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## **Problem of the Sustainable Development of Regional Systems in the Light of the Postnonclassical Science**

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*In the given article we consider the problem of a sustainable development of regional systems from the point of view of synergy-homeostatic approach, the concept of «self-sufficiency of development of region» is proved, and scenario model of evolution of complex social-natural system is offered.*

*In a context of new type of a reality – reality of global regionalization, stability of development is proved as self-sufficiency of development of complex open social-natural system at region level.*

*Authors come to a conclusion, that homeostatics adequately reflects convergent phase of a sustainable development of regional systems, and the synergetics, accordingly, a divergent phase.*

*Keywords: globalization, regionalization, stability, safety, self-sufficiency, synergy-homeostatics.*

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### **Point**

The XX-th century with the anthropocentrist priorities became a critical reference point in history of interaction of the nature and a society. The mankind cannot live any more «refusing nothing to itself» – such is a «bitter» axiom of the third millennium. In the light of a postnonclassical science necessity of change of «algorithms» of development as at global level – civilization level, and on local – region level – becomes more and more obvious.

However, the postnonclassical science and, first of all, synergetics explains why it is impossible to define unequivocally an optimum way of development, opening limits of essentially

possible planning-forecasting of natural and social changes, but also allows to «untangle» a ball of trajectories of a sustainable development.

Let's note one interesting moment. If it is possible to consider a classical science as a relevant antique philosophical tradition, then synergetics – daoistic. And if we take notice to the maintenance of seven substantive provisions classical Chinese «Books of Changes» (Confucius, 1999) that can be seen visually daoistic synergetics or synergetic confucianism.

In our opinion, the given feature of synergetics is shown, first, in search of the general laws of processes of formation – «followings Middle Path/madhyama pratipad», i.e. the birth

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of new quality – «Shown Dao not is constant Dao, but they are of one origin» (Compositions of the Chinese classics, 1967: 25, 40). Secondly, synergetic objects always appear as structure for which as prepotent attribute of their essence property of entire acts.

It is possible to tell, that an ancient principle of harmony of the world as balance, alternation Yin and Yang, their presence in each other, meaning pulsing equilibrium or nonequilibrium, as though anew revives in synergetic laws of self-organizing complicated, finding corresponding to the present stage of development of a civilization the strict mathematical form. Therefore there are all bases to search for the decision (them it can be valid much) problems harmonious or, being expressed by a modern language of science, a sustainable development from the point of view synergetic, and is more exact, synergy-homeostatic approach (Abramov and Bondarenko, 2002).

Certainly, in the global world the history proceeds differently: in it the new motive forces, new mechanisms and new directions are formed, and it cannot be ignored. But, nevertheless, it is represented, that for the decision of the given problem at global level it is necessary to understand preliminary with «stability of development» as self-sufficiency of development of difficult open social-natural system at region level.

Authors in a number of their works had shown, that the region is a concrete historical territorial social-natural integrity, possessing property resource (natural and social resources), technological and ethnocultural self-sufficiency for the expanded social reproduction, being the minimum unit of expansion noospheregenesis, integrating all qualities of the future Noosphere (Abramov and Bondarenko, 2002 a; Abramov et al, 2002 b; Abramov et al, 2006). A methodological basis of the given approach is the coherently-co-operative interrelation regionology with the doctrine about noosphere globalism, i.e., the

statement, that the global unity of mankind in knowledge can be presented as integrated set of representations about separately taken regions. Therefore the content of the general scientific term «region» appears it is necessary connected with requirement to display its general signs which, on the one hand, form representations about «uniformity» of terrestrial space, on the other hand, specify in ways of differentiation of each region from other and correlate its scales to scales global noospheregenesis.

We have in view that circumstance, that the postnonclassical science has faced new type of a reality – a reality global regionalization as one of displays of the social form of movement of a matter which the occurrence changes habitual forms social structuring as public life of people of all terrestrial community and therefore possesses a natural parametrical configuration of traditional discrete forms of various scale: global, regional, local, etc. (Abramov and Kujbar', 2008).

Following the brought logic, it is possible to conclude, that in territorial aspect the region is a socially-natural integrity which is set by historically developed set of natural and social resources of territory; in reproduction – the concrete historical forms of their interaction providing self-sufficiency of region.

