EXPERIMENTAL RESEARCH OF SKILLS IN AIRCRAFT CONTROL

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Summary. The problem of operator – pilot (OP) self-realisation is visualised by the movement of controls. It means that OP´s operating control skills present a complex process, which is influenced in connection with the aircraft. Newly created quality highlighted by the mutual intelligence of the man and the machine requires an exchange of information, which unites them. The particular measure in this connection is the professional ability in aircraft (machine) control, which can be called a skill. A specific approach to the solution of this complex task, which is connected with the quality of skills of operator – pilot to use the features of the aircraft to fulfil the flight task is shown below.

Keywords: symbiotic system, skill, economic effectiveness, asymptotic learning, area of success solutions

1. INTRODUCTION

Decision making process of the control of a modern aviation ergatic system (AES) is a natural reflection of operator - pilot (OP). OP´s output are the reaction to the aircraft control, which are visualised by the controls movement themseves. AES control process itself is accompanied by a complex coginitive activity (differentiation), sharpenning of received information logically organised into the sequence of operational performances of OP. Recently, requirements on the deisgn of control electronic system of an aircraft are increasing especially in the task to eliminate errors as best as possible. Recent aviation technology supported by electronic assistence systems supports OP´s control and respects functional redundancy (analytical, inherent, psychological, etc.), which are intrinsic demonstration of an aviation object.

2. EMPIRICAL RESEARCH OF LEARNINNG IN AIR TRANSPORT

To control an aircraft presents a sort of self-realisation or self-profiling for the professional pilot. The complexity of research in this area of profession lies in the method of obtaining information, which is the output of active control inputs into the aircraft control organs, which change flight characteristics of controlled object and its movement in space. It is possible to form basic ideas – hypothesis, which can show the direction of given research from the above mentioned connections [1].

a) Possibility to obtain information by measuring the movement and positions of controls as the input of OP´s abilities to control the aircraft. To obtain objective information about his/her professional quality (aptitudes).

b) To prove that OP´s self-creation expressed by the notion of „skill“ and that i tis connected with learning and subsequent development of professional skills.

c) It is possible to create a techno-sphere for fair and objective evaluation of OP´s conduct and motivation of personality development.

It follows form the realisation of deducted hypothesis it is possible to confirm one by testing. Testing requires empiric research and mathematical models, which can answer presented research problems by its objectiveness [2]. Presented methods of solution as well as relevant techno-sphere enable to create an image about the tested hypothesis without presence as well as presence of selected specimen of movement of OP´s aircraft control.

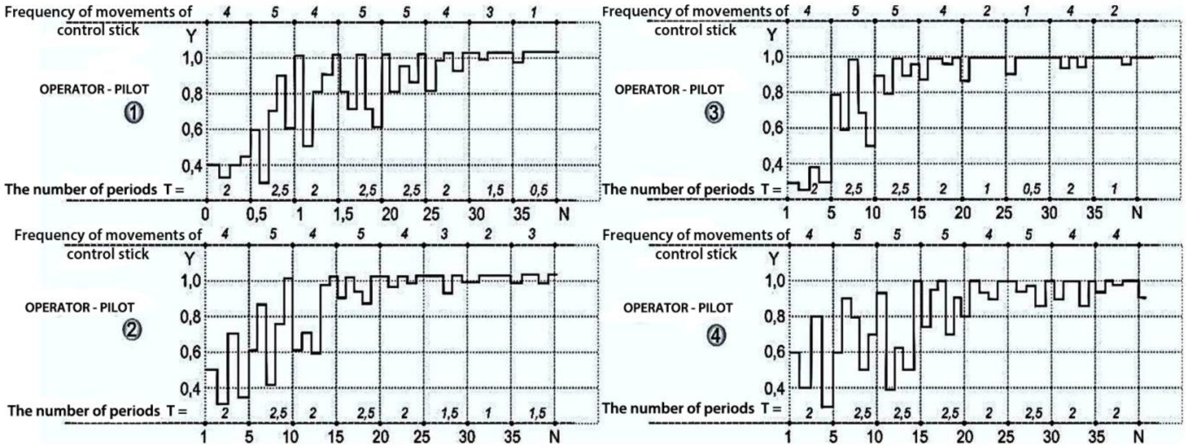

Figure 1 Representation of four OPs´ skills in the mode of two tasks solution

Graphic records have been a subject of objectifications by mathematical models, the results of which are available in separate recorders at relevant workplace of the faculty of aviation.

The content of considerations can be summarised into the following solution of the problem, which is connected with the control of aviation ergatic system (AES), when its reliability parameters defined are expressed by mathematical models [3].

