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On the issue of elaboration of methodical support for the pilot training according to the CRM program

Sobre la cuestión de la elaboración de apoyo metódico para la formación de pilotos de acuerdo con el programa CRM

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Content

ABSTRACT:

The paper describes the methodological problems, which often arise out of the application of the special software package, and identifies their reasons. The "CRM – two-member crew resource management" program, studied in this paper, is directed on and designed for the aviation personnel training, in particular, for the training of the state aviation pilots. This training program is also applicable for the pilots of civil and special aviation. The structure of training under this method is studied by the authors, and the most important aspects of the training program under consideration are emphasized. Based on the conclusions made in the framework of analysis of the method, the authors proposed the solutions to the main problems of the pilot training program as well as the main ways of implementation of the solutions proposed.
Keywords: flight safety, CRM, special software, methodological support.

RESUMEN:

El documento describe los problemas metodológicos, que a menudo surgen de la aplicación del paquete de software especial, e identifica sus razones. El programa de "gestión de recursos de la tripulación de dos miembros de CRM", estudiado en este documento, está dirigido y diseñado para la formación del personal de aviación, en particular, para la formación de pilotos de aviación estatal. Este programa de entrenamiento también es aplicable para los pilotos de aviación civil y especial. La estructura de la formación bajo este método es estudiada por los autores, y se destacan los aspectos más importantes del programa de formación en consideración. A partir de las conclusiones obtenidas en el marco del análisis del método, los autores propusieron las soluciones a los principales problemas del programa piloto de formación, así como las principales formas de implementación de las soluciones propuestas.
Palabras clave: seguridad de vuelo, CRM, software especial, apoyo metodológico.

1. Introduction

Modern working conditions become universally associated with computer software and they are less costly for the specific specialists than physical possession of their intellectual potential. To a greater extent all this leads people to hypodynamia. Special attention should be paid to health, performance and physical endurance during the transition from the passive to the active mode, as this period is particularly subject to development of the acute vascular or cardiovascular disease. It is quite easy to keep fit and counter the negative conditions of professional activity effectively by doing active physical exercises (jogging, swimming, gymnastics, sports, fitness equipment, etc.).

Despite the fact that physical and special training of the future civil aviation pilots during the physical training is carried out using sufficiently effective means and methods, the matter of training of the vestibular stability and resistance to the conditions of countervailing overloads remains relevant and demands the active improvement constantly (Leichenko, Malishevskiy and Mikhailik 2006).

2. Methods

One of the most important trends in improvement of the training program and teaching methods and actions is the constant improvement of the training facilities, their equipment with the special multi-purpose training means aimed at the development of physical and special qualities and simulating the professional activity of various specialties (Malishevskiy, Brovkin, and Vlasov 2014). In our opinion, special attention should be paid to the simulators, modeling the professional actions of pilots in the cockpit. The multipurpose simulators allow to provide the multi-directional overloads and to create the impact on the vestibular apparatus to train and to develop the statokinetic stability (Mukhtarov, Malishevskiy, and Mikhailik, 1999), the spatial orientation and adaptation to the adverse factors of real flight, as well as the work-out of the unpredictable conditions of possible in-flight emergencies (Leichenko, Malishevskiy and Mikhailik 2002; Malishevskiy and Arinicheva 2008). The research centers of the Research and Development Establishments and cosmonaut training centers are equipped with the centrifuges for simulation of the centripetal acceleration and creation of various overloads, simulating various flight conditions of modern jet aircrafts. The high cost and complexity of service make it impossible to use extensively the above-mentioned equipment in mass education and training of the various professionals related to the terms of their professional activities.

In addition to a thorough knowledge of the technical equipment, it is necessary to have a masterful command of it, to operate it in a skillful way, be ready to confront the negative conditions arising in the course of its operation. They include the impact of the multidirectional accelerations causing the multidirectional overloads both on the parts of the body and on the entire human body, the exposure to noise, vibration, atmospheric pressure, the lack of oxygen in the air, the change of temperature, as well as hypoxia. With so many negative factors, a person must control the technical means and his or her own actions, ensuring the successful performance of the mission. The role of the vestibular stability and the ability to withstand the multidirectional overload conditions become crucial, since the acceleration (resulting in a variety of situations in some specialties) can sometimes exceed the human tolerance limits (Leichenko, Malishevskiy and Mikhailik 2006).

