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REVIEW ARTICLE

Ontology of functional synergetics in virtual cognitive-semiotic design of information processes and systems

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Abstract

Objectives. In view of the currently expanding practice of applying methods for configuring ontologies of designing information processes and systems, information technology (IT) specialists need to disclose the definition of such a new concept as functional synergetics. This concept is actualized by the course of development of virtual information technologies, forming the system foundation for methods of design ontologies and indicating attributes for the correct formation of design ontologies of relevant dynamic information processes and systems. In the present work, this is done by means of analytical review.

Methods. The analytical review is based on the authors' vision of deepening the concept of synergetics as applied to a variety of modern information processes and systems. This context concessionally conjugates the combined use and consideration of such approaches as the method of ontologies (the major component of the resulting concession of methods), methods of cognitive semiotics, autopoiesis, and other manifestations of synergetics with related methods and techniques of emergent evaluation of the role and effectiveness of any occurring systemic changes. It is this combined dynamics of information processes and systems that allows the authors to put forward a developing treatment of the methods of synergetics as functional.

Results. The concept of functional synergetics was clarified and deepened based on the method of ontologies. In the theory of information processes and systems, it is manifested in updating ontologies accompanying scientific and engineering projects that use synergetics as an initial methodological basis. It turns out that the functional features of synergetics in the context of assessments and functional ordering of modern IT devices give it new opportunities in highlighting the significant indicators of system changes: properties, attributes, and manifestations of functional-synergistic nature. It is these three concepts, revealed by synergetics as a functional eyepiece, that distinguish functional synergetics from the generally accepted definition of synergetics as such. Matching form to content, autopoiesis, development, and transformations occurring with informational processes and systems with their emergent consequences are the essence and feature of functional synergetics. Tracing what is happening in dynamics, in the inseparability of assessments and regulations of the set of properties, attributes, and manifestations of the analyzed processes to an even greater extent clarifies the essence and role of the concept introduced by the authors in the general classical theory of information processes and systems. In the related analysis, virtual reality, augmented reality, mixed reality, expanded reality, composite reality, coupled reality, geoinformation systems, multidimensional computer graphics, fractal graphics, holographic graphics, computer teletype games, X-reality, etc., which have essential dynamic characteristics and properties, are included here as objects of research and design.

Conclusions. Improvement of the theory and practice of creating and using information processes and systems from the position of recognizingthe accelerating speed and dynamics of how their properties and indicators are modified leads the synergistic methodology of assessments and control mechanisms to the emergence of a clarifying concept of functional synergy. This is a complex and dynamic concept, which includes its interpretation of the positions of

classical synergetics and related paradigms of cognitive semiotics, etc. The method of ontologies, which is gaining more and more popularity, is the main means and tool of such unification. When combined with cognitive semiotics, functional synergetics becomes a powerful science-intensive tool for further development of the theory and practice of modern multimedia intensified information systems and their information fields described by both imperative and convivial paradigms.

Keywords: functional synergetics, spatial synergetics, confluence, emergence, autopoiesis

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ОБЗОРНАЯ СТАТЬЯ

Онтология функциональной синергетики в виртуальном когнитивно-семиотическом конструировании информационных процессов и систем

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Резюме

Цель. В связи с расширением в настоящее время практики применения методов онтологий проектирования информационных процессов и систем в кругу специалистов ИТ обозначилась потребность в том, чтобы дать и раскрыть определение такого нового, актуализированного самим ходом развития виртуальных информационных технологий понятия, как функциональная синергетика, образующего системные начала методов онтологий проектирования, обозначив в результате этого ее признаки для корректного формирования онтологий проектирования соответствующих динамичных информационных процессов и систем.

Методы. Аналитический обзор строится на обозначении авторского видения углубления синергетики как синергетики функциональной в применении к разнообразию современных информационных процессов и систем. В указанном контексте концессионно сопрягается совокупное использование и рассмотрение таких методов, как метод онтологий (генералитетная составляющая образуемой концессии методов), методы когнитивной семиотики, аутопоэзис и иные проявления синергетики со связанными с ними методами и методиками эмерджентной оценочности роли и эффективности любых происходящих системных изменений. Именно такая совокупная динамика информационных процессов и систем позволяет авторам выдвинуть развивающую трактовку методов синергетики, как синергетики функциональной.

