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DESIGN OF PROFESSIONAL COMPETENCIES OF AVIATION OPERATORS BY THE METHOD OF SITUATION-ORIENTED TRAINING IN A UNIFORM EDUCATIONAL ENVIRONMENT

Air traffic volumes will at least double by 2030, and with that in mind, thousands of new pilots and air traffic control officers (ATCO) will be needed. The object of research is the system of professional training of aviation operators. One of the problematic areas is the fact that, despite the similarity of both areas of training and professional competences, the training of these specialists is carried out completely separately. However, in the process of activity, they must work as a single team. The obtained results indicate that the vast majority of future control officers and pilots believe that training in the conditions of a single educational environment is necessarily required for a certain period. In order to increase the effectiveness of the interprofessional integration of such specialists and the system of their professional training, it is proposed to use the situation-oriented method in a single educational space for a certain period of time. The choice of this method is justified as follows. Virtually modeling, under the guiding influence of the instructor, the «student» solves the task in its own interpretation. Compared to similar known methods, simulation of the «real» working environment promotes the development of higher cognitive processes, such as analysis, risk management, consideration of possible alternatives and joint decision-making by the «ATCO-pilot» team. This approach makes it possible to transform theoretical knowledge into practical skills and operational skills in the most effective way, from the point of view of costs and benefits. An example of navigational guidance of an aircraft by the ATCO at the stage of descent and landing in conditions of loss of the signal of the global satellite positioning system is shown. This demonstrated the response of the training system to negative challenges in the state of the air navigation system within a relatively short period of time, as well as the formation of new competencies in the «ATCO-pilot» team.

Keywords: *air traffic control officer, pilot, situation-oriented training, joint decision-making, unified educational environment, navigation aid.*

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1. Introduction

The work of an air traffic control officer (ATCO), taking into account the significant cognitive and psychophysiological burdens against the background of a high level of responsibility for flight safety, is one of the most complex activities of a human operator [1]. A future air traffic control officer, even before starting professional training, must pass a multi-stage and complex test for the suitability of the profession [2]. Nevertheless, the deduction of future air traffic control officer officers (Ab-Initio), which is associated with the inability to master the initial training program, can reach several tens of percent plus economic losses, the cost of initial training can reach up to 100 thousand euros [3]. All of the above fully applies to the profession of a pilot. In turn, prognostic data of the International Civil Aviation Organization (ICAO), taking into account the growth of the aviation sector of the economy, given its global nature, indicate that by 2030, world civil aviation will need tens of thousands of new air traffic control officers, pilots and technical specialists [4, 5].

The factors that have a negative impact on the emergence of new specialists in the aviation industry are:

– high requirements for the profession, starting with the entry and the need to constantly maintain medical and professional indicators throughout the entire professional activity;
– work under stressful conditions, the need to make a decision under factors of uncertainty and risk with extreme responsibility for flight safety;
– strong competition for highly qualified personnel from other sectors of the economy;

– financial availability of professional education of this kind. For example, the cost of training for a private pilot program, which is the very first initial stage in a career, can reach up to 20,000 USD and more [6];
– the training system is not able to provide the industry's need for the required number of specialists.

In view of the above, if Ab-Initio has already overcome the extremely difficult stage of checking for potential suitability for the profession, the system of professional training of future air traffic control officers and pilots should do everything possible to effectively prepare such aviation operators.

The work is aimed at researching the possibility of purposeful formation of professional competences due to the application of the method of situation-oriented learning within the framework of a single educational continuum. Virtually simulating a real situation or one that could be Ab-Initio, comprehensively applying methods of individual, group and team training, develops higher cognitive processes. Namely, the purposeful collection of information, its analysis, synthesis of the obtained data, risk assessment, planning and making informed decisions, when researching problematic subjects [7–10].

Aviation has always been at the peak of scientific and technical progress. The emergence of new technologies and methods of air traffic management, the ever-growing volume of air transportation impose new requirements both on the future air traffic control officers and pilots themselves, and on the system of their training. As a response to the problem, ICAO is considering various mechanisms for providing civil aviation with the necessary number of competent personnel. And one of these solutions is the program «New Generation of Aviation Professionals» (NGAP – Next Generation of Aviation Professionals – «NexGen») [11]. This problem is inherent in Ukraine as well [12].

