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PRINCIPLES OF CREATING RELIABILITY SCHEMES FOR ELECTRIC AND MECHANIC SYSTEMS

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This article is about creating reliability schemes with electronic and mechanical parts' reliability factors are considered. Obstacles of this method is described with simple example of reliability factors' estimation and result's comparison.

Keywords: reliability, reliability scheme, mechanical system, reliability estimation methods.

This scientific research (project №14-05-0038) was made under support of program "NRU HSE's science fund" in 2014.

When dependability of different radio and electronic devices is estimated, mechanical parts don't be considered, such as soldering, welding, screws, stubs, seals, gaskets, shafts e.t.c. Today there is point of view that dependability of these parts is so good, that no need to consider them for summary estimation because there isn't statistic data of mechanical parts' failures. But dependability of electromechanical systems depends on dependability their parts, interconnections of these parts, relationship of their reliability factors and extreme conditions (see Figure 1) [1].

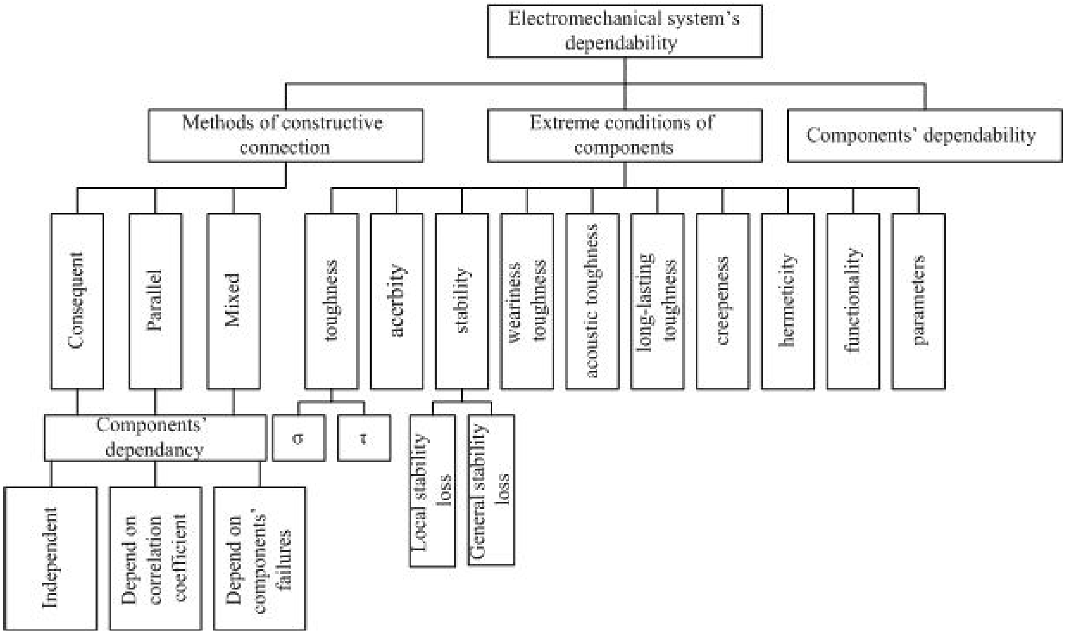

Figure 1 – Electromechanical systems' dependability dependency

Mechanical parts of electromechanical systems may be dependability independent and depend on correlation coefficients at the same time.

Dependability electromechanical systems' parts depends on correlation coefficients if correlation functions aren't equal zero ($r_{x1x2}(t_1,t_2)\neq 0$ or $r_{y1y2}(t_1,t_2)\neq 0$) or correlation coefficients aren't equal zero ($r_{x1x2}\neq 0$ or $r_{y1y2}\neq 0$). It is possible when composition of two system components' random functions (random values) contains same random process (values).

There is dependency on components' failures, when failed part's load (work) is divided among rest of working parts and dependability factors are deteriorated. This dependency is observed not only for parallel parts connection, but consequent too. It is significant that dependency may be on correlation coefficient and on components' failures at the same time.

Estimation methods for dependability mechanical parts are considered in treatises of Bolotin V.V.[2], Tchirkov V.P.[3], Selikhov A.F., Tchizhov V.M.[4] and others. It is necessary to have statistic data of mechanical parts' failures and special referenced data of materials for applying these methods. Two reference books are well-known: published by ICS RAS [7, 8] and NSWC-11 [5]. There is problem of actuality of statistic data because of growth rate of technology and changing of material properties.

Assuming, reliability schemes are represented as set of mechanical and electric parts (see Figure 2). There isn't electric and mechanical parts' failures interference at such presentation of schemes. Mechanism of this interference is complicated and its consideration needs solving of parametric differential equations. But there isn't opportunity to prove necessity of dependent failures' consideration because it's extremely difficult to identify them. That's why it's offered to use introduced reliability scheme for electromechanical system.

