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# FORMALIZATION OF INTERACTION BETWEEN SYSTEMS

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ABSTRACT: THE INTERACTION BETWEEN TWO OR MORE SYSTEMS IS DELIVERED THROUGH THEIR SETS. EACH SET INCLUDES A VARIABLE, A NEUTRAL AND A FIXED COMPONENTS. THE FORMALIZATION IS PRESENTED IN TERMS OF LEVELS OF ORGANIZATION OF THE STRUCTURE OF THE SYSTEMS THAT INTERACT. THE SETS ARE PRESENTED BY INFORMATION ENTROPY. THE CONVERSION OF THE VALUE OF THE SET IN ENTROPY TYPE IS A PREREQUISITE FOR LINEARIZATION OF THE SCALE OF ITS DEVIATIONS FROM THE RESISTANCE.

KEYWORDS: PSYCHOLOGY, SET, FORMALIZATION, THEORETICAL MODEL.

## Introduction

The article presents a theoretical model of interaction between a subject and great number of objects.

The subject is active participant in the interaction. It causes the object interaction. reacting to the subject.

The theoretical model of interaction is formed on the basis of the set of the man. The set is the most common characteristic of the system.

## Method

It is known that the development and degradation processes are subject to exponential law. The change of the characteristics of the system is analogical.

The behavior of a system can be represented by information entropy. Entropy is a measure of the extent of the shift from one to another relatively steady-state.

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

It is accepted that the value of the entropy of a system is changed in the range between 0 and 1 respectively the value of the set of system is modified between 1 to ≈ 2.72.

In accordance with Gustav Theodor Fechner the relationship between entropy and set is similar to the relationship between feeling and physical impulse. The internal perception (sensation, entropy) is a logarithmic function of the external impact (set, impulse).

The set of a system includes three complementary components:

$$Z = Z_V \cdot Z_0 \cdot Z_f, \quad (1)$$

$$1 < Z < e, \; 1 < Z_V < e, \; 1 < Z_0 < e, \; 1 < Z_f < e,$$

[1] Bjalava I.T. (1966) The psychology of the set and cybernetics, Science, Moscow, p. 237.

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Where **Z** - set of the system,
$\mathbf{Z_V}$ - variable set of the system,
$\mathbf{Z_0}$ - neutral set of the system,
$\mathbf{Z_f}$ - fixed set of the system (attitude).

The variable set includes the rapidly characteristics of a system. The variable set participates in the process of searching for a solution and in the management of the interaction with the external environment.

The changes of the variable set arise relatively faster compared to neutral and fixed sets of the same system.

The variable set regulates and adjusts the fixed set through the neutral set.

The fixed set:

- includes relatively persistent features of given system
- characterizes the backstory of the system
- changes relatively slower compared to the neutral and variable sets
- directs the changes of the variable set.

The border line between variable, neutral and fixed set is not fixed exactly.

The external information flows on the trajectory sequentially: variable set → neutral set → fixed set.

The inside information is involved in a particular interaction on the trajectory: fixed set → neutral set → variable set on a part of it.

## Formalization

### Subject

As more complex is the problem, as more levels of organization of the system shall be included in the process of searching for a solution. The variable sets of the subject from different levels of the organization complement each other in the process of searching for a solution:

$$^{S}\mathbf{Zv} = \prod_{i=0}^{n} {}^{S}\mathbf{Zv}_{i}^{\mu i}, \tag{2}$$

$$1 < {}^{S}\mathbf{Zv} < e,\ 1 < {}^{S}\mathbf{Zv}_{i} < e,\ 0 < \mu_i < 1,$$

$$\sum_{i=0}^{n} \mu_i = 1, \tag{3}$$

Where $^{S}\mathbf{Zv}$ –variable set of the subject S (set through which interacts with the external environment and with himrself)
$^{S}\mathbf{Zv}_{i}$ –variable set of the S on the level of integration i,

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**n** - number of levels of organization of the subject S, which are involved in the process of searching for a solution.

$\mu_i$ - degree of participation of the set ${}^{S}Zv$ in set ${}^{S}Zv$ in the process of searching for a solution.

After taking the logarithm on both sides of the equation (2) is obtained:

$$(4) \qquad {}^{S}Hv = \sum_{i=0}^{n} \mu_i . {}^{S}Hv_i ,$$

$$0 < {}^{S}Hv_i << 1, \quad 0 {}^{S}Hv_i < 1,$$

$$(5) \qquad {}^{S}Hv = \ln {}^{S}Zv ,$$

$$(6) \qquad {}^{S}Hv_i = \ln {}^{S}Zv_i ,$$

where ${}^{S}Hv$ – entropy of the variable set of S (information entropy, which modeled the interaction with the external environment and with himself),

${}^{S}Hv_i$ – entropy of the variable set of S on level of organization i,

$\mu_i$ - relative share of participation of ${}^{S}Hv_i$ in ${}^{S}Hv$.

**Object**

Each object $O_j$ may participate with several of his organization levels, when interacting with S. For example, a corporation can interact with customer through on administrative, expert and executive levels of its organisation.

