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Reform of the Talent Cultivation Model for Aircraft Electromechanical Equipment Maintenance Majors Driven by the Dual Engine of "Digital Intelligence + Industry-Education Symbiosis"

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Abstract: Against the dual backdrop of the digital intelligent transformation of the aviation industry and the in-depth integration of vocational education with industry, the talent cultivation for aircraft electromechanical equipment maintenance majors is confronted with a prominent contradiction between upgraded skill requirements and outdated training models. Centering on the dual driving philosophy of "digital intelligence + industry-education symbiosis," this paper analyzes the existing difficulties and deficiencies in current talent training combined with the job demands of the aircraft electromechanical equipment maintenance industry. It explores and constructs an innovative talent cultivation model featured by "digital intelligence empowerment, industry-education collaboration, integration of posts, courses, competitions, and certificates, and competency cultivation." By restructuring the curriculum system, innovating teaching modes, strengthening faculty development, and optimizing evaluation mechanisms, this study resolves the disconnection between traditional training models and industrial development. It provides practical approaches and theoretical support for fostering high-quality technical and skilled professionals who can meet the demands of the aviation maintenance industry in the digital intelligence era.

Keywords: Digital intelligence; Industry-education symbiosis; Aircraft electromechanical equipment maintenance; Talent cultivation model; Reform practice

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1. Introduction

The booming development of the air transport industry has driven the rapid expansion of the aircraft electromechanical equipment maintenance sector. The in-depth penetration of digital and intelligent technologies has reshaped the technical system and job requirements of the maintenance industry. The

application of new technologies such as drone inspection, digital twin, and AI-based fault diagnosis has set higher standards for the digital literacy and comprehensive professional skills of maintenance personnel. As the core development path for high-quality vocational education, industry-education symbiosis serves as a vital link connecting college training and industrial demands. At present, the major of aircraft electromechanical equipment maintenance still suffers from inadequate integration of digital intelligence skills, shallow industry-education collaboration, and rigid training models, which fail to adapt to the transformative development of the industry [1]. How to reform the talent cultivation model with digital intelligent technologies as the support and industry-education symbiosis as the path, and cultivate interdisciplinary maintenance talents equipped with professional competencies, digital literacy, and professional ethics has become an important issue for both vocational colleges and the aviation industry. Based on the dual-driven concept of "digital intelligence + industry-education symbiosis," this paper explores innovative paths for talent cultivation, so as to promote the coordinated development of specialty construction and the aviation industry.

2. Practical dilemmas of talent cultivation for aircraft electromechanical equipment maintenance under the dual drive of "digital intelligence + industry-education symbiosis"

2.1. Insufficient integration of digital intelligence and disconnection between talents and industrial demands

Currently, the aircraft maintenance industry is undergoing a transformation from experience-driven operation to data-driven operation. Digital intelligent technologies, including predictive maintenance, AR-assisted maintenance, and digital twin simulation, have been widely applied in maintenance practices. Talents proficient in digital operations and data analysis are in short supply across the industry. Nevertheless, most vocational colleges still focus on traditional mechanical maintenance skills in talent training. The setting of digital intelligence-related courses lags behind industrial development. Only a small number of information technology courses are added perfunctorily, without realizing the in-depth integration between digital intelligent technologies and core professional competencies. Students are only familiar with traditional maintenance tools and operational procedures, while lacking the ability to operate intelligent diagnostic equipment and digital maintenance platforms. As a result, they struggle to adapt to job requirements rapidly after graduation [2]. More notably, many colleges are not equipped with digital intelligent training facilities, making it impossible for students to experience the practical application of relevant technologies directly. The cultivation of digital literacy thus becomes empty talk, which constitutes the core root of the disconnection between talent training and industrial progress.

2.2. Superficial industry-education collaboration and incomplete symbiotic mechanism

Industry-education integration and school-enterprise cooperation are the core training paths for aircraft electromechanical equipment maintenance majors, yet their practical implementation is far from satisfactory. Most school-enterprise cooperation stays at a superficial level, and colleges and enterprises have not established an in-depth collaborative symbiotic mechanism. Enterprises lack enthusiasm for participating in talent cultivation. They merely provide a limited number of internship positions, without taking part in curriculum design, teaching implementation, and evaluation system construction. This leads to a gap between

college-trained talents and actual job requirements. On the other hand, colleges fail to accurately grasp the latest industrial technologies and professional standards. Their curriculum content is updated slowly, and teaching cases are divorced from real maintenance scenarios [3]. The prevalent situation of "active colleges while passive enterprises" prevents the effective implementation of industry-education integration and gives no full play to the educational value of industry-education symbiosis, ultimately undermining the pertinence and effectiveness of talent cultivation.

