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Training System and Career Development Plan for UAV Flight Control Talents

Xiande Wei[1,a], Fei Xu[1,b,*], Chao Wu[1,c], Lili Wu[1,d], Xu Wang[1,e]

[1]Army Aviation College, Beijing, China
[a]wxd_hynh@163.com, [b]xufei_lhxy@163.com, [c]wuchao_nuaa@163.com, [d]630533684@qq.com, [e]2569496268@qq.com
[*]Corresponding author

Abstract: *In response to the shortage of flight control talents in the context of the rapid development of the UAV industry, this study constructed a systematic UAV flight control talent training system and career development plan. The system adopts a teaching method that combines theory with practice, aiming to comprehensively improve students' professional skills and career development capabilities. The study investigated the effectiveness of the existing drone training system and found that students were less satisfied with drone courses, with the lowest average score being only 2.18 points. At the same time, when investigating the required abilities of UAV flight control personnel, it was found that the pre-flight inspection ability load was the highest, at 0.822. It proves that it is necessary to train new UAV flight control talents at this stage, and we should also focus on the training of pre-flight inspection capabilities in UAV talent training.*

Keywords: *UAV flight control; UAV talent training; career development planning; flight skills; career planning awareness*

1. Introduction

With the rapid development of science and technology, drone technology has been widely used around the world. From military reconnaissance and disaster relief to commercial logistics and agricultural plant protection, drones have shown great potential and value. Driven by this trend, the demand for drone flight control talents has increased dramatically [1]. However, the current training system for UAV flight control talents is still imperfect. There are problems such as disconnection between theory and practice, unreasonable curriculum setting, and lack of systematic career planning. As a result, the quality of talent training is uneven and it is difficult to meet the needs of industry development [2]. Therefore, building a scientific, systematic and efficient UAV flight control talent training system has become an important issue that needs to be solved urgently. In previous literature, many scholars have conducted in-depth research on the training of UAV flight control talents and proposed a variety of methods and strategies. However, most of these studies focus on the cultivation of a single aspect of ability, such as flight operation skills and theoretical knowledge, and lack discussion on the overall construction of the talent training system. In addition, the existing research is relatively insufficient in guiding career development planning, making it difficult to meet the needs of trainees for future career development.

In response to these challenges, this study aims to build a UAV flight control talent training system covering theoretical teaching, simulation training, field operation, career planning, etc. by comprehensively using a variety of teaching methods and technical means. Specifically, this study will first clarify the core competencies and quality requirements for UAV flight control talents through literature review and field research. Then, combining industry development trends and market demands, this study will design a scientific curriculum system and teaching model, focusing on the combination of theory and practice, as well as the cultivation of students' innovation and problem-solving abilities. On this basis, this study will also introduce a career planning guidance module to help students clarify their career goals, develop career development paths, and improve their employment competitiveness. During the research process, this study will collect data through questionnaires and conduct a comprehensive assessment of the students' learning outcomes and career development. At the same time, this study will also use simulated flight software and actual flight sites to conduct practical tests on trainees' flight control skills in order to verify the effectiveness of the training system. Through this

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series of research processes, this study hopes to solve the current problems in the training of UAV flight control talents and provide the industry with a group of high-quality flight control talents with solid theoretical foundation, superb flying skills, good professional qualities and clear career planning.