The behavior of these levels of organization is complemented by the behaviour of the system that unites them:

$$(7) \qquad {}^{Oj}Zv = \prod_{i=0}^{n_j} {}^{oj}Zv_i^{\eta_j},$$

$$1 < {}^{Oj}Zv < e , 1 < {}^{Oj}Zv_i < e, \quad 0 < \eta_j < 1,$$

$$(8) \qquad \sum_{i=0}^{n_j} \eta_j = 1,$$

where ${}^{Oj}Zv$ – variable set of object Oj (set through which interacts with the external environment and with himself)

${}^{Oj}Zv_i$ – variable set of object Oj on level of organization i,

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$\mathbf{n_j}$ –maximal number of levels of organization of object Oj that interacts with subject S,

$\boldsymbol{\eta_j}$ – the degree of participation of the set ${}^{Oj}_{i}Zv$ in set ${}^{Oj}Zv$.

After taking the logarithm on both sides of the equation (7) is obtained:

$$^{Oj}\mathbf{Hv} = \sum_{i=0}^{n_j} \eta j \,.\, {}^{Oj}_{i}\mathbf{Hv}, \tag{9}$$

$$\mathbf{0} < {}^{Oj}_{i}\mathbf{Hv} < \mathbf{1},$$

$$^{Oj}\mathbf{Hv} = \ln {}^{Oj}\mathbf{Zv}, \tag{10}$$

$$^{Oj}_{i}\mathbf{Hv} = \ln {}^{Oj}_{i}\mathbf{Zv}, \tag{11}$$

where ${}^{Oj}\mathbf{Hv}$ - entropy of variable set of an object Oj (information entropy, by which the interaction with the external environment and with himself) is modeled,

${}^{Oj}_{i}\mathbf{Hv}$ - entropy of variable set of subject Oj on the level of organization i,

$\boldsymbol{\eta_j}$ - relative share of participation of entropy ${}^{Oj}_{i}Hv$ in entropy ${}^{Oj}Hv$.

## Multiple

The team behavior of multiple m of objects can be represented through their complementary set. They occur in the process of interaction of team m with subject S:

$$^{M}\mathbf{Zv} = \prod_{j=1}^{m} \prod_{i=0}^{n} {}^{Oj}_{i}\mathbf{Zv}^{\,Mj \cdot \nu_{ij}}, \tag{12}$$

$$\mathbf{1} < {}^{M}\mathbf{Zv} < \mathbf{e}\,,\ \mathbf{1} < {}^{Oj}_{i}\mathbf{Zv} < \mathbf{e}\,,\ \mathbf{0} < \mathbf{Mj} < \mathbf{1},\ \mathbf{0} < \nu_{ij} < \mathbf{1},$$

$$\sum_{j=1}^{m} M_j = 1, \tag{13}$$

$$\sum_{i=0}^{n_j} \nu_{ij} = 1, \tag{14}$$

where ${}^{M}\mathbf{Zv}$ - variable set of multiple objects M (set, through which multiple objects M interacts with the subject S),

**m** – number of objects Oj that jointly engage in interaction with the subject S,

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**Mj** - degree of participation of the variable object Oj in the variable set of multiple M (m - number of objects in M).

$\nu_{ij}$ - degree of participation of the variable object Oj from the level of organization i with regard to the set of the variable level of organization i of multiple M.

Example: a team helps a sick colleague, such as:
- stimulates his desire to be restored to health,
- gives helpful tips,
- tells optimistic examples,
- looking for external assistance.

After taking the logarithm on both sides of the equation (12) is obtained:

$$^{M}Hv = \sum_{j=1}^{m} \sum_{i=0}^{n_i} {}_{M_j} . \nu_{ij} . {}^{Oj}_{i}Hv , \quad (15)$$

$$0 < {}^{M}Hv < 1, \; 0 < {}^{Oj}_{i}Hv < 1,$$

where $^{M}Hv$ - entropy of variable set of multiple objects M (entropy, whereby multiple entity that interacts with S),

$M_j$ - relative share of participation of $^{Oj}Hv$ in $^{M}Hv$,

$\nu_{ij}$ - relative share of participation of $^{Oj}_{i}Hv$ in $^{M}_{i}Hv$.

## Subject-object

The interaction between the sets of several systems is evident in the fact that:
- plants share information about davgers,
- if a person is concerned about the health of a friend, then he can get the same illness.

As a result of the interaction of subject S with object Oj a general variable set is formed of a system S-Oj:

$$^{S\text{-}Oj}Zv = \prod_{i=0}^{n} {}^{S}_{i}Zv^{\,g_S . \eta_S} . {}^{Oj}_{i}Zv^{\,g_o . \eta_o} , \quad (16)$$

$$1 < {}^{S\text{-}Oj}Zv < e , \; 1 < {}^{S}_{i}Zv < e , \; 1 < {}^{Oj}_{i}Zv < e ,$$

$$0 < g_S < 1, \; 0 < g_o < 1, \; 0 < \eta_S < 1, \; 0 < \eta_o < 1,$$

$$g_S + g_{Oh} = 1, \quad (17)$$

$$\eta_S + \eta_o = 1 \quad (18)$$

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where $^{S-Oj}Zv$ - variable set of a current interaction of subject S with subject Oj,

$g_S$ – degree of participation by the subject variable set of S in the variable set of system operator S - Oj,

$g_o$ - the degree of participation of the variable set of the object O in variable set of a system S - Oj,

$\eta_S$ - degree of participation of the variable set of the subject S of level i in the variable set of system S - Oj from level i,

$\eta_o$ - degree of participation of the variable set of object O from level i in the variable system S - Oj from level i.

