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IMPROVING THE EFFICIENCY OF HELICOPTER PILOTS TRAINING IN THE SIMULATOR

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Abstract. *The process of helicopter pilots training by simulator is considered. It is analyzed the aviation accidents due to human factor. It is proposed the way of improving of training helicopter, pilots by simulator with help of redistribution time training.*

Keywords: training; simulator; pilots; helicopter; aviation accidents.

Introduction

Nowadays, accidents are mostly attributable to the human factor, 80 – 90 % from all accidents, and, unfortunately, existing methods have not led to improvement of safety.

Pilots work is the most difficult type of human activity, consequently training is difficult as well. The process of professional training includes a wide variety of instruments and devices. The level of training should mainly guarantee safety. Since graduate flight school immediately take jobs in the crew of the helicopter.

Accident analysis and preconditions shows that factors such as the mistakes in flight operations , omissions and deficiencies in the organization and management of flights and aircrew training methodology , errors in piloting technique and operation of aviation equipment determines the overall accident rate and the reasons for them, they are notorious for its repeatability[1]–[5]. This causes the need to improve the organization and methodology of flight training for flight crews.

Aviation accident statistics, analysis of helicopter accidents

Here we see typical factors of unsatisfactory performance of the helicopter crew were:

– decision to take off or land during weather conditions that do not ensure the safety of the flight;

– late decision to change the flight plan, including the missed approach non-compliance with safe altitudes during landing;

– errors during operation with helicopter systems;

– violations of the documentation governing flight activity;

– deviations in maintaining flight parameters;

– violation of a given flight plan;

– poor interaction in a carriage;

– inability of the crew to choose an appropriate landing zone.

The analysis of reasons of helicopter accidents shows that they occur, usually due to a combination of inadequate crew training assignment, wrong altitude and airspeed during approach, inadequate actions of the crew to stop the decline and errors to perform the second round in the absence of visibility terrestrial landmarks, poor organization of flight operations.

Summary table of Russian helicopter crashes in 2000–2013. Total: 73 machines.

After analyzing this table, it is worth noting that the vast majority of helicopter accidents occur due to:

– a technical failure of the helicopter and the unwillingness of the crew to cope with this extreme situation;

– pilot error during landing (hard landing , landing in bad weather);

– helicopter collision with obstacles during low-level flight, or in mountainous areas due to insufficient knowledge of the landscape and the pilot's experience.

As safety is mandatory, we use accident rates redistribution plan of pilots training.

Aviation accident statistics, analysis of helicopter accidents

Model /Cause of crash	Technical failure	Shot	Errors during landing	Collisions	Errors during flight	Erros during maintance
Mi-8	16	12	7	5	1	3
Mi-24	7	8	1	7	–	–
Mi-28	1	–	–	-	–	–
Mi-35	–	–	–	1	–	–
Ka-27	–	–	2	–	1	–
Ka-60	1	–	–	–	–	–

Aviation training process consists of many elements, each of which has its own purpose. Simulator as part of the educational process and training plays an important role in training aviation specialists not only in the final stages of training, but also for training, during training and test knowledge and skills. In ICAO documents [6] determined that flight simulators can be used during the studying and testing of pilots to a greater extent than before. The profound use of such training methods is conditioned by the increased complexity of modern helicopter technique, cost and operating conditions. Simultaneous simulators can provide even more profound training than in reality to meet safety and correspondence to actual operating conditions. Displaying a variety of effects on the helicopter helps to implement such training and to ensure that the pilot will be able to reproduce his actions during the actual situation in flight. It is also important fuel economy and lack of harmful effects on the environment.

Flight simulator designed to prepare flight specialists exploring this type of helicopter in the following areas: initial flight training, quarterly training, seasonal training, qualification recovery after the break, extending the flight certificate, training of instructors to work upgrade.

Hardware-software training complex based on the use of personal computers in the local network. The software works in Windows XP operating system and stored on a dedicated server. Individual tasks run from a local disk for your computer.

Analysis features optimize training

The disadvantage of the conventional approach to the extended curricula and, in particular, in the planning simulator training is their reliance on "average pilot". However, even at constant composition subjects or skills makes sense to individualize the allocation of time for their development, taking into account the ability of each student and the complexity of the skills. This ability depends primarily on the quality of training or "progress" in the early stages and the degree of skills degradation with time (the ability to remember or forget assimilated knowledge).

Therefore it is necessary to study these abilities, which means to form a mathematical model of the quality of training and further – to estimate the parameters of the model for each individual group, for which it is offered a solution of optimization inverse problem. Obtained estimates allow to formulate and solve the direct problem of optimal flexible scheduling of, which should provide a positive effect.