First of all, they are: – the pilots of fighter and sport aviation, the astronauts, the pilots of racing cars, the pilots of the sea-based aviation, the workers and the employees of the Navy from among the seafaring personnel, the athletes of different sports – gymnastics and acrobatics, parachuting and the paratroopers, highboard diving and trampolining, ski jumping – freestyle etc., where the vestibular stability and the spatial orientation are among the decisive factors. The training of the vestibular apparatus and its role in the professional activity of the representatives of the above-mentioned specialties should be fully attributed to the major component of the overall readiness, along with the physical qualities of general endurance,

strength, speed and agility (Malishevskiy and Parfenov 2010).

The impact of the overloads on the human body must be considered from the perspective of the anatomy of the human body structure, its physiology and biomechanics, i.e. its impact on the human as a whole should be taken into account along with the biological impact on the body and the mechanical characteristics of the overload in relation to the human body.

A human body is not a homogeneous mass, but a complex biological system. The internal organs of a human have a different weight, shape, density, location and attachment system, there are pneumatic and fluid-filled cavities, and the tissues of the body have different elasticity and viscosity.

The direction of the overload depends on the part of the body, located in the chair, passing the extreme low point of rotation and receiving the impact accelerations:

1) positive – in the (head – pelvis) direction;

2) negative – in the (pelvis – head) direction;

3) left side and right side – in the direction of (its left and right sides);

4) direct – in the (chest – back) direction;

5) mixed – in the direction of (various parts of the body, with the additional rotation of the structure around the vertical axis).

The problem of maintaining of the performance in the representatives of the above-mentioned specialties requires a continuous improvement of all the elements of the training system, both in terms of professional knowledge and skills, and in terms of improvement of the physical and special qualities of (Malishevskiy, Arinicheva and Brovkin 2013; Malishevskiy and Brovkin, 2014). It should be fully attributed to the HEI students, preparing for careers in aviation and navy, especially in cases where the formation and development of the knowledge, competence and professional special skills is performed in the period of study and continues to be refined throughout the subsequent professional activity (Malishevskiy, et. al. 2006). At the same time, the role of physical fitness, both general and specific, must be at the required high level.

In this regard, special objectives for the physical training of the students – pilots will be the following: – the improvement of the coordination abilities, the development of the power and static endurance, speed and accuracy of reactions and actions, resistance to motion sickness, overloads and vibrations, spatial orientation, resistance to physical inactivity, the priority development of agility and speed (Leichenko, Malishevskiy and Mikhailik, 2002).

For the purposes of training and improvement of physical and special qualities, it is necessary to organize duly the physical training (PE) classes, and, along with the existing training programs and existing training facilities, it is required to improve the latter: to develop, to approve, to test and to implement the advanced training equipment allowing to solve more efficiently the objectives set for the trainees (Malishevskiy, Brovkin, and Vlasov 2014).

There are various ways to reduce the negative impact of the human factor on the flight safety. A number of researchers of SPbSU CA, including the author hereof, have studied in their papers (Leichenko, Malishevskiy, and Mikhailik, 2006; Malishevskiy, Brovkin, and Vlasov 2014; Mukhtarov, Malishevskiy and Mikhailik, 1999; Leichenko, Malishevskiy, and Mikhailik, 2002; Malishevskiy, and Arinicheva, 2008; Malishevskiy and Parfenov, 2010; Malishevskiy, Arinicheva and Brovkin 2013; Malishevskiy and Brovkin 2014; Malishevskiy, et. al. 2006; Arinicheva, et. al. 2008) the way involving the proper aircraft (AC) crew designation. Notwithstanding the prospectivity of this way, unfortunately, it is openly rejected by the aviation community, especially by Western. The other possible way, reviewed in the papers (Malishevskiy, Grigor'ev and Leichenko, 2005; Malishevskiy, et. al. 2009; Malishevskiy 2010; Dzhafaradze, T.P. and Malishevskiy 2013), involving the improvement of the existing professional psychological screening of the aviation personnel, is not rejected, but it remains at the level of the mid-1980s. The Guidelines (The Guidelines on Psychological Support of the Screening, Training and Vocational Activities of the Flight and Traffic Control Personnel of the Russian Federation Civil

