Branched chain reactions in social systems

Petukhov Alexander Yur'evich [1]

[1.] NI Lobachevsky Nizhny Novgorod State University, Nizhniy Novgorod, Gagarin Avenue, 23, 603950, Russia
Lectorr@yandex.ru

Abstract: This article is devoted to the modeling of chain reactions, as one of the variants of threshold effects in social systems. The social-energy approach and mathematical tools of branched chain reactions in chemistry are used to create the mathematical model. Internal processes in the social system are considered Wiener processes.
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1. Introduction

Physicists, chemists and representatives of some other natural sciences understand well the meaning of the term chain reaction. However, long enough it is also used relating to community. It is possible to hear about chain reactions from journalists, as well as from sociologists, economists, politics and many others. It is, nevertheless, difficult to find in open scientific literature direct scientific evidence of this effect in community and conditions of its emergence. Most probably, it is connected with the complexity of determination of the social environment parameters, their assignment in principle, because the analogies from the natural sciences use generally accurate figures. In fact, the very meaning of this effect is in the determinacy of parameters and accuracy of their determination. It is impossible to speak without it about the opportunity of prediction such processes and studying conditions of emergence. However, social processes cannot be exactly determined. Parameters that are assigned to a social system are usually sufficient artificial, and by definition, cannot be precise. So how do we use them to determine the effect, for which the slightest fluctuations of its main characteristics can lead to a qualitative change in the state system? In order to cut this Gordian knot, you need to change the approach to the social system and to abandon attempts to assign her own parameters of specialty, trying to determine the status of the given system. On the contrary, we must refer to the parameters indirectly, or distributed across individuals. Indeed, to find out whether there will be a chain reaction in a piece of pure uranium, you're not going to do a risky experiment and try to measure the density of the neutron flux inside him. You will take into consideration the weight and pressure of the environment. After these changes, you will be able to give an exact answer about the possibility or impossibility of a chain reaction. Thus, we did not examine the state of the system directly, but above all the conditions affecting it. Of course, this only makes sense when it is easier to define these terms, rather than the system state. We also should mention that, in general, it is more difficult with the social system than with uranium, because neutrons, unlike humans, do not have free will and the ability to make their own decisions. However, it is possible to take into account mathematically using stochastic equations [1-3], which are able to take into account the fluctuations of the social system with some assumptions.

Overall, what do we offer? What indirect parameters did we talk about?

Our proposed socio-energy approach describes social systems and processes. It is a scalable logical-mathematical tool that combines several different methods. Basically it has a social assessment of the system with the help of specially introduced term of the - "social energy" or Esoc (further simply E) [2-3]. Here, a quantity characterizing the potential of the social system to do the work is meant under this concept. This value is a little bit similar to the energy in its physical meaning, but it gives us a certain freedom in the interpretation of another "unused energy". Consequently it is the imperfect work in the valuation of possible energy of human work, not yet extracted resources, etc. This moment is very important for building the model; because it is necessary for the valuation of the social system to take into account all the factors that can influence it. For example, human work is often the determine parameter in the system and at the same time it is very hard classified in terms of the standard physical concepts.

This parameter allows you to represent intra- and extra-systemic processes such as change or redistribution of energy inside the system and between systems. Also, the same basic principles of systematic approach are used.

Internal processes in the social system are considered Wiener processes. Wiener process - in the

theory of stochastic processes - is a mathematical model of Brownian motion (it is described by the Langevin equation) or a random walk in continuous time [1].

In detail about the "socio-energy approach", its mathematical apparatus, nuances and s.o. – [2-3, 5-6].

2. Branched chain reaction

As noted physicists, chemists know very well about chain reactions, prediction of them and, managing them. They created several models and theories for a number of phenomena. Significant interest to our study is the so-called «branched chain reaction».

In chemistry, a chain reaction, in which, besides the reactions of initiation, propagation terminate chain reactions of chain branching. In one branching reaction active site generates the appearance of two or more active centers (atoms, radicals). Examples of branched chain reactions are hydrogen combustion, oxidation of carbon monoxide, the combustion fumes phosphorus decay NSl3 [8].

Branched chain reactions have a number of significant differences from the non-branched chain. The mechanism of these reactions has been opened NN S. Semenov and Hinshelwood (as well as their team) in the years 1925-28. By studying the conditions of ignition of vapors of phosphorus, N. Semenov, Y.B. Chariton and Z.F. Jacks found that the transition from no response to a flash vapor occurs at a strictly definite pressure of oxygen, which depends on the diameter of the vessel. In 1928, Semenov proposed mechanism of branched chain process involving oxygen atoms [9].

