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METHODS OF EFFECTIVE TRAINING OF TRAINEE PILOTS FOR CO-PILOT WORK

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Abstract
The paper considers methods of effective training of trainee pilots to work as co-pilots, with an emphasis on improving flight safety. Special attention is paid to theoretical training, which provides fundamental knowledge, and practical training on simulators, which helps to consolidate skills. Various approaches are considered, including problem-based and heuristic learning, as well as game methods that develop cognitive abilities and stress tolerance of pilots. An important aspect is distance learning, which includes online schools, webinars and individual coaching. Special attention is paid to the methodology aimed at working with highly automated aircraft and the importance of meteorological training. The use of innovative methods and technologies, such as the 4D system, helps to optimize teamwork and improve the professional training of pilots. In conclusion, the need to integrate competence-based and contextual approaches to improve the quality of education is emphasized.

Keywords Pilot training, training, training methods, trainee pilots, co-pilots, civil aviation pilot training, aircraft.

INTRODUCTION

The primary objective of all organizations that train pilots in aviation is to ensure the safety of flights. Since most aviation incidents occur due to human errors, any improvements in personnel training significantly enhance safety levels. The training of aviation specialists is divided into theoretical and practical parts. Theoretical training provides the foundational knowledge and skills that create the basis for further acquisition of more specific competencies. This stage is essential for the development of practical skills and the formation of approaches to performing specific tasks. Only with fundamental knowledge can specialists effectively apply them in practice, making theoretical training crucial for successful learning. After mastering theoretical knowledge, students move on to practical sessions on simulators. Reinforcing skills requires repetitive actions, which helps to strengthen synaptic connections in the brain [1].

Therefore, the aim of this work is to examine methods for the effective preparation of trainee pilots to work as co-pilots.

General Characteristics of Pilot Training

Pilot training is a process of education and training aimed at acquiring the necessary knowledge, skills, and experience for the safe and efficient operation of aircraft (hereafter referred to as AC) [2]. The relevance of researching this topic is driven by the number of aviation incidents, with statistical data presented in Table 1.

Table 1. Statistical Data of Air Accidents [3,4]

Type of Air Accidents	2023	2022	Average Over 5 Years (2019-2023)
Rate of all air accidents (accidents per million flights)	0.80 (1 accident per 1.26 million flights)	1.30 (1 accident per 0.77 million flights)	1.19 (1 accident per 0.88 million flights)
Total air accidents	30	42	38
Fatalities	72	158	143
Risk of fatality	0.03	0.11	0.11
Loss of aircraft hulls (per million flights)	0.00 (1 major accident per 0.00 million flights)	0.24 (1 major accident per 4.11 million flights)	0.14 (1 major accident per 4.94 million flights)
Loss of turboprop aircraft hulls (per million flights)	0.57 (1 hull loss per 1.76 million flights)	1.76 (1 hull loss per 0.57 million flights)	1.21 (1 hull loss per 1.03 million flights)
Total number of flights (million)	37.7	32.2	32.9

Increasing the likelihood of pilots performing error-free actions during aircraft operations is achieved by increasing the amount of information that needs to be processed and reducing the number of sources available in the field of vision. This approach allows for the determination of the optimal order of information usage during training and effectively engages cognitive converters, contributing to the formation of a conceptual model of the air situation for pilots [5].

The high level of responsibility placed on civil aviation pilots dictates specific requirements for both their selection and professional training. S.V. Marihin (Sergei Vasilyevich Marihin, Doctor of Pedagogical Sciences, Candidate of Psychological Sciences, Associate Professor, and Professor of the Department of Social and Economic Sciences and Services at the Saint Petersburg State University of Civil Aviation) and K.M. Nasirova (psychologist) emphasize in their research that qualities such as muscle strength, coordination, operational thinking, and psycho-emotional stability are crucial for pilots to effectively manage an aircraft.

In the Republic of Uzbekistan, pilot training is conducted in accordance with the Cabinet of Ministers' Resolution No. 524 dated July 19, 2017, aimed at improving personnel training in civil aviation. Courses for pilot training are conducted at the State Unitary Enterprise "Training Center" of the National Airline "Uzbekistan Airways" for specialists with higher technical education. The objectives of these courses are:

- Ensuring the training of civil aviation specialists in accordance with international standards.

- Developing curricula, programs, and methodological materials based on the advanced experience of leading global educational institutions in civil aviation.

- Strengthening cooperation with leading foreign universities and research centers specializing in civil aviation [11].

Thus, it can be noted that the regulatory act clearly outlines the requirements for training civil aviation pilots, ensuring a high level of safety and professionalism. In turn, to meet these requirements, it is necessary to use existing methods in the training process, which may include both theoretical training and practical exercises, enabling future pilots to acquire the necessary

knowledge and skills to work successfully in complex conditions. Below, Table 2 presents the main pilot training methods.