Aviation), effective currently, is practically the same as the previous Guidelines (Ryapolov 1986). Moreover, the SMIL test (the clone of the American MMPI test) recommended in (The Guidelines on Psychological Support of the Screening, Training and Vocational Activities of the Flight and Traffic Control Personnel of the Russian Federation Civil Aviation) for the professional psychological screening is generally not suitable for these purposes. According to Maklakov, one of the leading experts in this field: "The conformity assessment of the mental norm is the indirect indicator that can be taken into account during the physical fitness vocational screening. It is very useful in the screening for some specific activities, but it is not about the suitability for any profession. Furthermore, the use of the MMPI test is complicated by a number of design features of this test. Its results greatly depend on the cultural and national characteristics of the surveyed, as well as on the level of training of the researcher. Therefore, some countries, including the United States of America, prohibit the use of this test for the purposes of vocational psychological screening" (Maklakov 2008).

Therefore, the mainstream development of the aviation personnel training in the field of human factor (Leichenko, Malishevskiy and Mikhailik 2006; Mikhailik, Malishevskiy and Romanenko 1999) particularly, the CRM programs, seems to be the most appropriate.

The original version of "CRM Russia" program (Leichenko, Malishevskiy, and Mikhailik 2006; Mikhailik, Malishevskiy and Romanenko 1999) was converted into "CRM – two-member crew resource management" program in the mid-2000s. It mandatory includes the special computer software designed specifically for the assessment of the efficiency of the interaction in a pair of pilots. In order to improve the effectiveness of the training, a special software package for the aviation personnel training under "CRM – two-member crew resource management" program (Vlasov 2012) was developed by the author hereof.

This software and accompanying teaching aids were successfully implemented in the educational process, in which, however, various methodological problems were identified:

- the lack of personalization and personal accounting of the results;
- the lack of a common data storage;
- the lack of automated results processing system;
- insufficient control over the actions of the trainees;

Let us study the above-mentioned methodological problems and the ways of their solution. First of all, as the represented software package included, in general, the independent executable modules, it was decided to combine these modules into a common graphical environment, containing the theoretical information on CRM program, as well as the description of all the exercises with the ability to launch and to execute them. As each exercise maintains a log of results, independent from other applications, it is to the tutor to compare the results achieved by the trainees in each exercise, which is quite complicated. Especially considering the fact that during the exercise, no information on the trainees as well as the on the composition of the pairs is available. Thus, it becomes problematic to assess a particular trainee in the context of different pairs and exercises.

This fact is well illustrated by the correlations identified between the various indicators, as shown in Table 1 and Table 2 in the paper (Malishevskiy, Brovkin, and Vlasov 2014). According to Table 1 and Table 2, the greatest differences with the rest of the results are in the "bar" retention time within acceptable limits (TAzef) in "Azef" exercise. The objective of "Azef" exercise is the development of the anticipation in the pilot.

Being very useful for the training and warming-up, it is too sensitive to the random errors. This greatly reduces the possibilities of "Azef" exercise for the diagnostics of the efficiency of the interaction.

The "Ring-2" exercise shows a very narrow spread of results obtained.

TABLE 1. The correlations, identified between the indicators 04 צ, N, TRing, TAzef, 1 ש and 2 ש during the study of 52 pairs of participants in the test (Malishevskiy, Brovkin, and Vlasov 2014).

1 value 2 value	04 צ	N	TRing	TAzef	1 ש	2 ש
04 צ		-0.3029	-0.2302	-0.1489	-0.1091	+0.1108
N	P > 0.95		-0.0739	+0.0666	-0.0933	-0.0096
TRing	P ≤ 0.95	P ≤ 0.95		+0.0508	-0.0468	-0.1147
TAzef	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95		-0.0868	-0.0131
1 ש	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95		+0.7516
2 ש	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95	P > 0.999	

The values of the Pearson correlation coefficient between the performance indicators are given on the right and at the top; the characteristics of significance of the correlation are given on the left and at the bottom.

