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DEVELOPMENT OF THE ELECTRONIC TRAINING TOOL CONCEPTUAL MODEL "RE-ROUTING DURING THE FLIGHT"

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It has been determined that for safe operation of an aircraft flight special attention is paid to the process of operational control over it: monitoring its performance and supporting its safe completion. The flight dispatcher's actions in case of re-routing during the flight have been analyzed. It has been discovered that in the course of flight dispatchers' training, enough attention is not paid to modeling the situation of flight dispatchers' actions in case of re-routing during the flight. A description of the electronic training tool design main stages and the flight dispatchers' actions in case of re-routing during the flight have been carried out. On the basis of the described procedures, an algorithm for the flight dispatchers' actions has been developed, which will be further implemented in the electronic training tool. From the point of view of the system approach, the electronic training tool conceptual model of "Re-routing during the flight" has been developed, which is an ergatic system designed to automate the flight dispatcher's training process in the field of operational control over flight operations, namely, the development of the flight dispatcher's operations in case of re-routing during the flight. After developing the electronic training tool prototype "Re-routing during the flight" it is necessary to conduct a short-term experiment to test the developed software product. Approbation may reveal the disadvantages of technical, training-methodical, navigation and other types of support for the developed electronic training tool, which in turn will require the electronic training tool model further development which was developed at the theoretical stage of research.

Key words: *operational control of flight, flight dispatcher, electronic training tool, algorithm for flight dispatchers' actions, conceptual model, multiple-theoretic description, training system formalized description.*

1. INTRODUCTION

Formulation of the problem. Today pre-flight service is provided by flight dispatchers whose duties include providing flight crews with the necessary information and documentation relevant to the conduct of the flight [1, 2].

The flight dispatcher performs the full flight calculation for the flight crew: he makes the route, selects the alternate aerodromes, analyses the aeronautical information (ANI) and meteorological information (MI) along the flight route, makes navigation calculations of the flight taking into account the actual conditions of flight operation and determines the maximum allowable commercial load, calculates flight data for departure and arrival aerodromes. Also, his responsibilities may include the calculation of the aircraft centering [3].

Thus, the flight dispatcher's tasks are: to hold a briefing (consultations) about the flight to the aircraft captain concerning conduct of the flight; to deliver the package with the prepared documentation; to report about the aircraft technical conditions and the conditions (meteorological and aeronautical) in which the flight will be performed; to focus attention on all existing

restrictions; to answer the questions relating to the process of flight preparation and the conduct of the flight [1].

Despite the fact that consultations, information provision and assistance to the flight crew are necessary during preparation for the flight, there are also cases in which, in a very short time, it is necessary to provide the flight crew with information about any changes in the operation of facilities or services that provide the aircraft flight, re-routing, the alternate aerodromes, the provision of MI already during the flight, especially in the emergency situation.

For the safe conduct of the flight special attention is paid not only to pre-flight preparation but also to the process of operational control of the flight: monitoring its conduct and assisting its safe completion. Thus, with the help of modern computer and telecommunication technologies, the flight dispatchers monitor the flight and provide with information concerning changes in meteorological conditions at destination airports, the alternate aerodromes and the flight route, the change of aeronautical data immediately during the flight, as well as another information that may affect the safe completion of the flight and the flight dispatchers notify the flight crew of these changes with the issuance of their recommendations. In addition, the flight dispatcher constantly monitors the aircraft position during the flight, as well as the operation of the technical equipment and facilities which are necessary for the conduct of the flight and affect the safety and the ability to perform the flight.

For example, if there is a situation, in which during the flight it will be necessary to re-route the part of the route, the destination airfield, etc., the flight dispatchers will have to perform the following actions:

- to make new calculations for the flight;
- to submit a new (corrected) flight plan to the relevant authorities;
- to obtain permissions to use the airspace according to a new route;
- to select and provide with a new ANI and MI;
- to coordinate their actions with relevant units;
- to coordinate the flight crew actions and to provide with the necessary consultation.

In this case, the flight dispatcher should maintain constant contact with the relevant services: Air Traffic Services, Search and Rescue, Airfield Services, Meteorological Services, Authorized State Aviation Authorities and other services [4].

