The principle of continuity, longevity and perpetuation of the life of human systems as a basis for the mathematical theory of human behavior and activity:

Part 2. Change management in light of the principle of continuity, longevity and perpetuation of human life[1]

Pavel Barseghyan, PhD

Abstract

The transformation of the principle of continuity, longevity and perpetuation of human life into a mathematical description of the behavior and activity of human systems of fundamental nature in the form of equations of state opens up serious prospects for the further development of the field of sociodynamics.

For this purpose, further substantiation of the method of equations of state of life and activity of people is necessary, as well as the expansion of the field of their applications for solving urgent problems of organizational science.

In this sense, it is very important to consider the course of human life as a stream of changes within the framework of the principle of continuity, longevity and perpetuation of human life, with the goal of conceptually and mathematically linking this principle with the methodology of change management.

This approach makes it possible to reconsider a number of fundamental problems in the field of change management, including the mathematical problems of change analysis and synthesis.

The second part of the work is devoted to further substantiation of the method of equations of state of human systems and the applications of this method in the field of change management.

Introduction

[1] How to cite this paper: Barseghyan, P. (2020). The principle of continuity, longevity and perpetuation of the life of human systems as a basis for the mathematical theory of human behavior and activity: Part 2. Change management in light of the principle of continuity, longevity and perpetuation of human life; *PM World Journal*, Vol. X, Issue I, January.

In order to reliably ensure the continuity, longevity and perpetuation of people's life, it is necessary to know the basic laws of their behavior and activity in various modes and states of life.

In the first part of the work, the following steps and conclusions were made in order to achieve this goal [1].

The first step in the process of mathematical modeling of human activity is to clarify the concept of the state of human systems and its quantitative representation by parametric means.

The second step is to concretize the meaning of the principle of continuity, longevity and perpetuation of human life during the implementation of human actions and activities.

To this end, two main ideas are put forward:

1. The requirements or demand that puts life in front of people at every step, which aims to ensure the continuity, longevity and perpetuation of life.
2. People's suggestion for fulfilling the demand of life, based on their capabilities in the form of experience, resources, knowledge and skills.

The balance or imbalance between the requirements of life and the proposals of people for their implementation, as well as quantitative interpretations of these requirements and proposals, allow us to find mathematical equivalents of the principle of continuity, longevity and perpetuation of life in the form of mathematical equations and inequalities.

In general, it is clear that in order to navigate the extremely complex labyrinth of life of people and human systems using scientifically grounded methods, it is extremely important to represent human activity by powerful quantitative methods, which one way or another leads to a mathematical description of the state of these systems in space and time.

In classical quantitative sciences, state equations have long been used to mathematically describe the state of systems, reflecting the static and dynamic modes of behavior of the multiparametric objects in question.

As a rule, in these sciences, the static behavior of the studied objects is quantitatively represented by algebraic equations of state, and dynamic behavior - by differential equations [2,3,4,5,6].

In this sense, the life, behavior and activity of human systems are not unique, since they are also multi-parameteric systems that can be in a variety of static and dynamic modes and states.

This, in turn, means that, from a conceptual point of view, the mathematical description of the life, behavior and activity of human systems should not essentially differ from the mathematical approaches used for the same purposes in physics, economics and biology.

The fact that equations of state are the core of these approaches, whether they represent static or dynamic states of systems, shows that, in the case of human systems, equation-of-state approaches must also play an important central role.

In this regard, it is important to further substantiate the equations of state of human systems, which will be discussed below.

In addition, to further expand the field of application of the method of equations of state, it is necessary, within the framework of this method, to study the flows of various changes that always accompany people's lives [7].

Conceptually, the goal of research in this area is to first quantitatively describe changes in people's lives within the framework of the method of equations of state, and then use them for change management purposes.

With regard to the area of change management, it should be clearly divided into two complementary and mutually agreed parts, namely analysis of changes and synthesis of changes, issues that will also be discussed in this paper.

Obtaining the equations of state of human systems based on the balance of human efforts

Quantitative descriptions of the behavior and activity of human systems by the method of equations of state are based on the conditions of balance or imbalance between the requirements of life and the abilities of people who fulfill them.

