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Авиационная психология: состояние развития в науке и образовании

Введение. Авиационная психология является отраслью психологии, которая вносит существенный вклад в обеспечение авиационной безопасности. Изменения, происходящие на разных уровнях методологии авиационной психологии, требуют оперативной рефлексии и критической оценки для прогноза ее дальнейшего развития.

Целью данной работы является изучение современного состояния развития авиационной психологии в науке и образовании по материалам зарубежных и российских источников.

Материалы и методы. Материалами исследования послужили статьи зарубежных и отечественных периодических изданий, труды научно-практических конференций, монографии и учебные пособия. Методом исследования выступил анализ направлений развития авиационной психологии, особенностей развития отечественной авиационной психологии.

Результаты исследования. Авиационные психологи исследуют причины авиационных происшествий по человеческому фактору, совершенствуют методы психологического отбора и тренажерной подготовки, решают проблемы оптимизации летного труда, а также эффективной эксплуатации беспилотных летательных аппаратов в условиях технического прогресса в аэрокосмической сфере. Авиационную психологию преподают в профильных высших учебных заведениях и авиационных учебных центрах. Авиационная психология имеет неисчерпаемый познавательный ресурс для профессиональной ориентации молодежи.

Заключение. Современное состояние развития авиационной психологии в науке и образовании позволяет решать актуальные задачи, направленные на повышение надежности функционирования авиации как оборонно-транспортной системы. Наибольшее количество публикаций связано с инженерно-психологическими задачами обеспечения безопасности полетов при конструировании эргономики кабины, органов управления, информационного обеспечения летчиков; совершенствовании методики летного обучения и наземной подготовки летчиков на основе цифровых технологий; разработке интерфейсов для операторов дистанционно пилотируемых летательных аппаратов. Для отечественной авиационной психологии характерна направленность на рефлексию культурно-исторических и нравственных основ развития профессионализма в авиации.

Ключевые слова: авиационная психология, человеческий фактор, тренажерная подготовка, цифровые технологии, аэрокосмический университет, профессиональная ориентация

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Aviation psychology: development stage in science and education

Introduction. Aviation psychology is a sphere of psychology that makes a significant contribution to ensuring aviation safety. The changes taking place at different levels of aviation psychology methodology require prompt reflection and critical assessment for prognostication of its further development.

The purpose of this paper is to study the current stage of aviation psychology development in science and education, based on the materials from foreign and Russian sources.

Materials and methods. The research materials represent a corpus of articles of foreign and Russian periodicals, collections of applied research conferences, monographs, and training toolkits. The research method represents the analysis of aviation psychology development directions, along with the consideration of peculiarities of the Russian aviation psychology development.

Results. Aviation psychologists investigate the causes of aviation accidents caused by the human factor, improve the methods of psychological selection and simulator training, resolve the problems of optimisation of aircraft-specific work and find prerequisites for efficient operation of unmanned aerial vehicles in the conditions of the technological progress in the aerospace industry. Aviation psychology is taught at specialised higher education institutions and aviation training centres. Aviation psychology is in possession of inexhaustible cognitive resources for vocational guidance of young people.

Conclusion. The current state of development of aviation psychology in science and education makes it possible to solve the pressing tasks aimed at increasing the reliability of aviation as a defence transport system. Most publications are related to engineering and psychological tasks involved in securing flight safety in the context of cockpit and control equipment ergonomics design, information support for pilots; improving the methodology of flight- and ground training of pilots based on digital technologies; development of interfaces for operators of remotely piloted aircraft. Russian aviation psychology is characterised by the orientation towards cultivating the cultural, historical, and moral foundations of professionalism in aviation.

Keywords: aviation psychology, human factor, simulator training, digital technologies, aerospace university, professional orientation

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Introduction

Aviation psychology is aimed at securing psychological support for the reliability of the "operator-aircraft-environment" system. The object domain of aviation psychology progressively expanded throughout the twentieth century, covering the study not only of military and civil aviation pilots' actions but also those of other aviation specialists: flight attendants, air traffic controllers, engineering staff, representatives of the aviation safety service, etc. The improvement of digital technologies in aviation-related professions contributes to an increased level of labour safety, but at the same time requires psychological examination of specialists' ability to take proper decisions in extreme situations.

Traditionally, serious attention in aviation psychology is paid to the issues of training and education. It is very important to form a stable motivation for obtaining occupational skills in the specialities that assume the need for certain physical, psychophysiological, intellectual, psychological, and personal qualities and the willingness to self-development throughout the whole professional path.