The aim of research is to investigate the possibility of increasing the level of formation of basic competencies of future air traffic control officers and pilots by the method of situation-oriented training in a single educational environment.

To achieve the aim, the following objectives were solved:
– the effectiveness of professional training was determined when applying the situation-oriented teaching method;
– the reliability of the results of determining the effectiveness of professional training was evaluated;
– a virtual simulation of joint decision-making by the «air traffic control officer officer-pilot» team was carried out.

2. Materials and Methods

2.1. Analysis of the impact of the situation-oriented method on the effectiveness of training. The object of research is the system of professional training of future air traffic control officers and pilots.

Many years of practical experience of the author in the field of professional training (experience of working as an air traffic control officer) shows that the method of situation-oriented training makes it possible to transform theoretical knowledge into practical skills in the «working» environment most effectively, from the point of view of costs and benefits.

In the context of aviation operators, the method of situation-oriented training is as follows:

1. There is no unequivocal answer to the situation, but there are several competing «what if» alternatives.

2. The preparation is not focused on obtaining declarative ready-made knowledge, but on its development, with a guaranteed formed conviction, why it is necessary.

3. As a result of training, according to this method, not only purposefully formed knowledge, but also practical skills appear.

The transition from theoretical knowledge to effective practical actions has the greatest advantage among future air traffic control officers and pilots. In order to determine the effectiveness of professional training using the situation-oriented method, a survey was conducted among Ab-Initio, future air traffic control officers and pilots (Table 1). 34 people took part in the survey.

Table 1

The results of determining the effectiveness of professional training using the situation-oriented method

Staff	$\bar{x}$	σ^2	σ	c	*CV*, %	*CI* at P=0.95
Air traffic control officers	32.65	25.37	5.036	0.1543	15.43	30.26; 35.04
Pilots	31.17	36.03	6.002	0.1925	19.25	28.32; 33.02

Notes: $\bar{x}$ – the average value of the effectiveness of professional training using the situation-oriented method; σ^2 – dispersion; σ – standard deviation from the mean; c – dispersion coefficient; *CV* – Coefficient Variation; *CI* – Confidence Interval – a confidence interval with a confidence level of 95 %

To confirm the results of determining the effectiveness of professional training using the situation-oriented method, the Fisher criterion was used:

$$F = \frac{\sigma_1^2}{\sigma_2^2},$$

at $\sigma_1^2 = 25.37$, $\sigma_1^2 = 36.03$, $F = 0.7041$.

To determine the statistical significance of the F-criterion, let's compare it with the critical value of F for a given level of significance and degrees of freedom. To do this, it is possible to compare the obtained value of the F-test with the critical values from the Fisher distribution table [13]. In our case, the given level of significance is α=0.05 and 16 degrees of freedom. It is possible to compare the obtained F value with the critical F value:

$$F_{calculated} < F_{critical} \Rightarrow 0.7041 < 2.3522.$$

Based on the F-test, it is not possible to consider the differences in the variances of the data to be statistically significant. This means that the variances of Ab-Initio data of air traffic control officers and pilots can be considered approximately equal. This confirms that the method of situation-oriented training has a positive effect on the effectiveness of training of these categories of aviation operators.

The main advantages of the situation-oriented method in the professional training of future air traffic control officers and pilots:

1. *Significant professional practicality*: trainees work on real professional situations relevant to their future work.

2. *Development of critical thinking and decision-making*: practicing real situations helps develop problem-solving skills and decision-making in conditions of risk and uncertainty of information.

3. *Improves communication skills*: the situation-oriented learning method includes teamwork, in which the exchange of individual solutions to problems is transformed into joint decision-making by the team.

4. *Flexibility in preparation*. The search for the most optimal solution, in the conditions of time shortage, risks and uncertainty of information, encourages creativity and non-standard solutions in solving the problem.

The similarity of the given data indicates that these types of operator activities have quite a lot in common, starting with the necessary medical, psychophysiological, and cognitive qualities [14–16].

Only the «air traffic control officer – pilot» team at this moment in time in a specific air situation knows best what needs to be done to ensure the safety of the flight in the air situation that has developed. However, despite the similarity of both the areas of training and the required professional competencies, the theoretical and practical Ab-Initio training of air traffic control officers and pilots is carried out completely separately. At the same time, airlines also emphasize the great importance of effective professional interaction between pilots and air traffic control officers [17].