This balance and imbalance can be quantified using a variety of parametric means, including parametric representations of the complexity of human activity, parametric representations of human effort, and parametric representations of human physical energy or the equivalent energy of their social activity [1].

Let us consider a simple example of the activity of people associated with the condition of the balance of their efforts, when a joint group of N people, during the period T working with productivity P, carry out activities of volume or complexity C_D.

In this example, we are dealing with two definitions of human effort.

The first is the effort E_D required to perform an activity of complexity C_D with a performance P, which will be determined by the following ratio:

$$E_D = \frac{C_D}{P} \ . \qquad (1)$$

The second is the effort E_S, which is defined as the product of the number of people N and the time interval T.

$$E_S = N * T \qquad (2)$$

If these two efforts are equal, which means that people can make as much effort as is required to successfully overcome the volume or complexity of the activity C_D, then by combining expressions (1) և (2), one can obtain the required equation of state

$$N * T = \frac{C_D}{P} \qquad (3)$$

Taking into account that the complexity of C_D is defined as the product of the magnitude W of human activity by its difficulty or specific complexity D, that is, $C_D = W * D$, the equation of state (3) will look like this:

$$N * T * P = W * D \qquad (4)$$

This equation contains many functional relationships between parameters representing

Functional relationships contained in state equations

The principle of continuity, longevity and perpetuation of life and its direct consequences in the form of equations of state that combine various resources necessary for the functioning of human systems, human qualities and abilities, as well as the results of human activities, contain nonlinear functional relationships that objectively exist between the system level parameters of human activities [1,7,8].

This circumstance speaks in favor of the fact that the principle of continuity, longevity and perpetuation of life can indeed be a reliable basis for building an adequate mathematical theory of human behavior and activity.

Another important fact of the applicability of the same principle is that any phenomena or processes that occur in the life of people and human systems are qualitatively compatible with this principle and can be explained by a person's striving for the continuity, longevity and perpetuation of life.

Parametrization of this principle, in turn, leads to the fact that the phenomena and processes associated with human behavior and activities receive their adequate quantitative reflection.

To illustrate the above, consider the following equation of state, which quantitatively represents human activity [1]

$$N * T * M * P_{Max} = (W - W_0) * D. \qquad (5)$$

This equation is a reflection of the balance that ensures the continuity of life due to the balance between the complexity of the next life requirement $C_D = (W - W_0) * D$ and the complexity of $C_S = N * T * M * P_{Max}$ activities of a group of N people.

Here, the value W is the size of human activity, which is reduced by the value W_0, which is a ready-made reusable piece from previous human experience. The value D is the average degree of difficulty of actions performed by a person, or a measure of the complexity of the unit of activity W.

As for the components of complexity C_S, the value T is the period during which N people act together, M is the motivation of people ($0 \leq M \leq 1$), and P_{Max} is the maximum efficiency of human activity in ideal conditions, or their group productivity in working process.

The equation of state of the human system (5) contains many nonlinear functional relationships between the specified parameters of the system, which are essentially analogous to isobars, isochores and isotherms contained in the equation of state of ideal gases of classical physics [2,5,6].

The easiest way to show these functional relationships, as is done in physics, is to treat the parameters in pairs as variables and keep the values of the other parameters constant, thus obtaining a functional relationship between the two selected parameters, which are considered variables.

In order to obtain the above functional relationships, one can transform the equation of state (5), taking into account that the value $N * M * P_{Max}$ is the acting power H of a group of people, and the difference $W - W_0$ is the actual size W_{Real} of the activity that is needed overcome.

$$T * H = W_{Real} * D. \qquad (6)$$

Considering that the ratio W_{Real} / T is the average speed V of the human system's activity, one can obtain a functional relationship between the acting power H of the human system, the speed V of its activity and the degree of difficulty or specific complexity D which is overcome in the process of activity.

$$H = V * D. \qquad (7)$$

The resulting equation of state may have different semantic contents, the first of which is that in the case of constant acting power H of the human system, there is a hyperbolic relationship between the speed of human activity V and the difficulties D encountered in this process (Fig. 1).