Radical chain reaction occurs if the conversion of the reactants takes place through the active intermediate particles - atoms and radicals, and reactions involving them form a vicious cycle of transformations and the continuation of the chain is faster than an open. It is a branched chain reaction, if it takes such a stage in which one atom or radical generates the formation of several atoms and radicals. As a result, a favorable condition for the reaction increases the concentration of active centers and, accordingly, increases the reaction rate. This often results in a fire or explosion. If the branching takes place by the interaction of an atom (radical) to the molecule, by virtue of the conservation of an odd number of electrons in radical reactions in a system of a single appear 3 having an unpaired electron (in general 2n + 1).

An important feature of the kinetic branched chain reactions, which distinguishes them from other reactions, including chain is critical or marginal phenomenon. For systems that turn on the mechanism of branched chain reactions, the presence of conditions where the reaction occurs rapidly, often with a bang is characteristic.

Acts of branching allow the progressive increase in the concentration of active centers in time. In the situation of breakage and branching chains by reacting 1th order specific velocities and g f, respectively, the rate of change of concentration of active centers n is described by the equation [8]:

$$dn/dt = v_i-(g-f)n \quad (1)$$

There are two fundamentally different modes of reaction. Quasi-steady state, when g>f, breakage predominates over branching, then

$$n = v_i/(g-f) = const \text{ since } t > (g-f)^{-1} \quad (2)$$

and unsteady when f>g, t. branch is dominant. In this case, the concentration of active centers continuously increases over time, and if we do not take into accounts the consumption of reagents and the time variation of the v_i, g and f, then

$$n = v_i (f-g)^{-1}(e^{(f-g)t}-1) \quad (3)$$

A critical condition for the transition from one state to another is the equality f = g. Thus, the chain reaction, branching occurs as a self-accelerating process only when the active sites quickly come to the acts of branching than in the Acts of the cliff. [8]

Here it becomes clear why branched chain reaction selected as an analog flow limiting phenomena in the social and political processes. Indeed the generation of active sites in a chemical reaction is remarkably similar to the process of generating centers of activity in the riots, revolutions, even in the information war of protracted type. But also there are many differences. Firstly, they apply to the model parameters. The individuals and groups of individuals need to be described wider than the free radicals and molecules. Their capabilities are broader exposure scenarios and interaction.

So, we will make a small model of the distribution of information "virus - ideas" in the social and physical space. We assume that this information virus is active, efficient and is able to hit the cognitive individual installation for the next subsequent infection quickly.

Then:

N – the number of the "virus" carriers

G – the rate of informational circuit termination

F – branching rate of information flow in environment

V_t – the rate of individuals infection contamination

The external form of the equation does not change:

$$\frac{dN}{dt} = V_t - (G - F)N \qquad (4)$$

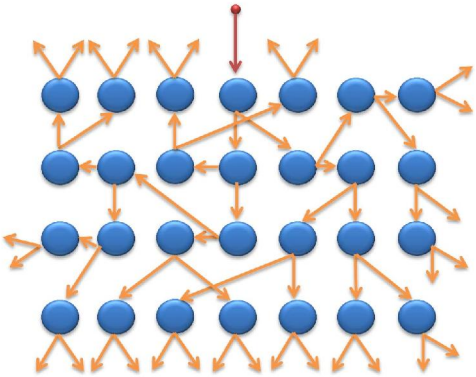

Fig. 1 Branched chain reaction branching parameter $\upsilon = 2$.

However, its parameters change significantly.

$$G = f(K_s, K_{sci}, I_p, S_p, X_{out})$$

$$F = f(K^N{}_s, K^N{}_{sci}, I_p, S_p, X_{out}) \quad (5)$$

Где

K_s, K_{sci} – factors of social activity and scientific potential, respectively, for uninfected individuals or groups of individuals

$K^N{}_s, K^N{}_{sci}$ - factors of social activity and scientific potential, respectively, for infected individuals or groups of individuals (active sites)

I_p – Information permeability of the social system

S_p - Social permeability of this social system

X_{out} – function that defines an information virus and related external influence on the social system (it can almost not be).

Thus, it is important to note that unlike chemistry information virus can theoretically be transmitted with one center unlimited number of other individuals. In practice, of course, this does not happen, because the amount of people, which are known by the majority of individuals, is very limited, so it is possible to use the average parameters.

For example, if the branch $\upsilon = 2$, it looks like Fig. 1.

It is clear that this is a simplified model. To reduce the work of the information war facilities to the "infected" or "not infected" certain "virus" would be too easy. However it is known that the basic human emotions spread similar scheme, for example, epidemiological spread panic in the crowd [10-11].

For further work with the equation (3) that define several of its parameters. First of all, needs to define the mechanism of threshold effect and its differences from its chemical equivalent. Initiation of branched chain reactions occur, for example due to the limiting pressure p1 <p <p2. There is also an analogue of the pressure in the social environment:

P_{so} – social pressure arising from the difference of the coefficients and social energy between individuals or sub-systems of individuals within their communication fields.

