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THE BASES OF NUMAN – OPERATOR DEPENDABILITY THEORY

The paper presents the bases of human – operator (pilot) dependability theory. The major property of human activity is called a category of assignment. The assignments can be estimated in structured generic segmentation of dependability concept. This study also shows that the time scale is the universal basis for segmentation of human dependability concept.

Keywords: *operator, pilot, assignment, individual dependability, occupational dependability, functional dependability.*

1. Introduction

Study of world experience of air service explains critical importance of pilot behavior. The description of behavior exists in concepts of psychological, technical, medical and social requirements of occupational suitability in a separate statement and application [1, 2, and 3]. At present, there is no general methodology for observation of physical and nonphysical quantities of human and pilot behavior. Physical quantities are measurable. Nonphysical quantities are estimable. Their interconnected theoretical and normative description has not yet been done.

This study presents the bases of human – operator (pilot) dependability theory [4, 5]. The major property of human activity is called a category of assignment. The assignments can be estimated in structured generic segmentation of dependability concept. This study also shows that the time scale is the universal basis for segmentation of human dependability concept.

2. The problem content

The problem is generated by the indistinct nature of human behavior through which his activity is observed: personality, health, age, education, qualification, and experience, capacity for work, working loading, tiredness, rest, anthropogenic influences and other properties. These behaviors are studied in various sciences, and they have the quantitative and qualitative, physical and nonphysical nature that makes up various opportunities for the formalization, computerized accounting and administrative decision-making.

Until now, there is still uncertain domain-specific knowledge, which is necessary for standardization and management of flight activity. For example, it is known from numerous researches that total pilot resource obtained by results of selection in occupation and in the subsequent professional work differs in 3-5 times. Now there is no theory and methods, which could take into account the given differences in uniform standards for all pilots [6, 7].

3. Problem statement

The methodological solution of research in the present work is development and application of *resource methodology* (RM) as an aggregate of empirical and heuristic examination of organized complexity forms by qualitative methods of *soft calculations* (SC) [8]. The field of knowledge about the aggregate of the organized activity combined on basis is understood as new discipline – resource science. The resource complex is understood as convertible energy sources, information and substances involved in expedient activity. Ordinarily the resource is understood as that is consumed and used. In resource methodology, any concept is considered as a resource: also used, but mainly – created. For example, the person reading a book uses the book, his energy and creates knowledge. It is a simple *resource complex* (RC), where an input is *used resources* (UR), and an output is created resource (CR) of knowledge or assignment resource (AR).

The authors of this paper offer the automated management algorithm of a pilot resources based on reasonable description of structure and contents of the pilot activity. Practical value of our proposal consists in the fact, that new relations optimizing preparation and decision-making have been established between different databases of airlines. The development is intended for the formation list of significant (rendering essential influence on air crash probability) parameters and measures used for long-term prediction with an opportunity of their numerical observations and measurement depending on time.

4. Development of the contents of pilot assignment behavior

Assignment resources are structured in three properties of dependability in time scale: resources of individual dependability (RID), resources of operational dependability (ROpD), and resources of occupational dependability (ROD), fig. 1.

Disclosing of the contents of the given constituents creates an opportunity of the interconnected formalized description of pilot resources that present the problem solution of analysis and prediction risks of flights safety. The structure of supervision terms (measurement, estimation) of objects' behavior values, which also meet the standard [9], has been developed for the formalized description. Each of resource behavior of a pilot dependability RID, ROpD and ROD are structured according to parameters and measures. Values of estimated quantities of resources in the selected scales