2.2. Implementation of an integrated educational environment in the professional training system. Any system of professional training must meet the requirements of the time and take into account the development of the industry [18, 19]. In order to improve the efficiency of the interprofessional integration of future air traffic control officers and pilots and the training system in general, it is proposed to consider the use of Situational Based Training in Integrated Educational Platform (SBT-IEP)) over a certain period of time. When applying this approach, professionally oriented information is structured under the necessary competence, which must be developed by the «air traffic control officer – pilot» team.

Studies conducted among Ab-Initio air traffic control officers and pilots have shown that the best for this category of operators is to acquire professionally oriented knowledge followed by their transformation into practical actions under the guiding influence of an instructor. The instructor, when implementing the situation-oriented method, plays a key role. As practical actions, virtual simulation was used as part of a group/team under control.

The instructor develops a simulation model of a certain situation that took place (could take place) in a real professional environment and which reflects the range of necessary knowledge and skills that Ab-Initio must acquire – master the necessary competencies under the managed control of the teacher/instructor.

Structurally, the distribution of time ($T=90$ min.) according to the method of situation-oriented preparation, looks like this:

1. *Briefing* – up to 10 minutes. Introduction. The instructor provides a general overview of the situational lesson, emphasizes the training goals.

2. *Study of theoretical material* – up to 30 minutes. Ab-Initio, under controlled supervision, they receive educational material in a multimedia form («a well-prepared presentation replaces a thousand words») regarding the rules, calculations, procedures, action algorithms related to the situation.

3. *Individual work* – up to 20 minutes. Ab-Initio independently analyzes the situation, makes calculations and produces individual solutions.

4. *Work as part of a group/team* – up to 20 minutes. Ab-Initio combine into a group/team to discuss their own proposals and develop a collective decision.

5. *Debriefing* – 10 minutes. «*Analysis of flights*». The instructor provides feedback: reviews the decisions made, the correct algorithms of actions, emphasizes the practicality of the results and their significance for Ab-Initio, gives, as confirmation, examples from the professional activities of specialists. Evaluates overall group/team and individual performance.

The actual time allocation may depend on the simulation model of the specific situation, the required competencies to be mastered, the Ab-Initio learning styles and the role played by the instructor.

Regarding the joint training of future air traffic control officers and pilots, the following data were obtained during testing among these categories of operators:

a) «mandatory» – 70.8 %;
b) «necessary» – 29.2 %;
c) «no need» – 0 %.

Regarding the duration of the period of joint training:

a) «three semesters» – 37.5 %;
b) «two semesters» – 50 %;
c) «one semester» – 12.5 %.

Accordingly, the vast majority of future dispatchers and pilots with a bachelor's degree believe that professional training in the conditions of a single educational environment is necessarily required over the course of two semesters. This, at a minimum, requires continued research and professional discussion regarding a possible revision of training programs for these operators.

3. Results and Discussions

3.1. Simulation of the flight situation «GPS failure at the stage of descent and landing». Why was the simulation of the flight situation in case of failure of the global positioning system (GPS – Global Positioning System) chosen as an example. Thanks to scientific progress, the emergence of modern technologies, diagnostic methods, the technical component of the negative impact on aviation activities, in comparison with the human factor, has been significantly reduced. However, the same development, the emergence of new innovative solutions leads to the emergence of other threatening influences on the activity of world general aviation. One of these threats, during a relatively short period of time, has become unauthorized interference in the operation of satellite navigation systems, in particular GPS. These interventions cause a failure in the operation of the navigation equipment of a wide range of aircraft [20], the so-called «GPS Spoofing» – navigational information about the location of the aircraft is significantly distorted.

