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SET AND HIERARCHY

Abstract: The purpose of the article is to present an analytical model of development of the set of a system in hierarchical aspect. The entropy as degree of modification of a process for this purpose is used. The entropy is a function of the set of a system.
The concepts are object of an analytical description. Each concept is a model of the image for an object. This image is characteristic of a specific level of organization. Accordingly the concept belongs to the level of organization of the object - model.
If the image is moved to another level of organization, the meaning of the concept, which characterizes this image, changes. The changing of the meaning of a concept as a change of its name is denoted.
Each level of organization has its own set. It is managed by the main managing factor which is characteristic of this level of organization.

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Entropy and the level of organization

Each level of organization of a system may be market by a specific term, concept or category, i. e. with a semantic model. The development of the organization of a system goes from low to its high levels.

Each level of organization of a system has entropy. The entropy is a function of a number of control factors.

The differentiation is a means for reducing of the complexity of a function as a result of reduction (simplification) of the restrictive conditions for its operation. The differentiation is a means for narrowing of the field of analysis. Accordingly the differentiation is a means for transition to a higher level of organization. In the present case it is an expression of transition of the entropy of a system to a higher level of its organization.

(1) $$\mathbf{H'}_{|i-1|} = \mathbf{H}_{|i|},$$

where $\mathbf{H}_{|i-1|}$ - entropy of the set of level of organization $|i-1|$ of a system,

$\mathbf{H'}_{|i-1|}$ – first derivative of the entropy with level of organization $|i-1|$ of a system with respect to the set of this system,

$\mathbf{H}_{|i|}$ - entropy of the set of level of organization $|i|$ of the system.

For example:

- the electric current is the first derivative of the charge, that forms it;
- the induced electromotive voltage is the first derivative of the magnetic flow, that forms it.
- According to adjacent levels of the organization they belong to couples concepts:
- the electric current and the charge that forms it.
- the induced electromotive voltage and the magnetic flow that forms it.

It follows from (1), that:

(2) $$H'_{|i|} = H_{|i+1|},$$

where $H'_{|i|}$ – the first derivative of the entropy of the set of a level of organization $|i|$ of this system,

$H_{|i+1|}$ - entropy of the set of a level of organization $|i + 1|$ of a system.

Entropy and set

"When the entropy is equal to zero, it must be assumed that the accuracy of the set, its specific gravity is approaching to unit"[1], i. e. the logarithm of the set is equal to the value of the entropy:

(3) $$H_i = \ln Z_i,$$

where H_i - entropy of the set of a system of level of organization i,

Z_i – set of a system of level of organization i.

It follows from (3), that:

(4) $$H'_i = Z_i^{-1}.$$

Respectively:

(5) $$H'_{i-1} = Z_{i-1}^{-1},$$

where Z_{i-1} – set Z of a system of level of organization i.

It follows from (2) and (4), that:

(6) $$H_{i+1} = Z_i^{-1}.$$

It follows from (6), that:

(7) $$H_i = Z_{i-1}^{-1}.$$

The hierarchical stability of the system is realized through evolutional continuity between its levels of organization.

We look at the evolutionary continuity as a continuous process of change of a system, which keeps the relationship between entropy and set (6), (7) on systematic and subsystematic level of organization, i. e.:

(8) $$H_{|i|} = Z_{|i-1|}^{-1},$$

[1] Бжалава И.Т.(1966) Психология установки и кибернетика, Наука, Москва, с.237 [Bjalava I.T. (1966) The psychology of the set and cybernetic, "Science", Moscow, p. 237].

where $\mathbf{Z}_{|\mathbf{i-1}|}$ – set of level of organization $|\mathbf{i-1}|$ of a system.

Respectively:

(9) $$\mathbf{H}_{|\mathbf{i-1}|} = \mathbf{Z}^{-1}_{|\mathbf{i-2}|},$$

where $\mathbf{Z}_{|\mathbf{i-2}|}$ – set Z of a level of organization $|i-2|$ of a system.