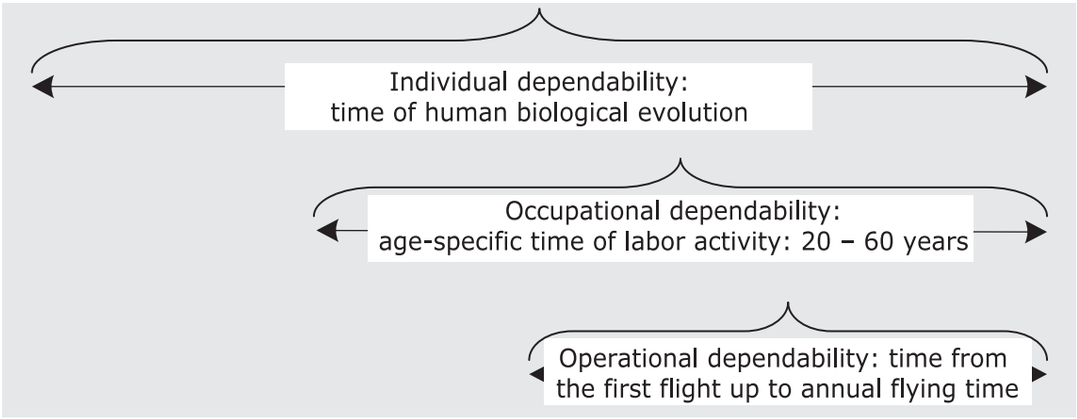

Fig. 1. Fundamental structure of pilot dependability resources

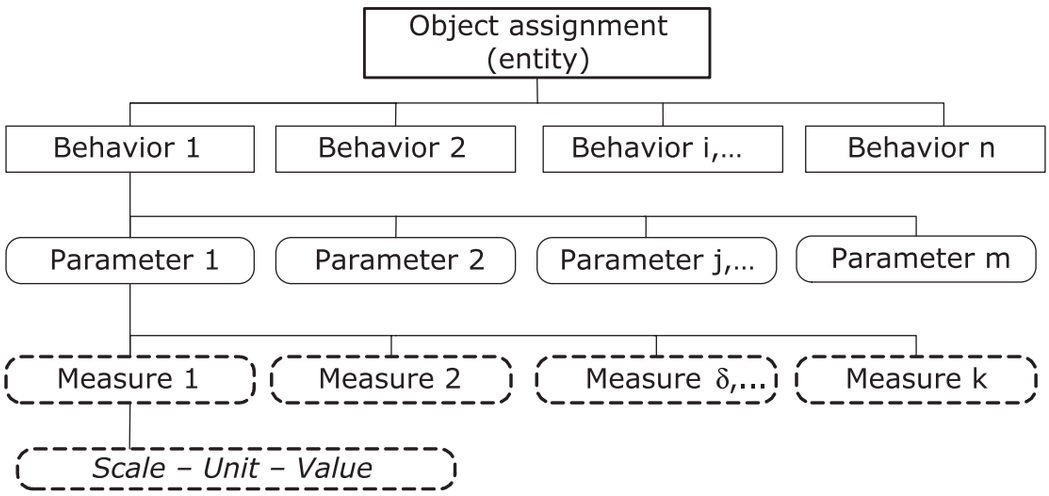

Fig. 2. Terms of values supervision in researched objects

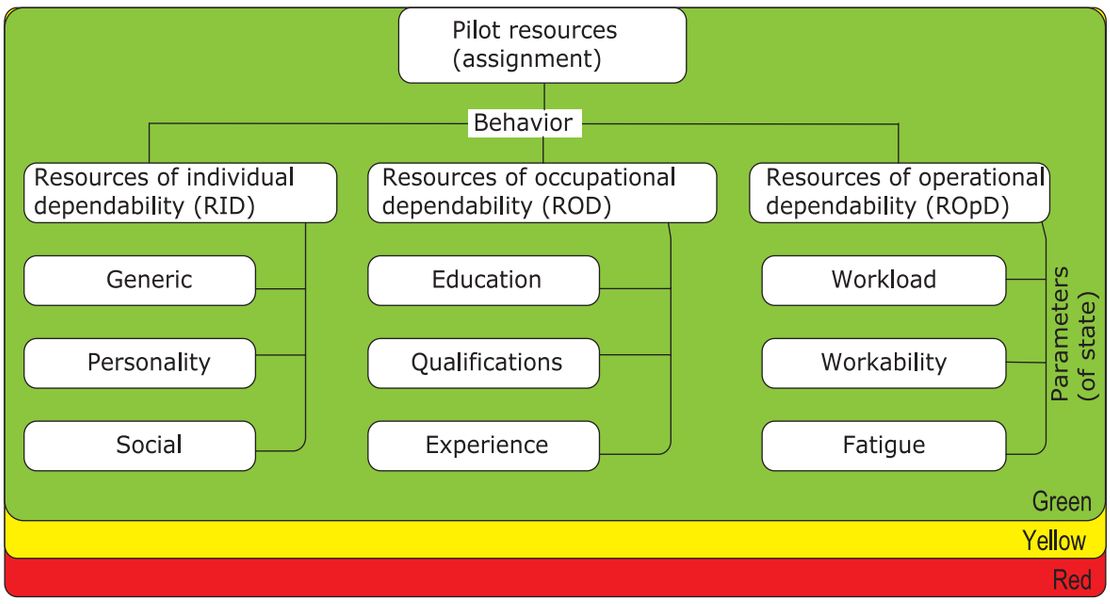

Fig. 3. The content of pilot resources

and units of measurements or estimation are attributed to dependability measures (see fig. 2).

Estimation of conditions is carried out in scales of designations and order of three-level matrix of risk: "high – average – low" 1-2-3, «red – yellow-green» or the greater number of levels. The content and measures' structure, of which parameters consist, makes the greatest volume of designing work and filling of an expert system shell [7], fig. 3.