Flight Academy of National Aviation University is responsible for the flight dispatchers' training. At present, during the training process, enough attention is not being paid to working out the operational control tasks over the conduct of the flight, namely, the situation of flight dispatcher's actions in case of re-routing during the flight is not simulated. In addition, changes in higher education standards lead to decreasing the number of classroom training hours and increasing the number of hours for independent and individual students' work [5]. At present, there are no analogues that would allow to improve the future flight dispatchers' training level in the field of flight operations operational control. Therefore, the development of the electronic training tool (ETT) "Re-routing during the flight" is relevant.

Analysis of recent research and publications. Training tools are essential for the implementation of the teacher's informational and management function. They help to call and support the cognitive students' processes, improve the clearness of the training material, make it more accessible, provide the most accurate information about the phenomenon which is under study, make independent work more intensive and allow it to be conducted at an individual pace.

The creation of equal access conditions to the best examples of electronic resources and training-related tools, safety and students' and cadets' comfort, while working with the information and communication technology tools (ICT), [6-9] requires technological platforms improvement, electronic training technical tools and methods of their application. In this regard, problems of scientific and methodological support improvement of training process informatization, particularly in terms of identifying the most appropriate ways of electronic training resources use are relevant.

In recent years the use of information technologies resources and tools in the training process are actively investigated (V. Andrushchenko, V. Bykov, S. Hryhor"yev, A. Hurzhiy, M. Zhaldak,

N. Morze, I. Robert, M. Smul'son, O. Spivakovsky and others); activity and communication peculiarities in the system "teacher-student" using information and communication technologies (A. Brushlyns'kyy, T. Habay, O. Matyushkin, Yu. Mashbyts', Y. Ryvkind etc.); the issue of secondary and higher schools informatization (V. Bespal'ko, V. Bykov, I. Bulakh B. Hershuns'kyy, S. Honcharenko, R. Hurevych, M. Zhaldak, V. Lapins'kyy, A. Manako, V. Mykhalevych, N. Morze, O. Ovcharuk, O. Spirin and others).

So H Kochler [10] emphasizes that in the 21st century important attention should be paid to the human education process throughout life. In his view, the use of new learning methods based on integrated education can be provided to increase the knowledge implementation effectiveness, to increase the specialist's adaptability and flexibility, which will lead to an increase in the economic results of his activities, as well as the deviation from standard educational methods.

V. P. Bespalko [11] emphasizes that the use of information technology in the training process allows maintaining a high level of motivation for students, satisfying them with a large number of ready, carefully selected, appropriately organized knowledge, developing intellectual, creative abilities and promoting the development of communicative aspects of working with information skills.

O. V. Matseiko [12] studying the use of information technology in vocational education makes a conclusion that this is one of the promising tools for the professional development of future skilled workers, which inherently is adequate to the state of society development, corresponds to the demands of modern education, allows effective implementation of didactic principles and offers conceptually new approaches to the formation of the necessary students' competencies. In his opinion, there is a need for further development: the development of methodology for conducting lessons with the help of ICT, the search for optimal forms of the electronic teaching materials use in the information and educational field, arrangement of the legal and regulatory framework for e-learning, monitoring the effectiveness of the use of ICT, defining the content of participants' training in the training process to work in terms of ICT use.

A. V. Lytvyn [13] believes that the professional competence of future professionals can not be imagined without the skills of using electronic communications, professionally oriented software, data banks normative, technological, forecast and economic information. But it emphasizes that future specialists should be trained (in accordance with the obtained qualification level) to practice the latest technologies, and therefore - educational institutions of all levels should form their respective competencies in advance.

N. V. Morze [14] stresses that a reliable basis and an integral part of the process of introducing innovative pedagogical technologies into the training process is the formation of teachers' informative competencies, employees and heads of educational institutions. The effectiveness of the training process depends on them. Moreover, the components of such informational competences must be updated at all times, depending on the objective changes that occur in education, society and the educational services market.

O. A. Chaikovska, [15] while researching the use of innovative information technologies in the context of the learning environment, pays special attention to the use of multimedia methods, the development of electronic textbooks and multimedia presentations. The paper concludes that computer-based training technology with high efficiency can function at all levels of education. The development of methodology for the introduction of new information technologies should not be carried out in isolation, but in a single complex in the system "elementary school - secondary – higher". Students of higher education institutions must master professional-oriented computer technologies and be able to use them in further activities in the information society.