Aviation ergatic system AES is considered to be controlled on the principle of error compensation. Error compensation algorithm is a part of OP´s learning programme. A model of the estimation of quality (science) and model of a learning standard of aircraft apparatus control. Method of control realisation is described and algorithmised in Matlab environment. Algorithm has been formed for solving equations in the following form [9]:

$$y_i = a \, . \, y_{i-1} - (1-a).\, q_i \tag{1}$$

In connection with metasystem F, which is expressed by the position Q of area of success solution (ASS) for q_i it is true:

$$q(i) = \begin{cases} 1, & \text{when } F \subset Qass \text{ is successful control} \\ 0, & \text{when } F \not\subset Qass \text{ is unsuccessful control} \end{cases} \tag{2}$$

Let the following inequalities are valid for successful and unsuccessful fulfilment of a task of the metasystem:

a) For qi = 1 = u(i) (3)
b) For qi = 0 = 1 – u(i)

For the case a) an equation 1 in the following shape can be formed:

$$y_i = a \, . \, y_{i-1} - (1-a), \tag{4}$$

In the work [3], there is a commented process, which leads to the shape of general convolution integral.

$$y(T) = \frac{1}{T_0}\int_0^T \exp\left\{-\frac{T-x}{T_0}\right\} q(x)d(x), \tag{5}$$

Where „χ“ is sought function, which can be interpreted as a parameter of skill in the learning equation No.4. The experiments (benefit for science) have shown that parameter *„a“* in equation 1 changes according to empiric law [8]:

$$a = 1 - \frac{4\,\tau_{q=0}}{T_0}, \tag{6}$$

Equations 1 to 6 determine the dependence of parameters T, T_0 on the value of illiteracy „a“ , by which entropy (illiteracy) of AES control is expressed. As it follows from equation 5, at known step

Δt, with maximum value of illiteracy, i.e. if a = 1, $T_0 = \infty$. It means that time constant OP is infinite and OP´s reactions will approach zero. It also means that if OP´s learning should lead from illiteracy to a concrete degree of professionality, learning must be selected so that it would be as small as possible [4].

The form of the equation 5 illustrates dependence of illiteracy on the periods of cycles T tied to empiric value $T_{q=0,}$ which is time of AES presence out of demarcated flight route.

Illustrations in Fig. 2 are the output from solved tasks.

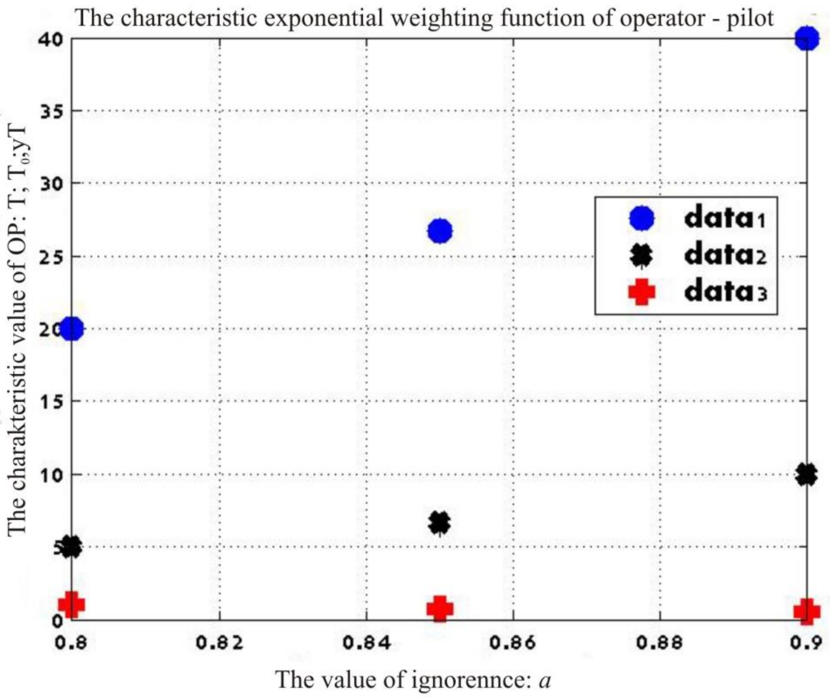

Figure 2 Outputs of solving of convulsion of personality professional parameters of OP
Legend: red: a = 0.9; black = 0.85; blue = 0.8

The importance of solving this task lies in the fact through which also non-standard situation can be discovered. Non-standard flight is presented by the movement of aircraft out of the boundaries of successful control [5].

