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Investigation of aviation accidents. Part 2. Pseudophysical logic of event modeling

Abstract. A new approach to investigation of aviation accidents is proposed, based on logical research. The ICAO standard sets out the subject matter content and key definitions of Investigation of aviation accidents. Starting with the glossary of modern standards, the unsatisfactory logical development of the documents becomes noticeable. Aviation accident investigation, cannot be considered sufficiently scientifically substantiated.

Keywords: standards, aviation accidents, aviation incident, investigation, pseudophysical logic, natural language

Introduction. This paper examines the subject of civil aviation accident (AA) investigation in the context of international ICAO standards. Key definitions and the structure of the investigation task are presented. Logical analysis of the relationship between the basis and the consequence in the progressive direction and in the regressive direction can give different consequences in different cases, and as for the consequence, the same consequence can be obtained from different reasons. The conclusion contains the need for a detailed logical study of modern standards and guidelines.

Modeling of the cause-and-consequence relationship of events is possible with a description in non-classical logic, also called qualitative, pseudo-quantitative, pseudophysical logic (PL). This paper offers descriptions of the logic of relations, temporal, spatial, causal logic, their combination on a subjective heuristic basis for the presentation of knowledge. A classification of relations based on the categories "to have - to be" is compiled. The object is presented in the form of a relatively simple model that correlates with its actual complex description.

Pseudophysical logic of relations. The theory of PL models statements and reasoning of subjective meaning in terms of relations of

natural language (NL). These concepts are lexical means of the language of resource modeling of objects of the subject area of study. The result is formal models of normative behavior, the implementation of which can be transferred to a machine. The properties of objects are observed in the relations of activity - time, space, causality, which are variables. The axioms of PL are based on the perception of the world by a person in terms of NL by means of generalizations. To date, theories of different PL relations have been developed with varying degrees of theoretical depth and justification. According to D.A. Pospelov, the PL of the causality relation is the most complex and the least developed theory [3]. Propositions are put forward about the connection of the PL of the relations of time, space and causality.

For the subject area selected by the researcher, characteristic sets of relations are designed. 1) Relationship of meaning: one word is correlated with the meaning of another word. Example: the word "flight" has the meaning of movement in space of a material body or an abstract concept of "flight of thought". 2) Relationship of feature: the word names qualitative differences, properties in a feature; the word attributes features to concepts. 3) Quantitative relationships: have the meaning of quantitative properties of measurable quantities of an object. 4) Qualitative relationships: have the meaning of qualitative properties of the evaluated quantities of an object; 5) Relationship of comparison: comparison of values, features, states. 6) Temporal relationships: comparison of time values in features earlier, later, simultaneously. 7) Spatial relationships: have the meaning of the place of objects in extension: left, right, closer, further. 8) Causal relationships: have the meaning of causality of events. Instrumental, informational, ordinal relationships are also considered. These and other relationships are called statistical. Generalizations of the PL are achieved by connecting relations of different natures.

Pseudophysical logic of the relationship of time. In the metric display, time is structured by intervals of the ordinal scale in units, quantities, and names. In the culture of calendar time calculation, a hierarchical discretization of units of time is carried out. The onset of each subsequent unit of time is fixed definitely, the left boundary [square bracket), Eq. 1.

$$\begin{matrix}\text{units:}\\ \text{quantity:}\\ \text{names:}\end{matrix}\begin{bmatrix}\dots,\text{second},\dots\\ 60\\ "46th"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{minute},\dots\\ 60\\ "34th"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{hour},\dots\\ 24\\ "18th"\end{bmatrix}$$
$$\subseteq\begin{bmatrix}\dots,\text{day},\dots\\ 7\\ "\text{thursday}"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{week},\dots\\ 4\\ "\text{third}"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{month},\dots\\ 12\\ "\text{may}"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{year},\dots\\ 100\\ "2012"\end{bmatrix} \quad (1)$$
$$\subseteq\begin{bmatrix}\dots,\text{century},\dots\\ 100\\ "\text{XXI}"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{millennium},\dots\\ n\\ "\text{third}"\end{bmatrix}\subseteq\begin{bmatrix}\dots,\text{era},\dots\\ m\\ "\text{н. э.}"\end{bmatrix}\subseteq\begin{bmatrix}\dots,period,\dots\\ k\\ "Mesozoic"\end{bmatrix}.$$

The ideas about non-metric time are as follows. The pseudo-physical logic of the relationship of time is expressed in the concepts of the EP: present, past, future, beginning, end, later, earlier, now, now. Pseudo-physical time is given by a scale of names that we call *moments*, Eq. 2.

$$\widetilde{T}:\left(\underbrace{t_{l-k},\dots,t_{l-1},\dots}_{\text{past}},\ \underbrace{\begin{matrix}"\text{now}"\\ [t_i]\end{matrix}}_{\text{present}},\ \underbrace{\dots,t_{l+1},\dots,t_{l+k}}_{\text{future}}\right), \quad (2)$$

where any subsets t_{l-1}, t_{l+1} are non-metric time intervals; the subset $[t_i]$ is called a "moment", "present", the left part of the shown sequence is called "past", the right part is "future". The central concept of pseudo-physical time is the concept of a discrete "moment" $[t_i]$. Moments are understood and perceived subjectively, pseudo-quantitatively, pseudo-physically. The fuzzy value of pseudo-physical time is expressed in the concept of "now", colloquial "now", and also as "instant", "moment". The pseudo-connection of the present, past and future tense can be found in the concept of "already". This was discovered in ancient works. According to Aristotle, “already” denotes a part of the future time, close to the present indivisible “now”…, “already” also denotes a part of the past time, not separated from “now” [4].