Результаты. Уточняется и углубляется понятийная сторона нововведения – функциональной синергетики (с опорой на метод онтологий) – в теорию информационных процессов и систем, что проявляется обновлением онтологий, сопровождающих научные и инженерные проекты, использующие синергетику

как исходный методологический базис. При этом выясняется, что функциональные черты синергетики в контексте оценок и упорядочения функционала современных устройств информационных технологий придают ей новые возможности в выделении значимых показателей системных изменений: свойств, признаков и проявлений функционально-синергетического характера. Именно эти три понятия, раскрываемые синергетикой как функциональным окуляром, отличают функциональную синергетику от общепринятого определения синергетики как таковой. Соответствие формы содержанию, аутопоэзис, развитие и преобразования, происходящие с информационными процессами и системами с их эмерджентными последствиями, являются сутью и особенностью синергетики, трактуемой как синергетика функциональная. Прослеживание происходящего в динамике, в неразрывности оценок и регулирований совокупности свойств, признаков и проявлений анализируемых процессов в еще большей степени уточняет сущность и роль вводимого авторами понятия в общую классическую теорию информационных процессов и систем. В связанный с этим анализ в качестве объектов исследования и проектирования здесь включены обладающие существенно динамическими характеристиками и свойствами виртуальная, дополненная, смешанная, расширенная, составная, сопряженная реальности, геоинформационные системы, многомерная компьютерная графика, фрактальная, голографическая графика, компьютерные телетайповые игры, дополненная реальность и т.п.

Выводы. Совершенствование теории и практики создания и применения информационных процессов и систем с позиций учета все более существенно возрастающих скоростей, динамики видоизменений их свойств и показателей приводит синергетическую методологию применения оценок и механизмов управления ими к появлению уточняющего понятия функциональной синергетики как понятия комплексного и динамического, вбирающего в свое толкование как позиции самой классической синергетики, так и сопряженных с ней парадигм когнитивной семиотики и т.п. Базисным генералитетным средством и инструментом такого рода объединения является набирающий все большую известность метод онтологий. В соединении с когнитивной семиотикой функциональная синергетика становится мощным наукоемким инструментом дальнейшего развития теории и практики современных разноплановых интенсифицированных информационных систем мультимедиа и их информационных полей, описываемых как императивной, так и конвенциональной парадигмой.

Ключевые слова: функциональная синергетика, пространственная синергетика, конфлюэнтность, эмерджентность, аутопоэзис

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INTRODUCTION

The study aimed to give and reveal the definition of such a new concept, actualized by the very course of development of virtual information technologies, as *functional synergetics*, and identify its signs for the correct formation of design ontologies of the corresponding dynamic information processes and systems. The expediency of introducing this somewhat updated concept of synergetics into the basic ontology of the modern theory of information processes and systems is prompted by two important interrelated circumstances.

First, the variety of interpretations of the terms of *synergy*, *synergetics*, *synergetic effect*, and other similar concepts requires clarification [1–9]. In other words, it is essential to determine how these terms are understood in relation to the tasks and procedures for constructing design ontologies in the information technology (IT) sphere and its information fields. The fundamental provisions of synergetics serve as the basis for the new term *functional synergetics*. The innovation creates effective prerequisites and opportunities for the analysis and ordering of complex information processes in the information fields of modern dynamic IT [10–14].

Secondly, synergetics in any of its representations and interpretations presupposes the possibility of both a positive synergistic effect with a plus sign (“+1”), and a negative one with a minus sign (“−1”), as a rule, without fixing intermediate values in the range from −1 to +1 and, moreover, not illustrating the dynamics of the sliding of synergy within the limits indicated here.

The algorithm of actions for the implementation of the task is transparent:

Step one: outlining at least an approximate list of types of virtualization, to which the definition of the concept of *functional synergetics* and its ontological interpretation are correlated here.

Step two: determination of the boundaries and parameters of processes, phenomena and properties of the entire list of virtualizations, to which the modified term belongs, or, which is the same, the determination of the continual area, continual boundaries in information fields, which are subject to the declared paradigms, properties, and manifestations of those or other processes and phenomena considered from the standpoint of synergetics.

Step three: clarifying the formulation of the signs of continuity in line with the functionality of synergetics, thereby giving a clear idea of the semantic meaning and setting capabilities of the introduced concept in the theory and practice of synthesis of ontologies of certain dynamic information processes and systems.