TABLE 2. The correlations, identified between the indicators 04 צ, N, TAzef, Nmist., 1 ש and 2 ש during the study of 62 pairs of participants in the test

1 value 2 value	04 צ	N	TAzef	Nmist.	1 ש	2 ש
04 צ		-0.1808	-0.0646	+0.0133	+0.0079	+0.0903
N	P ≤ 0.95		-0.0175	+0.1058	-0.2429	-0.0877
TAzef	P ≤ 0.95	P ≤ 0.95		+0.1386	-0.0711	-0.0576
Nmist.	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95		-0.1879	-0.2101
1 ש	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95		+0.7188
2 ש	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95	P ≤ 0.95	P > 0.999	

The values of the Pearson correlation coefficient between the performance indicators are given on the right and at the top; the characteristics of significance of the correlation are given on the left and at the bottom.

The following terms are used in Table 1 and Table 2:

- TAzef = Tret.F is the "bar" retention time within acceptable limits;
- TRing is the time of passage of the predetermined path by TO;
- Nmist. is the number of mistakes made during 300 sec;
- ש1 is the average score of two testees for the exercise "CrossCheck 2" (the worst result);
- ש2 is the average score of two testees for the exercise "CrossCheck 2" (the best result);

The exercise "CrossCheck 1" is aimed at the development of the cognitive-motor interaction in

a pair within cross-control mode and assessment of its effectiveness. According to Table 1 and Table 2, the match with almost all the experimental results is reliable enough, except for the results of the exercise "Azef." But one more problem arises here. The older age groups have the problems associated with the use of a personal computer: the excellent response and the sufficient coherence are accompanied by the insufficient motor skills of use of the I/O devices, which adversely affects the time of completion of the exercise and the result. (In other words, some older pilots have problems finding the necessary characters on the keyboard.) At the same time this problem is almost not relevant for the younger generation, therefore, there is an additional correlation of the experimental results and the age of the testees.

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3. Results and Discussion

Thus, there are a number of difficulties attributed to the use of the separate modules without complex processing of them. The solution to this problem is the introduction of a centralized storage of the data of the students, as well as the results of the completion of all exercises. Figure 1 shows the entity-relationship model (ER-model) (Hoffer, Venkataraman and Topi 2012). of the database, the main entities of which are the following:

• users – the table of students, used to store a list of the students trained under the CRM program, and to authenticate them in the system;

• sessions – the table of user sessions. When two users enter the system on the same computer to perform the exercise, the session is created and a variety of user IDs and additional information is stored in it;