Continuing the analysis, from equation (7) one can obtain a simple and obvious, but very important expression of the fundamental nature for a quantitative description of the speed of human activity.

$$V = \frac{\mathbf{H}}{\mathbf{D}}, \qquad (8)$$

A number of obvious statements can be made from this simple formula.

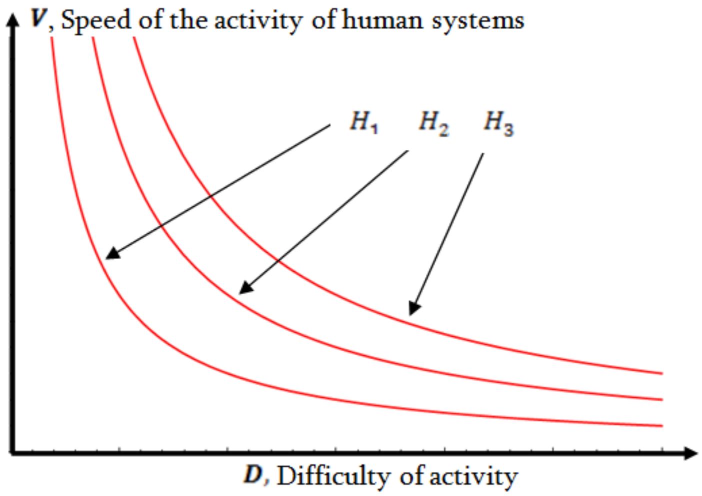


Fig. 1 In the case of fixed actioning powers of human systems H_1, H_2 and H_3 ($H_1 < H_2 < H_3$), the speed V of human activity is hyperbolically related to the specific complexity D of their activity.

1. If we are dealing with constant difficulty or specific complexity of activity D, then there is a linear relationship between the power H of the human system and the speed V of its activity.
2. If the difficulty D of human activity changes in order to keep the speed V of the human system's activity constant, its power H must be changed accordingly either by changing the number of people, or by changing the efficiency of their activities by choosing people or changing tools.

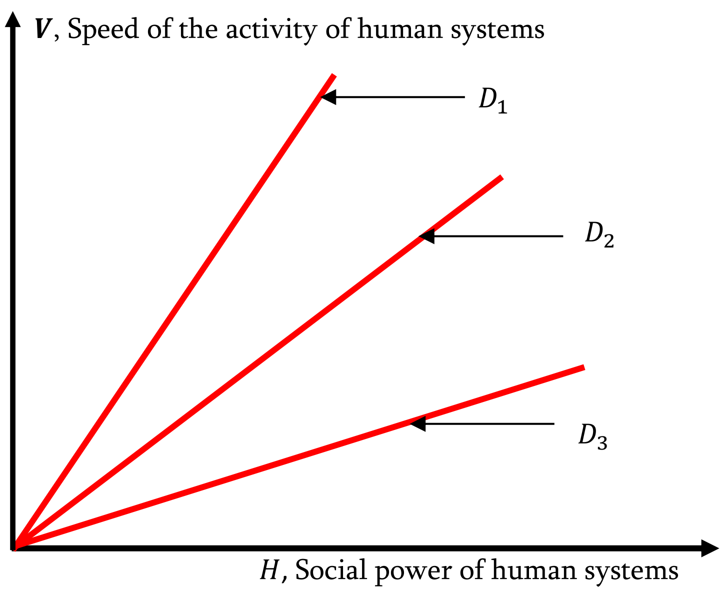


Fig. 2 Relationship between social power of human systems and the speed of their activity with three constant values of the difficulty of activities $(D_1 < D_2 < D_3)$

The conclusions made on the basis of the results obtained, which on the one hand are obvious, and on the other hand do not contradict the logic of life, thereby show that, firstly, the equations of the state of human system are adequate, and, secondly, the principle of continuity, longevity and perpetuation of life on the basis of which the equations of state were obtained itself is adequate and viable.

The adequacy of these simple and obvious conclusions is important primarily because the equations of state that underlie them can also be used for making decisions in such critical circumstances when, due to the complexity of the situation, the decisions are not obvious and unambiguous.