Consequently, the development of vocational guidance and professional selection methods in the aerospace sector requires understanding the due labour activity patterns with regard to the high-tech component, along with the creation of proper conditions for the formation of personal responsibility and patriotism.

The development of professional training technologies in the field of flight operation and technical maintenance of aircraft equipment is a traditional subject of research in aviation psychology. The role of psychological and pedagogical-profile disciplines in aerospace engineering universities is increasing.

At present, the conceptual basis for remotely-piloted aircraft operation psychology is underway. Thus, the changes taking place at different levels of aviation-psychology methodology require prompt reflection and critical assessment for due prognostication of its further development.

The purpose of the article is to study the current state of aviation psychology development on a global scale on the basis of materials borrowed from foreign and Russian sources.

Materials and methods

The research materials included the following: articles from foreign (The International Journal of Aviation Psychology, The International Journal of Aerospace Psychology, and others) and Russian periodicals (Human Capital, Psychological Science and Education, and others); proceedings of applied research conferences; monographs and training toolkits.

The research method represents the analysis of aviation psychology development trends, along with the consideration of peculiarities of the aviation psychology development.

Results

The theoretical basis of aviation psychology is represented by different scholarly approaches and scientific schools, including behaviourism, cognitive psychology, humanistic psychology, and phenomenology. Russian aviation psychology in the Soviet period was dominated by the activity and system approach to understanding the patterns

of organisation, functioning, and development of the human psyche. Currently, one may observe the enhancement of integration processes aimed at the consolidation of theoretical foundations of psychological research – for instance, cognitive psychology – and the activity approach in the solution of tasks bringing together artificial and natural intelligence. Modern aviation psychology is in possession of a methodology for psychological support of aircraft-specific work, that takes into account flight duration, the number of crew members, departmental affiliation, the type of aircraft, and the specificity of extreme situations [17; 31; 32].

Special techniques for diagnosing psychophysiological and psychological qualities have been developed and introduced into the practice of professional-aviation staff selection [22]. The development of aviation technology in the twentieth century has led to the creation of simulators capable of forming not only the motor skills of the airborne staff but also contributing to prudence, motivation, self-control, intellectual orientation with foresight elements, the "feeling" of the airplane and flight vision, operational mindset [7; 25; 28].

Pilots' human-factor-related errors are systematised; a number of psychological recommendations for their prevention have been offered [1; 8; 19]. The generalised data on the current trends of aviation psychology development are available [4; 15]. The engineering, psychological, and ergonomic targets relating to the operation of remotely piloted aircraft (RPA) have been formulated [3; 5; 24]. The research into the psychology of air traffic controllers is in progress, including the development of methods to increase their stress resistance [20], to optimise their work in the conditions of air traffic control transformation from the radio-communication radar system to the satellite system [29].

Aviation psychology is an academic discipline in the system of higher professional education and supplementary vocational education, intended for both aviation psychologists and aviation staff [1; 6; 26]. The methods for vocational guidance of young people are permanently improved to meet the requirements of aviation [9; 21].

Discussion

The important issue of aviation psychology in global terms is the study of psychological aspects of automation. Automation supposes transferring some of the pilot's functions to the automated control system. Autopilot navigators used to be the predecessors of automated control systems, making it possible to stabilise the flight along the assigned route (aircraft heel) and altitude (tangage). High-tech automation in manned aviation is represented by aircraft control technology using computer programmes implemented by technical devices under the control of the crew. In this case, the pilot has a possibility to make adjustments in the automation system or switch to manual control mode. High-tech automation in civil aviation makes it possible to handle all aircraft control procedures, including the most difficult flight stages (takeoff and landing), in automated mode. In addition, automation in military aviation and aviation troops within the authority of other security structures ensures, partially or completely, due combat use of various types of weapons.

However, the number of accidents caused by the human factor, involving highly automated airplanes, remains substantial. The problem is that automation, originally designed to optimise piloting, does not enhance, and in some cases, impairs flight safety. In this regard, it is important to get an insight into the pilots' comprehension of the objective

advantages and disadvantages of using various automated systems. It was found out that the pilots' awareness of risk increased when the level of complexity and ambiguity of the autopilot navigator's operation made it difficult to analyse their own actions [25].