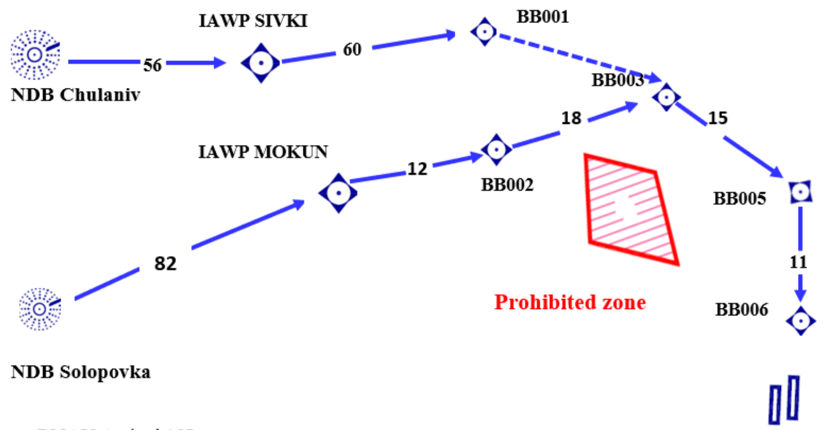
According to a report to the International Air Transport Association (IATA), 28.3 % of problems in receiving navigation information from GPS are related to the descent and landing phase. At the same time, the average time of GPS signal loss was within 14.5 minutes [21]. Is 28.3 % loss of GPS signal in the final leg of the flight too much or too little? Descending from the flight echelon, boarding and landing is the most difficult segment of the flight, in which air traffic control officers and pilots are faced with an acute shortage of time, and in the event of an emergency or non-standard situation, also with the need to make decisions in conditions of risk and uncertainty.

According to the US Federal Aviation Association (FAA – Federal Aviation Administration) [22], in the vast majority of reports from aboard the aircraft, regarding problems with obtaining navigational information, the crews required radar guidance from air traffic services (ATS). In turn, the European Aviation Safety Agency (EASA – The European Union Safety Agency) directly recommends that pilots, in case of problems with receiving GPS signals, be ready to request and receive guidance from the ATS authority as much as necessary [23, 24].

The civil aviation of Ukraine also repeatedly suffered from problems related to the loss of GPS signals. A particularly sharp increase in the number of events related to the failure of GPS navigation systems occurred in the fourth quarter of 2021 [25]. At the same time, a number of aircraft crews requested navigational guidance from ATS authorities. This means that from this moment on, the crew completely relies on the expertise and assistance of the air traffic control officer.

Thus, it is possible to simulate a similar working situation in the air navigation system of Ukraine in the context of situation-oriented Ab-Initio training of air traffic control officers and pilots.

As mentioned earlier, the average time of GPS signal loss is within 14.5 minutes. The Boeing 737-800 aircraft at flight echelon 250 (FL 250=25,000 feet) reached the calculated boundary of the transfer of control over the aircraft from the air traffic control officer of the district control center to the air traffic control officer of the control body of the approach (Approach) at a distance of 125 km and establishing radio communication with «Approach» and after receiving further dispatch instructions from it, continued the descent.



RNAV Arrival 19L

Designator	Route	Altitude
SL 1A Solopovka ONE ALFA	On track 065° to IAWP MOKUN, then on track 085° via WPT BB002 to IWP BB003, turn RIGHT on track 135° to WPT BB005, turn RIGHT on track 187° to FAWP BB006, then according to approach chart	Cross SL NDB at FL 170 or above, IAWP MOKUN at 2150 or above, IWP BB003 at 850 or above, WPT BB005 at 750 or above, FAWP BB006 at 750

Fig. 1. Kyiv/Boryspil RNAV Arrival Procedure GPS 19: NDB – Non Directional Radio Beacon – non-directional radio beacon, driving radio station; IAWP – Initial Approach Way Point – navigational reference point of the initial stage of approach; BB001-BB006 – navigational guidance for landing at Kyiv/Boryspul airport

Table 2

Metrological conditions and technical parameters of runways of Kyiv/Boryspil, Odesa, Kharkiv, Dnipro, Zaporizhzhia airfields

Flight termination option	*S*, km	L_{RWY}, m	LMH	δ°/*Um*, sec	*CB/Vis RWY*, m
b_1 – Kyiv/Boryspil	125	4000	01/19	180°/7	200/3000
b_2 – Odesa	435	2800	17/35	140°/10	300/3000
b_3 – Kharkiv	490	2220	08/26	110°/6	200/2500
b_4 – Dnipro	460	2840	09/27	120°/5	120/1500
b_5 – Zaporizhzhia	420	2500	03/21	150°/12	150/1800

Notes: *S*, km – distance to the airfield; L_{RWY}, m – runway length of the runway; LMH – Leanding Magnetic Heading – magnetic landing course; δ°/*Um* – direction and speed of the surface wind in the landing zone; *CB/Vis RWY* – Cloud Base and Visirility on the Runway

The landing is planned to be carried out according to the instrument landing procedure using the method of regional navigation (Regional NAVigation Arrival Procedures) with the use of GPS navigation information. The total flight time will be 11 minutes. After 1 min. the crew reported the loss of the GPS signal and requested navigational assistance – radar guidance from the «Approach» side. Under normal instrument approach flight conditions, using the method of area navigation (RNAV Arrival Procedures) with the use of GPS navigation information, the crew should have performed the following instrument approach procedure (Fig. 1).