As for the equation of state (5), it is applicable to a quantitative representation of the activity of a human system of any size and does not contain any internal contradictions, because, indeed, any human system to successfully fulfill the demands of life with complexity $(W - W_0) * D$ balances this complexity with its skill $N * T * M * P_{Max}$.

When using this equation of state, it is also necessary to take into account the fact that an incorrect interpretation of the functional relationships contained in it can lead to logical contradictions and incorrect conclusions.

In particular, the interpretation of the functional relations between the members of this equation without taking into account the nonlinear interdependencies of all the members of the equation and the goals pursued by the human system can lead to errors.

For example, if we leave all the parameters in this equation constant, except for productivity P_{Max} and difficulty or specific complexity D, then it turns out that the effectiveness of human activity is directly proportional to the difficulty of its activity.

But this contradicts the facts, since it is well known that the effectiveness of P_{Max} of human activity tends to decrease with increasing difficulty D.

Quantitative interpretation and management of changes in the static mode of human activity: analysis and synthesis of changes

In an equilibrium or static mode, the life and activity of human systems also proceeds under conditions of constant changes, and in this sense, the static mode does not differ from the dynamic mode of human life.

The point here is that in a static mode the main parameters of human life do not depend on time or change very slowly, therefore, for some time intervals of life, they can be considered constant values.

For example, the parameter P_{Max}, which characterizes the efficiency of human activity, is a very slowly changing parameter over time, but in certain situations, the actual productivity P of a person can fluctuate dramatically due to changes in his motivation M or for other reasons.

In a broader sense, this problem leads to the analysis of the behavior of a multi-parameter system, including a human system, when the values of one or more of its parameters change for some reason [7,8].

The problems in this area and the specific tasks associated with them fall into two main groups:

Проблемы в этой области и связанные с ними конкретные задачи делятся на две основные группы:

1. Analysis and assessment of the impact of consequences of changes in the parameters included in the equation of state.
2. Evaluation or synthesis of the necessary changes in the parameters included in the equation of state to ensure a given change in the output parameter, which is an inverse problem with respect to the direct analysis problem.

To solve such problems, it is possible to use pairwise functional relationships of the parameters included in the equations of state, but not in the same way as it is done under the condition that the values of some of the parameters remain constant.

The fact is that many parameters of human systems, which are combined into the equation of state, are interconnected by clear functional relationships, which differ significantly from the functional relationships obtained through the conditions of constancy of other parameters.

Because of these relationships between parameters, a change in one or more of them leads to changes in the values of other parameters, which can be estimated using equations of state and additional conditions [7,8].

Thus, change management in the form of analysis and synthesis of the behavior and activities of human systems can be accomplished through equations of state, which in turn are the direct consequences of the continuity, longevity and perpetuation of life.

This means that the concept and methodology of change management are fully in line with the principle of continuity, longevity and perpetuation of life of human systems.

More in-depth representations of the problems posed in the present work can be found here [9].

Conclusions

1. Universal equations of state of the activity of human systems can be obtained on the basis of equilibrium conditions of a different nature, including the balance of complexities associated with the course of life, the balance of various human efforts, etc.

2. The functional relationships between the high-level parameters of human systems, based on the principle of continuity, longevity and perpetuation of human life, adequately reflect the realities of practical life, which indicates the accuracy and acceptability of this principle.

3. Equations of state contain many functional relationships between the characteristic parameters of human activity, which can be extracted from these equations by different methods.

4. A change in one or more of these parameters leads to nonlinear changes in other parameters, which can be estimated using the specified functional relationships.

5. This suggests that the method of equations of state can serve as a basis for analytical approaches to change management.

6. Moreover, using equations of state, the analysis and synthesis problems that arise in the field of change management can be posed anew.

7. In the case of analysis, it is the estimation of the effects of the changes made, and in the case of synthesis, it is the estimation of the magnitude of the changes in the parameters to ensure the magnitude of the given effects.

Continuation of work

The efficiency of life and activity of human systems, which is the productivity of people in normal working mode, depends on many biological and social factors.

To ensure the effectiveness of the activities of human groups at any level, they must have the necessary resource, information, organizational and other support, which, together with the level of professionalism of people, must become necessary components of the mathematical model of the effectiveness of the human system.