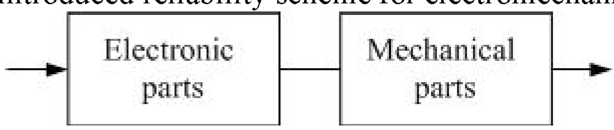

Figure 2 – Electromechanical system's reliability scheme

For example VGA connector is considered. It consists of two connectors and screws (see Figure 3). Reliability scheme of this connector is consequent connection of three components in accordance to GOST 27.002-89 [6] (see Figure 4).

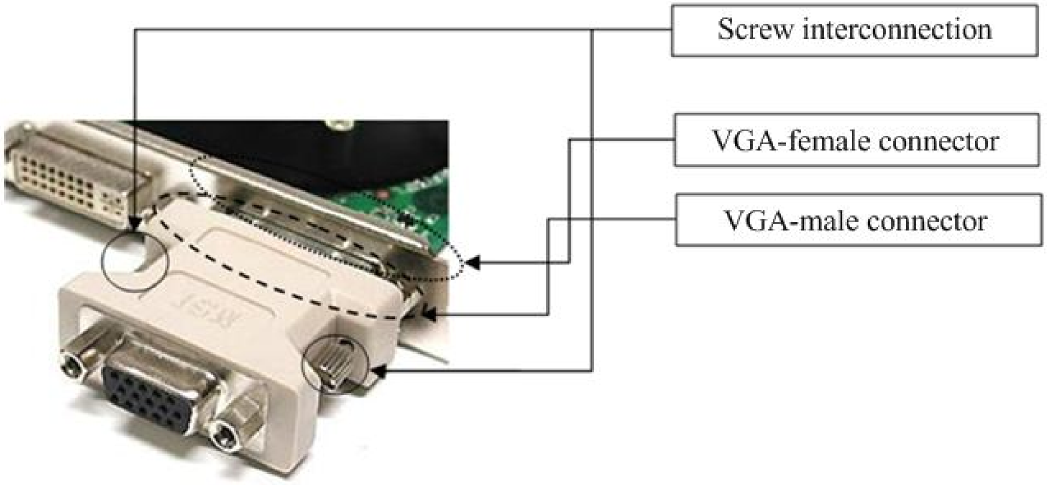

Figure 3 – VGA connector

Estimation of VGA connector components' reliability factors was made using software package ASONIKA-K. Results are shown in Table 1. Reliability function of VGA connector according to components' estimated reliability factors is calculated by following equation:

$$P_{VGA}(t) = P_{VGA-m}(t) \cdot P_{VGA-f}(t) \cdot P_{screw}(t) \quad (1)$$

where $P_{VGA-m}(t)$ - reliability function of VGA-male connector; $P_{VGA-f}(t)$ - reliability function of VGA-female connector; $P_{screw}(t)$ - reliability function of screw connection.

Figure 4 – Reliability scheme of VGA connector

Failure rate of mechanical part (screw connection) is almost equal to electronic parts' failure rate as shown on Figure 5, where results of reliability factors estimation of VGA connector components are represented. This fact is confirmed of failure's rate quantitative estimation, i.e. components' failure rate has the same order.

Table 1 – Reliability factors estimation results for VGA connector's component

Component	Operational failure rate, 1/h	Standby failure rate, 1/h
X1 (VGA-female)	8,00e-08	8,00e-10
X2 (VGA-male)	9,20e-08	9,20e-10
Screw connection	4,10e-08	4,10e-10

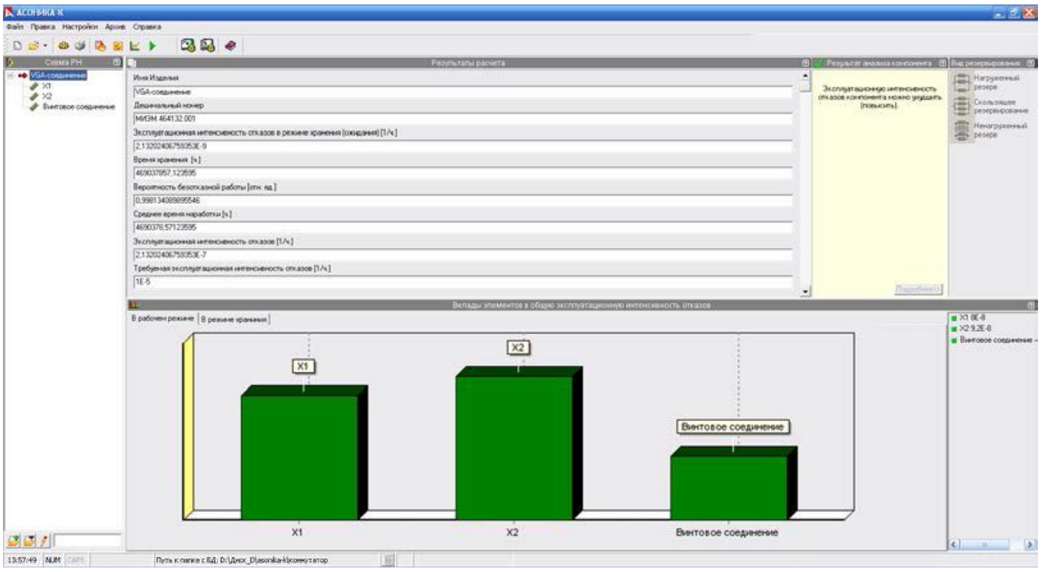

Figure 5 – Reliability factors estimation results for VGA connector obtained using software package ASONIKA-K