After taking the logarithm on both sides of the equation (16) is obtained:

(19) $$^{S-Oj}Hv = \sum_{i=0}^{n} g_S . \eta_S . {}^{S}_{i}Hv + g_O . \eta_O . {}^{Oj}_{i}Hv ,$$

$$0 < {}^{S-Oj}Hv < 1, \quad 0 < {}^{S}_{i}Hv < 1, \quad 0 < {}^{Oj}_{i}Hv < 1 ,$$

(20) $$^{S-Oj}Hv = \ln {}^{S-Oj}Zv,$$

(21) $$^{S}_{i}Hv = \ln {}^{S}_{i}Zv,$$

(22) $$^{Oj}_{i}Hv = \ln {}^{Oj}_{i}Zv,$$

where $^{S-Oj}Hv$ - entropy of variable set of the current interaction of subject S with an object Oj,

$g_S$ - relative share of participation of $^{S}_{i}Hv$ in $^{S-Oj}_{i}Hv$,

$\eta_S$ - relative share of participation of $^{S}_{i}Hv$ in $^{S-Oj}_{i}Hv$,

$g_o$ - relative share of participation of $^{O}_{i}Hv$ in $^{S-Oj}_{i}Hv$,

$\eta_o$ - relative share of participation of $^{O}_{i}Hv$ in $^{S-Oj}_{i}Hv$.

**Subject – multiple**

The subject S can personal interact with multiple M of objects Oj. As a result is formed a common variable set of the currently formed system subject S - multiple M:

(23) $$^{S-M}Zv = {}^{S}Zv^{\,g_M} . {}^{M}Zv^{\,\phi},$$

$$1 < {}^{S-M}Zv < e , \; 1 < {}^{S}Zv < e , \; 1 < {}^{M}Zv < e, \; 0 < g_M < 1, \; 0 < \phi < 1,$$

(24) $$g_M + \phi = 1 ,$$

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where $^{S-M}\mathbf{Zv}$ - variable set of currently interaction of subject S with multiple M with objects Oj,

$\mathbf{g_M}$ - degree of participation of $^{S}$Zv in $^{S-M}$Zv,
$\phi$ - degree of participation of $^{M}$Zv in $^{S-M}$Zv.

If the entropy of a subsystem is small, this subsystem can adjust the entropy of the system, in which participates. The small amount of entropy of the subsystem has great potential for impact. A similar potential holds the amplitude characteristic. Amplitude characteristic expresses the intensity of conversion that is applied.

In the general case the subsystem periodically adjust the entropy of the system. The periodic effects of subsystem on the entropy of a system has character of frequency response. For example the victim repeatedly thanked everyone who participated in his rescue.

After taking the logarithm on both sides of the equation (23) is obtained:

(25) $$^{S-M}\mathbf{Hv} = \mathbf{g_M}.\ ^{S}\mathbf{Hv} + \phi.\ ^{M}\mathbf{Hv},$$

$$\mathbf{0} < {}^{S-M}\mathbf{Hv} < \mathbf{1},\ \mathbf{0} < {}^{S}\mathbf{Hv} < \mathbf{1},\ \ \mathbf{0} < {}^{M}\mathbf{Hv} < \mathbf{1},$$

where $^{S-M}\mathbf{Hv}$ – entropy of variable set of current interaction of subject S with multiple M with objects Oj,

$\mathbf{g_M}$ - relative share of participation of $^{S}$Hv in $^{S-M}$Hv,
$\phi$ - relative share of participation of $^{M}$Hv in $^{S-M}$Hv.

Interaction between variable entropy of subject $^{S}$Hv and variable entropy of the objects $^{M}$Hv flows through various management factors.

If the subject needs help, that is $^{S}$Hv > $^{M}$Hv , and the flow of entropy flows from subject to object.

If the subject treats the objects, that is $^{S}$Hv < $^{M}$Hv, and the flow of entropy flows from objects to subject.

The proportion $\phi$ characterizes the ability of the system to filter the flow of entropy that passes through it, this current is formed by entropy with specific governing factors in result of the combination of these ingredients:

- the system forms the desired entropy
- the system has a smaller value than the entropy of its subsystems – emergent effect
- the system has a shorter life than the duration of its subsystems.
- the mutual exchange of entropy between subsystems further additionally increases the resistance of the system.

## Results

1. **The conversion of the value of the set in entropy type is a prerequisite for linearization of the scale of its departures from the resistance.**
2. **The development of the fixed set is carried out as additional development of the main structure of the system.**
3. **The integrations of subsystems with low values of the entropy forms increases the stability of the system.**

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