Thus, under radar guidance, the crew will begin to comply with the dispatcher's instructions regarding the navigational assistance of the crew – to maintain the flight profile in plan and height for landing on runway 19L (ZPS 19 Liva) of the Kyiv/Boryspil airport. During the descent, the crew requested and received the metrological conditions and technical parameters of the runway (runway) of several airfields in Ukraine (Table 2).

3.2. Virtual simulation of joint decision-making by the «air traffic control officer-pilot» team in the «GPS failure» situation. One of the most significant factors influencing decision-making processes can be attributed [26]:

1. Uncertainty of the situation.
2. Misperception of the degree of significance of risks.
3. The target conflict.
4. Sharp increase in workload.

Returning to the situation regarding GPS failure at the stage of descent and landing, the following are suggested to be the main influencing factors that will influence the modeling of joint decision-making processes of the «air traffic control officer-pilot» team:

1. State of the aircraft: a_1 – how fully the pilot/crew can exercise control over the aircraft and the subsequent course of the flight.

2. Selection of the landing airfield: a_2 – this factor is influenced by the distance to the airfield, the flight technical parameters of the aircraft itself, the length of

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the runway, the radio light and technical equipment of the airfield.

3. Meteorological conditions along the flight route to the airfield and at the airfield itself – a_3.

4. Aeronautical familiarity of the crew with the airfield and the approach profile to it – a_4.

5. Probability of receiving emergency rescue assistance in case of unsuccessful landing – a_5.

In order to make a joint decision (CDM – Collaborative Decision Making) in the «air traffic control officer – pilot» team and choose the safest option for ending the flight, from the point of view of minimizing negative consequences, it is suggested to use the Wald criterion [27]:

$$W = \max_{B_i}\left\{\min_{A_j} u_{ij}(B_i, A_j)\right\}, \quad (1)$$

where $B_i = \{b_1, b_2, b_3, b_4, b_5\}$ – set of possible alternatives for terminating the flight, $i=\overline{1,5}$; $A_j = \{a_1, a_2, a_3, a_4, a_5\}$ – set of factors affecting the choice of landing airfield, $j=\overline{1,5}$; u_{ij} – results of i-th options of flight termination, taking into account j-th influencing factors.

The Wald criterion is based on the maximin strategy, which gives a guaranteed result in any event.

When evaluating various factors influencing the result of the safe termination of the flight, a nominal rating scale is used, where the best result receives a rating of 5. The Tables 3, 4 provide matrices of possible solutions from the point of view of the pilot and the air traffic control officer, where the influencing factors are grouped according to the following characteristics: a_1 – the state of the aircraft (how fully the pilot/crew can exercise control over the aircraft and the subsequent course of the flight); a_2 – selection of an airfield for a safe landing; a_3 – meteorological conditions along the flight route to the airfield and at the airfield itself; a_4 – aeronautical familiarity of the crew with the airfield and the approach profile to it; a_5 – communication with ground services and assistance to the crew.

Table 3

Matrix of possible solutions from the pilot's point of view: «GPS failure» situation

Flight termination options	Factors affecting the successful termination of the flight					Wald criterion, W
	a_1	a_2	a_3	a_4	a_5	
b_1	**4**	**5**	**4**	**5**	**5**	**4**
b_2	4	4	5	3	4	3
b_3	4	3	3	2	4	2
b_4	4	2	3	1	3	1
b_5	4	2	4	1	3	1

Table 4

Matrix of possible solutions from the air traffic control officer's point of view: «GPS failure» situation

Flight termination options	Factors affecting the successful termination of the flight					Wald criterion, W
	a_1	a_2	a_3	a_4	a_5	
b_1	**3**	**5**	**4**	**5**	**5**	**3**
b_2	**3**	**4**	**5**	**4**	**4**	**3**
b_3	3	2	3	2	4	2
b_4	3	2	2	1	3	1
b_5	3	1	3	1	3	1

Algorithm for determining the optimal solution to the «GPS failure» situation according to the Wald criterion:

1. Let's find the minimum results for each option W_i, $i=\overline{1,5}$, $j=\overline{1,5}$:

$$W_1 = \min u_{1j}.$$

$$W_2 = \min u_{2j}.$$

$$W_3 = \min u_{3j}.$$

$$W_4 = \min u_{4j}.$$

$$W_5 = \min u_{5j}.$$

2. Let's compare the obtained values of the minimum results for each flight termination option and find the largest value. The flight termination option that receives the maximum value W_i, $i=\overline{1,5}$, and will be considered the optimal solution.

