Mathematical images of learning technology and its action on region

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ABSTRACT: *The system approach to management of knowledge in region is presented. The main principles of more effective control of knowledge networks is proposed. The effective way to the interactions between learning institutes and the industrial organisations was considered.*

Keywords: system, learning, knowledge, information, development, control, interaction, effectivity

INTRODUCTION: THE MAIN CONTRADICTION

At last time all over the world information is produced more and more effective. Total quantity of information in all information's branches including business is near the boundary after which the effective operations and transformations with the information are impossible. But the main contradiction between information and knowledge is increased in our time. The Internet is the best example of this contradiction. Internet keeps a huge quantity of information but doesn't give new knowledge. The other example this contradiction is the actual system of education in Belarus. Education system in our country felt in a big collapse after SU destruction. The system of education replicates information but doesn't create new knowledge. This is connected with bad management and bad structure of organisation of education. The contradiction is usually induced by the mistakes of the complex organisation of education system. The main problem consists in the changes system to more effective structure according to the purposes of the system operating. This problem could be solved by using of the multilevel hierarchical system theory (MHST). According MHST we must manage the knowledge level to control the social and business system. Formulating of aims on knowledge level allows to optimise the way to the business and social development can be obtained. As a rule we speak about the large scale system, but our glance can be used for small firms, too.

HIERARCHICAL CONSTRUCTION

The MHST is developed on the base of general system theory (Bertalanffy 1977, Mesarovich 1970, 1975). The MHST is applied to knowledge managing at works (Kile 1995, Novikava et all 1991, 1993, 1995a), Groumpos 1997). We are studying the social and business development at present paper as tightly bounded processes which are interdependent. According to the MHST interactions between all systems are divided into two big classes: interactions of control and interactions of collaboration. This two cases of interactions corresponds to interactions between systems which are situated at different levels and interactions between systems which are situated at the same level. All systems together are constructing the hierarchical world. This hierarchical world has the graphics image (Fig.1) (Novikava et all. 1990, 1991, 1995b, Buka et all. 1997). The system development in our space is equivalent to the movement of a point in the hierarchical space according to the general principles of point dynamics in the generalised space (Bremermann 1972). The mathematical images of large scale systems are well known (Chestnut 1995, Kile 1995, Novikava 1995, 1997). The sample of that kind of hierarchical world is the hierarchical State model. All strata have diverse characteristics in concrete States statutes (symbol image) of which must be connected to their history with sway strategies in their space. The states are changing diverse details of their own constructions on all strata and these interactions are the base of unions of state. Till now the process of world changing is realised without actual understanding of its laws and since that with hard errors within the States and their alliances. The general theory of new world construction can be build on the base of Aed theory.

Aed theory (A^{λ} mathematics) has now two own main hierarchical symbol images ${}^{x}\alpha^{\lambda}$ and ${}^{+}\alpha^{\lambda}$ which answer to acts of multiplying (learning) and uniting (design). They contain the new means of control and connect the strata (directions) of A^{λ}. Aed strata are: Λ, λ - level (time), Γ, γ - statute (law, connection), P, ρ - act (process), Ω, ω - unit (state) Σ, σ - construction (contents), B, β - new time (arising level), A, α - sway (coordinator). Aed statute A^{λ} in current levelλ is described by its symbol image ${}^{x}\alpha^{\lambda}$ in following way:

${}^{x}\alpha^{\lambda}$:

$$A^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta \\ \omega \end{matrix} \underset{\rho}{\overset{\gamma}{A}} {}^{\lambda}_{\sigma} \right\}^{A^{\lambda}}_{\lambda \to \beta}, \qquad \Lambda^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta \\ \omega \end{matrix} \underset{\rho}{\overset{\gamma}{\Lambda}} {}^{\lambda}_{\sigma} \right\}^{\Lambda^{\lambda}}_{\lambda \to \beta},$$

