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Modeling and optimal control in ethnosocial systems

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Summary

The mathematical description of the social and ethnical groups development proposed. The social and ethnic groups had the multilevel hierarchical system structure which had their internal constructions, the behaviour in the environment (among other groups), and their holding systems are able to change their constructions and dynamics. The group description on isolated level may be considered as a typical synergy problem for the open systems. The configurational and informational entropy in the Shannon sense for the system is a key parameter of the model. General entropy of an ethnos is a complex superposition of the levels of intellectual evolution of individual members of society and depend on the structure of society. The holder system on ethnoses level is in the hierarchical hazy but its mathematical expression can be constructed from point of view their subsystems (their details of lower levels).

I. Introduction

Recent events around the world indicate complete insolvency of the traditional view on the social world state and evolution. The new reality demands a new approach to the social process evolution and control.

The classical “descriptive” approach does not satisfy the main idea of quantitative description. This approach only analyzes the past situation. But now we need another description, which can give us the prediction, the control parameters and the critical points characteristic [Kile (1995), Groumpos (1997), Miklachevich(1998. 1999a, 1999b].

In this way the main problem consists of the possibility that processes and social groups evolution of mathematical description of the social are amenable. Another point of view states that all social groups include indescribable elements (“the spirit”). The main argument on the first point of view is some good examples of successful description of social state and interaction like economics or demography.

Starting from this supposition we believe that all social groups (and the ethnos as a specific social group) can be mathematically described and given quantitative prognosis.

II. The general definition.

Actually there are some difficulties with the mathematical approach to the social problems. The traditional sociological variables are not very good for the quantitative description because the sociological variables do not satisfy condition of the theory of measurement [Chaytun(1983)]. The main conditions are:

1/ The variables are subset to numerical or the relations expression.

2/ The variables are independent of the kind of system that belongs to the same class of systems.

3/ The variables either are independent of the measurement process or depend according to standard law.

4/ The outcome of measure can be verifiable.

5/ The measurement process must be the same when applyied to systems of identical character.

Let’s introduce some definitions.

Hierarchical space. It is a mathematical image of the world structure and construction. It is the bundle space.

Space of state. It is the mathematical construction that corresponds to the system being described. It is the subspace of the hierarchical space.

Coordinates of state They represent the full set of variables essential for selected system.

State of the system. It is point in the space of state.

Trajectory of evolution. It is the ensemble of points in the space of state. If the full trajectory of the system belongs to one space of state then the system does not change his own stratum.

According to our definitions the evolution of real systems is isomorphous to the motion of the point in the space of state.

III. The mathematical description of ethnogeny

1.The base of image.

Mathematical description of ethnogeny seems to be a very interesting problem. The process of ethnogeny is tightly joined with sustainable development and conflict or peaceful relations between ethnoses. The social and ethnic groups can be represented as the strata of hierarchical multilevel system (Fig.1.) with interaction between levels and the sway (coordinator) acting in the system [Novikava (1993, 1997), Miklashevich(1998)]. The sample of this kind of hierarchical world is the hierarchical State model. All strata have diverse characteristics in ceretain States statutes (symbol images) which must be connected with their history and 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 the state. Till now the process of world changing have been realised without actual understanding of its laws and hence with hard errors within the States and their alliances. The general theory of new world construction can be built on the base of Aed theory [Novikava(1993, 1995a, 1995b, 1997), Buka(1997)].

Aed theory (A^{λ} mathematics) now has two main hierarchical symbol images ${}^{x}\alpha^{\lambda}$ and ${}^{+}\alpha^{\lambda}$ which correspond to acts of the multiplying (learning) and the uniting (design).