In turn, self-sufficiency is correlated by quasi-isolation (openness-isolation degree) of separate region and is determined by its place in uniform process noosphere globalism. Totality of noospheric processes, thus, receives the logic completeness at regional level in the form of system set of the basic qualities of a noosphere.

Certainly, the synergetics does not give, as was earlier with social theories, a set of concrete social recipes. The future at such description appears not predetermined, and probable, plural. The fundamental problem arising in connection with formation of new interdisciplinary language of the description of a sustainable development of

regional systems, – a problem of representation of social processes as evolving structures, dissipative systems (Bransky, 1999). Methodological preconditions of such language are designed in synergetics. The synergetic methodology does not allow to substitute complex objects for their elementary, invariant forms. Hence, more precisely the essence synergetic the approach can be defined as research of laws of formation simple difficult, difficult superdifficult, i.e. as knowledge of processes of complication of ways of self-organizing (and, naturally, disorganization) of open systems.

With reference to region it means conceptual transformation: the development description not as result, and as formation, i.e. process of self-generation of chaos at microlevel of parameters of a macroorder by means of which evolutionary valuable selection is realized. Especially it is necessary to underline, that synergetics, investigating the general mechanisms of development, funds a role of relative stability of complex systems.

Representation about attractors as the factors defining a direction and a course of developments in nonequilibrium nonlinear systems, allows to present more correctly a sustainable development as the phenomenon of channeled developments of regional systems. Speaking about region as a whole, we will notice, that the phenomena, for which maintenance of a constancy of some parameters of system is characteristic (for example, live organisms or technical devices) are investigated by homeostatics. Here we deal with similar, but much more complex phenomena as at constant level should be supported not any one parameter, not stable condition, but extensive in time change process (in the formalized kind representable as channeled a trajectory which draws nearby trajectories of movement) at the expense of long-living variables. These long-living variables (for example, a region climate,

presence/absence of minerals, national traditions, etc.) Which become parameters of an order of a new homeostasis, subordinating themselves the system by means of set of negative feedback, thereby, is provided with the minimum borders of steady functioning.

It is necessary to note especially that fact what exactly application synergetic approaches to region gives invaluable possibilities of that formalized description what to formalize it is «practically impossible. For us in the methodological relation it is important, that opening of structures-attractors gives additional possibilities for drawing up of short-term forecasts of a sustainable development of regional systems.

Taking into consideration the fact of remarkable universal property of thin orientation of systems on factors of internal and external conditions of the structurization – the resonant excitation of dissipative structure meaning, that, despite a quantitative variation in a certain range of parameters, does not occur qualitative changes of a picture of process the attraction same attractor – development ways, in other words, remains, it is possible to consider the mechanism of the co-ordinated (co-operative) movement as the stability mechanism. Varying only character of initial influence it is possible to receive qualitative change of processes – complication and organization degradation not at the expense of change of parameters of system, and as result of resonant excitation of system.

Therefore the knowledge of initial data leading to rather steady conditions of system – to structures-attractors of evolution of region, in many cases would be rather useful and would give the chance more exact forecasting on what of four basic types of dynamic modes of functioning development of concrete region will go:

- A mode with abnormally low fluctuations, not reacting on irritants

- (a conservative homeostasis, a mode of stable stability);
- A fluctuating mode of «strange attractor» type (a mode of practically uncontrollable, catastrophic development);
  - Fluctuating stochastically determined, with moderate sensitivity to external indignations of system (a mode of channeled stability);
  - The fluctuating chaotic mode which is in coordination-sensitive to indignations of environment (mode of directed development) (Abramov and Bondarenko, 2002).

### Example

Now, it is hardly possible to deduce strict «formula» of a sustainable development of region since from the formal point of view it is impossible to speak about development of optimum strategy of achievement of the several purposes simultaneously (rational wildlife management, increases of a standard of life of the population, noncritical development of economy, spiritual revival etc.) . Nevertheless, the modern toolkit of mathematical modelling and carrying out of computing experiments allows to define contours of strategy and tactics of a safe sustainable development of concrete territory on the basis of drawing up of various scenarios of synchronization of management and selforganizing regional structures (ecologically comprehensible social and economic and technological development of region and taking into account influence of the human factor). And also to investigate in the formalized kind the central moments of developments of complex systems on the basis of standard models of transitions «chaos-order» (Malinetsky and Kurdyumov, 2001; Mainzer, 1996).