2.3. Rigid curriculum system and inadequate integration of posts, courses, competitions, and certificates

The traditional curriculum system of aircraft electromechanical equipment maintenance majors is highly rigid. Courses are designed based on disciplinary knowledge rather than job competencies. There is a lack of organic connection between different courses, accompanied by problems such as overlapping content and poor pertinence. The integration of posts, courses, competitions, and certificates remains superficial. Curriculum content is not fully aligned with vocational qualification standards such as CCAR-66R Aircraft Maintenance Personnel License. Competition content is separated from classroom teaching, and certificate assessment operates independently of course delivery. The educational goals of "designing courses based on posts, promoting learning via competitions, and improving quality through certificates" cannot be achieved [4]. In addition, curriculum content is updated sluggishly. New industrial technologies and specifications including composite material maintenance and drone inspection are not incorporated in a timely manner. The knowledge learned by students deviates greatly from industrial realities and cannot meet the dynamic demands of professional posts.

2.4. Backward faculty development and urgent improvement of dual-qualified competencies

The teaching staff acts as the core support for the reform of talent cultivation models. At present, the faculty team of this major has prominent deficiencies. For one thing, most full-time teachers have no frontline working experience in the maintenance industry. Though they possess solid theoretical knowledge, their practical teaching ability is inadequate. They cannot combine industrial practical cases with classroom teaching effectively, which greatly reduces teaching effectiveness. For another, the overall digital literacy of teachers is low. They are not proficient in digital intelligent maintenance technologies and digital teaching tools, and thus cannot meet the teaching requirements for cultivating digitally competent talents [5]. Meanwhile, the construction of part-time teachers from enterprises is imperfect. Effective incentive mechanisms are absent, resulting in low enthusiasm of enterprise technical backbones for teaching work. The development of the dual-qualified faculty team falls far behind the pace of talent cultivation reform.

3. Reform paths of the talent cultivation model under the dual drive of "digital intelligence + industry-education symbiosis"

3.1. Targeting digital intelligence demands and restructuring the integrated curriculum of posts, courses, competitions, and certificates

The curriculum system is the core carrier of talent cultivation. The reform shall be oriented toward digital intelligent transformation and centered on job competencies to restructure the curriculum system with deep

integration of posts, courses, competitions, and certificates. Firstly, conduct in-depth industrial surveys. Cooperate with leading enterprises such as China Eastern Airlines Technical Department and COMAC to analyze the core competency requirements of aircraft electromechanical maintenance posts in the digital intelligence era. Clarify the digital skill demands for route maintenance, scheduled inspection maintenance, and component & accessory maintenance, and integrate digital twin, AI fault diagnosis, AR-assisted maintenance, and other technologies into core professional courses [6].

Secondly, build a modular curriculum system consisting of basic module, core module, digital intelligence module, and expansion module. The basic module covers general disciplines including mathematics and English as well as mechanical fundamentals. The core module focuses on professional skills such as aircraft electromechanical system maintenance and fault troubleshooting. The digital intelligence module adds featured courses on digital maintenance technologies and maintenance data analysis. The expansion module incorporates professional ethics, innovation, and entrepreneurship education to realize all-round cultivation of knowledge, skills, and personal qualities.

Furthermore, further deepen the integration of posts, courses, competitions, and certificates. Incorporate the assessment criteria of CCAR-66R License and fitter certificates as well as competition rules into curriculum design, and adjust teaching objectives and content to realize high alignment among courses, posts, certificates, and competitions. For instance, in the course of Aircraft Electromechanical System Maintenance, integrate core knowledge and skill points for license assessment, and introduce typical cases from National Civil Aviation Vocational Skills Competitions to guide students to prepare for certificates and improve abilities in the learning and practicing process [7]. In addition, establish a dynamic curriculum updating mechanism. Invite enterprise technical experts to participate in curriculum seminars on a regular basis, and add new industrial technologies, norms, and equipment to teaching content in a timely way, so as to keep curricula consistent with industrial development. The curriculum system oriented by job demands and supported by digital intelligence can cultivate interdisciplinary talents that truly satisfy industrial needs.

3.2. Deepening industry-education symbiosis and building school-enterprise collaborative education mechanism

Industry-education symbiosis is the key to bridging the gap between talent training and industrial development. It is essential to establish an education mechanism featuring school-enterprise collaboration, complementary advantages, and shared interests to realize a seamless connection between college training and enterprise demands. To begin with, set up a major construction committee jointly founded and managed by colleges and enterprises. Composed of college administrators, professional teachers, enterprise technical backbones, and human resource supervisors, the committee takes charge of the whole process including the formulation of talent training programs, curriculum design, teaching implementation, and performance evaluation, ensuring that talent cultivation is in line with enterprise job requirements.

