UDC 371.694:004:656.7(045)

[1]V. M. Sineglazov,
[2]Ju. M. Shmelev

ESTIMATION OF HELICOPTER PILOTS TRAINING EFFICIENCY IN THE SIMULATOR

Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine
E-mails: [1]svm@nau.edu.ua, [2]klk-nay2000@mail.ru

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 estimation of helicopter pilots training efficiency in the simulator.*

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

I. 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.

II. TRAINING IN SIMULATOR

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.

Efficiency of the use of simulators is considered to be effective, however practically, there are no reasonable methodologies for assessing the effectiveness of training in a form of reduction of accidents, not counting the numerous statistics on accidents in the heli-industry. However, for the correct use of statistics we need a sufficient amount of information for the similar events, and accidents involving the human factor, usually they are unique, nature and the specific chain of events are rare.

Next step, the assessment of reduction of accidents, failures from the use of training at a particular event is calculated by a relatively small and incomplete set of unique reasons of accidents which significantly differ from each other.

Finally, the calculation of the efficiency of the implementation of simulators based with a statistical approach of the accident rate is not accurate, as it is impossible to evaluate a qualitative difference between simulators and improve the methodology for trainings. It is intended to convince the leaders to by a new one, rather than to improve the effectiveness of an older one

Besides the lack of constructive criteria for the simulators. People usually neglect that fact that engineers experience scarce of the resources on its development , and time for schedule managing .

Actually, students experience problem of “forgetting”, process when they partially lose skills learned in training over the past themes, and this loss may exceed the effect of the new trainings. Specific indicators are strictly individual for each expert. In the presence of methodology for calculating the efficiency, wecan define point which is called “interruption rate” if the loss of “forgetting” exceed the acceptable level , then the process of training for this specialist cannot be recognized as an effective and sufficient .

Consider the problem of evaluating the effectiveness of training and, accordingly, use of the simulator

in detail. A number of works offered constructive approach to the problem of evaluating the effectiveness of training, and, respectively, to a comparison of functional characteristics of simulators.

III. SINGLE TRAINING

For the tasks of planning, it is necessary to divide all field of professional activity of pilots, on separate episodes or themes, behavior in which can have either positive or possible negative detrimental effect

Training is based on a principle of applying various modes both normal and emergency. The standard algorithms of activity are formed on the base of description of a real flight, which are made by professional pilots

IV. FUNCTIONAL OF PROBABILITY

For the quantitative estimation of reliability of personnel and probability of emergency the concept of probability of making a mistake by a pilot is entered. Simulator at such approach – maximally reduces probability of errors made by pilot on every episode. Thus, the task of the system of training is realization of the single training on every topic from a complete list to the complete exception of errors. Probability of making a mistake after educating is not equal to the zero and depends on adequacy of simulator to the terms of a real flight, including the presence of stress, and also "forgetting" of skills in the conditions of monotonous and accident-free work.

V. FUNCTIONAL OF ERRORS

Reasons indicated above, show that accurate description of the functional of probability does not exist , however we see its tendency in terms of declination of amount of errors during education on a trainer. Thus, in spite of absence of strict statistical ground, judging about character of functional of probability of errors is possible.

VI. FUNCTIONAL OF EFFICIENCY

On the basis of the given descriptions, we can set quantitative criterion of efficiency, reflecting the functional utility of trainer and system of the conducted training from the point of view which shows safety. One of practical approaches in this case is an setting to every single training some numeral value for example, middle damage when a specialist makes an error on the topic of the single training on real helicopter. This number cannot be got from statistics correctly from insufficiency of initial information, however the usage of method of expert estimations gives a reasonably scientific base. Moreover, summarizing of the achieved marks adds additional objectivity to the final results according to the law of large numbers (Wiener-Khintchine theorem).

Certainly, summarizing of all damages from all possible catastrophes, can exceed the cost of helicopter. However who will give guarantee, that defects in preparation of personnel will not give multiplicative effect on the whole great number of objects or reiteration of accidents on the same object? Therefore the use of similar estimations has important practical sense.

How the mark which estimates efficiency behaves with the increase of time dedicated for education? Obviously, trained pilot is safer than untrained. Training requires time. It is possible reasonably enough to suppose that exists some training time T_{max} for the gaining certain skill. At time of educating more than T_{max} gain of experience is absent [7].

At time of educating, insignificantly different from $t = 0$, admitting of specialist to the flight will bring the most major damage, thus the subsequent educating will result in reduction of this damage. Thus, time of educating does not influence on efficiency, and increase of efficiency certainly described by the function of decline of amount of errors from duration of training. It will be shown further, that reduction of training value T_{max} allows to increase a general size of prevented mistakes which cause damage (risk, fine).

We will enter the concept of functional of efficiency of the single training, qualitatively repeating the functional of errors, it's numeral values for time of completion of training of $t = t_{max}$ are set from a condition, that general area (or certain integral) is equal to the value of middle damage when a specialist makes an error on the topic of the single training on real helicopter (Fig. 1). Let's assume that damage from non-fulfillment of training is S. For the case of linear approximation area of triangle under a curve for a calculation – $dS/dt_0 \cdot T_{max}/2 = S$, where dS/dt_0.