Electromechanical system's reliability function estimation was realized for continuous work period is equaled to 15 years. Following results are obtained: reliability function for system without mechanical parts is equal 0,977653 and reliability function for system with mechanical parts is equal 0,972399. With regard to requirements to reliability function was given accurate within 3-4 significant digits, we obtained its inflated estimation (see Figure 6).

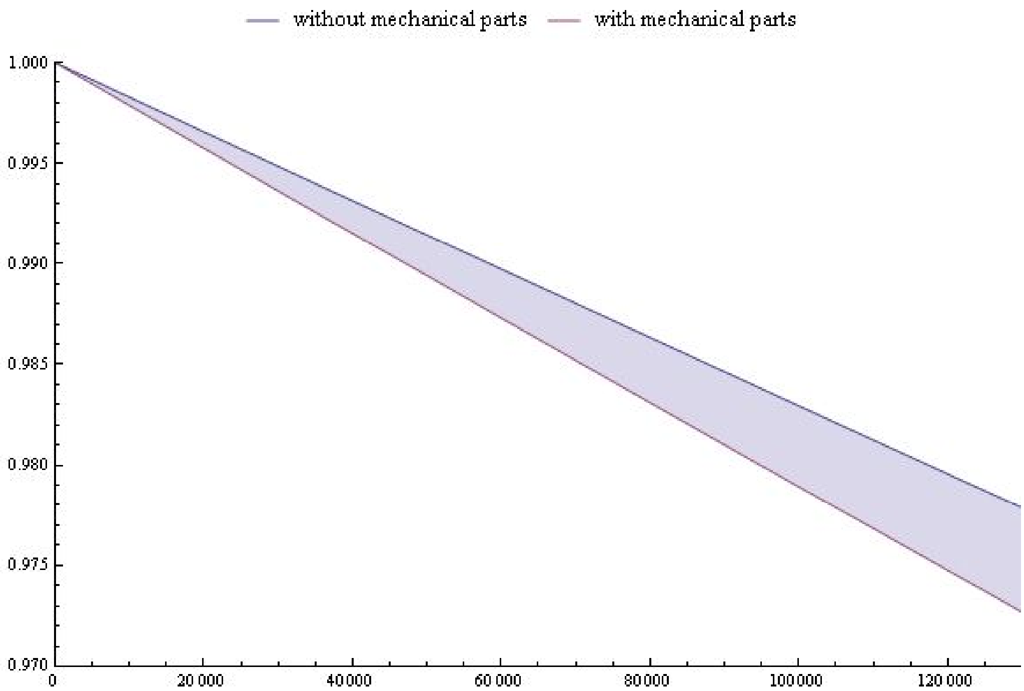

Figure 6 – Reliability function depending on time diagram

Assuming, it's necessary to consider electromechanical system failure as electric and mechanical parts' failure. We obtain more precise reliability factors' values using this method. Meanwhile it's difficult to make conclusion about precise of method because we need more statistic data of failure system, which reliability factors was estimated, and models approbation.

But this method allows considering more failures' cases. In the nearest future correlation function's development and method precise estimating are planned to realize.

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INFORMATION TECHNOLOGIES FOR AIRCREW'S FUNCTIONAL HEALTH STATE ESTIMATION IN REAL TIME

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In this article possibilities of information technologies in aviation medicine applications are considered. Development of hardware-software complex is proposed for remote monitoring and large distance transferring of signals registered on a pilot without quality decrease in real time.

Keywords: information technologies, aircrew, monitoring.

At modern level of the development of information technologies in aviation medicine more and more attention is paid to operators', pilots', traffic controllers' and other people's responsible for complex equipment maintenance health care control. This problem is as important as the problem of equipment control itself because man's mistakes can cause catastrophic emergencies. This problem cannot be solved only with the help of regular medical examination in a specialized medical centre. Pilots and air traffic controllers often work in extreme conditions and their work is very stressful. Thus it is necessary to control their current functional state during their work process.

At present days wide range of special equipment responsible for electrocardiogram control able to remote data transfer and automatic results interpretation in specialized medical centers is developed. However there are no such techniques and resources able to identify early signs of organic lesions or functional blood vessel system, vegetative neural system or central neural system strain in general. As long as flight activity requires constant straining of these systems, the development of adequate techniques and conventional hardware-software control means for the whole aircrew in real time is topical.

For the increasing of functional health state estimation efficiency it is suggested to perform parallel examination of informative parameters of cardiorhythm, breathing rhythm, brain functioning and pulse wave. As long as blood vessel and neural systems interact closely