3. TEST EFFECTIVENESS DURING EXPERIMENT

Economics deeply influences the depth of research and its duration. The quality of each test is determined by an effort to obtain scientific findings; however, each of them is limited by spent means. From that viewpoint the notion of effectiveness, which beside economic demonstration also contains system utility, its functionality, reliability, resistance, and life, comes forward [6]. Concrete presentation of the estimation of effectiveness in the process of OP´s asymptotic learning in development of his/her skill. Except useful demonstration of learning process objectification, presented method is an asset in the way of observation of AES and metasystem convergence:

$$Q_i(ASS) = W_z - W_i \tag{7}$$

Where:
Wz – is probability of distribution of AES positioning in ASS
Wi – probability of distribution of positioning without inertial ASS. Demonstrations of OP´s time delay are not visible in this estimation OP see chapter 2, [8].

Probability, which is given constant in metasystem control cycle is the comparer quality. Used mathematical model and its distribution probability in the form of the research. Rayleigh distribution enables to create an algorithm, the output of which is shown in Fig.3.

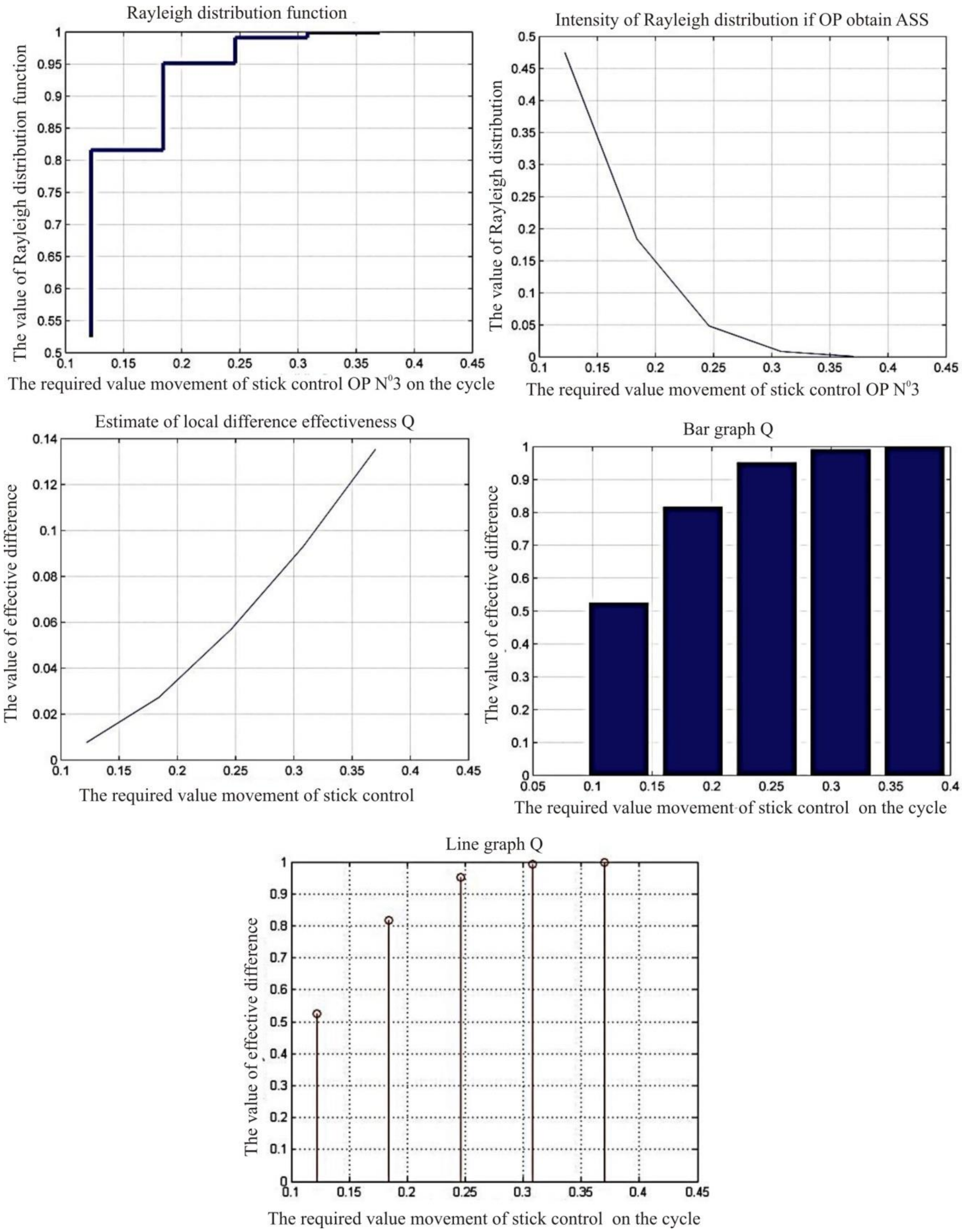

Figure 3 Graphic demonstration of local distribution of parameters of effectiveness of asymptotic learning without delays

Economic effectiveness, for instance according to Fig. 3, can be determined by the rate:

$$E = \frac{Q_i(ASS)}{S_i} \qquad (8)$$

where there are aliquot unit expenditures on i – th step of the experiment in obtaining ASS by selected OP. Measurement can be performed on symbiotic complex, Fig. 4, the programme of which enables to realise the task [4].
Reliability of experimental apparatus considerably influences the estimation of effectiveness W [7].
In the concrete case, the problem of estimation of reliability of symbiotic system readiness according to (Fig. 4).