2. Related Works

With the rapid development and widespread application of drone technology, the training and education of drone operators has become increasingly important. In order to meet this challenge, many scholars and research institutions have conducted in-depth research. Tikhonov et al. found that the applicability of existing drone training programs in the construction industry was questionable, so they assessed the training needs of drone operators in Hong Kong through semi-structured interviews and desk research [3]. Nwaogu et al. discussed the main problems faced by the Moscow Aviation Institute in training high-quality talents in the field of drones, emphasizing the need to improve the effectiveness of the educational process by introducing advanced learning forms and technologies [4]. Blagodaryashchev et al. analyzed the laws, regulations and training systems in the field of unmanned aerial vehicle systems in Russia, the European Union and the United States, pointed out that the training system needs to be graded according to the maximum take-off weight and purpose of the unmanned aerial vehicle, and put forward the prospects and suggestions for the development of the unmanned aerial vehicle personnel training system [5]. Finally, Menkhoff et al. implemented a new course at Singapore Management University that explored the history, uses, ethical, and legal issues of drone and robotics technology through a multidisciplinary learning experience, highlighting the importance of collaborative intellectual leadership in a rapidly changing higher education environment [6]. Choi compared civil aviation with the UAM (Urban Air Mobility) system and combined civil aviation experience to propose directions for UAM safety development and develop pilot training standards [7].

The above research has made significant progress in drone operator and training education, but there are still some shortcomings. These studies have obvious geographical limitations and lack a global perspective and cross-industry applicability. At the same time, some studies focus on a single educational institution, and there is uncertainty about their applicability to other regions and institutions. Therefore, this paper not only comprehensively considers the global development and cross-industry applications of UAV technology but also focuses on building a complete training system and career planning path, aiming to cultivate UAV flight control talents with practical operation ability, theoretical literacy and professional ethics.

3. Methods

3.1 Exploration on the Integration of UAV Talent Training and Industry Needs

In the new engineering environment, the electronic information major faces a conflict between the industry's employment needs and the education talent training standards. To solve this problem, the major has given a clear direction in terms of talent training characteristics, which is to build a comprehensive innovation and practice platform for higher vocational education based on drones. This paper focuses on the system implementation of each link from the conception, design, manufacturing to operation of UAV technology, aiming to establish an engineering system perspective through skill practice and cultivate multidisciplinary cross-disciplinary capabilities and team management capabilities. The platform combines the learning of theoretical knowledge, completes engineering verification based on theoretical knowledge, supplements classroom knowledge with practical skills, and guides interest through practice. By using the UAV comprehensive innovation practice platform as a carrier, it can meet application needs, explore professional frontiers, and form a multi-angle, multi-level, and three-dimensional innovative talent training model[8]. At the same time, the open platform design highlights the characteristics of higher vocational education, continuously optimizes the professional settings and teaching standards system, embeds drone-related knowledge points and skills, enhances students' professional learning ability and employment competitiveness, and combines innovation and entrepreneurship education to stimulate students' enthusiasm for self-employment.

3.2 Training System for UAV Flight Control Talents

Traditional automatic control technology and UAV experimental teaching are often teacher-led,

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focusing on teaching experimental operation methods. In this process, students mainly imitate teachers to perform UAV flight control operations, readings and records. However, this teaching method results in students' incomplete understanding of the experimental phenomena and a lack of in-depth exploration of the UAV flight control mechanism[9]. In contrast, the UAV virtual simulation experiment adopts an interactive and heuristic teaching method, organically combining UAV cognition and installation experiments, and flight control experiments for UAV warehouse inventory, and effectively creating situations to address the difficulties in experimental teaching and the limitations of experimental conditions.

In teaching demonstrations, practical exercises and simulated assessments, the drone virtual simulation experiment presents a panoramic view of the learning space, allowing students to independently choose and experience multiple times through the set virtual simulation interactive buttons during the video course playback. At the same time, in key chapters, assessment points are set in combination with virtual simulation experiments, and virtual simulation resources are cleverly integrated into the course. The online virtual simulation teaching system is used to implement personalized jumps in teaching demonstrations, practical exercises, and simulation assessment modules. As shown in the module jump example in Figure 1, when students are watching the teaching demonstration, they can jump to the experimental demonstration, experimental practice and simulation assessment links of the virtual simulation platform at any time.