O. M. Spirin, [16] while studying the information and communication technology of learning, concludes that it should be interpreted as didactic technology, which ensures the achievement of learning objectives only subject to obligatory use of ICT. It is advisable to evaluate the quality of design, development and implementation of ICT using external criteria, which include design, constructive, organizational, communicative and gnostic, and internal criteria - differentiation,

individualization, intensification of the learning process and the effectiveness of educational activities.

M. I. Zhaldak [17] believes that the basis of the educational process informatization should be the creation and widespread introduction into the everyday pedagogical practice of new computer-oriented training methods on the principles of gradual and non-antagonistic, without destructive reorganization and reform, integration of information and communication technologies into active didactic systems, a harmonious combination of traditional and computer-oriented learning technologies, without denial and rejection of the past pedagogical science achievements, but, on the contrary, their improvement and strengthening, including pedagogically appropriate use of advances in computer technology and communications. He also emphasizes that the use of a computer in the educational process should be pedagogically balanced and efficient, based on the harmonious combination of methodological achievements of the past and modern information and communication technologies.

Today there is a significant range of electronic training resources intended for information provision, functioning and development of the education system. Among them are: local and network electronic training aids, in particular on optical digital media; educational Web-resources: specialized sites, electronic collections, libraries, collections of training materials, etc.; electronic databases and educational knowledge; systems and platforms for electronic learning including remote and virtual. But the review of existing platforms for the creation of the ETT revealed their inconvenience to simulate precisely specific tasks in the field of operational control over the flight operations. Therefore to implement the ETT an appropriate platform, capable of simulating the flight dispatcher's professional actions in case of re-routing during the flight, will be selected.

The purpose of the article is to develop and describe the conceptual model of the ETT "Re-routing during the flight".

2. RESULTS AND DISCUSSION

As a rule electronic training tools are training programs of comparatively small amount, providing students with knowledge of theoretical material, training and knowledge level control of the subject being studied.

The main stages of designing the ETT:

1. Construction of the training material content model (division into training elements).
2. Development of the mastering the training material learning model.
3. Determination of the ETT composition.
4. Development of training exercises.
5. Development of test tasks.
6. Designing of training algorithms.

In the first stage of the ETT modelling, it was important to develop an algorithm for the flight dispatcher's operations in case of re-routing during the flight, which will be implemented in the ETT.

The situation of re-routing during the flight requires the following actions:

1. To make new calculations for the flight:

In case of the destination or alternate aerodromes change, first of all it is necessary to check the runway (RW) availability for accepting this type of airplane by checking the classification numbers (ACN/PCN) of the aircraft and the physical characteristics (length, width) of the RW.

- to make a new route, taking into account the current position of the aircraft, and the possibility of flight performance along this route (analysis of limitations).
- to make new fuel calculations necessary for the safe completion of the flight and to check the amount of fuel available on board the aircraft.
- to make appropriate changes to the flight plan (FPL) by editing the field 18 [10]. In this case, in the column of field 18, the abbreviation RIF/ ... is placed followed by the point from which the route and its new data are changed, as well as the four letter ICAO code of the new destination airfield (example: RIF / ESP G94 CLA APPH).

