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Volodymyr Gorbunov

OBJECTIFICATION OF ERGONOMIC ASSESSMENT OF THE PILOT OPERATION ON THE BASIS OF "PHOTOSHOP – TECHNOLOGY"

National Aviation University
Kosmonavta Komarova avenue 1, 03680, Kyiv, Ukraine
E-mail: d_gor@rambler.ru

Abstract. *On the basis of information technology "Photoshop" the means of the objective ergonomic evaluation of the professional activity of pilot on piloting the plane has been developed. Procedural characteristics, peculiarities and objective criteria if his work on aviation equipment is ergonomically acceptable, as well as the order of revealing the ergonomic shortcomings of the arrangement of his working place that decrease the flight safety from the position of human factor have been determined.*

Keywords: ergonomic evaluation; flight safety; human factor; information technology; "Photoshop"; pilot.

1. Introduction

According to current statistics of accidents in aviation, the vast majority of aviation accidents are caused by the irrational actions of the crew in stressful flight conditions [Hurst, Hurst 1986]. This "professional inefficiency" is caused firstly, by not optimal algorithms, whose correctness of fulfilment practically is not controlled in flight testing.

During the investigation of aviation accidents [Rules…2002], the degree of compliance of the performance of the working algorithms by pilots, according to the Manual Instruction (MI), rather is not determined but assigned on the basis of the mentioned requirements.

2. Statement of the problem

It is known that, how the crew must work in the normal and refusal flight situations, ultimately, is defined in the flight tests. They are testers, first of all pilots, who are "ideological creators" of MI, thereby ensuring, first of all, the security of passengers and, equally important, legal security of the crew in the process of maintenance of serial aircraft. Thus, MI as a legal document is a kind of "procedural guarantor" of successful flight and a "legal shield" for crew from legal proceedings, in the event of an aircraft incident. Otherwise, it is ergonomic source of flight risk, especially in respect to working algorithms of the crew in refusal situations.

However, the responsibility of testers for "dangerous FO" is not foreseen by existing aviation legislation [The air…1993] and the guilty in an aircraft accident as a rule considered being a victim crew. Although from the standpoint of modern aviation ergonomics, it's absolutely groundless, because, in most cases, line pilots acted according with the MI.

This situation occurs due to the lack of sufficient attention to procedural characteristics of the professional activities of the pilot in flight tests, as by the testers themselves so by the relevant aviation regulatory authorities.

3. Analysis of research and publications

Existing official documents on the flying certification of the aircraft [Unified…1985; Aviation…1994] do not contain a separate section with special requirements to the ergonomics of the working algorithms of the crew. This question indirectly is considered in connection with the assessment by the MI degree of flight situation danger [Unified…1985] or professional personnel of the crew [Aviation…1994]. As a consequence, out of sight of controlling aviation bodies there are such important procedural characteristics affecting flight safety, as the timeliness of the beginning of the algorithm execution, the order and the number of necessary operations, their executors, the duration of each operation and the whole algorithm, the time of the day when test flight is performed etc. Often, the positive results of flight tests, especially in relation to takeoff and landing characteristics, bear the imprint of the "special" test process [Guidance…1982], which is aimed, first of all, to confirm the safety of the operation of the new aircraft, according to the "aerodynamic" requirements of existing regulations [Unified… 1985; Aviation…1994].

The lack of methodological maintenance for objective control of ergonomics of the performance of the algorithms that are directly related with flight safety, does not allow to perform their objective evaluation to identify ergonomic shortcomings of professional activity of the pilot.

Such lack of control leads to the fact that "linear pilot", performing his professional responsibilities exactly according to MI (not adjusted to the peculiarities of the test flight, unexpectedly for himself, as if "specially" might create "a special flight situation" with all the possible tragic consequences.

On the other hand, the natural aspiration of the tester to demonstrate high maintenance characteristics of the aircraft, even with taking into account the special means of test flight security [Guidance… 1982], can lead to purposely more procedurally favourable redistribution of functional responsibilities between the pilots, contrary to MI, and the creation of more favourable time conditions for the fulfilment of "refusal algorithm". Thanks to such "good" procedural violations, the time of fulfilment of appropriate algorithm for the elimination of refusal situation reduces and flight safety in the investigated refusal situation such as "interrupted take-off" will be objectively proven but only according to aerodynamic indices.