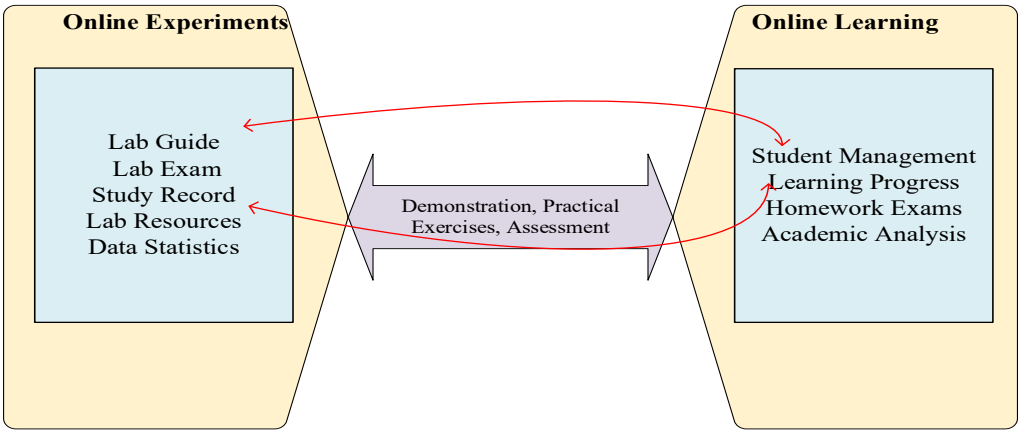

Figure 1: UAV talent training system

3.3 Semi-Realistic Simulation Training System

In the field of UAV flight training, the key to ensuring flight safety lies in the superb skills and emergency response capabilities of ground control station operators, and the training of these capabilities is inseparable from a large number of actual combat operation exercises. Therefore, the professional training program for flight control officers not only covers solid theoretical learning but also emphasizes the indispensability of practical activities. However, current drone training practices face two major challenges: first, the number of actual equipment is limited; second, actual training will accelerate equipment wear and tear, which is not only costly but may also increase the risk of flight accidents. In addition, the high difficulty of control during launch and recovery makes direct actual flight training impractical for trainees.

To address the above challenges, simulation training has become an effective solution. Beginners can conduct preliminary practice through flight simulation software, which is highly consistent with real flight simulators in basic knowledge, principles and operating procedures, helping trainees become familiar with the operating procedures. As students gain more skills, they can further train using simulated aircraft. However, there are still differences between simulated training devices and real equipment, which limits the implementation of certain training subjects[10].

From a long-term training perspective, it is particularly important to build a semi-realistic simulation training system, which can ensure the realism of the training environment while improving the transferability of training experience, thereby optimizing training results. Simulation training not only helps trainees discover and improve deficiencies in operations, master processes, and accumulate practical experience but also deepens the learning of theoretical knowledge through the assistance of simulators, achieves a perfect integration of theory and practice, and helps trainees quickly adapt to professional positions and improve their ability to perform their duties. In addition, the reusability of

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the simulator and its flexibility without being restricted by site, airspace and weather ensures that every student can get sufficient training time, saving training costs and increasing flight training opportunities.

4. Results and Discussion

4.1 Satisfaction with UAV Courses

The study investigates the current status of UAV application courses in terms of teaching objectives, design, implementation, conditions, and effects. Through student feedback, it is hoped that improvements can be found to improve teaching quality. The reliability verification result of the questionnaire data is 0.832, indicating good reliability. The specific results are shown in Table 1.

Table 1: Reliability analysis of the questionnaire on drone application courses

Name	Relevance	Deleted coefficients for α ratio	Crobach α ratio
Teaching objectives	0.475	0.831	0.832
Instructional design	0.464	0.722	
Teaching facilities	0.518	0.711	
Teaching effectiveness	0.564	0.710	
School enterprise cooperation	0.567	0.868	

According to the reliability analysis results of the UAV application course questionnaire in Table 1, the correlation between each dimension and the overall course is between 0.464 and 0.567, showing a certain correlation. After deleting any item, the Crobach coefficient (except for the teaching objectives) did not increase significantly, indicating that the internal consistency of the questionnaire is good.