Scenario model of evolution of complex social-natural system can be described outwardly

very simple equations if to use models of dynamics of nonlinear systems:

$$\begin{aligned} dS_i &= -k(S_i + T) \\ dT &= -S_e G + wS_e - IT \\ dS &= S_i T - kS, \end{aligned}$$

where  $S_i$ ,  $S_e$  – are generalized parameters of internal and external stability of system,  $S$  – the general stability of system,  $T$  – technological potential,  $G$  – the generalized characteristic of operating parameters (the management mechanism),  $w$  – the generalized parameter of natural resources,  $I$  – the generalized parameter of information resources,  $k$  – the generalized characteristic of self-sufficiency of region (Self-Contained Region, in abbreviated form – «SCR»)

Variable  $S$  characterizes a field of speeds of evolution of system,  $k$  – is, some kind of, parameter of critical conditions of system. From the point of view of mathematics, such dynamic system, what it modelled, describes point movement in phase space. Dimension – the major characteristic of this space, i.e. number of sizes which are necessary for setting for definition of a condition of system. From the mathematical point of view, it is not too important, that it for sizes – number of the enterprises in certain territory, the share markets or the variables describing conditions of stability of region. If to consider, that a point, moving to phase space, reserves a trace to a certain condition of system there will correspond a set of trajectories.

However the another is important, namely, proceeding from the general mathematical structure of the equations describing the various phenomena by the nature, even the computer analysis of system would lead to basic result: such system has a final limit of the forecast which depends on speed of divergence of nearby trajectories and as a result time interval on which the forecast can be given depends on this size.

It is natural, that for each system there will be a limit of the forecast.

At a certain stage of development of a bifurcation tree or at occurrence of strange attractor there comes the stage of dynamic chaos carrying in both riches of possible structures, and impossibility of their full comprehension. To keep up a trajectory begins very difficult, and language of the statistical description is entered: likelihood distribution, correlation functions, Kolmogorov's entropy, etc. Usually these modes of so-called non-computable systems when trajectories fill geometrical objects of fractal nature, set not by algebraic equations, as habitual varieties, and iterative procedure. Fractals, on the one hand, suppose statistical interpretation, and with another – have an analytical origin and as much as rich geometrical structure on any scale for which self-similarity principles are characteristic. Fractals are typical stochastic structures on strange attractor. But every time the system has sprouts of all variety of the structures distinguished in chaos. To these images the principle ancient «all in one» not only when the structure is visible on one scale, and chaos on other is conformable, but also exist simultaneously in one reality. Such in the general theoretic-mathematical lines development of complex dissipative systems, including region, in synergy-homeostatic variant appears.

At computer modelling regional systems are pertinently to be represented as hierarchically-heterarchical cyclic structures for which as prepotent attribute of their essence property of integrity (self-sufficiency) acts, thanks to action of the so-called circular causality causing synchronization of straight lines and feedback of elements, a coordination of processes on micro- and macrolevels. As elements of such systems stable formations should act not, for example,

social groups, institutes or relations, populations or ecosystems, and etc. And one more important point that the region acted as complete and thus as self-sufficient structure of connection between elements should carry grouping and regrouping processes, organization and reorganization processes, structurization and formation processes not hierarchical, but network character.

Especially, it is necessary to stop on concept of self-sufficiency of region, since it an essence instructions on dialectics of stability and variability, accident and necessity within the limits of general property of regional system to support succession of cyclic structure of connection of volume and the content of the ability to live in conditions of fluctuating influences of environment.

It is represented, that self-sufficiency is a property of region as opened hyperquasicyclical systems to adjust relationships of cause and effect between elements at the expense of coherent stimulation of reproduction of parameters (volume and the content) abilities to live. We will dwell upon this important point necessary for understanding of specificity of a problem of a sustainable development of regional systems.