Determination of the optimal solution from the pilot's point of view:

1. Minimum results for each flight termination option:

$$W_1 = \min(4,5,4,5,5) = 4.$$

$$W_2 = \min(4,4,5,3,4) = 3.$$

$$W_3 = \min(4,3,3,2,4) = 2.$$

$$W_4 = \min(4,2,3,1,3) = 1.$$

$$W_5 = \min(4,2,4,1,3) = 1.$$

2. The optimal option for terminating the flight:

$$4 > 3 > 2 > 1 \rightarrow W_1 > W_2 > W_3 > W_4 = W_5 \rightarrow b_1.$$

Option b_1 of flight termination, given the available factors influencing the situation, «GPS failure» is the most optimal, from the pilot's point of view.

Determination of the optimal solution from the point of view of the air traffic control officer:

1. Minimum results for each flight termination option:

$$W_1 = \min(3,5,4,5,5) = 3.$$

$$W_2 = \min(3,4,5,4,4) = 3.$$

$$W_3 = \min(3,2,3,2,4) = 2.$$

$$W_4 = \min(3,2,2,1,3) = 1.$$

$$W_5 = \min(3,1,3,1,3) = 1.$$

2. The optimal option for terminating the flight:

$$3 > 2 > 1 \rightarrow W_1 = W_2 > W_3 > W_4 = W_5 \rightarrow b_1 = b_2.$$

Options b_1 and b_2 of the end of the flight, with the available factors affecting the «GPS failure» situation, are, according to the Wald criterion, equal. However, in terms of flight time and the crew's awareness of the airfield, the most optimal, from the point of view of the ATC, would be option b_1.

Joint decision-making by the air traffic control officer-pilot team.

Table 5 shows the matrix of joint decision-making by the «air traffic control officer-pilot» team according to the Wald criterion, for the «GPS failure» situation.

$$W = \max_{B_i}\left\{\min_{O_k} u_{ik}(B_i, O_k)\right\}, \quad (2)$$

where $B_i = \{b_1, b_2, b_3, b_4, b_5\}$ – set of alternative flight termination options, $i = \overline{1,5}$; $O_k = \{o_1, o_2, o_3\}$ – set of factors influencing CDM (opinions of decision-making operators) $k = \overline{1,3}$; u_{ik} – CDM results regarding i-th options for the safe termination of the flight by the k-th operators.

Table 5

Joint CDM matrix by Wald criterion: «GPS failure» situation

Flight termination options	Factors affecting CDM (opinions of decision makers)		Wald criterion, W
	O_{pilot}	O_{ATCO}	
b_1	**4**	**3**	**3**
b_2	**3**	**3**	**3**
b_3	2	2	2
b_4	1	1	1
b_5	1	1	1

Table 6 provides a matrix of joint decision-making by the «air traffic control officer-pilot» team in the «GPS failure» situation using the Laplace criterion [28, 29]:

$$L = \max_{B_i}\left\{\frac{1}{k}\sum_{k=1}^{K} u_{ik}(B_i, O_k)\right\}, \quad (3)$$

where $B_i = \{b_1, b_2, b_3, b_4, b_5\}$ – set of possible alternatives for terminating the flight, $i = \overline{1,5}$; $O_k = \{o_1, o_2, o_3\}$ – set of factors affecting CDM (opinions of decision makers), $k = \overline{1,3}$; u_{ik} – results of joint decision-making by the k-th operators regarding i-th flight termination options.

Table 6

Joint CDM Laplace matrix: «GPS failure» situation

Flight termination options	Factors affecting CDM (opinions of decision makers)		Laplace criterion, L
	O_{pilot}	O_{ATCO}	
b_1	**4**	**3**	**7/2**
b_2	3	3	6/2
b_3	2	2	4/2
b_4	1	1	2/2
b_5	1	1	2/2

According to Laplace criterion, option b_1 will be the most optimal from the point of view of clarity of understanding.