Problem statement

Consider the problem of multi-stage skills development at their parallel study at each stage with the following assumptions [7], [8]:

– set the total number of stages of training $v = 1 \dots N$ and the total number $n + m$ parallel mastered skills, which are the same at each stage: n simple and m complicated skills;

– the quality of simple skill grows exponential model development

$$x_i(t_j) = \left(1 - e^{-\alpha_j t_j}\right)^{q_j}; \quad i = 1 \dots n,$$

where $x_i(t_j)$ is standardized estimate of training quality, when the maximum level of development taken as a unit; *i is* the current number of the simple skill; *j is* number trained group; t_j is the time allotted for training; α_j is personal speed indicator of development of simple skill, subject identification; $q_j \le 1$ is exponent varied in depending of the individual peculiarities of student; *n is* the total number of simple skills, quality of a complex skill – on the logistic model

$$y_k(-\tau_j) = \left(1 - e^{-\beta_j \tau_j}\right)^{p_j}; \quad k = 1 \dots m,$$

where y_k standardized estimate of training quality; k is current number of the simple skill; j is number trained group; τ_j is the time allotted for training; β_j is personal speed indicator of complex skills development to be identified; $p_j > 1$, is exponent of, which increasing emphasizes the logistical nature of training, the parameters of which $\alpha_j, \beta_j, q_j, p_j$ shall be identified by the test results at the next stage of training.

Indicators of the training rate $\alpha_j(v)$ and $\beta_j(v)$ in turn depend linearly on the training results the previous step $(v-1)$

$$\alpha_j(v) = r_j(v) + l_j x_j(v-1);$$

$$\beta_j(v) = \theta_j(v) + k_j y_j(v-1),$$

where $r_j(v)$ or $\theta_j(v)$ are development rates of simple or complex skills in the "absence" of training in the previous stages, appointed an instructor a priori; l_j and k_j are desired correlation coefficients of new skills with the previous.

All students of the group is divided into three subgroups: strong (j = 1), medium (j = 2) and weak

(j = 3), who are receiving appropriate evaluation x_j and y_j at every stage of training.

In general, the optimality criterion is presented training formula [9]

$$z = \sum_{j=1}^{3}\left[C_1 \sum_{i=1}^{n} x_i(t_j) + C_2 \sum_{k=1}^{m} y_k(\tau_j) \right]$$

$$= \sum_{j=1}^{3}\left[C_1 n \left(1 - e^{-\alpha_j t_j}\right)^{q_j} \right.$$

$$\left. + C_2 m \left(1 - e^{-\beta_j \tau_j}\right)^{p_j} \right] \underset{t_j, \tau_j}{\Rightarrow} \max, \qquad (1)$$

where C_1, C_2 are the coefficients of the relative importance of development of simple and complex skills, which together with the parameters $\alpha_j, \beta_j, q_j, p_j$ are considered as given, if for the optimum it is taken the maximum total (or average) progress of all students z taking into account the linear constraints

$$nt_j + m\tau_j < T,$$

$$\delta_1 < \tau_j < \Delta_1, \quad \delta_2 < t_j < \Delta_2.$$

Under these assumptions requires:

– estimate the parameters $\alpha_j, \beta_j, q_j, p_j$ of simple and complex skills development rate and relationship coefficients l_j and k_j by the results of testing;

– realize the optimal planning of individual training in the new stage for each of the three study subgroups.

To optimize individual plans of training, linear convolution (1) can be represented in the form of three terms for each of the study subgroups and to optimize separately.

If we turn to the weak subgroup (j = 3) and under certain assumptions about the small values of α_3, β_3 linearize the criterion (1), then we obtain a linear programming problem with $q_j, p_j = 1$.

$$z_3 = C_1 n \alpha_3 t_3 + C_2 m \beta_3 \tau_3 \underset{t_3, \tau_3}{\Rightarrow} \max,$$

$$nt_3 + m\tau_3 < T,$$

$$\delta_1 < \tau_3 < \Delta_1, \quad \delta_2 < t_3 < \Delta_2, \quad \text{when} \quad C_1 = C_2 = 1.$$

The solution to this problem by the simplex method gives an unique answer-simple tasks and appropriate to them simple skills that have a greater weight in the convolution α_3, β_3, are able to take a share T the maximum, i.e. $t_3 = \Delta_2$, and for difficult tasks and appropriate to them difficult skills is still time $\tau_3 = \delta_1$. Then the total progress of weak students will be maximum.

Conclusions

Based on the analysis of helicopter accidents it is proposed to take into account its results in helicopter pilots training at simulators. It is developed the procedure of the time training redistribution for skills acquisition by helicopter pilots.

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В. М. Синеглазов, Ю. М. Шмельов. Підвищення ефективності навчання пілотів вертольотів на тренажері
Розглянуто процес навчання пілотів вертольотів на тренажері. Проаналізовано авіаційні пригоди як наслідок людського фактору. Запропоновано шлях покращення навчання пілотів вертольотів на тренажері завдяки перерозподілу часу навчання.
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В. М. Синеглазов, Ю. Н. Шмелев. Повышение эффективности обучения пилотов вертолетов на тренажере
Рассмотрен процесс обучения пилотов вертолетов на тренажере. Проанализированы авиационные происшествия как следствие человеческого фактора. Предложен путь улучшения обучения пилотов вертолетов на тренажере на основании перераспределения времени обучения.
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