Preliminary once again we will underline, that, first, so-called circular causality is not exclusive, but the typical characteristic of any formation which gives to him system and allows to speak about association of internal connections in cycles. Secondly, it is trivial, but the fact, that all elements (economy, a policy, social structure, an environment etc.) of regional system too in their turn are systems. Therefore the region as a whole acts as hypersystem (system of cyclic connections of subsystems), stimulating reproduction of the elements (subsystems) at the expense of ring straight lines and feedback. Owing to a basic openness of hypersystem it becomes quasicyclic, but to compensate adverse external influences, as a rule, shown in rupture of relationships of cause and

effect the given system should possess, some kind of, safety factor, i.e. a complexity minimum level.

Appropriately there is a question: why association of subsystems in hypersystem is capable self-sustained? It is natural, that such association provided self-sufficiency, specific coherent connection, type of optimum parameters homeostasis which it is possible to name the generalized characteristic of self-sufficiency of region «SCR», being on a concrete historical stage succession is necessary.

Entering abstract criterion «SCR» – as an extremum of self-sufficiency of region, we not only in general can define borders of preservation of certain level of complexity, i.e. integrity of system, but also to fill the given criterion with the concrete-scientific content.

The aforesaid allows to methodologically justified to enter concepts of «strong» and «weak» self-sufficiency of region. So, hypothetically believing, for example, if «SCR» > 1 it corresponds to abilities of system to the expanded self-reproduction and means «strong» self-sufficiency, at «SCR» < 1 – there is a «weak» self-sufficiency, and the region gradually «dies out», and speed of the given process essentially depends on synchronization of use of internal reserves and external natural, social and information streams. At «SCR» = 1 there is a situation of a dynamic optimum of stabilization of system when speed of a relaxation (instabilities) is much more than speed of development of fluctuations and the system falls under action of principle of Pareto: the variant of the decision which cannot be improved on one parameter without that value of any other parameter has not changed is called as optimum (Kendall and Stewart, 1976). To this constant condition there corresponds the absolute stability actually meaning simple reproduction of natural and social resources, absence of progressive and regressive changes and, hence, and isolation of system.

Extremely simplify self-sufficiency can be defined as such ratio of qualitative and quantitative conditions of elements of system which submits, figuratively speaking, to principle of Pareto. Elements of any system, entering interaction and being somehow ordered, form the organization which level is characterized by an order and chaos ratio, or entropy. If all events or system elements are distributed equiprobably or homogeneously it is unstructured and chaotic, and entropy is maximum ( $H_{max}$ ). The most real from structure-stochastic and is functional-reproductive positions is the condition combining chaos and an order. In this condition real entropy  $H$  characterizes, as it is accepted to speak, a disorder measure, or system randomnesses, and ( $H_{max} - H$ ) – degree of its structural organization.

And, in regional system the culture plays an antientropy role. The treatment of culture as complex of the antientropic mechanism focuses attention on primary discrepancy of social-natural and intrasocial relations, and also on phenomena of nonlinearity following from here, bifurcation phases and evolutionary accidents. As stabilization of a nonequilibrium condition is possible only for the account of growth of entropy and in other systems, existence of a social organism is interfaced to inevitable destructions of environment and with anthropogenous crises. The last penetrates history of almost any culture and extremely become aggravated, when monotonous strengthening antientropic mechanisms does them too cost-based, i.e. destructive for environment. Here it is useful to specify in one more general system appropriateness opened within the limits of the theory of self-organizing and having essentially great value for understanding of essence of the put problem. Analyzing dynamics of organizational connections in complex developing systems, Russian scientist E. Sedov had proved, that effective growth of a variety at top level of structural hierarchy is always

paid by restriction of a variety at the previous levels and on the contrary – variety growth at the lowest level turns around destruction of highest levels. As the told concerns systems of any type the law of hierarchical indemnifications (Sedov law) gets general scientific value and with solving image supplements the law of a necessary variety formulated by Ashby in the fifties (Sedov, 1993). Today it is impossible to discuss seriously prospects and strategy of development of regional systems, ignoring interpretation of this not trivial dependence: a payment for growth of a cultural variety biodiversity reduction, homogenization of mental structures etc. will be obligatory.