Fig. 2 presents the deterministic model of CDM implementation by the «air traffic control officer-pilot» team in the «GPS failure» situation.

3.3. Determination of elements of competence of air traffic control officers and pilots during navigation guidance at the stage of descent and landing in case of loss of GPS signal. One of IATA's recommendations is to establish effective procedures in case of unforeseen circumstances related to the loss of the GPS signal. Thus, ATC dispatchers and pilots must have certain competencies in performing such a procedure. According to [15], competence is a characteristic of human activity that is used to reliably predict the success of performance of official duties. Competence is manifested and observed through professional behavior, in which the necessary knowledge, skills and attitudes are demonstrated in the process of performing tasks in given conditions. Competence is a framework that includes units of competence, elements of competence and criterion of performance/outcomes (observable behavior). Competence consists of both technical and non-technical knowledge, skills and abilities that are needed [30, 31].

In order to successfully solve this flight situation Ab-Initio during the class using the method of situation-oriented training, it was necessary to comprehensively apply the following professional knowledge and skills:

– regulatory and legislative framework related to flight operations and air traffic maintenance;
– application of radio exchange rules not lower than 4th on the ICAO scale;
– flight aerodynamics and flight technical characteristics;
– air navigation, analysis and use of large volumes of aeronautical information;
– technical means of communication, navigation and surveillance, their advantages and disadvantages;
– aviation meteorology and the influence of weather phenomena on the performance of flights and air traffic maintenance;
– interaction and communication at the team level: «air traffic control officer – pilot», as well as with other air traffic services and flight support services;
– making adequate management decisions in conditions of time shortage, increased workload, risk and uncertainty of information.

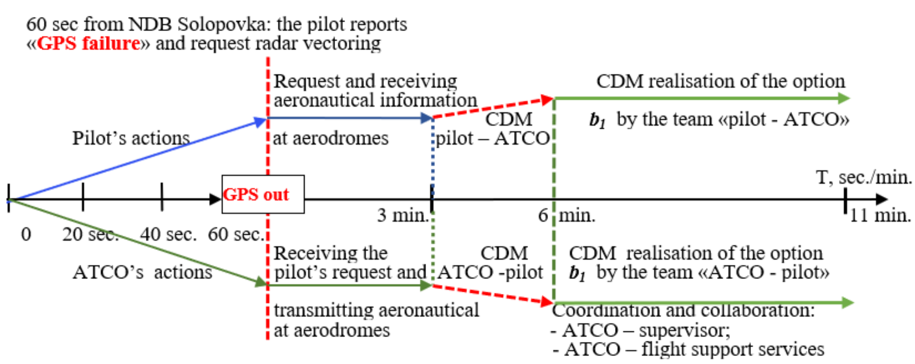

Fig. 2. Deterministic model of implementation of the joint decision of the ATCO – Pilot team

Given the limited scope of work, below are the competences and elements of competence for an air traffic control officer that it must demonstrate and for which, in accordance with the established performance criteria, a conclusion of «ready – not ready» will be made for operations in conditions of loss of the GPS signal when performed by the «air traffic control officer – pilot» team of the navigation guidance procedure at the stage of descent and landing.

Competence «Navigation guidance of the aircraft during landing». Elements of competence/indicators of professional behavior:

- effective use of available equipment and tools;
- guidance of the aircraft taking into account the capabilities of the aircraft, the pilot, meteorological conditions and restrictions in the airspace;
- demonstration of communication skills for effective interaction with the pilot and related specialists;
- ability to quickly analyze information and make informed decisions;
- situational awareness of the current situation in air traffic and its extrapolation;
- ability to manage stress at an increased workload.

3.4. Discussion. The formation of the necessary basic Ab-Initio competencies of air traffic control officers and pilots in a single educational environment by the method of situation-oriented training on the example of a real flight situation «GPS Failure» was considered. The listeners carried out a virtual simulation of a given flight situation.

The study and simulation of the flight situation was transformed into:

- a matrix of possible solutions from the pilot's point of view;
- a matrix of possible solutions from the air traffic control officer's point of view;
- the CDM matrix of the «air traffic control officer – pilot» command.