Gear ratio

The ratio between the generalized characteristics of level of organization $|i|$ and the generalized characteristics of level of organization $|i-1|$ form the gear ratio of the evolutionary process, flowing between these levels.

(10) $$\mathbf{W}^{|\mathbf{i}|}_{|\mathbf{i-1}|} = \mathbf{H}_{|\mathbf{i}|} . \mathbf{H}^{-1}_{|\mathbf{i-1}|},$$

where $\mathbf{W}^{|\mathbf{i}|}_{|\mathbf{i-1}|}$ - gear ratio W between entropy of the set of levels of organization $|i-1|$ and $|i|$.

It follows from (8), (9) and (10), that:

(11) $$\mathbf{W}^{|\mathbf{i}|}_{|\mathbf{i-1}|} = \mathbf{Z}_{|\mathbf{i-2}|} . \mathbf{Z}^{-1}_{|\mathbf{i-1}|}.$$

It follows from (11) that, in the process of evolutionary development from the level of organization $|i-1|$ to the level of organization $|i|$ participate the sets of levels $|i-1|$ and $|i-2|$. The gear ratio (11) has a character of a transition from level $|i-1|$ to level $|i-2|$. This result can be explained by return "two steps back to be made one step forward" (development) towards the level of organization $|i|$. The return to the backstory of the process of development is crucial for the formation of qualitative evolutionary changes.

The entropy of a system in the process of its individual development increases on a scale from 0 to 1.

The transition of the evolutionary development from the level of organization $|i-1|$ to the level of organization $|i|$ is associated with change of the managing factor $\zeta_{i-1} \rightarrow \zeta_i$. To be realized the managing factor ζ_i on level of organization $|i|$, it is necessary its entropy to be smaller in value, than the entropy of its predecessor ζ_{i-1} on level of organization $|i-1|$.

The ratio of the entropy of sets of adjacent levels of organization of a system is relevant.

In the initial phases of formation on the level $|i|$:

(12) $$\mathbf{H}(\zeta_i)_{|\mathbf{i}|} < \mathbf{H}(\zeta_{i-1})_{|\mathbf{i-1}|},$$

where $\mathbf{H}(\zeta_i)_{|\mathbf{i}|}$ - entropy H of the set with main control factor ζ_i on level of organization $|i|$ of a system,

$H(\zeta_{i-1})$ - entropy H of the set with main control factor ζ_{i-1} on
$|i-1|$
level of organization $|i-1|$ of a system.

It follows from (10) and (12), that $W(\zeta) < 1$ for the period of formation on level $|i|$.
$|i|$
$|i-1|$

In advanced stage of development of the set of level of organization $|i|$ its entropy is larger than the entropy on level of organization $|i-1|$. In this phase of development:

(13) $$H(\zeta_i) > H(\zeta_{i-1}),$$
$$|i| \qquad |i-1|$$

It follows from (10) and (13), that $W(\zeta) > 1$ for advanced phase of development on
$|i|$
$|i-1|$
level $|i|$.

It follows from (10), (12) and (13), that the gear ratio (10) changes consecutively from a value less than 1 to a value greater than 1. From this it follows that the evolutionary transition from level of organization i–1 to level of organization i is a fading process.

A transition from level of organization i to level of organization i + 1 through another main control factor can take place.

The development of the set runs in exponential function. The ratio (11) between two exponential functions is an exponential function. It follows, that flows of evolutionary development from low to high levels of organization of system run continuously. The reversion process occurs when it is unable to pass the "evolutionary relay race" on a higher level of organization.

Conclusions

1. **The entropy of the set of a system is a means for a summary valuation of the behavior of the system.**
2. **A flow from low to high levels of organization in the set of a system continually runs.**
3. **The development of every level of organization of a system is managed by the evolutionary previous level of organization.**