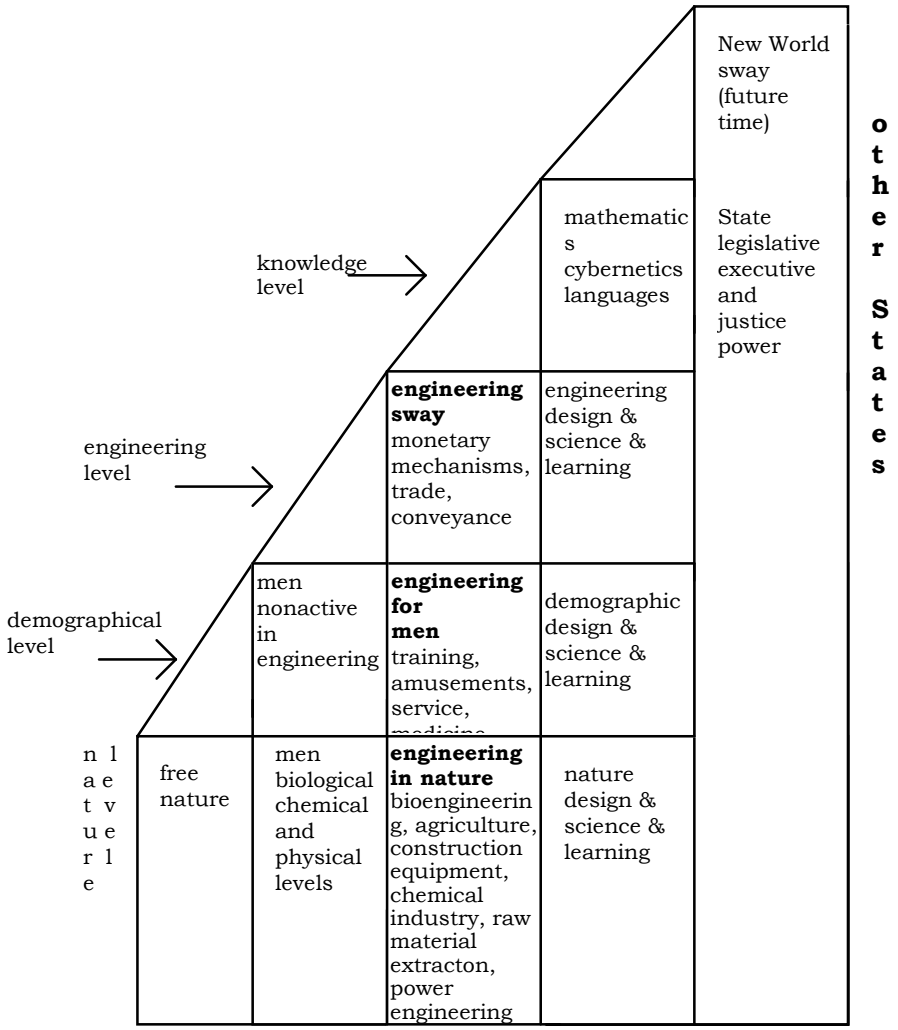

Figure 1: The graphic image of hierarchical world.

$$\Gamma^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta \\ \omega \end{matrix} \underset{\rho}{\overset{\gamma}{\Gamma}} {}^{\lambda}_{\sigma} \right\}^{\Gamma^{\lambda}}_{\lambda \to \beta} \qquad P^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta \\ \omega \end{matrix} \underset{\rho}{\overset{\gamma}{P}} {}^{\lambda}_{\sigma} \right\}^{P^{\lambda}}_{\lambda \to \beta},$$

$$\Omega^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta \\ \omega \end{matrix} \underset{\rho}{\overset{\gamma}{\Omega}} {}^{\lambda}_{\sigma} \right\}^{\Omega^{\lambda}}_{\lambda \to \beta}, \qquad \Sigma^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta \\ \omega \end{matrix} \underset{\rho}{\overset{\gamma}{\Sigma}} {}^{\lambda}_{\sigma} \right\}^{\Sigma^{\lambda}}_{\lambda \to \beta},$$

$$B^{\lambda} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} \beta & \gamma \\ \omega & B_{\sigma}^{\lambda} \\ & \rho \end{matrix} \right\}_{\lambda \to \beta}^{B^{\lambda}}, \qquad A^{\beta} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} ? & \gamma \\ \omega & A_{\sigma}^{\beta} \\ & \rho \end{matrix} \right\}_{\beta \to ?}^{A^{\beta}} \quad (1)$$

In this way all aed strata can renovate its original unit A^{λ}, they have all its signs and abilities, $\leftrightarrow$ is the correspondence relation. The strata $\Lambda, \Gamma, B, P, \Sigma, \Omega$ are strongly connected both by their original unit A^{λ} and by the details of their own constructions (by their new interactions). Thanks to that all aed strata may be renovated when any stratum is changed. The acts of original unit A^{λ} multiplying and their symbol images uniting lead to the arising of the new time unit A^{β}. It contains hazy symbols in its image (they are signed by the symbol ? and they will be defined in time β) (Novikava et al, 1997). The image ${}^{x}\alpha^{\lambda}$ allows to see the acts of multiplying&uniting (learning&design), their bases, aims and connections.