The application of the situation-oriented method made it possible to form the necessary final competence and its main elements for the air traffic control officer and the pilot when performing the navigation guidance procedure in the «GPS failure» situation. This approach is proposed for consideration and approval in other flight situations, primarily in emergency and non-standard conditions of activity of aviation operators.

Thus, taking into account the frequency of occurrences of the «GPS Failure» situation and its significant negative impact on flight safety, the successful termination of the flight will depend entirely on the effectiveness of interaction and the jointly adopted and implemented decision of the «air traffic control officer – pilot» team. This can be achieved through awareness and understanding of each other's professional competencies in the conditions of a unified educational environment of future air traffic control officers and pilots. It is at the stage of initial training of future operators that long-term memory is formed on the spectrum of necessary knowledge, skills and abilities.

The air traffic control officer and the pilot must act as a single team, where each fully understands the actions of the other. The success of its successful termination depends on the extent to which these specialists understand the specifics of the situation. Almost never does a flight or air traffic control shift work go perfectly, but that doesn't mean the flight can't be completed safely. Therefore, understanding the processes of joint decision-making is more important than ever. At a specific time, in a specific air situation, only the air traffic control officer and the pilot know better than anyone how to safely complete the flight.

The COVID-pandemic, the impact of martial law, and hence distance learning for a long period led to a negative impact on the quality of the system of professional training of aviation specialists. The proposed approaches will allow, in limited time, to form at least the necessary basic competencies of air traffic control officers and pilots and to reduce the costs of professional training – to attract instructors who are no longer active. Also, perhaps it will be useful for the training of specialists in other areas.

It should be noted that the research data has certain barriers. Limited quantitative sample of respondents, taking into account the specificity of the profession. Also, the research was conducted over a limited period of time so that the long-term impact of the identified trends could be assessed. This will definitely be taken into account in further work. Also, further research will be aimed at forming a base of professionally oriented «training protocols» based on the basic competencies of air traffic control officers and pilots. It is planned to adapt the method of situation-oriented training to the individual learning styles of future air traffic control officers and pilots.

4. Conclusions

The design of professional competencies by the method of situation-oriented training in a unified educational environment will promote professional trust and interaction between these specialists. Training, over a certain period, in the conditions of a single educational environment will contribute to the development of mutual awareness in each other's work activities and the improvement of interprofessional communication, which will contribute to the effectiveness of team activities in the future regarding joint decision-making, and hence, the minimization of threats and errors. As a result, interprofessional situational awareness and ultimately flight safety are enhanced.

Situation-oriented professional training effectively helps to develop decision-making skills in conditions of uncertainty and stress, which is extremely important for a pilot and air traffic control officer – the skills of stress resistance, situation analysis and prioritization, development and implementation of adequate action algorithms are formed.

Emotional stability. A situation-oriented approach is able to provide much more realistic professional training. During virtual simulation, active cognitive activity is carried out: obtaining and processing significant amounts of information, analysis, synthesis, development and consideration of possible alternatives, adoption and implementation of the final decision in conditions of uncertainty, lack of time and the high price of the decisions made. This makes it possible to develop multitasking skills and readiness to manage emergency and non-standard situations.

Active form of professional training. All participants without exception are involved in the work process (passive presence, as in lectures, is impossible). This ensures a solid understanding of the learning material (I do it because I understand the importance of it for my practical activity) and acceptance of personal responsibility for the learning process, as the intervention of the instructor is limited. Mistakes that are assumed become a source of knowledge. Case-based training enables Ab-Initio to make and correct mistakes in a controlled learning environment.

When training in the conditions of a single educational environment using the method of situational learning, prerequisites for the formation of a new, very important, work competence arise – the predictability of each other's professional actions. This is especially important in tactical air defense and flight operations, where communication and interaction are key factors in ensuring flight safety and efficiency. Each situation has so-called situational indicators, when studied together, it is possible to predict which probable course of action can be chosen by the pilot (air traffic control officer). This is extremely important in team activities, because it will contribute to increasing the speed of making the right decisions (for example, in an emergency situation, time is not on the side of the pilot and the air traffic control officer).

The indicator of the economic efficiency of the training system is improving: the implementation of the stage of a single educational continuum allows combining human resources, educational materials and the classroom fund of an educational organization. At the same time, the educational institution reduces material, technical and human costs, while simultaneously increasing the quality of professional training: the necessary teacher/instructor for the required topic/subject.

Conflict of interest

The author declares that he has no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Use of artificial intelligence

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