Pseudophysical logic of the relationship of space. Russian philosopher, theologian and mathematician P.A. Florensky writes the following about space. “Firstly: on the question of the space of the world, it must be said that in the very concept of space, three layers are distinguished that are far from identical to each other. These are: abstract or geometric space, physical space and physiological space, and in the latter, in turn, tactile space, auditory space, olfactory space, gustatory

space, space of the general organic sense, etc. are distinguished with their further, more subtle subdivisions. For each of the outlined divisions of space, large and fractional, one can, abstractly speaking, think very differently" [5].

In a metric mapping, a discrete space, a set S, is defined by subsets: a point s_0 of a zero-dimensional discrete space, a line s_1, a plane s_2,, a volume s_3, Eq. 3.

$$S(s_i): \left(\underbrace{[s_0]}_{\text{точка}} \subseteq \underbrace{(s_1)}_{\text{линия}} \subseteq \underbrace{(s_2)}_{\text{плоскость}} \subseteq \underbrace{(s_3)}_{\text{объем}} \right). \quad (3)$$

The concept of non-metric pseudo-physical space is the concept of "place" (site) (s_i). Pseudo-physically "place" can be understood in the absence of an indication of the mapping. Then the indication of the place can be the concept of "here". To establish the connection between the metric and non-metric pseudo-physical mapping of space, we will draw up the following diagram (table 1).

Table 1 – Metric of space

№		measure of space	metric mapping (quantifiers)	non-metric mapping (qualifiers)
0	s_0	zero-dimensional	point	close
1	s_1	one-dimensional	line	front, back
2	s_2	two-dimensional	plane	side
3	s_3	three-dimensional	volume	top, bottom
4	s_4	four-dimensional time	time	"temporization" of space

"Temporization" example – construction: the appearance of a three-dimensional object in the fourth dimension – time.

In classical predicate calculus logic, two quantifiers are used: universal quantifiers: $\forall_x, P_x$ means "P(x) is true for all (any) x" and existential quantifiers: $\exists_x, P_x$ means "there is at least one x such that P(x) is true", which are also called quantifiers. "Quantifier: An expression that is an indication of some quantity" [6], that is, concepts that name the measurable value of an object.

The concepts shown in the table - "close", "in front", "behind", "above", "below" and the like, are also called quantifiers in the literature. In our opinion, these concepts are qualifiers, that is, they indicate quality. They do not indicate or name any "some quantity". The meaning of the definition, which the author [6] put into the concept of "some quantity" and is an indication of the evaluation (qualification), but not measurement (quantification) of the magnitudes of the properties of objects.

Classification of relations development. Classification of relations of PL can be formed on the basis of concepts that have philosophical, psychological, natural scientific, technical bases. Below is the development of classification on the basis of ontology "to have or to be". This is one of the fundamental philosophical views described in the works of ancient thinkers, medieval mystics, e.g. Meister Eckhart; (1260-1328), contemporaries like E. Fromm [7]. This classification is an example and model of relations of words of the language, which can have more structural levels. Alphanumeric designations of relations can be replaced by special symbols (table 2).

Table 2 – Classification of relations “TO HAVE OR TO BE”

Class	Section 1	Subsection 1.1	Subsection 1.1.1
HAVE	H-1. Possess	H-1.1. Property	H-1.1.1. State
		H-1.2. Measure	H-1.2.1. Clear
			H-1.2.2. Fuzzy
		H-1.3. Magnitude	H-1.3.1. Greater H-1.3.2. Equal H-1.3.3. Less
		H-1.4. Concept H-1.5. Name H-1.6. Attribute	
	H-2.	H-2.1. Object	

	Belong	H-2.2. Subject H-2.3. Partially H-2.4. Completely	
BE	B-1. Entity	B-1.1. Purpose B-1.2. Cause B-1.3. Sequence B-1.4. State B-1.5. Situation B-1.6. Event	
	B-2. Whole	B-2.1. Part	B-2.1.1. Generic B-2.1.2. Species
	B-3. In time	B-3.1. Present	B-3.1.1. Synchronous B-3.1.2. Asynchronous B-3.1.3. Begin B-3.1.4. End
		B-3.2. Past	B-3.2.1. Later
		B-3.3. Future	B-3.3.2. Earlier
	B-4. In space	B-4.1. One-dimensional	B-4.1.1. Together B-4.1.2. In front B-4.1.3. Behind B-4.1.4. Intersect B-4.1.5. Touch
		B-4.2. Two-dimensional	B-4.2.1. Sideways B-4.2.2. Left B-4.2.3. Right B-4.2.4. Between B-4.2.5. On B-4.2.6. Closer B-4.2.7. Further
		B-4.3. Three-dimensional	B-4.3.1. Above B-4.3.2. Below B-4.3.3. Among B-4.3.4. Above B-4.3.5. Under

Conclusion. The pseudological nature of events turns out to be hidden and inaccessible in modern standards. Thus, modern technical standards and guidelines do not have the proper and necessary humanitarian elaboration - philosophical, philological, logical. As a result, R&D in regulation and management, using the example of the AA investigation, cannot be considered sufficiently scientifically substantiated.

The author believes that the presented work expands the subject of aviation accident investigation into the necessary context of preliminary humanitarian research for further technical developments of aviation equipment operating manuals.

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Сравнение моделей энергетических воздействий в управлении пластичностью металлов при обработке металлов давлением

Аннотация: Рассмотрена возможность объединения моделей управления деформируемостью при обработке металлов давлением с использованием внешних энергетических импульсных воздействий: термообработки, ультразвукового вибрационного воздействия и