If, considering the aforesaid, to enter relation  $k = \Psi^{-1}$ ,  $\Psi = (H_{\max} - H)/H_{\max}$  (where  $\Psi$  – generalized characteristic of a ratio «stability-variability» of system,  $H$  – entropy of system), then with  $H = 0$   $\Psi = 1$ , that corresponds completely to reproductive system which repeats itself, i.e., is absolutely steady. If  $H = H_{\max}$   $\Psi = 0$ , hence  $k \rightarrow \pm \infty$ , i.e. system is completely unsteady, its each new condition is distinct from the previous. Thus the direction of changes characterizes or system growth (strong self-sufficiency), or its disintegration, degradation (weak self-sufficiency). If to consider regional system – harmonious, and taking into account that in harmonious system the order should prevail and operate by Sedov law there should be close to «gold distribution» a measure of structural organization, i.e. such ratio in system of chaos and an order which finds reflexion in corresponding «gold» value of relative entropy  $H_{\text{opt}} = H/H_{\max} = 0,382$ . The intuition prompts, that in this case theoretically  $k = 1,618$ .

Leaning against concept «SCR», we will consider behaviour of the regional (closed) socially-natural system in which consumption of natural and social resources does not put a damage, both to environment, and the society. That is connection between quantity  $a_i^n$  natural and  $b_i^n$  social resources accessible to consumption

by separate social structure (i), and present quantity of the material and spiritual blessings  $w$  in socially-natural system in whole ( $\sum_j x_j^n + w_{\square}^n$ ) is expressed by an inequality:

$$a_i^n + b_i^n \leq F\left(\sum x_j^n + w_{\Sigma}^n, a_j^n + b_j^n\right)$$

Differently, when one of structures consumes certain quantity of resources, the quantity of resources accessible to other members of a society does not decrease (or is «instantly restored»), thus the balance natural-technological is not broken. Naturally, most ideal kind of inexhaustible resources of collective and individual consumption is the information: inventions, literary works, audio- and videorecordings, computer programs, etc., concerning other resources about it it is possible to dream only. Nevertheless, this inequality is fair if to consider absolutely small time intervals of evolution of system, i.e. a discrete spectrum of conditions, when  $\Delta t \rightarrow 0$ . Then, having extrapolated M.Waldrop's equation (Waldrop, 1993: 118-122) with reference to a problem considered by us, the complex self-sufficient system can be described the following optimizing problem of reception «Pareto – optimum point» in which corresponding Lagrangian looks like:

$$L(a, b, x, y, g) = (\sum f_i(y_i) + \sum F_i(g_i) + \sum r_i(x_i) + \sum w_{\Sigma}^n + S\partial(\sum a_i^n + b_i^n) - \sum (a_j^n + b_j^n)),$$

Where  $y$  – criterion function of behaviour of subjects,  $g$  – function of management by society, and  $k$  in case of absolute stability it is equal to unit. To deduce the differential characteristic of any point of an optimum, conditions (mathematical) differentiability of all functions and non-negativeness of a gradient, and also Kun-Takker balance theorem are used. The differential characteristic of balance will look like:

$$\partial y_i(a_i + b_i) / \partial y_i^n(a_i + b_i) = -(x_i y_i / g(t)) / s$$

in other words, if differential characteristics of an optimum and balance coincide, that, probably, to pick up parameters  $\mathbf{y}, \mathbf{g}, \mathbf{s}$  a Lagrangian such, that at the moment of time  $\mathbf{t}$  Lagrangian reaches an unconditional extremum  $\int \mathbf{L}(\mathbf{a}, \mathbf{b}, \mathbf{x}, \mathbf{y}, \mathbf{g}) \delta \mathbf{t} = \mathbf{0}$ , that is the necessary condition of a conditional extremum of a problem is satisfied:

$$da^n(t) / dt = s(\sum_i x_i^n(t) - y^n(t))$$

$$db_i(t) / dt = s(x_i(t) - y(t)), \quad g(t) \equiv \sum_i y_i(t).$$

In the simplified kind, the consensus, in sense  $y_i \equiv \partial F / \partial g_i$  – also is an optimality sign i.e. if «good and wise» legislators a priori establish «correct management», corresponding to criterion functions of subjects of society, and in turn the behaviour of subjects will correspond to presence of natural and social resources it means a situation of self-sufficiency of system.