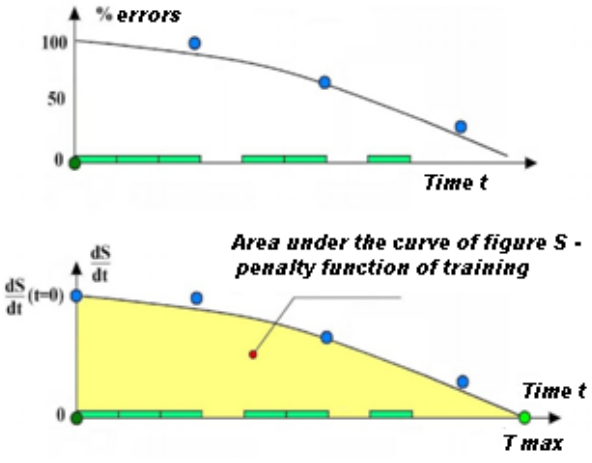

Fig. 1. The functional efficiency

We get

$$dS/dt_0 = 2s/T_{max} \text{ (at } t = 0);$$

$$dS/dt = 0 \text{ (at } t = T_{max}).$$

For the groups of specialists and groups of training – we use average coefficients of linear approximation of a1 and a0. Calculation of T_{max} and dS/dt for $t = 0$ is analogical.

VII. Optimal number of training

General optimal plan of training, which provides maximal efficiency from all number of the passed training, we will build in the next manner. We will divide the functional of efficiency on every single training on equal time segments (Fig. 2).

Then, taking into account circumstance that specific cost of minute for the different training can differ (for example, the simulators of different cost are used), we will build the sequence of segments, starting with a segment possessing the highest correlation "efficiency-cost" and to the segment with the least size of this rate

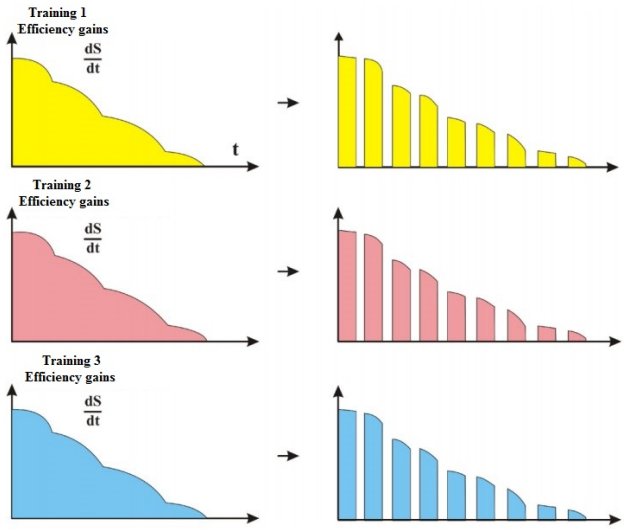

Fig. 2. Comparison of functional efficiency for different groups of individual training

If we take into account specific cost of training T_{opt} appears, alternative to T_{max}, if these variables are equal, training starts to be useless (Fig. 3).

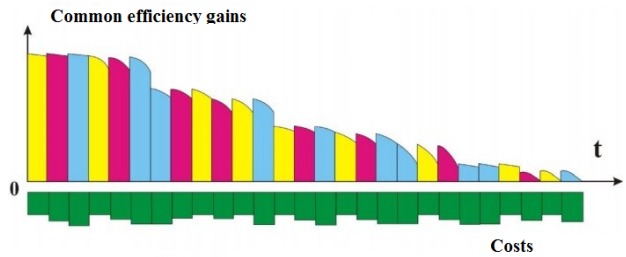

Fig. 3. Optimal set of training

Having such optimal plan, it is possible to estimate efficiency of the use of simulator, and also expediency of their reconstruction and development of new facilities. If amount of hours for training is not enough, than it is used ineffectively.

The structure of the computer system is shown in Fig. 4. In this system, each participant presents results through the communication channel, the quality of performed task is estimated by time he needs to give namely correct answer. Depending on the results, the optimizer of a plan assigns a new type of job, with a time individually limited for every student in accordance with a specified total training time. We take into account the most important factors affecting the development of one skill, speed of skill development, level of previous skills development, when current skill is based on previous, degree of degradation or "forgetting" previous skills, when next skill has to be developed.