In the authors' opinion, it is necessary to discuss one more problem connected with the human factor. At present, a number of up-to-date airplanes (built without imported components or with their minimal use) are undergoing factory tests in Russian aviation: Ил-112В, Ил-114-300, МС-21. In the near future, this aviation machinery will join the aircraft stock of various aviation departments on a mass scale. The above aircraft models will replace the outdated Russian and foreign air vehicles. On a par with airplanes as such, the entire line of training aids will be put into operation: cockpit procedure manned flight simulators; emergency escape exercise trainers for various conditions (e.g. splashdown); simulators of the entire flight. All possible special cases involving the operation of equipment and simulation of various meteorological conditions will be considered. Various computer programmes facilitating the study and competent operation of the aircraft and its systems will be practiced. However, aviation psychologists and pedagogues of aviation training centres, instructors and methodologists are faced with an important mission – account of individual characteristics of being-retrained learners and their experience of handling the aviation equipment before retraining. There have been a number of aircraft accidents connected with loss of dimensional orientation. As a rule, these incidents are rooted in the pilot's having been retrained from one type of horizon indicator (the main flight-control instrument) to another. This involves direct-reading meters (a view "from the plane to the Earth") and reverse-reading meters (a view "from the Earth to the plane"). In case of a stressful emergency situation, the skill of handling the previously operated aircraft is spontaneously practiced, and the pilot makes a fatal mistake. This is just one of the typical examples.

The revival of Russian aviation is at its onset, and it anticipates large-scale retraining of pilots and engineering staff who used to work with different aircraft types, both Russian and foreign. The task of aviation psychology and pedagogy is to maximise the possibility of transferring the skills of handling the outdated aviation machinery towards mastering the up-to-date Russian airplanes at the initial stage of retraining, and subsequently to provide maximum assistance in the development of the entire line of the national flying vehicles, from a glider to a most sophisticated aircraft, combining efforts with designers, constructors, ergonomists, aviation engineers – in order to exclude the possibility of transferring "detrimental" skills. Aviation psychology and pedagogy should be embedded in the fabric of the training process for pilots and engineers, with regard not only to a specific aircraft model but also to the purpose of achieving maximum professionalisation of aviators in mastering several types of aircraft machinery.

Psychological support for military pilot's actions is aimed at maintaining their performance ability in the conditions of flight overload and exposure to dangerous physical factors of the flight. In addition to the assessment of ergonomics of instrumentation and protective gear, or the impact of on-board automated systems on the pilot's psychophysiological resource, a number of methods are being currently improved in aviation psychology, in particular for the development of professionally important qualities, such as noise immunity, adequate response to stress, and professional reflection [7].

Flight simulators based on computer technologies are widely used. However, the predominant training of pilots on this kind of simulator, as well as the flights with preferential use of automatic control mode, leads to decreased preparedness for extreme situations.

Thus, modern computer technologies should not completely replace the traditional types of training involving mandatory manual control of the aircraft, both during the initial training and in the process of subsequent professionalisation of pilots. This is especially important during the initial training.

A paper presenting a comparative analysis of the efficiency and economic benefit of the primary flight training of cadets under a programme where 25% of instruction was flight simulators training, versus the programme not envisaging a similar scope of simulator training, mentioned that the real-flight training programme was insignificantly reduced in terms of hours. At the same time, the total training time was extended after the inclusion of simulator training [27].

The further improvement of the flight training methodology will be implemented through maintaining the military and civil aviation specifics and developing a common tendency to increase the role of technical facilities in airborne staff training [12].

Presently, augmented reality technology is being actively introduced in aviation. It represents a combination of the real and the virtual in one space, being a computer-created combination of a real image and the information obtained from cameras. Augmented reality reduces the pilot's information load, enhances flight safety in the conditions of limited visibility (for instance, on a runway strip). However, in case of a computer failure, the pilot needs some time to adapt to the changed situation and to switch to manual piloting – this way the issue of ground training optimisation regains relevance.

The research undertaken by Berezina, Buzanov, and Fatyanov proves that virtual reality technologies have an impact on a human operator's mental state, fatigue, emotional and psychophysiological spheres, which in the long run will allow one to manage own functional states and thus to develop and properly train the necessary personal traits and the somatic parameters of the organism [2].

According to the psychologists, the efficiency of the virtual reality simulator, when practiced by the Australian army in the course of parachute training, was as follows. One group of examinees was trained on the simulator; the other group underwent theoretical training in a specialised class. No significant differences between the two groups in terms of jump accuracy and safety were registered. However, the participants who were trained on the simulator required less feedback from the instructors during the real jumping [23].