The pressure can be easily determined through the energy:

$$P_{so} = \frac{2}{3} n < E_{in} > \qquad (6)$$

Were

n – the number of individuals

$E_{in} = \Psi E_{total}$ – interaction energy, that energy that an individual or sub-system can be directed to the interaction with other individuals or subsystems. Obviously, it cannot be greater than the total social energy of the individual.

Ψ - energy transfer coefficient

$$\Psi^i = K_s^i K_{so}^i \qquad (7)$$

Thus, for each individual i is true:

$$E^i{}_{in} = \Psi^i E^i{}_{total} \qquad (8)$$

Since the energy dissipation in the social - physical space is not, you can consider this system as Hamiltonian:

$$E^i{}_{in} = \Psi^i H^i \qquad (9)$$

H^i – Hamiltonian of the individual or individual's subsystem. Then we can write the first canonical Hamiltonian equation:

$$\frac{d}{dt} p^{ij}{}_{so} = \Psi^i E^i{}_{total} - \Psi^j E^j{}_{total} = \Delta(\Psi^{ij} E^{ij}{}_{total}) \qquad (10)$$

Hence

$$\frac{d}{dt} p^{ij}{}_{so} = \Delta E^{ij}{}_{in} \qquad (11)$$

This leads us to

$$\frac{d}{dt}P^{(j)}{}_{so} = \Delta(\Psi^{(j)}H^{(j)}) \qquad (12)$$

That is the fundamental equation to describe the social pressures of society's interactions between individuals and subsystems individuals.

3. Conclusion

Thus, in this paper we have proposed a mathematical model by which the author intends to further develop an approach to model and study the threshold effects. Using proven approaches of scientific disciplines in the humanities applications seems promising. Indeed, the generality of the laws of nature extends to its integral part - human, albeit often we forget about it.

Simulation of a number of social and political processes through the mechanism of generation and flow of branched chain reactions - can be an effective way for forecasting such processes.

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Corresponding Author:
Dr. Alexander Petukhov Y.
Institute for Global social political processes,
NI Lobachevsky Nizhny Novgorod State University
Russia, Nizhniy Novgorod, Gagarin Avenue, 23, 603950
Lectorr@yandex.ru

References

1. A. Guts, V. Korobitsyn etc. Mathematical models of social systems. Tutorial. - Omsk Omsk State. The University, 2000.
2. A. Petukhov. Modeling manipulation consciousness of the masses in the political process through the communication field. Bulletin of the Nizhny Novgorod State University (transliteration - Vestnik Nigegorodskogo Gosudarstvennogo Universiteta). NI Lobachevsky Nizhny Novgorod, 2011, No. 6. p. 326-331.
3. Petukhov A. 2014. Threshold effects in the social and political processes. Social-energy approach. World Applied Sciences Journal, Volume 30 (10), p. 1340-1345 DOI: 10.5829/idosi.wasj.2014.30.10.14147.
4. V. Volkov, A. Denisov. Basics of systems theory and systems analysis. St. Petersburg. : Print. SPbGTU, 1997. 510.
5. A. Petukhov. Modeling of social and political processes in the conditions of information warfare. Socio-energy approach. Fractal Simulation, T. n.1, 2012, p. 16-32.
6. A. Petukhov, N. Chuprakova. Modeling of socio-political development of Russia in the 20-21 century. Socio-energy approach. Bulletin of the Nizhny Novgorod State University University (transliteration - Vestnik Nigegorodskogo Gosudarstvennogo Universiteta). NI Lobachevsky Nizhny Novgorod, Issue 6, 2012, 289-293.
7. J.A. Holyst, K. Kasperski, F. Schweitger Phase transitions in social impact models of opinion formation. Physica. 2000 v.A285. p. 199-210.
8. E. Denisov, A. Sarkisov, H. Lichtenstein, Chemical Kinetics, Chemistry, Moscow, 2000
9. N. Semenov, Chain Reactions, Nauka, Moscow, 1986.
10. N. Lepeshkin Psychological foundations of terrorism and counter-terrorism in modern conditions: Textbook. N. Lepeshkin, V. Vasilin, A. Obirin, V. Talynev, ed. prof. I. Yarulin. - Khabarovsk Khabarovsk Border Institute of the Federal Security Service of the Russian Federation, 2008.
11. Nyustrom J., K. Davies Organizational Behavior. Publisher Peter -South Year: 2000 Pages: 448.
12. Trushnikov, D., Belenkiy, V., Shchavlev, V., Piskunov, A., Abdullin, A., & Mladenov, G. (2012). Plasma Charge Current for Controlling and Monitoring Electron Beam Welding with Beam Oscillation. Sensors, 12(12), 17433-17445.

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