They contain new means of control and connections of the strata (directions) of $\mathbf{A}^{\boldsymbol{\lambda}}$. Aed strata are: $\boldsymbol{\Lambda}$, $\boldsymbol{\lambda}$ are level (time), $\boldsymbol{\Gamma}$, $\boldsymbol{\gamma}$ are statute (law, connection), $\mathbf{P}$, $\boldsymbol{\rho}$ are act (process), $\boldsymbol{\Omega}$, $\boldsymbol{\omega}$ are unit (state) $\boldsymbol{\Sigma}$, $\boldsymbol{\sigma}$ - construction (contents), $\mathbf{B}$, $\boldsymbol{\beta}$ - new time (arising level), $\mathbf{A}$, $\boldsymbol{\alpha}$ - sway (co-ordinator). Aed statute $\mathbf{A}^{\boldsymbol{\lambda}}$ in current level $\boldsymbol{\lambda}$ is described by its symbol image ${}^{x}\boldsymbol{\alpha}^{\boldsymbol{\lambda}}$

Trajectory of evolution.

Let's define the norm in the hierarchical space as

$$\left\|\Delta^r\right\| = \sqrt{\sum_i \left(\left\langle \Delta_i^r \right\rangle - \Delta_i^r\right)^2}\,, \tag{1}$$

$$\left\langle \Delta_i^r \right\rangle = \frac{1}{i}\sum_i \Delta_i^r\,. \tag{2}$$

Here Δ is the value of characteristics, in Δ_i^r the index r denotes all strata and their characteristics (λ, Λ, γ, F...), the index i enumerates all systems which are situated on the current level. We take the trajectory as a optimal when

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

Condition of optimality depends on the system state averaging and the coordinator tasks. More exactly, averaging system is the outcome of the control influence in the past and the value δ is the parameter of stability.

According to general mathematical considerations we believe the social system is stable when