Interdisciplinary research data are important for aviation psychology. Soloviev, Tarasov, and Petrov analysed the use of virtual and augmented reality in road transport and in industrial production. The principal difference between virtual and , according to the authors, is that virtual reality creates a digital universe with an immersive experience, while adds components of the digital world to the real one [18].

can be applied in remote cooperation, in technical maintenance of aircraft. Aircraft maintenance errors also pose a safety risk. By studying a 3D model of a structural element of an aircraft, specialists can view synchronised information from the Digital Twin database collected throughout the entire period of the aircraft operation [30]. Engineering, psychological, and ergonomic applications in the area of design and control of RPA are relevant as well. The RPA advantages relative to aircraft machinery are obvious: low cost, simplified on-board equipment, operator's safety, independence of manoeuvre effectiveness on the human psychophysiological resource. The psychological aspects of unmanned aerial vehicle control are presently under development. For instance, a scientifically substantiated methodology for the efficient formation of "RPA feeling" is truly necessary, since the operator is located remotely and receives a signal

requiring additional intellectual processing efforts when solving piloting and navigation problems [3; 5; 13].

A publication addressing the optimisation of manual RPA control offers a solution for the communication latency problem. The core of this approach is the development of skills for predicting aircraft state changes. In order to reduce the feedback time interval, the operator is trained in the technique modelled on the basis of multiuser video games [24].

In order to identify the psychological aspects of advantages and risks of as a technology used in highly automated airplanes, the authors undertook an empirical study. The selected participants amounted to 65, of them: civil aviation pilots (N=32), test pilots (N=3), maintenance staff (N=30). The examinees were asked a question: "List the possible positive and negative aspects of using the augmented reality technology during the flight".

The most probable positive aspects of using augmented reality during the flight, as viewed by the examinees, are: alleviation of psychological strain at the critical stages of the flight; improved quality and pace of decision making in the air; possibility of more precise control of the situation in the air. The most likely negative aspects of augmented reality are: the pilot's reduced promptitude in switching to manual control in the event of computer and visualisation failure; reduced level of cognitive activity during the flight; the pilot's reduced personal responsibility in performing flight elements in complicated conditions. The test pilots, as representatives of topmost professionalism in aviation, gave a more complete list of advantages and risks of augmented reality, related not only to flight safety but also to combat performance and simulator training.

Ponomarenko's scientific school substantiates the concept of a dangerous profession; one of its fundamental provisions is comprehending the moral nature of a flying person: it is marked by determination, topmost degree of motivation to flying, readiness for creative and responsible solutions in extreme conditions [16].

Ponomarenko concludes that the philosophical categories of "space" and "time" become a professional value for the pilot, since psychologically they are included in the purpose and means of his actions. On the one hand, space and time during the flight represent an informational category; on the other hand, they represent a social category aimed to preserve the country's national security, eliminate the causes of catastrophic environmental situations, etc.

In connection with Ponomarenko's accentuating the social significance of aircraft-specific work, the authors deem it important to monitor the development of an aviator's image and the importance of aviation as a profession, in order to improve the methods of vocational guidance for young people towards patriotic education and overall cultural education of the population. The image of an aviator and aviation as a profession should include the intrinsic characteristics of labour in military and civil aviation and its specifics [11].

According to the history of aviation psychology, the following professional areas supporting air force combat performance were developed during the Great Patriotic War: psychophysiological, clinical, psychological-pedagogical, and operational-psychological. It should be noted that the works of art heroising aviation (cinematograph, poetry, songwriting, fiction), created in that special period, became an efficient instrument of forming a sense of professional pride among the pilots and the sense of confidence in air fighters among the population, which strengthened the psychological and pedagogical aspect of aviation psychology [13]. It means that Russian aviation psychology follows the global development trends, but at the same time has specific cultural and historical characteristics.

Therefore, aviation psychologists investigate the causes of aviation accidents caused by

the human factor, improve the methods of psychological selection and simulator training, resolve the problems of optimisation of aircraft-specific work and find prerequisites for efficient operation of unmanned aerial vehicles in the conditions of the technological progress in the aerospace industry. Aviation psychology is taught at specialised higher education institutions and aviation training centres. Aviation psychology is in possession of inexhaustible cognitive resources for vocational guidance of young people.

Conclusion

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Most publications are related to engineering and psychological tasks involved in securing flight safety in the context of cockpit and control equipment ergonomics design, information support for pilots; improving the methodology of flight- and ground training of pilots based on digital technologies; development of interfaces for operators of RPA. Russian aviation psychology is characterised by the orientation towards cultivating the cultural, historical, and moral foundations of professionalism in aviation.

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