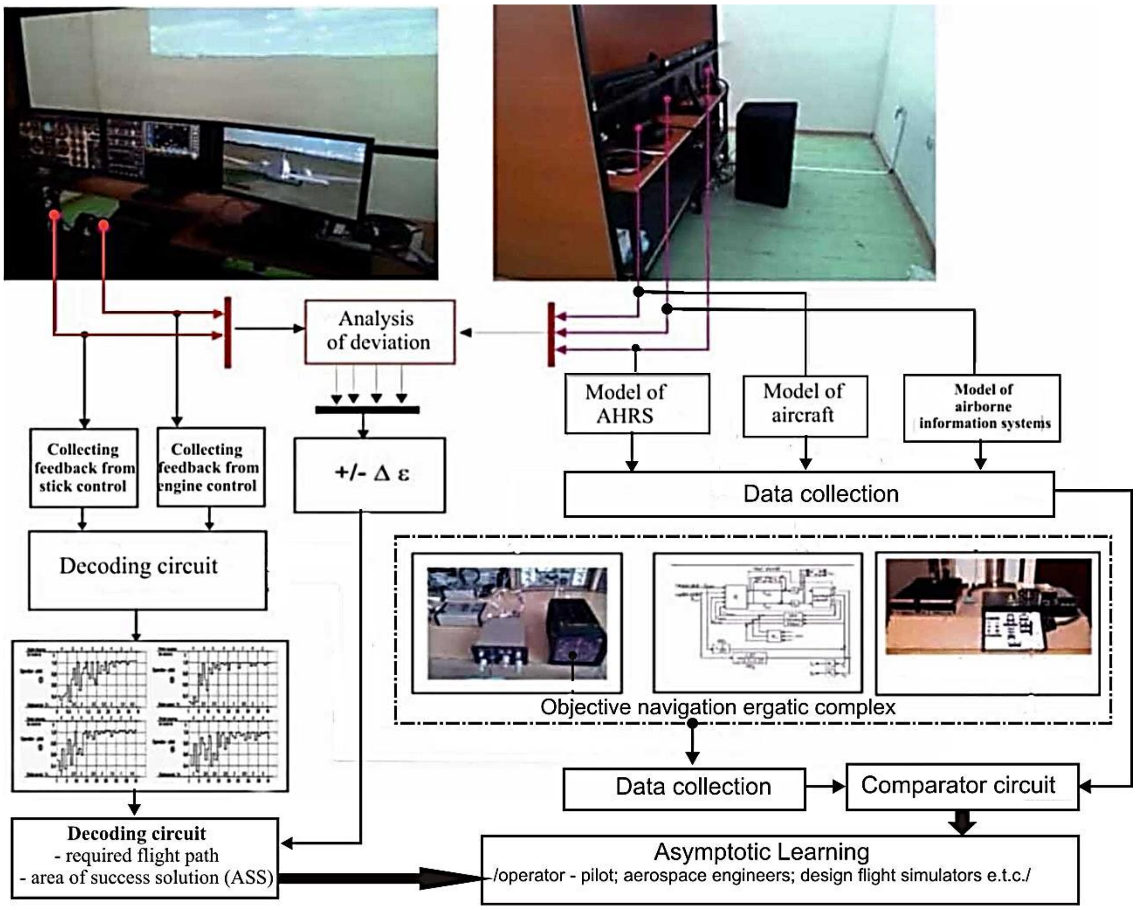

Figure 4 To the explanation of the readiness of symbiotic system for the research of asymptotic learning effectiveness

4. CONCLUSION:

Successful connection of scientific facts and their transformation into mathematical models have enabled to create conditions for the creation of the plan of experiment of skill observation on a symbiotic system in the conditions at the Department of avionics. Suitability of this connection is documented by analysed results, which are shown in media in a suitable way and available for analysis under the influence of variable delay on the preciseness of complex aviation system control. The connection of science and experiment is suitable to be evaluated from the viewpoint of total performance, i.e. also human activity – research organiser. Obtained results show the perspective of working out such notions as securing of the skill through instrumental technology and time observation of the development of asymptotic learning, which transform into the notion of the „skill“. It is possible to evaluate the required effect with the help of control quality and observation of the intensity of crossing of flight trajectory in the area of successful control.

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