Table 2. Pilot Training Methods

Training Methods	Method Description
Problem-based learning	The problem-based learning method is actively used for training aviation personnel. During training on complex flight simulators, instructors create problematic situations by simulating various flight conditions. The instructor, acting as one of the pilots, deliberately makes errors to develop trainees' skills in attention distribution and switching under increased workload. This includes: a) failure to perform the required action; b) performing unnecessary actions; c) inaccurate execution of the required action; d) delayed execution of the necessary action.
Heuristic method	The heuristic method, developed by Yu.Yu. Mikhalchevsky, A.V. Sedov, and M.Yu. Smurov, focuses on the creative analysis of decisions. Trainees compare their solutions with those of experienced pilots, which contributes to the long-term retention of knowledge and skills.
Game-based method	Research by V.P. Tretyakov and A.V. Zakharov highlights the effectiveness of game-based methods in pilot training. They note that generating games used during training improve pilots' readiness for extreme situations. These games help accelerate the formation of a professional pilot image, which enhances the reliability of flight task performance.
Distance learning methods	In the modern world, distance learning plays an important role in aviation personnel training. Key methods include: Online schools – comprehensive programs aimed at developing crew resource management competencies. Online webinars – involve discussions, exercises, and observations that contribute to a deeper understanding of topics. Auto-webinars and self-study – allow trainees to absorb materials at a convenient time. Individual and team coaching – helps trainees to uncover their goals and tasks, developing non-technical competencies. The 4D system consists of four dimensions: depth of knowledge, dynamics, directiveness, and didactics. Depth of knowledge implies a comprehensive study of the theoretical foundations of aviation and all aspects related to piloting. Dynamics involve the active use of simulators to create various flight scenarios, allowing pilots to gain experience in different conditions and situations. Directiveness involves a structured approach to training, where trainees receive clear instructions and guidance from experienced instructors, helping them to acquire the necessary skills and knowledge more effectively. Didactics encompasses the methods and principles of training aimed at enhancing the effectiveness of the learning process through interactive methods, feedback, and continuous assessment. This system focuses on optimizing problem-solving and improving teamwork, ensuring comprehensive pilot training by combining theoretical learning with practical exercises, resulting in highly qualified specialists capable of performing their duties safely and efficiently [6,8].

Currently, Uzbekistan operates a training center dedicated to the training and retraining of aviation personnel. The center provides initial training for pilots, civil aviation flight attendants, and flight operations personnel for work in airline flight control centers and air navigation services. Advanced training courses, approved by the Aviation Administration of the Republic of Uzbekistan, are conducted in strict accordance with ICAO and IOSA standards. The center is equipped with a modern simulator complex [12,13].

A.A. Biryukov (author of scientific works, postgraduate student at Ulyanovsk State Pedagogical University named after I.N. Ulyanov, Ulyanovsk) notes that the purpose of advanced training courses is to adjust the professional skills of pilots to ensure the safety of all flight participants. Particular importance in ensuring the proper level of pilot training has been given to approaches such as the contextual and competence-based approaches. The competence-based approach focuses on developing specific skills and abilities in pilots necessary for performing tasks under real conditions. It involves not only theoretical learning but also practical training aimed at honing specific skills (aircraft control, navigation systems usage, decision-making in complex situations). The contextual approach, in turn, emphasizes training under conditions as close to real-life scenarios as possible, including the simulation of various flight scenarios and emergency situations. Therefore, it is hard to disagree with T.V. Safonova (Doctor of Pedagogical Sciences, Professor, Professor of the Department of Social and Humanitarian Disciplines, GUZA) who believes that the success of pilot training will significantly increase with the integration of competence-based and contextual approaches. In her work, Safonova identifies several stages of pilot training, presented in Table 3.

Table 3. Stages of Training of Civil Aviation Pilots [6]

Training Stage	Training Goal	Main Content	Organization Form	Methods
Informational	Forming motivational and theoretical readiness of pilots	Transformation of educational activities into educational-professional joint activities	Lecture	1) Informational 2) Problem-based 3) Dialogical
Practical	Forming motivational and practical readiness of pilots	Transformation of educational activities into quasi-professional joint activities between instructor and trainees, and among trainees	Business game	1) Dialogical 2) Problem-based
Independent Work	Motivating independent activities	Transformation of independent educational activities into educational-professional activities	Business game; simulation training; course work, report preparation	Research method
Diagnostic Stage	Reflective function in training,	Transformation of reflective educational	Tests, control work, exam	Dialogical method

	feedback	activities into educational-professional reflective joint activities		

MODERN TRAINING METHODS

The concept of combined activity emphasizes the importance of performing multiple tasks simultaneously during flight, especially independently. This aspect requires pilots to have skills in attention distribution and correct task execution order, which can be challenging for beginners. Flight instructors in the initial stages of training are required to help students develop the ability to clearly apply theoretical knowledge in practice, teach proper attention distribution, and the correct order of actions. The training program includes exercises to practice various failures and emergency situations both on the simulator and in actual flight, allowing for the assessment of the pilot's actions and stress resilience. Regular post-flight debriefings and check flights aim to increase students' readiness for any deviations from the flight plan.