Designing of a resource complex includes development of resource contour structure, constituents, their names, definitions and establishment of supervision parameters. The resource complex of assignment forms I, II, III..., J, …, N contours, each of which consists of initial resource a components, converging for creation of a resource of j-th contour assignment, where X_i, Y_i, Z_i is the name (label) of a resource component of j-th contour. The choice of names of any resource components is carried out by an expertise. The quantitative composition of three initial resources is a choice of the present method. Each of resource components, for example X_i, is described as follows:

$$X_j = \sum : \{X_{j-1}, Y_{j-1}, Z_{j-1}\} = R_j^X, \qquad (1)$$

where R_j^X is the created nominal assignment resource of j-th contour, which is the initial resource of (j–1)–th contour. The content of a resource complex assignment of a pilot activity is performed by an expertise. The brief and full-scaled description and definition of each resource is made in the natural language. For the elementary formalization, symbols and designations of English-speaking lexicon are introduced.

The first resource contour

The first contour R_I^p is made up in three resource groups supervised in dependability parameters: resources of operational dependability (ROpD), resources of occupational dependability (ROD), resources of individual dependability (RID). Time is accepted as a supervision base. The offered content has the basis – supervision distinguishability of each group of resources in time. Operational dependability is understood as an aggregate of flight conditions and states specified for realization of organized activity in the selected environment. Operational dependability can be supervised in structure of time: time of one flight, a monthly and annual flying time. Occupational dependability is understood as an aggregate of personality acquired in occupation in selected environment of activity. Occupational dependability possesses the value of labor employment duration of human approximately during the period from 20 until 60 years. Individual dependability is understood as an aggregate of evolutionary generic biological characteristics of in human environment and selected surrounding of activity. Individual dependability possesses the objectification value of the generic evolution many times exceeding age of human life. Content disclosure of the given constituents is a problem of resource contours' description. Symbolical representation of the first resource contour is described by the following tuple:

$$R_I^P = \sum : \{R_I^p(i), R_I^p(p), R_I^p(o)\}. \qquad (2)$$

The second resource contour

Three groups of resources of the first contour are structured in the following content and definitions of dependability component of the second resource contour. Resources of operational dependability (ROpD) consist of the following parameters: workload (wl), workability (wa), fatigue (fg),

$$R_I^p(o) = \sum : \{R_{II}^p(o)\text{wa}, R_{II}^p(o)wl, R_{II}^p(o)\text{fg}\}. \qquad (3)$$

Resources of occupational dependability consist of the following parameters: cumulative experience of the pilot experience (pe), common education (ca), professional qualification (pq), differently:

$$R_I^p(p) = \sum : \left\{ R_{II}^p(p)pe, R_{II}^p(p)ca, R_{II}^p(p)pq \right\}. \quad (4)$$

Resources of individual dependability consist of parameters and are structured by three groups of components according to duration in time: $R_{II}^p(i)\varphi$, generic – resources of adaptation of the individual to environment. The given category of resources exceeds the end of life and contains generation of adaptable mechanisms; $R_{II}^p(i)\psi$ personality – formed during individual life; $R_{II}^p(i)\delta$, social – the demographic characteristic of psychosomatic health:

$$R_I^p(i) = \sum : \left\{ R_{II}^p(i)\varphi, R_{II}^p(i)\psi, R_{II}^p(i)\delta \right\}. \quad (5)$$

Combining formulas {3-5}, the content of resource complex assignment of a pilot activity can be presented as follows:

$$R_I^P = \sum : \begin{Bmatrix} R_{II}^p(o)wa, & R_{II}^p(o)wl, & R_{II}^p(o)\text{wa} \\ R_{II}^p(p)pe, & R_{II}^p(p)ca, & R_{II}^p(p)pq \\ R_{II}^p(i)\varphi, & R_{II}^p(i)\psi, & R_{II}^p(i)\delta \end{Bmatrix}. \quad (6)$$

It should be noted, that the presented symbolical description is a technique of initial formalization of concepts and means of a natural language. Elements of formulas are written down through commas that mean complex relations and connections of unknown functions. The problem of development consists in search and establishment of the given relations and connections. The sense of the symbolical description is to facilitate the search. For example, it is known, that workability (wa) and fatigue (fg) are reciprocal quantities. Therefore, in expression (3) they can be written down through fraction.

Conclusion

The shown description of a pilot activity has basic difference from the contents in existing studies [10, 11, 12, 13]. The content is structured in time scales of completely different duration – from current time until time of evolution.

Concepts of physiological, psychological and demographic components of activity for a long time are quoted in studies, but their content is far from being discovered. So physiological dependability is understood as workability or ability to work during cycles of activity. Demographic dependability can be considered as working capacity or labor capacity according to a state of health.

The further development is directed to establishment of behavior, parameters, and attributes of the identified resources. The given procedure refers to as normalization and it is the basis of activity standardization. Making-up the content of resource contours of the next levels is performed similar to introduced developments. Resource components are entities of various physical and nonphysical nature and they demand the unequal approach of formalization. The given approach has the name of pseudo-physical logic of quantity estimation. The decision on the further formalized development will be accepted by expertise based on necessity and expediency.

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