talent cultivation model in China primarily draws on and develops the engineering education concepts of the Soviet Union and exhibits the following characteristics [5,6,7,8,9]:

The curriculum attaches great significance to basic courses and professional foundation courses. Basic courses typically comprise advanced mathematics, linear algebra, college physics, C programming and other fundamental science courses, along with professional core courses like automatic control principles, circuit analysis, microcomputer principles, and so on. The aim is to establish a solid professional theoretical foundation for students.

The practical teaching process generally comprises experimental courses, course design, and internships. The experimental course is aimed at deepening students' understanding of theoretical knowledge via practical operations; Course design demands that students comprehensively apply their acquired knowledge to solve specific professional problems; Internship enables students to go to the enterprise site to comprehend the actual work environment and processes.

The characteristic of teaching methods is that classroom lectures are the main emphasis. Teachers systematically expound professional knowledge in the classroom, while students mainly learn by listening and taking notes. Emphasis is laid on theoretical teaching, with a focus on imparting theoretical knowledge and relatively little attention paid to practical applications and engineering practices.

The assessment and evaluation of students are mainly based on their examination scores. Usually, the final examination scores are the main criterion for comprehensive evaluation, combined with regular assignments and attendance records. The examination questions are mostly standardized, emphasizing the assessment of students' knowledge memorization and comprehension abilities.

2.2. Existing Issues

During the modernization period, the traditional engineering talent training model in China has rapidly cultivated a large number of engineering professionals who meet the requirements of national construction. However, with the development of the times and the progress of technology, this model has gradually exposed some issues, which are manifested as follows [10,11,12,13]:

Regarding curriculum design, knowledge updates are sluggish and there is inadequate interdisciplinary cooperation. With the rapid development of technology, traditional course content fails to keep pace with the latest trends and demands of the industry promptly, leading to a certain disparity between the knowledge acquired by students and their practical applications. Owing to the influence of the Soviet engineering education philosophy, there is an excessive focus on specialized specialization and a shortage of interdisciplinary courses, which is not conducive to cultivating students' comprehensive quality and innovation ability.

Regarding teaching effectiveness, students lack initiative and the practical teaching outcome is unsatisfactory. The teaching approach mainly centered around teacher lectures can readily place students in a passive state of reception, lacking the impetus for active thinking and exploration. There are formalistic issues in the practical

teaching process, and students lack genuine practical opportunities and in-depth participation, making it hard to effectively integrate theoretical knowledge with practical operations.

Regarding assessment and evaluation, the evaluation approach is simplistic and lacks incentives for innovation. Excessive reliance on examination scores makes it challenging to comprehensively assess students' overall qualities and practical capabilities. Standardized assessment is not conducive to stimulating students' innovative thinking and personality development.

3. The Goals and Specific Measures of Talent Cultivation Model Reform

3.1. Principles and Objectives of Talent Training Model Reform

To address the drawbacks of the traditional engineering talent training model, we have set the following goals and principles when reforming the talent training model for the aircraft control and information engineering major.

The overall reform objective is to foster high-quality professionals in aircraft control and information engineering with innovative practical capabilities and the ability to adapt to the development requirements of the regional unmanned aerial vehicle (UAV) industry. Specifically, it encompasses knowledge objectives, ability objectives, and quality objectives, for example, students should master solid professional fundamental knowledge, possess strong engineering practice capability and innovative spirit, and have good teamwork and communication skills.

The reform principles encompass the application-oriented principle, the integration of industry and education principle, the student-centered principle, and the principle of continuous improvement. Closely align with local economic and industrial development requirements, and place emphasis on practical teaching and the cultivation of application abilities. Strengthen cooperation with enterprises to achieve deep integration of education and industry. Pay attention to students' individual development and needs, and design teaching content and methods with students as the center. Establishing a quality monitoring and feedback mechanism for talent cultivation, and continuously optimizing the talent cultivation model.

3.2. Specific Measures for the Reform of the Talent Cultivation Model

3.2.1. Optimizing the Professional Curriculum System

Based on the requirements of the drone industry and an analysis of the target job competencies of the trained students, adjust the professional curriculum and add courses related to emerging technologies and industries, such as "Robotics", "Matlab Programming", and "Machine Vision and Applications".

Construct a modular curriculum system comprising professional basic course modules, professional core course modules, practical teaching course modules, and extended course modules to achieve an organic connection and mutual support among courses. Eventually, three major course systems are formed, including those related to drone hardware, drone information processing (software development), and drone industry applications. Among them, courses related to drone hardware include "Principles and Applications of Embedded Systems", "Communication Navigation and Radar", "Sensor and Detection Technology", "Rotor Drone Control Technology",

and “Aircraft Manufacturing Technology”, etc. For drone information processing (software development), it includes courses such as “MATLAB Programming”, “Signals and Systems”, “Database Applications”, “Artificial Intelligence Drones”, “Robotics Technology”, “Algorithms and Data Structures”, etc. In the field of drone industry applications, there are courses such as “drone photogrammetry”, “GIS software applications”, “machine vision and applications”, “information security technology”, “drone security technology”, and “drone mission planning”, etc.