Thus, the absence of separate special ergonomic requirements for the objective control of the procedural characteristics of the professional activities of pilots as well as the absence of objective methodology for their assessment significantly reduces the quality of the certification tests. The obtained results, as a rule, do not contain objective confirmation of the flight safety of working algorithms of the crew from the standpoint of human factor, first of all, in respect to the refusal flight situations.

The existing methodological approaches can provide preventive analytical estimation of the ergonomic characteristics of the working activity of the crew [Gorbunov 2010; Gorbunov 2012], even before the flight tests. But they are not intended for experimental testing of the ergonomics of the layout of the workplace, working algorithms and distribution of functional duties among the crew.

4. The purpose of the study

Therefore with the purpose of objectification of the results of ergonomic flight tests, in respect to the professional activity of pilots, the method of objective after flight video-control and analysis of its procedural peculiarities using information technology Photoshop [Boughton 1998] has been developed.

5. Photoshop is software method of objectification of the ergonomic assessment

The method of ergonomic assessment of professional behaviour of the pilot using information technology Photoshop contains the following stages: marking various elements of the pilot under investigation and his workplace, spatial calibration of object (markers), video shooting, video recording of working process, selection of video frames which are necessary for picture analysis, layout of generalizing picture from them, the following analysis of the peculiarities of professional behaviour, on the basis of corresponding video registration, their expert evaluation for accordance with ergonomic criteria.

Effective application of this method to the "ergonomic certification" of professional behaviour of the pilot is provided by certain methodological requirements for each of the stages. So, labelling (marking by marker) the item (parts of pilot's body, areas of workplace, etc.), that is video-recorded, carries out if it could appear on a video frame only at certain working postures of the pilot or is "key" in the algorithm, or testify about the inconvenience of performance of working operations, etc. First of all, those potentially informational parts of the video-shooting object are marked with special labels (markers) that require particularly careful monitoring because of their importance for flight safety. They ultimately determine positive or negative ergonomic assessment of the professional activity of the pilot. Markers can be placed as directly on the pilot's hands, head, torso, legs, etc., as well as on separate areas of panels etc. associated with the correct execution of the working algorithm.

So the markers placed on the separate informational parts of the body, in certain point places on the pilot's head, arms, hands, torso associated with the change of working postures when performing certain operations, will a help to record objectively the fact of inconvenience at work. Marking of certain "functional areas of workplace", separate operation means (switches, buttons, levers, etc.) will allow to determine the authorship and time indices of their using in the process of work. Based on the markers of "belonging to profession" for a certain position in the crew we can clearly say who of the pilots performed specific operations with specific aircraft equipment, at what stage of the performance of work process and at what time and whether in accordance with the requirements of MI.

For the qualitative objective ergonomic assessment of professional behaviour of the pilot, all of these types of markers should be clearly visible in the video frames and have such dimensions that when creating the integral "picture" they will allow to place them, according to the path of monitored item, within the size of the picture on a video frame.

Marking is closely linked with spatial calibration of markers' location. It can be performed as for separate marked parts and areas of the body, so for separate working areas, that form working space around the running pilot (the human-operator). Preliminary determination at what positions of markers on parts of the body in the "picture" there are negative ergonomic characteristics of the layout of the workplace, for example, uncomfortable, not be seen, not achievable etc. will allow to unambiguously interpret the spatial position of these markers' representation in the process of the work.

Thus objective data, in the form of video frames, in respect to comfortable performance of working algorithm by the particular member of the crew with the use of the respective operation means (switches, buttons, levers, etc.), instruments, sensors, detectors, etc. will be obtained.

Video registration is undertaken primarily for those working processes, the results of which unambiguously determine the safety and/or quality and/or reliability of the performance of the specific flight task. Constant shooting angle, for example, with respect to the point "C", will allow to fix the markers on the working parts of the body (head, fingers, hands, etc.) involved in the working process, on background of the corresponding marked areas of layout of workplace, thus providing an objective control of the ergonomic parameters of activity of the pilot.

Existing automatic indication of time under the video frame (hour, minute, second) specifies the daily period, the duration of individual work operations and algorithm as a whole, and parallel sound recording allows you to "bind" the audio features of the negotiations to the appropriate video.

The selection of video frames, necessary for ergonomic analysis, is caused, first of all by their information content, that demonstrates the "authorship" and the sequence of movement of working parts of the body, changing the state of applied functional items of the layout of the workplace, as well as, if possible, emotional reaction of the pilot (facial expressions, or/and the frequency-amplitude characteristics of the voice in the conversation, or/and the "emotional content" of the negotiation).