PROBLEM OF COLLABORATION (ONE-LEVEL INTERACTION)

The base of control of highest strata is the system of lower strata. Some different systems are situated at the same time at the same level. The level of the business activity coincides on the level of the social organisation. Then the business development is possible only with one-level interaction with social development. The controlling level (knowledge) influence on both systems, but the results of influence are different because the sway (co-ordinator) has its own tasks. The bottom levels are effectively influencing on the sway only when the deviations of theirs trajectories in hierarchical space from the trajectory of evolution defined by sway are rather small. The value of this deviation δ for each trajectory is determined by parameters $\Gamma \& \gamma$ (law and connection) and controlled by coordinator. Let's define the norm in the hierarchical space as

$$\left\| \Delta^{r} \right\| = \sqrt{\sum_{i} \left(\left\langle \Delta_{i}^{r} \right\rangle - \Delta_{i}^{r} \right)^{2}}, \quad \left\langle \Delta_{i}^{r} \right\rangle = \frac{1}{i} \sum_{i} \Delta_{i}^{r}. \qquad (2)$$

Here Δ is value of characteristics, in Δ_{i}^{r} index *r* denotes all strata and its characteristics $(\lambda, \Lambda, \gamma, F...)$, index *i* enumerates all systems which are situated on the current level. We take the trajectory as a optimal when

$$\left| \Delta_{i} - \left\| \Delta^{r} \right\| \right| = \varepsilon < \delta(\Gamma \& \gamma). \qquad (3)$$

According to our definition the total trajectory can be optimal in global meaning but not optimal in local meaning of big deviation due to relative of one of characteristics. We have only one arbitrariness which depends on the optimisation according to the law of sway.

From other way interaction between two different system which are situated on the same level has other character. Let's study the case when the hierarchical level contains only two affiliate systems. This model is not limiting the general conclusion. Because both systems have the equal weight in sway the control is possible only trough the sway. The first system exchange with the sway its own original unit and details of their own construction.(Novikava et all 1997, Buka et all 1997) After the sway exchanges with second system its own original unit and the details of its own construction. Because the sway have the law relatively the lower level the sway can exchange the law, too.

If the system of the lower level has the mathematical expression of the sway (It is the competent system) this exchange is realised more effective and this system uses law of sway more effective, too. As a result the development trajectory of a competent system is nearer to the optimal trajectory.

In any case interaction between one - level system is reduced to the interaction between co-ordinator and the system. Thus the main problem of optimisation of the trajectory is the more effective using the law and sway expression.

LEARNING, SOCIAL STRUCTURE AND ORGANISATION

The problem of the optimal structures of organisations of business and its mathematical description is well known and successfully developed [Therborn. (1995), Van Steenbergen (1994), Puu (1997)]. The problem of the optimal social structure is known worse but some aspects of social interaction as a mathematical problem are studied [Weidlich (1991, 1997), Andersson (1997), Hedström (1998)]. As a social structure we understand the

manifold diverse social unions. All these unions are included in the State but sometimes the social systems are more spacious than a State. (Some examples are: Irish ethnos in Ireland and GB, Albanian in Albania and Yugoslavia, Tajiks in Tajikistan and Afghanistan).

One of the main problems of any level description is the choice of the universal characteristic of different systems which are situated at this level. Because we are interesting in systems on knowledge level the information can be accepted as this characteristic (Miklashevich 1999 a, b). Information description is successfully used also to living and biological system (Ebeling 1986, Helbing 1997, Brillouin 1956, Volkenstein 1980, 1994, Gatlin 1972).

Let's introduce the coefficient of receptivity of the sway influence

$$\frac{1}{\Re} = \frac{I_s}{I_a}, \tag{4}$$

I_s is the amount of control information production of the sway, I_a is the amount of information accepted by system. Under other equal condition let

$$\lim_{\lambda \to \beta} I_s = const = I_s^0, \tag{5}$$

but the I_a is the essential nonconstant,

$$I_a = I_a\left(VED, \varepsilon\right). \tag{6}$$

VED is the assembly of averaging data which characterised the person belonging to the social system.