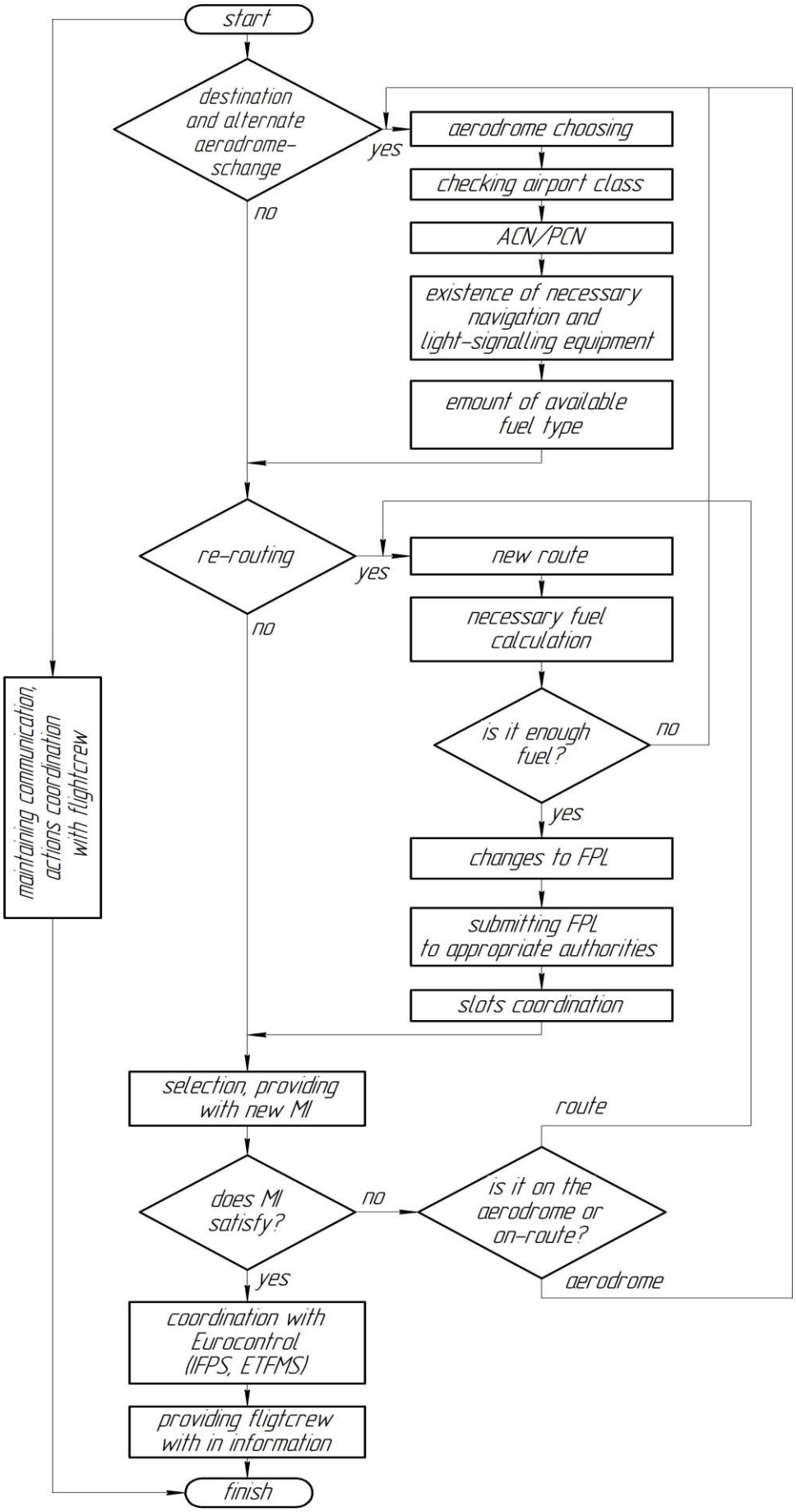

Fig. 1. Flowchart of the flight dispatcher's actions algorithm in case of re-routing during the flight

2. To submit a new (corrected) flight plan to the appropriate authorities. It is important to remember that if the changed destination airfield is not included in the Eurocontrol area of responsibility, the appropriate data (addresses) of the destination airport and the national aviation authorities of the destination airfield must be added to the flight plan address field.

3. To obtain permissions to use airspace according to a new route.

4. To pick up and provide with new aeronautical and meteorological information along the route of flight at the destination and alternate aerodromes.

5. To coordinate the actions with the relevant units.

6. To coordinate the crew actions and provide with the necessary consultation.

On the basis of the described sequence of operations, an algorithm for the flight dispatcher's actions has been developed in case of re-routing during the flight (Fig. 1).

The sequence of cadets' work with the ETT can be determined by the cadets independently or they can follow the training trajectory offered by the system and while they perform the following training activities:

- studying or reviewing theoretical material consisting of lectures and regulations used in the flight dispatcher's professional activity;
- performance of training or control exercises;
- performance of test tasks, etc.

After the cadet performs the training activities, the system analyzes the received responses and issues the result in the form of an assessment, as well as recommendations for further cadet's actions in the ETT.