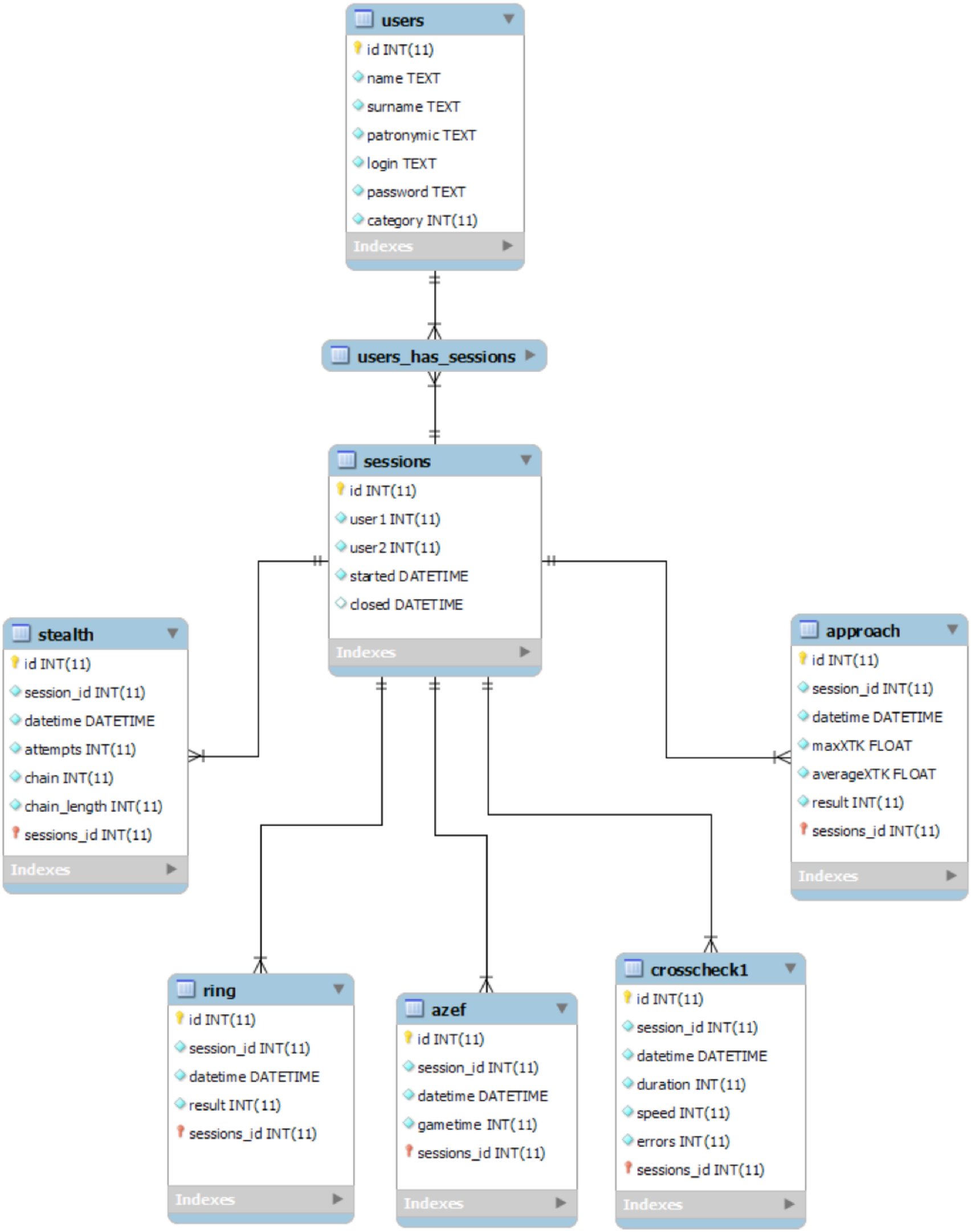
• stealth, ring, azef, etc. – the tables of the exercise results. They store the ID of every session in which each exercise is performed and the results obtained.

The links in the model:

• the link "many-to-many" among the entities, users and sessions reflects the existence of many sessions of one and the same user (possibly, with different partners) as well as the fact of participation of more than one user in each session;

• the link "one-to-many" between the tables of results and the table of user sessions reflects the fact of belonging of each result to a specific session, as well as the fact of the possibility of performing of a variety of different exercises within one session.

Fig. 1. The simplified ER-model of the proposed database



The centralized data storage solves the problem of collection of the exercise results, and the personalized access system in conjunction with the mechanism of sessions makes it easy to obtain the results of a particular trainee and to analyze them in the context of different exercises and pairs in which these exercises were performed. This system of accounting of

performance of the exercises is also the basis for construction of the automated evaluation of the results of completion of CRM program.

Another significant problem is the lack of the concept of separation of the operating modes into the training and scoring ones. The training mode implies the absence of restrictions, as well as the possibility to stop and to restart the execution of the exercise at any time. While the scoring mode, by limiting the freedom of action, does not allow the trainees to restart the exercise, if, according to the trainee, it is not executedwell. The limitation of the scoring tries will result in the increase of the adequacy of the results used for evaluation.

4. Conclusion

In general, the improvement of the special software used in the training under CRM program will enhance the effectiveness of such training and the objectivity of the obtained assessment.

References

Arinicheva, O.V., Kovalenko, G.V., Malishevskiy, A.V., Parfenov, I.A. and Petrova, M.V. (2008). Issledovanie metodov upravleniya v sfere vozdushnogo transporta s ispol'zovaniem sotsionicheskikh modelei [The Study of Methods of Control in the Field of Air Transport Using the Socionic Models]. Polet, 1, 45-49.