In the next place, implement the combined mode of order-based training and modern apprenticeship. Sign talent cultivation agreements with enterprises to train targeted talents according to job needs. Enterprises participate in the whole teaching process by providing internship positions, technical guidance, and faculty support. Students can be employed directly after graduation, realizing the goal of “enrollment equivalent to employment and graduation equivalent to taking up a post” [8].

Moreover, jointly build digital intelligent training bases by integrating resources from both sides.

Construct comprehensive training platforms integrating digital twin simulation, AR-assisted maintenance, and intelligent diagnosis, and equip them with retired civil aviation aircraft and intelligent maintenance equipment to simulate real working scenarios. Such facilities help students improve digital operation capabilities and professional skills through immersive training. Meanwhile, establish a two-way personnel exchange mechanism between colleges and enterprises. Encourage college teachers to take temporary posts in enterprises and participate in actual maintenance projects to enhance practical abilities and digital literacy. Invite enterprise technical experts to serve as part-time teachers to deliver practical courses and technical lectures, bringing the latest industrial technologies and practical experience into classrooms. This in-depth industry-education symbiosis mechanism gives full play to the educational advantages of colleges and the practical resources of enterprises, and steadily improves the quality of talent cultivation.

3.3. Innovating teaching modes and building digital intelligence-enabled teaching scenarios

The innovation of teaching modes acts as a key link in talent cultivation reform. Leverage digital intelligent technologies to break the time and space limitations of traditional teaching, and create a diversified teaching model combining online and offline learning, theory and practice, as well as simulation and physical operation. First of all, adopt project-based teaching. Take actual maintenance projects as the carrier, integrate theoretical knowledge and practical skills into project implementation. Divide students into groups to complete project research, scheme design, fault diagnosis, and maintenance acceptance, so as to cultivate their teamwork and problem-solving capabilities. For example, set the fault diagnosis project of the Airbus A320 electromechanical system, and guide students to adopt intelligent diagnostic tools combined with theoretical knowledge to complete fault location and maintenance work, realizing the deep integration of theory and practice.

Secondly, utilize digital intelligent technologies to build smart teaching environments. Launch online teaching platforms to upload digital teaching materials, training videos, and virtual simulation courseware for students to learn independently anytime and anywhere. Introduce AR and VR virtual simulation technologies to simulate complex aircraft maintenance scenarios. Students can conduct high-risk and high-cost maintenance operations in virtual environments, which reduces training risks and costs while optimizing training effects [9]. Meanwhile, adopt case-based teaching and situational teaching methods. Combine real enterprise maintenance cases to guide students to think actively and explore independently, so as to develop innovative thinking and practical capabilities.

3.4. Improving support system and strengthening quality control of talent cultivation

The implementation of talent cultivation reform relies on a sound support system. Firstly, reinforce the construction of teaching staff. Build a compound faculty team composed of dual-qualified teachers and industrial experts. On the one hand, increase training investment for full-time teachers. Organize regular digital intelligence technology training and industrial seminars, encourage teachers to obtain vocational qualifications and take on-the-job training in enterprises to improve practical competencies and digital literacy. On the other hand, optimize the incentive system for part-time teachers from enterprises. Provide corresponding salary and teaching support to attract enterprise technical experts to engage in teaching work and enrich the teaching team.

Secondly, establish a diversified collaborative evaluation mechanism. Abandon the single evaluation mode of the past, and construct a multi-dimensional assessment system covering college evaluation, enterprise evaluation, student evaluation, and social evaluation [10]. College evaluation focuses on students' mastery of theoretical knowledge and practical skills. Enterprise evaluation assesses students' job adaptability and professional ethics. Student evaluation reflects teaching effects and learning experience. Social evaluation judges graduates' employment quality and industrial recognition. The evaluation content covers knowledge, operational skills, digital literacy, and professional ethics. Adopt the combination of process evaluation and result evaluation, focus on students' ability growth and development process, and ensure the objectivity and comprehensiveness of assessment results.

4. Conclusion

Digital intelligent transformation and in-depth industry-education integration are inevitable trends for the development of modern vocational education, as well as the core orientation of the reform on talent cultivation for aircraft electromechanical equipment maintenance majors. The talent cultivation model reform driven by the dual engine of "digital intelligence + industry-education symbiosis" can effectively solve various drawbacks of traditional training modes by restructuring curricula, deepening school-enterprise collaboration, innovating teaching modes, and improving supporting systems, and realize the precise docking between talent cultivation and industrial as well as job requirements. Admittedly, talent cultivation reform is a long-term, systematic project. It requires joint efforts and continuous exploration from colleges, enterprises, and all sectors of society.

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Disclosure statement

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