Then, the study was conducted on the students' satisfaction with the UAV course design, aiming to evaluate the course quality. The study involved five indicators: teaching objectives, teaching design, teaching facilities, teaching effects, and school-enterprise cooperation, with a full score of 5 for each indicator. The survey results are shown in Figure 2.

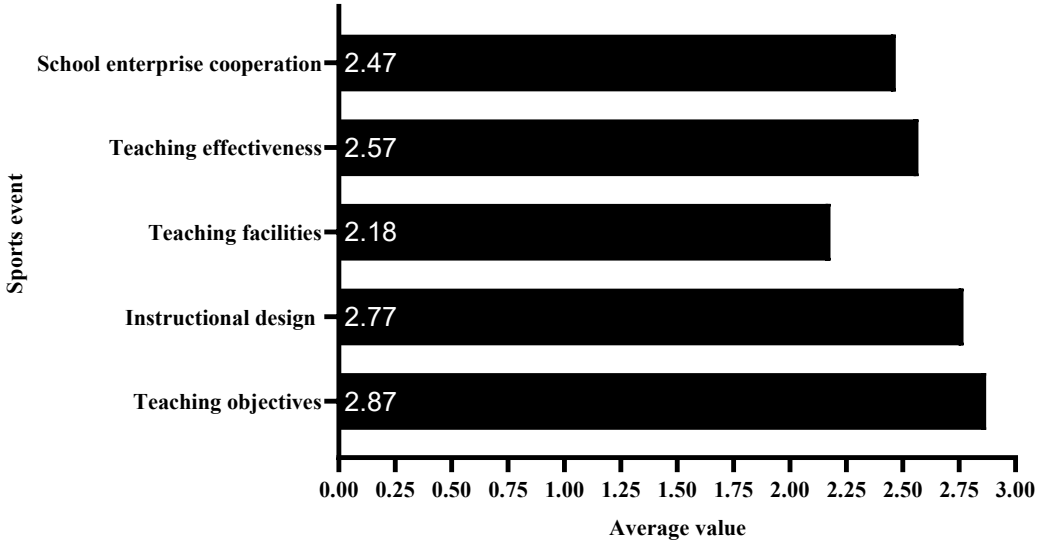

Figure 2: Course status satisfaction survey

According to the results of the drone course design satisfaction survey in Table 2, students score above average in each indicator. Among them, teaching facilities score the lowest (2.18 points), indicating that students are least satisfied in this aspect, which may be a key factor affecting the quality of the course. It proves that the design of UAV courses needs to be comprehensively improved in teaching facilities, teaching design and teaching effects in order to enhance students' overall satisfaction with the course quality.

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4.2 Factors for the Cultivation of UAV Talents

The study uses factor analysis to explore the structure of the abilities required for UAV flight control talents, clarify the correlation and differences between various ability factors, and provide a scientific basis for the cultivation of UAV flight control talents. The experimental results are shown in Table 2.

Table 2: Validity analysis results

Name	Factor loading coefficient			Commonality
	Factor 1	Factor 2	Factor 3	
Standardize flying ability	0.765	0.308	0.215	0.866
Theory of unmanned aerial vehicle systems	0.752	0.076	0.421	0.703
Pre flight inspection capability	0.822	0.131	-0.196	0.632
Post flight maintenance capability	0.681	0.294	0.342	0.526
Maintenance capability	0.733	0.141	0.059	0.623
Comprehensive evaluation capability	0.765	-0.072	0.343	0.765

According to the validity analysis results in Table 2, the required abilities of UAV flight control talents can be classified into three factors. Pre-flight inspection ability has the highest loading (0.822) in factor 1, indicating its importance; UAV system theory and standard flight ability also have high loadings, indicating that they are key abilities for training flight control talents. Although post-flight maintenance and overhaul capabilities have a certain load, they are relatively low, indicating their secondary position in the capability structure.

The study then simulated the UAV flight control scenario, designed flight missions including take-off, cruising, and landing, and set up emergencies such as sudden weather changes and mechanical failures to evaluate the trainees' flight control capabilities in a simulated environment. The results are shown in Figure 3.