The full VED set of variables depends on sorts of social system. All elements are interacting according to the law. The main problem is the correct choise of configurational space. The basis vectors of this space must be the main conditions which characterise this social groups. The most interesting system for us is the ethnos. This comprehension is nowadays discussed new (Rutkevich 1999, Smith 1976). The traditional sociological characteristics are not good for the mathematical description (not numbers,.not well tested, not good replicated). All known definitions of ethnoses (Gumiljov, Bromley, Tylor, Levi-Strauss) are pure sociological or political definitions. They don't satisfy our requirements. The pure genetic definitions are not fulfil to our requirements too because the distinguishes of genetic indications do not clear (Dubinin 1994, UNESCO 1997). The complete description of the set of variables is the object of next research.

From other way the internal interaction of any system situated on each level can be represented as a variant of the statistical interaction. The unit of our level Ω contains a lot of almost identical elements with own sway. This model corresponds to the theory of the open system (Haken 1982, Weidlich 1991, Klimontovich 1995, Miklashevich 1998). The sway is the field operating on the statistical system. In this case system is describing not exact discrete variable but the function of the probability distribution. For the social system one of possible characteristics which are included in VED is the IQ (Intellectual quantity) of distribution. IQ is the good function from mathematical point of view. This from the equation (6) we obtain

$$I_a = I_a\left(VED\left(IQ\right), IQ, \varepsilon\right). \tag{7}$$

It is well known that density of distribution $\varphi(\kappa)$ of IQ as a rule has the Gauss form

$$\varphi(\kappa) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\kappa-\xi}{\sigma}\right)^2} = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\kappa-70}{\sigma}\right)^2}. \tag{8}$$

Here, σ is the dispersion of distribution, ξ is the central tendency of the data retrieval, κ is the phases variable.

According to the main principles of thermodynamics of the open systems the information is connected with the entropy (Klimontovich 1995, Kadomtsev 1997)]. If we will introduce the entropy we also can investigate the variational problem for the optimal trajectory. The general task of the sway control is

$$\lim_{\lambda \to \beta} \Re = \max. \tag{9}$$

Taking into account (5, 6) this gives

$$\lim_{\lambda \to \beta} I_a = \max . \tag{10}$$

According to (1) total process of interaction between business systems and social systems through knowledge level has the form

$$\Pi \leftrightarrow {}^{+}\rho^{\lambda} \oplus {}^{\times}\rho^{\lambda} , \tag{11}$$

${}^{\times}\rho^{\lambda}$ is the multiplying act of original state (Novikava 1997), ${}^{+}\rho^{\lambda}$ is the uniting act of connection of the ordinary units and creation of the new sway, $\oplus$ is the symbol of operation between two acts. With (4, 5, 11) for the full coefficient of receptivity we will obtain

$$\left(\frac{1}{\Re}\right)^{\oplus} = \sum_{\substack{j,k=1 \\ j \neq k}}^{i} \left(\frac{1}{\Re}\right)_j \oplus \left(\frac{1}{\Re}\right)_k = \sum_{\substack{j,k=1 \\ j \neq k}}^{i} \frac{I_{sj}^0}{I_{aj}} \oplus \frac{I_{sk}^0}{I_{ak}} . \tag{12}$$

Equation (12) written in generalized case when *i* systems are situated on the same level. The optimal strategy of the learning technology available from equations (9), (12).

CONCLUSION: VARIABLES SET AND HIERARCHICAL HAZY

The hierarchical hazy is out of the boundary of pyramid (Symbol ? in equation (1)). We can not know the exact law of the hazy, but only some influence of this higher strata to our lower strata can be studied. But hazy problem is important only for some of known social systems. As an example, at this moment we do not have full set of variables and the law of the ethnos. In this case the ethnos as object belongs to the relatively higher strata, i.e. to hierarchical hazy and we understand only some of its aspects. As the system of the highest strata ethnos also includes genetic, social and business substrata and it is the coordinator (sway) of this strata. The whole ethnos is the complex system, which includes all lower strata (all pyramid) but have more general characteristics. Because the existence of the sway depends on the existence of the lower strata that is why hierarchical hazy is condensed near the breaking point of the evolution lower strata. (The sociological example is the war that is accenting the national spirit). The evolution of system can be turned from the stable to nonstable state near this critical point of the social development (Dendrinos 1990). It is well known that control influence is more effective near the critical point of development for all systems (Haken 1982, Weidlish 1994, Helbing 1997, Klimontovich 1995). In any case this state also admits the control of influence (Shinbrot 1995).

The full "hierarchical portrait" for the most part of the other systems now can be received. Thus influence and direction of development can be optimised. In our changeable world only correct understanding of the main principles of system evolution allows to win in the development.

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