Optimizer of the curriculum can be represented as:

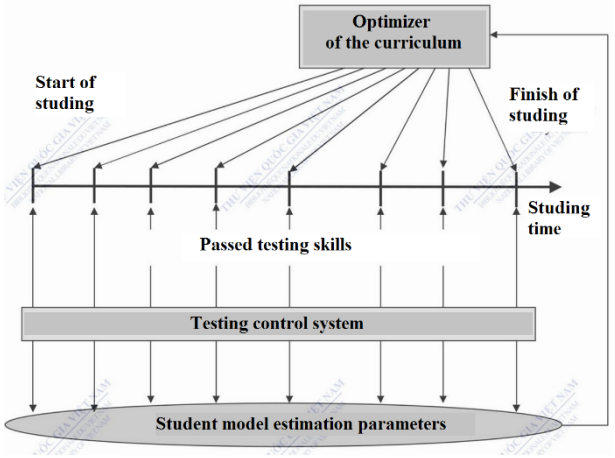

Fig. 4. Optimizer of the curriculum

VIII. 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 estimation of helicopter pilots training efficiency in the simulator.

References

[1] Robert, L. Helmreich. "Future directions in crew resource management training." *Helmreich. ICAO Journal*. 1993. vol. 48 no. 7. pp. 8–9.

[2] Harry, W. Orlady. "Airline pilot training programmes have undergone important and necessary changes in the past decade." *1C AO Journal*. 1994. vol. 49 no. 3. pp. 5–10.

[3] Capt. Johnston, A. N.; Capt. Maurino, D. E. "Human Factors training for aviation personnel." *1C AO Journal*. 1990. vol. 45 no. 5. pp. 16–19.

[4] Capt. Johnson, Neil. "Integrating human factors training into ab initio airline pilot curricula." *ICAO Journal*. 1993. vol. 48 no. 7. pp. 14–17.

[5] Safety Regulation Group. CAP 718. Human Factors in Aircraft Maintenance and Inspection (previously ICAO Digest no. 12). *Safety Regulation Group.* TSO. 2002. 56 p.

[6] Doc 9625. 2003. Manual of Criteria for the Qualification of Flight Simulators. 2nd edition. Montreal: ICAO. 90 p.

[7] Ckafizov, F. Sh.; Shevchenko, D. I.; Kofanov, A. V.; Nikolaev, I. A. "Optimization of training process in oil and gas industry with limited resources" *in © Electronic scientific journal "Oil and Gas Business"*, 2011. no. 5. Ufa State Oil Technical Univ. (in Russian).

Received 06 December 2013

Sineglazov Viktor. Doctor of Engineering. Professor.
Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine
Education: Kyiv Polytechnic Institute, Kyiv, Ukraine (1973).
Research area: Air Navigation, Air Traffic Control, Identification of Complex Systems, Wind/Solar power plant.
Publications: 456.
E-mail: svm@nau.edu.ua

Shmelev Juriy. Post-graduate student.
Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine.
Education: National Aviation University, Kyiv, Ukraine (2005).
Research area: aviation safety, aviation simulations.
Publications: 4.
E-mail: klk-nay2000@mail.ru

В. М. Синеглазов, Ю. М. Шмельов. Підвищення ефективності навчання пілотів гелікоптерів на тренажері
Розглянуто процес навчання пілотів гелікоптерів на тренажері. Проаналізовано авіаційні пригоди як наслідок людського фактору. Запропоновано шлях покращення навчання пілотів гелікоптерів на тренажері завдяки перерозподілу часу навчання.
Ключові слова: навчання; симулятор; пілоти; гелікоптер; авіаційних подій.

Синєглазов Віктор Михайлович. Доктор технічних наук. Професор.
Кафедра авіаційних комп'ютерно-інтегрованих комплексів, Національний авіаційний університет, Київ, Україна.
Освіта: Київський політехнічний інститут, Київ, Україна (1973).
Напрям наукової діяльності: аеронавігація, управління повітряним рухом, ідентифікація складних систем, вітроенергетичні установки.
Кількість публікацій: 456.
E-mail: svm@nau.edu.ua

Шмельов Юрій Миколайович. Аспірант.
Кафедра авіаційних комп'ютерно-інтегрованих комплексів, Національний авіаційний університет, Київ, Україна.
Освіта: Національний авіаційний університет, Київ, Україна. (2005).
Напрям наукової діяльності: авіаційна безпека, авіаційний тренажер.
Кількість публікацій: 4.
E-mail: klk-nay2000@mail.ru

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.
Ключевые слова: обучение; симулятор; пилоты; вертолет; авиационных происшествий.

Синеглазов Виктор Михайлович. Доктор технических наук. Профессор.
Кафедра авиационных компьютерно-интегрированных комплексов, Национальный авиационный университет, Киев, Украина.
Образование: Киевский политехнический институт, Киев, Украина (1973).
Направление научной деятельности: аэронавигация, управление воздушным движением, идентификация сложных систем, ветроэнергетические установки.
Количество публикаций: 456.
E-mail: svm@nau.edu.ua

Шмелев Юрий Николаевич. Аспирант.
Кафедра авиационных компьютерно-интегрированных комплексов, Национальный авиационный университет, Киев, Украина.
Образование: Национальный авиационный университет, Киев, Украина (2005).
Направление научной деятельности: авиационная безопасность, авиационный тренажер.
Количество публикаций: 4.
E-mail: klk-nay2000@mail.ru