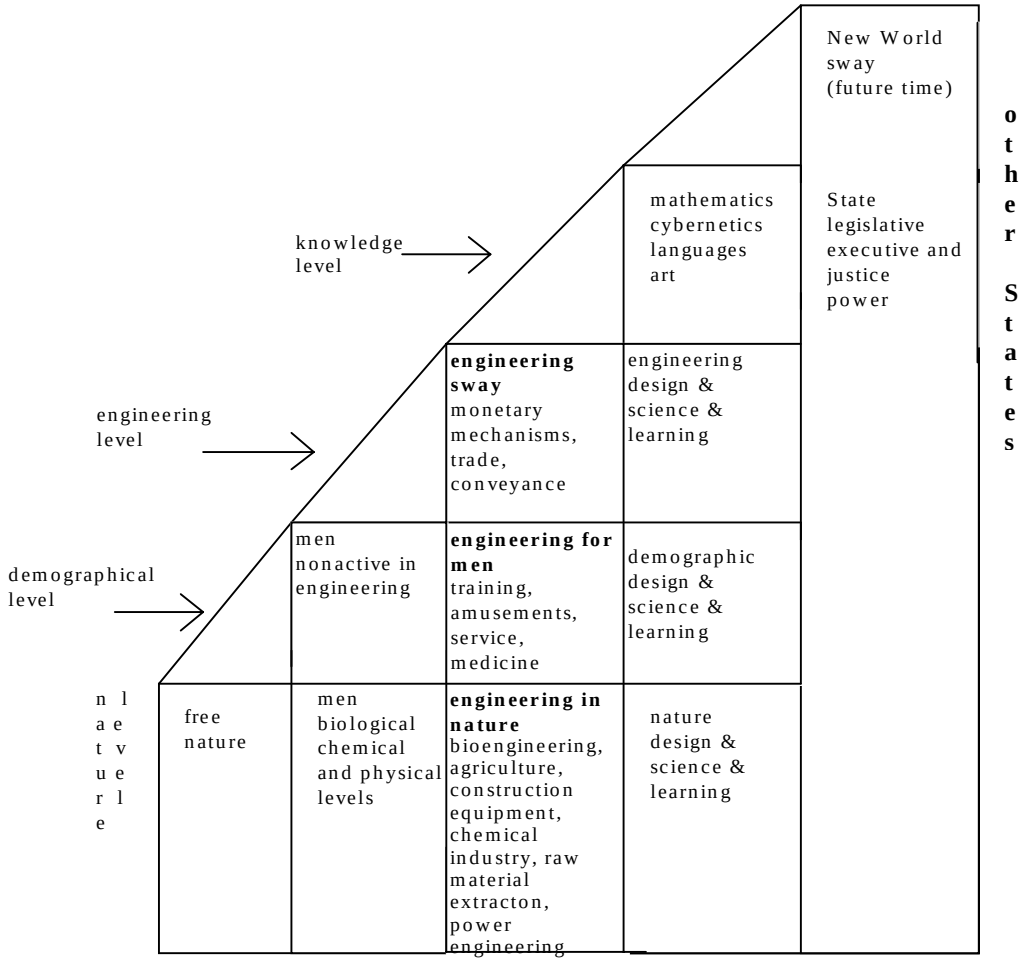

Fig.1. The graphic images of hierarchical world.

$$\lim_{\lambda \to \infty} \delta = \mathbf{0}. \tag{4}$$

Take into account (3,4) the optimal trajectory is stable. To make note of the our definition the total trajectory can be optimal in global meaning but not optimal in local meaning of big deviation due to relative to the one of characteristics. We have only one arbitrariness which depends on the optimisation according to the law of sway.

IV. Two types of interactions

According to our model the social system has two types of interactions: interactions between different levels and interactions between system situated on the same level. The first types of interactions is called control interactions, the second kind is called interactions of collaborations.

1. Control interactions and collaboration interactions.

The sway belongs to the upper strata because there's full structure and law does not clear for the lower strata. From the main equation of hierarchical mathematics [Mesarovich (1970, 1975), Novikava (1993,1997)], we obtain

$$A^{\beta} \underset{\rho}{\overset{\gamma}{\leftrightarrow}} \left\{ \begin{matrix} ? & \gamma \\ \omega & A^{\beta}_{\sigma} \\ & \rho \end{matrix} \right\}^{\beta \overset{A^{\beta}}{\underset{\rho}{\rightarrow}} ?} . \qquad (5)$$

Symbol ? in equation (5) is a symbol of hierarchical haze which correlates to order of uncertainty of the higher strata.

On the other hand interaction between two different system that are situated on the same level has a different character. Let's study the case when the hierarchical level contains only two affiliate systems. This model does not limit the general conclusion. Because both systems have the equal weight in the sway the control is possible only trough the sway. The first system exchanges with the sway its own original units and details of their own construction.[Novikava (1997), Buka (1997)] Then the sway exchange with the second system its own original units and the detail of their own construction. Since the sway have the law for relatively lower level the sway can exchange the law, too.

According to (5) the total process of interaction between one- level systems (as example, two ethnoses or business and social system) through higher level has the form

$$\Pi \leftrightarrow {}^{+}\rho^{\lambda} \oplus {}^{\times}\rho^{\lambda} , \qquad (6)$$

${}^{\times}\rho^{\lambda}$ is the multiplying act of original state, ${}^{+}\rho^{\lambda}$ 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. As a example, interaction between social system and business system trough the knowledge level is realised. 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 the system uses the law of sway more effectively, 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 the coordinator and the system. Thus the main problem of optimisation of the trajectory is the more effective usage the law and sway expression.

2. The statistical approach of the ethnos evolution

From the point of view elementary interaction between all elements of the system the big social systems are good samples of statistical systems. Maybe each elements has a different connection and interaction but spatial averaging in the space of state gives us the averaging of continuum. This means that ergodic theorem is true for social groups. Thus we understand that our systems are nonlinear nonholonoum stochastic system, for which equations of state must be constructed and an evolution for the system must be defined . This problem may be considered as a typical synergy problem for the open social systems. Such approach allows to pick out a number of essential moments, that are not taken into consideration by known models.

For simplification of the model and obtaining more obvious results, an idealizated problem of evolution of monoethnos within the limits of the established social systems (monostate) has been examined. From the point of view of physics the problem of planing of ethnogeny of the system is more correct because it allows to eliminate some arbitrary variable data, which are introduced for description of interaction of a majority with minorities (interethnic interaction). Ethnos is considered to be an open physical system with many parameters, for which the principle of the thermodynamics and the statistical mechanics of non- stationary systems are true. Statistical approximation for the living system is well known [Shapovalov(1998)]. For such a model you can use the basic position of the theory of open systems, if an exchange with external systems is considered to

be informational exchange. Then, it is possible to introduce a key parameter of the theory of open systems that is called entropy for the system.