In the 21st century, with most flights being conducted using autopilot, pilots may lose concentration and reaction speed to deviations. Therefore, it is crucial for pilots to constantly monitor the operation of all systems and be ready to make decisions to safely complete the flight. This concept is applied at the third level of initial training on DA-42 NG aircraft, where a significant portion of flights is performed in autopilot mode. Instructors periodically assign students tasks to determine the current flight parameters and require a switch to manual mode to perform maneuvers, which develops engagement and concentration on flight control.

At the same time, there are concepts that require improvements in their implementation. The concept of simulator training is an essential part of pilot training. Modern simulators can model up to 97% of real flight, allowing for the practice of any emergency situation without risk. However, in civil aviation educational institutions, simulators are often used to familiarize students with cockpit equipment and standard procedures due to technical limitations. Instructors note that this can lead to negative skill transfer from the simulator to the actual aircraft. More advanced simulators, such as Full Flight Simulators (FFS), could improve training, but their use is limited due to high financial costs and maintenance complexity. As a result, simulators are not perceived by students or instructors as close to real flights.

The concept of human factors (HF) is also important in modern aviation. In the 21st century, with the high reliability of aviation technology, most aviation incidents are related to human errors. The consideration of human factors is necessary at all stages of aviation activities, including initial training. The International Civil Aviation Organization (ICAO) defines HF as the science of people in their working environment and their interactions with machines and surroundings. Leading airlines implement Crew Resource Management (CRM) techniques and Evidence-Based Training (EBT), which contribute to developing the competencies needed for the safe operation of aircraft. However, in Russian civil aviation educational institutions, there is no initial training in CRM, which negatively affects pilots' professional growth. Introducing a CRM program at the initial training stage would positively impact pilot training and employment, as the level of HF training in the CIS regions is insufficient [7].

When discussing approaches to training trainee pilots to work as co-pilots, this process includes several key stages aimed at enhancing their competence and readiness to perform their duties.

Initially, candidates for the role of co-pilots undergo a selection process that includes interviews, technical knowledge assessments, psychological testing, document verification, and cognitive tests [8]. After successful selection, trainee pilots undergo a "Pilot Indoctrination"

course, which lasts about two weeks and includes theoretical training. During this course, candidates for the co-pilot position become familiar with the airline's operational and administrative policies, study manuals, undergo emergency procedure training, and perform administrative functions related to flight operations.

The next stage is "Initial Qualification Training," which includes several series of training. Stage 1 focuses on learning aircraft systems, followed by Stage 2, which involves studying systems in a non-simulated environment. Stage 3 consists of practical piloting skills training in a full-flight simulator with visualization, and in the penultimate stage, pilots fully master all phases of flight in real conditions. The final stage involves maneuver checks and obtaining a pilot's license [9].

After this, pilots undergo the "Operational Experience in Aircraft" stage, where they perform actual flights under the supervision of an experienced instructor. Upon completing the required number of hours and landings, pilots undergo a final evaluation, known as the "Line Check," after which they receive full co-pilot qualification. Effective methods in this process include:

- The use of simulators, allowing pilots to safely practice various scenarios, including emergency situations, which significantly enhances their readiness for actual flights.

- The integration of theory and practice enables pilots to better understand and retain the material necessary for performing their duties.

- Periodic training and reevaluation of abilities help pilots maintain a high level of qualification and readiness for any situations that may arise during a flight.

- Psychological testing and training to assess and develop the ability of pilots to remain calm and act effectively in stressful situations [10].

These methods aim to ensure flight safety and efficiency, as well as support the professional growth of pilots throughout their careers.

CONCLUSION

In conclusion, the effective preparation of trainee pilots to work as co-pilots requires a comprehensive approach that combines theoretical and practical training. Theoretical training provides the foundation for developing the necessary competencies, while practical sessions on simulators help solidify skills and strengthen synaptic connections. The application of various training methods, including problem-based, heuristic, and game-based approaches, enhances pilots' cognitive abilities and stress resilience. Distance learning and individual coaching play crucial roles in the modern educational process. The implementation of innovative methods and technologies, such as the 4D system, along with a focus on meteorological training, significantly enhances the level of professional preparation. The integration of competence-based and contextual approaches is a key factor in ensuring high-quality training and, consequently, improving flight safety.

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