Dzhafaradze, T.P. and Malishevskiy, A.V. (2013). Problema sovershenstvovaniya professional'nogo psikhologicheskogo otbora pilotov grazhdanskoi aviatsii [The Challenge of Improvement of the Psychological Vocational Screening of the Civil Aviation Pilots]. Mediko-biologicheskie i sotsial'no-psikhologicheskie problemy bezopasnosti v chrezvychainykh situatsiyakh, 3, 66-70

Hoffer, J.A., Venkataraman, R. and Topi, H. (2012). “Modern Database Management” (11th ed.). Pearson Education Limited

Leichenko, S.D., Malishevskiy, A.V. and Mikhailik, N.F. (2002). Patent RF 2182815, MPK7 A61B 5/16. “Sposob otsenki podgotovki ekipazha vozdushnogo sudna v oblasti chelovecheskogo faktora” [Patent RF 2182815, MPK7 A61B 5/16. A Method of Assessment of the Aircraft Crew Training in the Field of Human Factors].

Leichenko, S.D., Malishevskiy, A.V. and Mikhailik, N.F. (2006). “Chelovecheskii faktor v aviatsii” [Human Factor in Aviation] (Vol. 2), St. Petersburg: Publishing House of Saint Petersburg State University of Civil Aviation; Kirovograd: State Aviation Academy of Ukraine

Leichenko, S.D., Malishevskiy, A.V. and Mikhailik, N.F. (2006). Chelovecheskii faktor v aviatsii [Human Factor in Aviation] (Vol. 2), St. Petersburg: Publishing House of Saint Petersburg State University of Civil Aviation; Kirovograd: State Aviation Academy of Ukraine.

Maklakov, A.G. (2008). “Professional'nyi psikhologicheskii otbor personala. Teoriya i praktika: uchebnik dlya vuzov” [Professional Psychological Screening of Personnel. Theory and Practice: Study Book for HEIs], St. Petersburg: Piter, 2008.

Malishevskiy, A.V., Brovkin, P.E. and Vlasov, E.V. (2014). “Otsenka effektivnosti ekipazhei letatel'nogo apparata” [Evaluation of the Effectiveness of the Aircraft Crews]. Mir transporta, 5(54), 216-229

Mukhtarov, M.A., Malishevskiy, A.V. and Mikhailik, N.F. (1999). Patent RF 2128471. “Sposob otsenki effektivnosti vzaimodeistviya chlenov ekipazha vozdushnogo sudna” [Patent RF 2128471. A Method of Evaluation of the Effectiveness of Interaction Among the Members of the Crew of an Aircraft].

Malishevskiy, A.V. and Arinicheva, O.V. (2008). “Issledovanie metodov i sredstv upravleniya i planirovaniya v sfere vozdushnogo transporta na baze sotsionicheskikh modelei” [The Study of Methods and Means of Control and Planning in the Field of Air Transport on the Basis of Socionic Models]. Nauchnyi vestnik Moskovskogo gosudarstvennogo tekhnicheskogo universiteta

grazhdanskoi aviatsii. Seriya Aeromekhanika i prochnost', 125(1), 186-190.

Malishevskiy, A.V. and Parfenov, I.A. (2010). “Ispol'zovanie sotsionicheskikh modelei dlya upravleniya i planirovaniya v sfere vozdushnogo transporta” [The Use of the Socionic Models for Control and Planning in the Field of Air Transport]. Nauchnyi vestnik Moskovskogo gosudarstvennogo tekhnicheskogo universiteta grazhdanskoi aviatsii, 154(4), 117-123.

Malishevskiy, A.V., Arinicheva, O.V. and Brovkin, P.E. (2013). “Analiz eksperimentov po otsenke effektivnosti vzaimodeistviya v parakh pilotov” [Analysis of the Experiments on Evaluation of the Performance of the Interaction in Pairs of Pilots]. Transport Urala, 3(38), 28-35.