Certainly, «Pareto – optimality» of equilibrium socialnatural systems – is an idealized case. This equation, will have theoretical character until corresponding variation principles of self-organizing of open systems will be found. Despite seeming complexity, this problem, nevertheless, should have, the decision. The matter is that in this case the open system receives energy and somehow it will transform so, that in the environment there are new structures (social, natural), that corresponds to such mathematical images as whirlwinds, funnels, helicoid waves, periodic structures, etc., and in many cases is described by the known equations of self-organizing. However in anthroposocial systems the problem becomes complicated whereas along with power component, similar systems receive also information, and the optimization problem, in this case, becomes complicated also that is

necessary to consider influence of last, both on an individual, and on all social group. Nevertheless, a problem of self-organizing which, finally can be shown to some variation, by means of introduction of factor of self-sufficiency and, the so-called basic equation of the theory of the self-organizing, used in many sections of physics, chemistry, biology, population dynamics, etc.:

$$\frac{\partial u}{\partial t} = \sum_i a_i(u, x_j) \frac{\partial u}{\partial x_i} + F(t, x_j, u)$$

(Where  $u$  – required function;  $t, x_j$  – independent variables) empirically still should have the decision.

Such is paradox of self-sufficiency: in a condition of itself acme the self-sufficient system cannot be improved on one significant parameter without deterioration of other parameters. For overcoming of such stability of the systems which have reached of the peak of stabilization, it is necessary to address to use of possibilities of other wider territorial formations, i.e. to metasytems with their metahypersystemic possibilities. But it is conversation special though it is in advance possible to tell, that such conversation assumes use of language of synergetics which, as is known, is not only the self-organizing theory, but also the theory of joint action of many systems, including hierarchical and heterarchical relations between them.

The aforesaid allows to well-founded believe, that the modern science should «operate» to be guided by search and allocation in functioning and development of regional systems of the main things, leading variables, some kind of parameters of hyperquasicyclic self-sufficiency – Self-Contained MultiRegion (SCMR) to which all other degrees of freedom SCR of separate region are arranged. Corresponding influence on these parameters, urged to provide adequacy of behaviour of operated systems to administrative efforts of subjects.



### Resume

In the conditions of uncertainty informative efficiency synergy-homeostatic the approach to the decision of problems of a sustainable development is obvious: the operationally-quantitative description of process of a sustainable development demands enough the strict determined language, both in respect of the description of occurrence new, and in respect of the description of deduction and preservation of the reached positive.

Rather «stability of development» of regional systems we can tell, that homeostatic adequately reflects its convergent phase, and the synergetics, accordingly, a divergent phase. And, these two phases of self-organizing of region alternate also each of them prepares conditions for another. Therefore the unity of synergetics and homeostatics harmoniously

combines informative potential of the concept of a sustainable development, allowing to consider synergetics as sustainable development strategy, and homeostatics – as tactics. Moreover, synergy approach gives an evident substantiation of bifurcational development, and, in turn, supplementing it homeostatic approach allows to reveal interrelation of recurrence, channeling development of region with its such intrinsic characteristic as self-sufficiency.

Thus, the basic result of conceptual transformation of the decision of a problem of the safe sustainable development is represented, that, caused by penetration of synergy-homeostatic ideas of a postnonclassical science in social outlook is a conviction that the future is unequivocally not programmed, over it it is necessary to work both theoretically and practically both in global, and in regional aspect.

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## **Проблема устойчивого развития региональных систем в свете постнеклассической науки**

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*В статье рассматривается проблема устойчивого развития региональных систем с точки зрения синерго-гомеостатического подхода, обосновывается понятие «самодостаточности развития региона», предлагается сценарная модель эволюции сложной социоприродной системы. В контексте нового типа реальности – реальности глобальной регионализации устойчивость развития обосновывается как самодостаточность развития сложной открытой социоприродной системы на уровне региона. Авторы приходят к выводу, что гомеостатика адекватно отражает конвергентную фазу устойчивого развития региональных систем, а синергетика, соответственно, дивергентную фазу.*

*Ключевые слова: глобализация; регионализация; устойчивость; безопасность; самодостаточность; синерго-гомеостатика.*

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