Moreover, we will enhance the updating and integration of course content, introduce the latest technologies and cases in the drone industry, and focus on cultivating students’ practical application and problem-solving capabilities.

3.2.2. Strengthen Textbook Development.

Given the emerging interdisciplinary nature of aircraft control and information engineering, there is a shortage of mature textbook systems compared to traditional and well-established majors. Hence, it is of particular significance to develop a textbook construction plan that meets the requirements of this major. As of now, the compilation and publication of the textbook for the course “Introduction to Drones” have been completed.

Regarding subsequent textbook construction, we will concentrate on two aspects and make significant efforts. Firstly, in the area of “intelligent technology + aerospace” integrated teaching materials, deeply integrate artificial intelligence technology with unmanned aerial vehicle technology to cultivate students’ ability to use artificial intelligence technology to solve application problems in the field of unmanned aerial vehicle technology. Secondly, we need to develop textbooks for the unmanned aerial vehicle field. For example, traditional “flight mechanics” textbooks are often targeted at manned aircraft or winged missiles. There are relatively few such textbooks for unmanned aerial vehicles on the market, so this is also another key area of our development.

3.2.3. Innovative Teaching Methods and Approaches

In the teaching process of professional courses, promote the project-based teaching method. Use actual projects as carriers to guide students to learn and apply professional knowledge in the project implementation process, and cultivate students’ engineering practice ability and innovative thinking. For example, in the study of drone photogrammetry, students are required to operate drones to complete a three-dimensional reconstruction of a ground building. Adopt the case teaching method. By analyzing typical cases, students can understand the solutions and methods for practical engineering problems and improve their analytical and decision-making abilities. In the course of database application, students will understand the role and specific implementation methods of databases through different cases such as warehousing systems and online shopping systems. For example, at the conclusion of the “Introduction to Drones” course, students are obliged to independently create a small rotary-wing drone and submit video materials as the basis for grading this course. Figure 1 depicts the production and flight testing process of a cardboard rotor unmanned aerial vehicle made by a student.

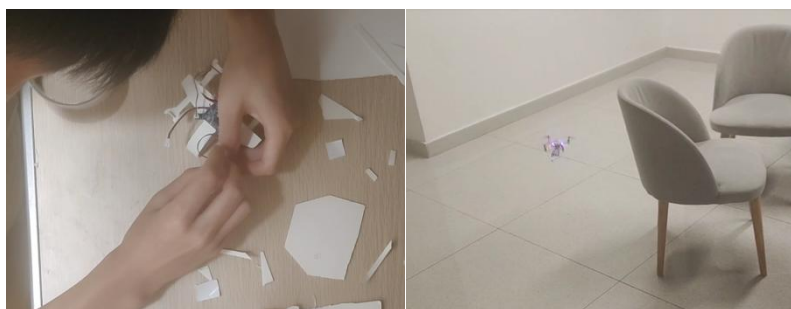


Figure 1. *Course Assignment - Student-Made Cardboard Rotorcraft Drone.*

Make use of modern educational technology to conduct blended online and offline teaching, enrich teaching resources, and enhance teaching effectiveness. At present, various online teaching platforms such as Rain Classroom and “Chenggong Zhixue” have been established. These platforms can help teachers record the teaching process, build course resources, and increase classroom interaction with students through network technology.

3.2.4. Deepen School-enterprise Cooperation and Strengthen the Construction Of off-campus Practice Bases

Establish a long-term school-enterprise cooperation mechanism and jointly develop talent training programs, curriculum standards, and internship and training plans with drone companies. Co-build an industry-university-research cooperation platform, jointly carry out scientific research projects and technological research and development, and promote the transformation of scientific and technological achievements. Invite experts from drone companies to participate in the teaching process, serve as part-time teachers, give lectures, and guide graduation projects. For example, when formulating the new talent training plan, this major focused on researching Sichuan Yidian Aviation Technology Co., Ltd. and Xi'an Lingkong Electronic Technology Co., Ltd. to understand the requirements of enterprises for the job competencies of graduates.

Regarding the construction of off-campus practice bases, multiple internship bases have been established, such as China Electronics Technology Special Aircraft System Engineering Co., Ltd., Chengdu Zongheng Automation Technology Co., Ltd., AEE Sichuan Yidian Aviation Technology Co., Ltd., and Chengdu Tianxing Zhihang UAV Technology Co., Ltd., fully meeting the internship and practice requirements of students majoring in this field. Figure 2 presents the production and assembly process of a large-scale industrial eVTOL drone which students visited at an off-campus practice base.