The full entropy is divided into two part: configurational entropy and informational entropy in Shannon sense. The configurational entropy can be derived according to standard procedure

$$S(\lambda) = -k \int f_n(X, \lambda) \ln(f_n(X, \lambda)) dX \ , \qquad (7)$$

$f_n(X, \lambda)$ is the function of distribution of the states.

$$f_n(X, \lambda) = \lim_{N_n \to \infty} \frac{dN_{en}}{N_{en}} dV \ . \qquad (8)$$

N_{en} is the number of the ethnos representatives, dN_{en} is the number of ethnos representatives which are situated near current state of system, dV is elementary volume of the state, X is the full set of variables of system, λ is current level (time), k is the coefficient.

According to the total mathematical principles the function of distribution is the normalized quantity.

$$\int f_n(X, \lambda) dV = \mathbf{1}.$$

The second part of the full entropy is the information entropy. It is connected with the hierarchical variables $\mathbf{\Gamma}$, γ and $\mathbf{\Sigma}$, σ. The mathematical expression of the information entropy is the object of our upcoming articles.

Conclusion: some remarks relative to the critical points of development

Now it is important to speak about specific level of maturity for planing all sorts of system. After a statistical averaging of the stochastic system on the whole multitude (socium), we can speak about a specific leve of intellectual maturity. Prima facie a country with higher level of education and larger specific IQ will attain a preference. However, the situations are possible, when in spite of the high enough value of specific IQ , an ethnos is situated near the lowest point of the curve of its own evolution and its further fall may happen literally in the nearest 10 - 15 years, simultaneously with departure of the present generation from historical arena. In this case long - term investment may give significant losses instead of expected profits. It is especially dangerous just because large indeed, not purely intellectual and dynamic projects, which require large investment, are counted on recoupment in the long time, compared with the time of disappearance of the system.

From this point of view Republic of Belarus represents practically an ideal model range for examination process of ethnogeny in its conclusive stage -the stage of ethnocide. Ethnos in Belarus is old enough in historical plane (approximately 200 generation [Mikulich (1999)]. Processes of more or less natural convergence of nations, united in those times in the one state formation - Russian empire- were significantly and artificially forced in the following time on political and ideological considerations. Those political processes were aggravated by unpremeditated factors, causing an avalanche of ethnocid. The genofund (fairy weaken because of the numerous and imperfective chemical productions of the last years and historically chronic alcoholism) was exposed to radioactive emanation as a result of Chernobyl catastrophe. The radioactive emanation is a synergy process, when small influences can lead to qualitative changes of the system. Any mutation in this plane is a qualitative change. It is known, that in the result of the radioactive emanation the curve of the distribution of intellectual abilities on the whole does not change its appearance, but it moves to the part of diminution of the meaning. In the result, a specific intellectual ability of young generation decreases [Gofman(1995)]. This situation is constant and for the following generations, too, because a reproductive function of this category of people retains without changes, but genetic deficiency of the following generation is kept constant and forced by accumulative weak emanation. This lowering of the whole intellectual level of youth is put on fairly developed public health system, which led to conservation of the most undeveloped part of the ethnos of elderly age. (In the real conditions intellectual elite belonging to the old generation had been artificially annihilated as a result of the political events of the 30-th). In addition to this a perspective of changing the ethnocid stage to the stage of a new rise seems to be impossible because of the irretrievable total emigration of the more active and educated part of the ethnos remaining.

So, mathematical analysis of the sociogenesis allows to find the points of bend on the curves, characterizing the conditions of social systems and to analyze fairy long-term evolution of such systems. Starting from

the general physical principles of the development of open systems it is possible to suppose minimal external affects, leading the system out of environs of the critical point. The proposed method of analysis allows to predict arising of sudden social conflicts, not caused by economical and political reasons within the frame of the stable (before these conflicts) social groups (monostates) and make predictions of means of optional management of such conflicts.

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