The third part of the paper will discuss the mathematical models of the efficiency of human systems and the equations of state associated with them.

References

1. Barseghyan, P. (2020). The principle of continuity, longevity and perpetuation of the life of human systems as a basis for the mathematical theory of human behavior and activity: Part 1. Quantitative interpretation of the principle of continuity, longevity and perpetuation of human life; *PM World Journal*, Vol. IX, Issue XII, December. https://pmworldlibrary.net/wp-content/uploads/2020/12/pmwj100-Dec2020-Barseghyan-Principle-of-Continuity-Part-1-quantitative-interpretation.pdf

2. Charles Kittel. (1969). **Thermal physics**, John Wiley & Sons, Inc.

3. J. D. Murray, (1993). **Mathematical Biology**, Springer.

4. A. Mas-Collel, M. D. Whinston, J. R. Green. (1995). **Microeconomic Theory**. Oxford University Press.

5. L. D. Landau, E. M. Lifshitz, (1980). **Statistical Physics**. Vol. 5 (3rd ed.). Butterworth-Heinemann.

6. Yu. L. Klimontovich, (1986). **Statistical Physics**. Taylor & Francis.

7. Barseghyan, P. (2009). **Principles of Top-Down Quantitative Analysis of Projects: Part 2 Analytical Derivation of Functional Relationships between Project Parameters without Project Data.** PM World Today – June 2009 (Vol XI, Issue VI). 16 pages. http://www.scribd.com/doc/113911821/Principles-of-Top-down-Quantitative-Analysis-of-Projects-Part-2-Analytical-Derivation-of-Functional-Relationships-Between-Project-Parameters-Without-P.

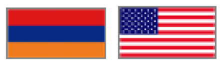
8. Barseghyan, P. (2013). "**Equilibrium and Extreme Principles in Discovering Unknown Relationships from Big Data: Part 2: Non-statistical Mathematical Methods in Project Management**" *PM World Journal Volume 3, Issue 1 January 2014* – 14 pages. http://pmworldjournal.net/wp-content/uploads/2014/01/pmwj18-jan2014-barseghyan-big-data-part2-non-statistical-mathematical-methods-FeaturedPaper.pdf.

9. **Pavel Barseghyan,** Articles and papers: https://pmworldlibrary.net/authors/dr-pavel-barseghyan/

About the Author

Pavel Barseghyan, PhD

Yerevan, Armenia
Plano, Texas, USA



Dr. Pavel Barseghyan is a consultant in the field of quantitative project management, project data mining and organizational science. Has over 45 years' experience in academia, the electronics industry, the EDA industry and Project Management Research and tools development. During the period of 1999-2010 he was the Vice President of Research for Numetrics Management Systems. Prior to joining Numetrics, Dr. Barseghyan worked as an R&D manager at Infinite Technology Corp. in Texas. He was also a founder and the president of an EDA start-up company, DAN Technologies, Ltd. that focused on high-level chip design planning and RTL structural floor planning technologies. Before joining ITC, Dr. Barseghyan was head of the Electronic Design and CAD department at the State Engineering University of Armenia, focusing on development of the Theory of Massively Interconnected Systems and its applications to electronic design. During the period of 1975-1990, he was also a member of the University Educational Policy Commission for Electronic Design and CAD Direction in the Higher Education Ministry of the former USSR. Earlier in his career he was a senior researcher in Yerevan Research and Development Institute of Mathematical Machines (Armenia). He is an author of nine monographs and textbooks and more than 100 scientific articles in the area of quantitative project management, mathematical theory of human work, electronic design and EDA methodologies, and tools development. More than 10 Ph.D. degrees have been awarded under his supervision. Dr. Barseghyan holds an MS in Electrical Engineering (1967) and Ph.D. (1972) and Doctor of Technical Sciences (1990) in Computer Engineering from Yerevan Polytechnic Institute (Armenia).

Pavel's publications can be found here: http://www.scribd.com/pbarseghyan and here: http://pavelbarseghyan.wordpress.com/. Pavel can be contacted at terbpl@gmail.com