From the point of view of the system approach, the ETT conceptual model of "Re-routing during the flight" has been developed, which is an ergatic system designed to automate the flight dispatcher's training process in the field of operational control over flight operations, namely, the development of the flight dispatcher's operations in case of re-routing during the flight.

In fig. 2 the ETT conceptual model "Re-routing during the flight" is depicted.

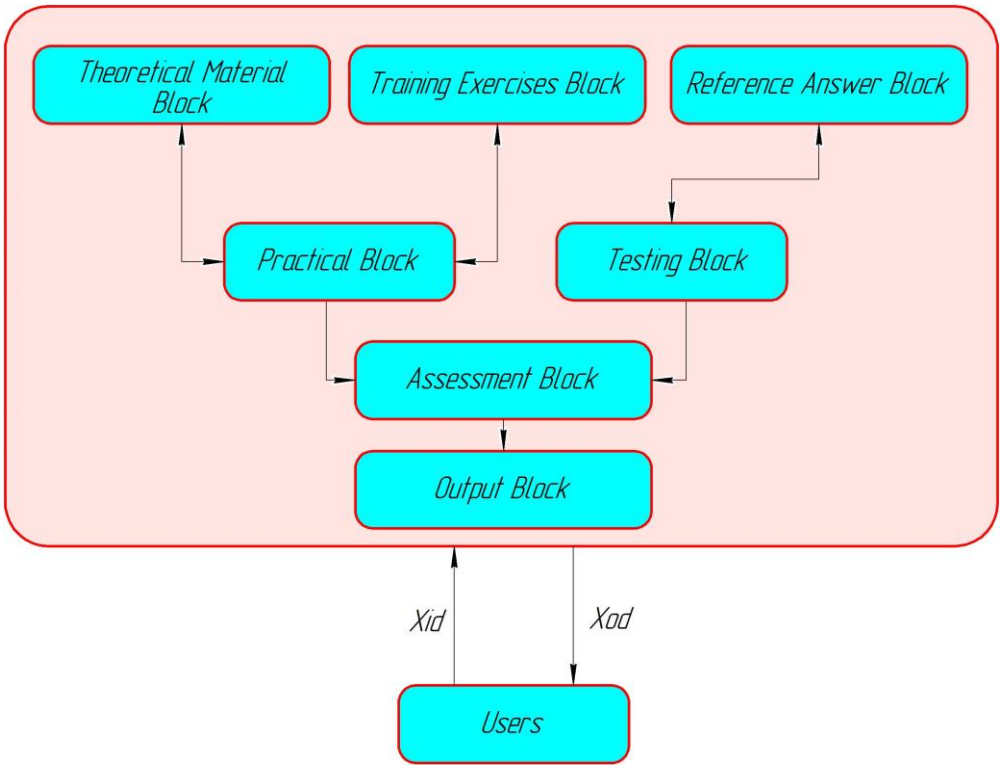

Fig. 2. The ETT conceptual model "Re-routing during the flight"

In Table 1 we describe each block functions which were distinguished according to our concept.

Table №1.

The ETT blocks functions "Re-routing during the flight"

Block Title	Tasks (functions)
Theoretical block	Theoretical material keeping Access to the theoretical material
Training exercises block (reference tasks)	Training and control exercises keeping Training and control exercises reference answers keeping Training and control exercises export Task solution references export
Practical block	Training and control exercises generation Training and control exercises providing Training and control exercises solution keeping by cadets
Reference answer block (tests)	Test tasks keeping Reference answer keeping Test tasks export Reference answer export
Testing block	Test tasks generation Test options formation Test tasks providing
Assessment block	Comparing passed test with reference answers Comparing exercises solution with reference solution Exercises solution assessment Testing assessment Training trajectory determination
Output block	Exercises and tests results output Providing recommendations

One of the complex systems methods description is a multiple-theoretic approach, which is based on the system representation as a set of elements, the corresponding structure of which is defined as a set of different classes surfaces and sets of combinations, defined on the structure elements, and the procedure of synthesis in the form of multiple-theoretic operations [11].