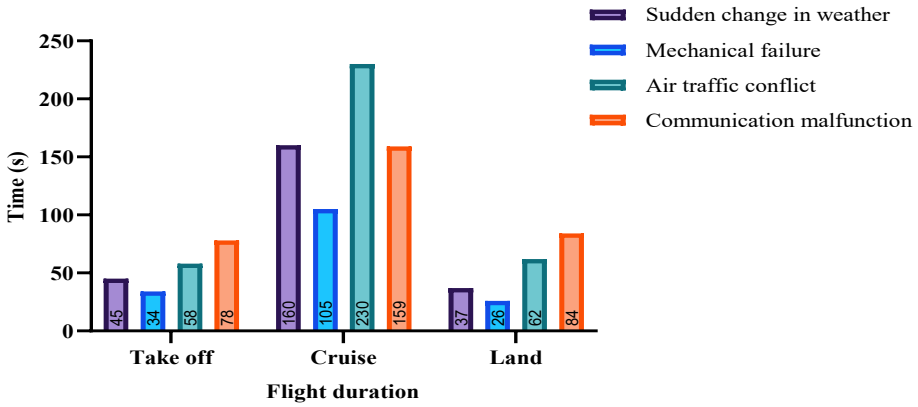

Figure 3: UAV flight control simulation experiment

According to the simulated flight control task results in Figure 3, there are significant differences in the difficulty of students dealing with various emergencies at different flight stages. The cruising phase is the hardest hit area, with 160 weather changes, 105 mechanical failures, 230 air traffic conflicts, and 159 communication failures, far exceeding the take-off and landing phases. This clearly shows that the cruising process is extremely complex and susceptible to interference from a variety of factors, making it a key area for practical training in talent training. In terms of single emergencies, the frequency of communication failures in the take-off, cruising and landing stages cannot be underestimated, which are 78 times, 159 times and 84 times, respectively. This highlights the key significance of ensuring the stability of the communication link for precise flight control. Once communication problems occur and flight conditions occur frequently, it is imperative to strengthen teaching in this area. Furthermore, comparing different emergencies, air traffic conflicts are most prominent during the cruising phase, with 230 times, reflecting that the trainees' ability to control airspace environment changes and coordination between aircraft is relatively weak during this phase. This is not only the focus of current training improvement but also the key skills that need to be continuously improved in subsequent career development. The training system should focus on these key points to help students grow into

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excellent UAV flight control talents.

5. Conclusion

The study aims to address the demand for flight control talents in the UAV industry and build a UAV flight control talent training system to improve students' theoretical knowledge, flight skills, innovation ability and career planning awareness. The study found that the existing UAV training courses have the disadvantages of low satisfaction and low efficiency. The simulation of UAV flight control scenes is used as an important means to evaluate students' flight control ability. The assessment design includes flight missions in the take-off, cruising and landing phases, and also includes emergencies such as sudden weather changes, mechanical failures, air traffic conflicts and communication failures. According to data analysis, communication failures occur frequently during takeoff, cruising and landing phases, emphasizing the importance of stability and reliability of the communication system; air traffic conflicts are most prominent during the cruising phase, requiring pilots to remain highly alert; and although sudden weather changes and mechanical failures are reduced during the landing phase, they cannot be ignored during the takeoff and cruising phases. In response to these key points and emergencies, the training system for UAV flight control talents should strengthen relevant training, including the use and maintenance of communication systems, monitoring and analysis of air traffic dynamics, and strategies and techniques for dealing with weather changes and mechanical failures. At the same time, we provide students with targeted guidance based on the UAV industry's career needs for flight control talents, and through the introduction of career planning guidance modules, students can have a clearer understanding of their career goals and develop practical career development paths. However, this study also has certain limitations. The limited experimental samples have a certain impact on the general applicability of the research results. Therefore, the paper suggests that future studies can further expand the sample range and improve regional representativeness to verify the wide applicability of this culture system.

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