Malishevskiy, A.V. and Brovkin, P.E. (2014). “Rezul'taty otsenki effektivnosti vzaimodeistviya v parakh pilotov s ispol'zovaniem intertipnykh otnoshenii V.V. Gulenko i rezul'tatov spetsial'nykh komp'yuternykh ispytanii” [The Results of Evaluation of the Efficiency of Interaction in Pairs of Pilots Using the Intertype Relations of Gulenko V.V. and the Results of Special Computer Tests], Nauchnyi vestnik Moskovskogo gosudarstvennogo tekhnicheskogo universiteta grazhdanskoi aviatsii, 1(199), 108-115

Malishevskiy, A.V., Arinicheva, O.V., Parfenov, I.A. and Petrova, M.V. (2006). “Psikhologicheskaya sovmestimost' v trudovom kollektive. Sotsionicheskii podkhod” [Psychological Compatibility in the Workplace. Socionic Approach]. Vestnik psikhoterapii, 17(22), 46-53.

Malishevskiy, A.V., Grigor'ev, G.I. and Leichenko, S.D. (2005). “Problema sovershenstvovaniya professional'nogo psikhologicheskogo otbora aviatsionnogo personala” [The Problem of Improvement of the Vocational Psychological Screening of the Aviation Personnel]. Vestnik psikhoterapii, 14(19), 58-75.

Malishevskiy, A.V., Arinicheva, O.V., Parfenov, I.A., Petrova, M.V. and Arakelyan, D.A. (2009). “Sotsionicheskii podkhod k probleme sovershenstvovaniya professional'nogo psikhologicheskogo otbora aviatsionnogo personala” [Socionic Approach to Improvement of the Vocational Psychological Screening of the Aviation Personnel]. Nauchnyi vestnik Moskovskogo gosudarstvennogo tekhnicheskogo universiteta grazhdanskoi aviatsii. Seriya Ekspluatatsiya vozdushnogo transporta, Bezopasnost' poletov, 149, 83-89.

Malishevskiy, A.V. (2010). “Sovershenstvovanie upravleniya i planirovaniya v sfere vozdushnogo transporta metodami sotsionicheskoi selektsii aviatsionnogo personala” [Improvement of Management and Planning in the Field of Air Transport by the Methods of Socionical Screening of the Aviation Personnel]. Nauchnyi vestnik Moskovskogo gosudarstvennogo tekhnicheskogo universiteta grazhdanskoi aviatsii, Seriya Aeromekhanika i prochnost', 151(1), 150-157

Mikhailik, N.F., Malishevskiy, A.V. and Romanenko, V.V. (1999). Patent RF 2119357. MPK7 A 61 M 21/00. A 61 B 5/16. “Sposob povysheniya professional'noi podgotovki letnogo sostava” [Patent RF 2119357. MPK7 A 61 M 21/00. A 61 B 5/16. A Method for Improvement of the Training of the Flight Personnel].

“Rukovodstvo po psikhologicheskomu obespecheniyu otbora, podgotovki i professional'noi deyatel'nosti letnogo i dispetcherskogo sostava grazhdanskoi aviatsii Rossiiskoi Federatsii” [The Guidelines on Psychological Support of the Screening, Training and Vocational Activities of the Flight and Traffic Control Personnel of the Russian Federation Civil Aviation], Moscow: Vozdushniy transport.

Ryapolov, I.V. (Ed.), (1986). “Rukovodstvo po professional'nomu psikhofiziologicheskomu otboru v grazhdanskoi aviatsii” [The Guidelines on Professional Psycho-Physiological Screening in the Civil Aviation], Moscow: Vozdushniy transport.

Vlasov, E.V. (2012). Primenenie prikladnogo programmnogo obespecheniya v protsesse podgotovki aviatsionnogo personala [The Use of the Application Software in the Process of Training of the Aviation Personnel], In Problemy letnoi ekspluatatsii i bezopasnost' poletov: mezhvuzovskii sbornik nauchnykh trudov (Issue 6, pp. 182-188), St. Petersburg: St.

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2. St. Petersburg State University of Civil Aviation, 196210, St. Petersburg, Pilotov, 38
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4. St. Petersburg State University of Civil Aviation, 196210, St. Petersburg, Pilotov, 38
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