Figure 2. *Visiting and Interning at an Off-Campus Practice Base.*

3.2.5. Encourage Students to Take Part in Subject Competitions

By taking part in subject competitions related to their major, students can solidify their professional knowledge and expand their knowledge scopes. Generally, competitions demand that students comprehensively apply their professional knowledge, such as aerodynamics, flight principles, aircraft structures, and engines, etc., to solve practical problems. To achieve good results in competitions, students need to actively learn and understand cutting-edge technologies, emerging research directions, or interdisciplinary knowledge in the aviation field and broaden their knowledge bases. This helps them keep up with the development trends of technology.

Enhance hands-on skills and foster engineering practical capabilities. Taking the Sichuan Province College Students Future Aircraft Challenge that is participated in every year as an example. As shown in Figure 3, this competition requires students to actually operate airplane models, aviation equipment, or conduct flight simulations. Through these practical activities, students can convert theoretical knowledge into practical operational skills and improve their hands-on ability and practical experience. During the process of participating in competitions, students can learn how to design systems, develop engineering plans, arrange project schedules rationally, and collaborate with team members to complete tasks. These are essential practical abilities in the field of drone engineering.



Figure 3. Teachers and Students Taking Part in Subject Competitions.

Inspire innovation consciousness and cultivate problem-solving abilities. During the process of taking part in competitions, students need to constantly consider how to improve existing technologies or designs to enhance performance, reduce costs, or increase security. In competitions, students will encounter various complex problems and challenges, and they need to apply their learned knowledge and innovative thinking to analyze the essence of the problems and find solutions.

3.2.6. Conduct Strict Selection and Provide Guidance for Graduation Project Topics

Graduation design, as the last crucial part of undergraduate teaching, is also a comprehensive manifestation of students' academic capabilities. When determining the graduation project topic, it should be related to the major, and the proportion of design-related topics should be increased as much as possible. The topic should center on unmanned aerial vehicle industry services, have certain academic value and research significance, and be able to reflect the theoretical and applied hot issues in this professional field. For example, in a design project for an intelligent logistics distribution system for cargo drones, students need to comprehensively apply knowledge of flight mechanics to design reasonable flight trajectories and control strategies, utilize communication principles to achieve data transmission between

drones and ground stations, employ navigation principles to ensure the accurate arrival of drones at target positions, and combine automatic control principles to analyze the stability and reliability of the entire system. This kind of question can encourage students to organically combine these scattered professional course knowledge and apply it to the practical design, analysis, and implementation of unmanned aerial vehicle systems.

In the guidance process, it is crucial to ensure that the real tasks are completed accurately. For example, some content of a drone environmental data monitoring project can be transformed into a graduation project, and students can be guided to participate in real scientific research projects. As shown in Figure 4. Guide students to master scientific research methods and paper-writing skills, and focus on cultivating their abilities in literature retrieval and review, data analysis and processing, as well as logical thinking and argumentation. By strictly requiring students to adhere to academic standards in their graduation design, it can enhance their academic literacy and research ability, laying a foundation for them to pursue further studies or engage in academic research work in the future.



Figure 4. Student Involvement in UAV Environmental Data Monitoring Project.

3.2.7. Enhance the Quality Assurance System for Talent Cultivation

Establish a sound teaching quality management system, standardize teaching process management, and reinforce teaching quality monitoring. Construct a diversified teaching evaluation system that comprehensively takes into account factors such as students' academic performance, practical ability, and overall quality to evaluate teaching effectiveness comprehensively. Strengthen the tracking and feedback of graduates, understand the employment situation of graduates and the needs of employers in a timely manner, and provide a basis for the reform of the talent training mode.

4. Conclusion and Prospect

As an emerging interdisciplinary undergraduate major, Aircraft Control and Information Engineering is suitable for cultivating composite talents who serve the regional aviation and unmanned aerial vehicle industry. This also imposes higher requirements on teaching teams and talent cultivation models. Through years of continuous exploration and improvement, the quality of talent cultivation in this major has been effectively enhanced, achieving excellent results in terms of student employment rate, postgraduate entrance examination rate, and subject competitions. The major's ability to serve society continues to strengthen. As of now, the teachers and students of this major have participated in and completed multiple provincial and ministerial-level scientific research projects as well as enterprise horizontal projects.

Due to the limitations of the experience and level of professional teacher teams, there is still much room for improvement in the reform of talent cultivation models. The follow-up work will focus on the following three directions: further strengthening the construction of practical conditions; continuously sorting out and adjusting the direction of professional courses in response to technological development trends and industry demands; establishing a school-enterprise cooperation and collaborative education mechanism compatible with the development of the unmanned aerial vehicle industry in the Sichuan-Chongqing region. To continuously enhance the quality of talent cultivation and better serve the aviation and drone industry in the Sichuan-Chongqing region is the goal we aim to reach.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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