When you create summarizing "picture", the representations of marked items from different video frames recording working process in time, and also their separate fragments, that play an important role in ensuring flight safety, are used.

Further analysis of this "picture" will allow to find out the time moments and places of appearance of certain markers in the video frames, to compare them with the results of calibration and to determine authorship, correctness, completeness and ease of performance of working algorithms, to calculate time procedural gaps between individual work operations and to determine their timeliness, "associate" with them, in real time, the crew talks and, thus, to evaluate the adequacy of the professional actions of the pilot (crew) to the requirements of MI.

The resulting video information will help to confirm "documentary" the shortcomings of the cabin layout, as well as the violation of the distribution of functional responsibilities among the members of the crew and the optimality of the studied working algorithms.

Thus, "Photoshop", method of ergonomic objective evaluation of the professional activity of the pilots either during the actual piloting an aircraft, or in flight simulation on the simulator, or on the model cockpit, developed on the basis of information technology, will allow more qualitatively, compared with only subjective method [Gorbunov 2009], to assess the correctness and the comfort of the work of flight crew during the specific flight missions. This will contribute to more adequate measures to improve the ergonomics of the working conditions of pilots to ensure the flight safety from the standpoint of human factor.

6. Conclusions

1. "Photoshop" as a software tool for processing the video information, allows to determine the objective indices of ergonomic assessment of professional activity of the pilot.

2. Objective video registration and expert analysis of the procedural characteristics of the work of the pilot, in the process of piloting, objectively assess the degree of ergonomics of his workplace, ergonomic perfectness of working algorithms and optimal distribution of functional responsibilities among the members of the crew.

3. Software information technology Photoshop (and similar modern software products) is a promising research method of aviation ergonomics for the objective identifying ergonomic shortcomings of professional activity of the pilot.

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Національний авіаційний університет, просп. Космонавта Комарова, 1, Київ, Україна, 03680
E-mail: d_gor@rambler.ru

На основі інформаційної технології «Photoshop» розроблено метод об'єктивної ергономічної оцінки професійної діяльності пілота. Визначено процедурні характеристики, особливості й об'єктивні критерії ергономічної оцінки умов роботи з авіаційним обладнанням, ергономічні недоліки компоновки робочого місця, що знижують безпеку польоту. «Photoshop» розглянуто як програмний засіб обробки відеоінформації, який дозволяє на основі відеореєстрації та експертного аналізу процедурних характеристик роботи пілота визначити показники процесу пілотування, оцінити ергономічну досконалість алгоритмів роботи та оптимальність розподілу функціональних обов'язків між членами екіпажу. Показано, що програмна інформаційна технологія «Photoshop» та аналогічні сучасні програмні продукти є перспективним дослідницьким методом авіаційної ергономіки для виявлення ергономічних недоліків професійної діяльності пілота.

Ключові слова: безпека польоту; ергономічна оцінка; інформаційна технологія; людський фактор; пілот; «Photoshop».

В.В. Горбунов. Объективизация эргономической оценки деятельности пилота на основании «Photoshop-технологии»
Национальный авиационный университет, просп. Космонавта Комарова, 1, Киев, Украина, 03680
E-mail: d_gor@rambler.ru

На основе информационной технологии «Photoshop» разработан метод эргономической оценки профессиональной деятельности пилота. Определены процедурные характеристики, особенности и объективные критерии эргономической оценки условий работы с авиационным оборудованием, эргономические недостатки компоновки рабочего места, снижающие безопасность полета. «Photoshop» рассмотрен как программное средство обработки видеоинформации, позволяющее на основании видеорегистрации и экспертного анализа эргономических характеристик работы пилота определить показатели процесса пилотирования, оценить эргономическое совершенство алгоритмов работы и оптимальность распределения функциональных обязанностей между членами экипажа. Показано, что, программная информационная технология «Photoshop» и аналогичные современные программные продукты являются перспективным исследовательским методом авиационной эргономики для выявления эргономических недостатков профессиональной деятельности пилота.

Ключевые слова: безопасность полета; информационная технология; пилот; человеческий фактор; эргономическая оценка; «Photoshop».

Gorbunov Volodymyr (1948). Doctor of Biology. Professor. Aviation Psychology Department, National Aviation University, Kyiv, Ukraine. Education: Shevchenko Kyiv State University.
Research area: ergonomical investigations of the reliability and safety of the operator's activity of aircrew and operators of other "man - mashine" systems.
Publications: 72.
E-mail: d_gor @ rambler.ru