Applying this approach we will represent the ETT in the form of reflection:

$$F_i=F_i(t, X_{id}, X_{od}, X_a, X_b) \quad (1)$$

where t is – the time interval that reflects the dynamic characteristics change of a complex system, what is the ETT;

X_{id} – a set of input parameters that characterizes the system users that have different access rights to the system;

X_{od} – a set of input parameters that characterizes results of users' activity in the system;

X_a – a set of parameters that characterizes the users' activity types in the system;

X_b – a set of parameters that characterizes system blocks.

Let's consider a plural variety of users' activity in the system in more detail:

$$X_a = \{A_{ds}, A_{pa}, A_{ta}\}, \quad (2)$$

A_{ds} - debugging systems activities

A_{pa} - preparatory activities

A_{ta} - training activities

Table №2.

Types of the user's activity in the system

№	Activity type title	Code	Types of activity on system debugging	Code
1	Activities on debugging the system	A_{ds}	Training material update	d_1
			Training material change	d_2
			System configuration update	d_3
			System configuration change	d_4
			Training material navigation update	d_5
			Training material navigation change	d_6
			System functions update	d_7
			System functions change	d_8
2	Preparatory activity	A_{pa}	Personal users' data input	p_1
			Providing users with information about the ETT purpose, structure and work with it	p_2
			Training activities initial trajectory determination	p_3
			Training activities current trajectory determination	p_4
3	Educational and training activities	A_{ta}	Theoretical information study	t_1
			Theoretical information reviewing	t_2
			Training exercises performance	t_3
			Control exercises performance	t_4
			Test tasks performance	t_5

A set of parameters X_b characterizing the system blocks can be represented as the following set:

$$X_b = \{B_1, B_2, B_3, B_4, B_5\} \quad (1.3)$$

Table №3.

A set of parameters characterizing system blocks

№	Parameters of system blocks	Code	Information content of system blocks
1	Theoretical material	B_1	Documents regulating operational control
			ICAO documents (International Civil Aviation Organization)
			Route maps and charts SID, STAR
			Aerodrome data
			The tactical and technical characteristics of the aircraft
			Instructions for working with the system
2	A set of exercises	B_2	Training exercises
			Control exercises
3	Standard solutions	B_3	Standard solutions of training exercises
			Benchmarking control exercises

№	Parameters of system blocks	Code	Information content of system blocks
4	Test tasks	B_4	Options for test tasks
			Standard answers
5	Criteria for evaluation	B_5	Criteria for assessing the performance of training exercises
			Criteria for assessing the implementation of control exercises
			Criteria for evaluating the performance of tests
			General criteria for assessing knowledge
			Personal data
			Criteria for determining the trajectory of training

All components of X_b are also structured data. For example, the set B_1 in turn can be considered as the expression $B_1 = \{в_{11}, в_{12}, в_{13}, в_{14}, ..., в_n\}$ - the set of dynamic information regarding operational control, which is changed and supplemented in accordance with the requirements of state and international organizations regulating the activity of civil aviation (ICAO, Eurocontrol, State Aviation Service, UkSATSE, etc.). Similarly, other system parameters can be described.

The conducted theoretical studies became the basis for the development on the platform of Uniti prototype ETT "Re-routing during the flight".

3. CONCLUSIONS AND FOLLOW-UP RESEARCH

In this study, the development of a conceptual model of the electronic training tool "Re-routing during the flight" is considered. The conducted studies allowed to obtain the following results:

1. On the basis of analysis of flight dispatchers' scientific work, professional training and operations (namely, operational control functions), the ETT conceptual model "Re-routing during the flight" has been developed, the blocks and the ETT blocks functions have been described.

2. The flight dispatchers' operation algorithm in case of re-routing during the flight, based on which, training exercises to work out the operational control tasks and test complex will be created.

3. For the formal description of the system, the multiple-theoretic description of complex systems has been applied and a set of the users' activity type description in the system has been described.

4. In the future, it is planned to conduct a short-term experiment to test the developed software product. Approbation will enable: to identify the disadvantages of technical, educational, methodological, navigation and other types of developed ETT provision; to refine the ETT model, which was developed at the theoretical stage of the research.

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РОЗРОБКА КОНЦЕПТУАЛЬНОЇ МОДЕЛІ ЕЛЕКТРОННОГО ЗАСОБУ НАВЧАННЯ «ЗМІНА МАРШРУТУ ПІД ЧАС ВИКОНАННЯ ПОЛЬОТУ»

Визначено, що для безпечного виконання польоту повітряного судна особлива увага приділяється процесу оперативного контролю за ним: відстеженню його виконання та сприяння його безпечному завершенню. Проаналізовано дії диспетчера із забезпечення польоту у випадку зміни маршруту під час виконання польоту. З'ясовано, що на сьогоднішній день в процесі підготовки диспетчерів із забезпечення польотів не приділяється достатньої уваги моделюванню ситуації його дій у випадку зміни маршруту під час виконання польоту. Проведений опис основних етапів проектування електронного засобу навчання та дій диспетчера із забезпечення польоту при виникненні ситуації зміни маршруту під час виконання польоту. На основі описаних процедур розроблено алгоритм дій диспетчера із забезпечення польоту, який в подальшому буде реалізовано в електронному засобі навчання. З позиції системного підходу була розроблена концептуальна модель електронного засобу навчання «Зміна маршруту під час виконання польоту», що представляє собою ергатичну систему, яка призначена для автоматизації процесу підготовки диспетчерів із забезпечення польоту в області оперативного контролю за виконанням польотів, а саме відпрацювання його дій у випадку зміни маршруту під час виконання польоту. Отримана концептуальна модель взята за основу для розробки прототипу електронного засобу навчання «Зміна маршруту під час виконання польоту» також необхідно провести короткочасний експеримент з метою апробації розробленого програмного продукту. Апробація допоможе виявити недоліки технічного, навчально-методичного, навігаційного та інших видів забезпечення розробленого електронного засобу навчання, що в свою чергу дасть можливість доопрацювання модель, яка розроблена на теоретичному етапі дослідження.

Ключові слова: оперативний контроль за виконанням польоту, диспетчер із забезпечення польоту, електронний засіб навчання, алгоритм дій диспетчера із забезпечення польоту, концептуальна модель, теоретико-множинний опис, формалізований опис навчальної системи.

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РАЗРАБОТКА КОНЦЕПТУАЛЬНОЙ МОДЕЛИ ЭЛЕКТРОННОГО СРЕДСТВА ОБУЧЕНИЯ «ИЗМЕНЕНИЕ МАРШРУТА ВО ВРЕМЯ ВЫПОЛНЕНИЯ ПОЛЕТА»

Определено, что для безопасного выполнения полета воздушного судна особенное внимание уделяется процессу оперативного контроля за ним: отслеживанию его выполнения и содействия его безопасного завершения. Проанализировано действия диспетчера по обеспечению полета в случае изменения маршрута во время выполнения полета. Определено, что на сегодняшний день в процессе подготовки диспетчеров по обеспечению полетов не уделяется должного внимания моделированию ситуации его действий в случае изменения маршрута во время выполнения полета. Проведено описание основных этапов проектирования электронного средства обучения и действий диспетчера по обеспечению полета при возникновении ситуации изменения маршрута во время выполнения полета. На основании описанных процедур разработан алгоритм действий диспетчера по обеспечению полета, который в дальнейшем будет реализован в электронном средстве обучения. С

позиции системного подхода была разработана концептуальная модель электронного средства обучения «Изменение маршрута во время выполнения полета», что представляет собой эргатичную систему, которая предназначена для автоматизации процесса подготовки диспетчеров по обеспечению полета в области оперативного контроля за выполнением полетов, а конкретнее отработки его действий в случае изменения маршрута во время выполнения полета. Полученная концептуальная модель взята за основу для разработки прототипу электронного средства обучения «Изменение маршрута во время выполнения полета» также необходимо произвести кратковременный эксперимент с целью апробации разработанного программного продукта. Апробация поможет выявить недостатки технического, учебно-методического, навигационного и других видов обеспечения разработанного электронного средства обучения, что в свою очередь даст возможность доработать модель, которая разработана на теоретическом этапе исследования.

Ключові слова: оперативный контроль за выполнением полета, диспетчер по обеспечению полета, электронное средство обучения, алгоритм действий диспетчера по обеспечению полета, концептуальная модель, теоретико-множественное описание, формализированное описание обучающей системы.