Step four: assessment of the possibility and prospects of applying the updated approach in the vast field of diversity of modern information processes and systems, including for the prospect of their expected development from a technological perspective.

In the most pronounced form, this is manifested in the tasks of research, creation, design, and maintenance of a wide range of IT multimedia related to a wide range of virtualization of multimedia objects of high dynamics, which, for example, are virtualization devices as part of IT multimedia, such as virtual reality devices and their various modifications, geoinformation systems, systems of modern highly dynamic multidimensional computer graphics, holographic and fractal graphics, computer teletype games, X-reality, etc.

The formation of basic ontologies of this kind of IT arrangements based on the emerging positions and views of *functional synergetics* is fragmentarily presented below using examples of multimedia virtualization objects as a starting point for development, by analogy with an extensive list of concepts of the ontology of IT *functional synergetics*, intended to serve as an ontology for the design of information processes and systems.

OBJECTS OF VIRTUALIZATION AS A PART OF MULTIMEDIA IN THE VISION OF THE PARADIGMATICS OF *FUNCTIONAL SYNERGETICS*

Virtual reality is an imagery created by technical means, transmitted to the user through his sensations and perceptions by the senses and his own cognitive processing. Virtual reality simulates both an exposure and responses to the exposure. To create a convincing complex of sensations, close to true reality, the computer synthesis of properties and reactions of virtual reality is performed in real time[1, 2] [15]. The user can act on these objects in accordance with the principles, procedures and technological features of state and control indications embedded in the information system (IS) of virtual reality. In this variety, as in all subsequent components of this ontological assembly, there are clearly expressed functional synergistic features, traced in the properties, manifestations, and signs of information processes and in the system arrangement of very dynamic (in the most general case) virtual reality systems, in high continuous dynamics conjugation of forms and the content of procedural and displayed signs and manifestations, including those related to the phenomena of spatial synergetics and autopoiesis.

Augmented reality is the result of the introduction of various sensory data into the field of perception and cognitive processing of the IS of augmented reality in order to supplement information about the environment and improve the perception of information[3]. The most common element of augmenting virtual reality that converts it into augmented reality is the input commentary text.

Mixed reality is functionally complicated augmented reality, reflecting the explicitness of the concept of the virtual continuum and the application of the taxonomy of this classification to the means of displaying reality[4, 5] [16].

Extended reality, often referred to as a hybrid reality, represents the synclide of augmented reality and augmented virtuality, and is a consequence of combining the real and virtual worlds to create new environments and visualizations that have a synergistic effect in relation to the components, that is, the effect of the appearance of new properties,

[1] Isaac J. Step into a new world – Virtual Reality (VR). Basic Concepts of Virtual Reality along with Research Challenges explained in simple words. 2016. URL: https://www.completegate.com/2016070154/blog/virtual-reality-explained. Accessed August 13, 2021.

[2] Astonishing innovations of VR. URL: https://web.archive.org/web/20200112191904/https://caersidi.net/blog/vr-astonishing-innovations. Accessed August 13, 2021.

[3] What is augmented reality? URL: https://www.fi.edu/what-is-augmented-reality. Accessed August 13, 2021.

[4] What is mixed reality? URL: https://docs.microsoft.com/ru-ru/windows/mixed-reality/discover/mixed-reality. Accessed August 16, 2021 (in Russ.).

[5] A Taxonomy of Mixed Reality Visual Displays. URL: https://search.ieice.org/bin/summary.php?id=e77-d_12_1321. Accessed August 16, 2021.

signs, and manifestations that are invisible in the components. It is a highly merged virtualization implementation[6].

Composite reality, in the author's vision, is an extended reality with pronounced properties of confluence, as a result of which the specified variety can be considered as a set of layers into which it is dismembered, but it is protected from this via the principles and mechanisms of confluence within the life cycle of an IS composite reality.

Conjugate reality, in the author's vision, is a composite, augmented reality that has, throughout the life cycle, general features of the interconnection of IS layers, nonseparability of the virtuality continuum and mediality continuum of serviced objects and their virtualizations [16].

Geographic IS (GIS) is a system for collecting, storing, analyzing, and graphically visualizing the spatial (geographical) data and related information about the required objects [17–19]. The popularity and wide variety of GIS, methods and technologies for working with them exclude the possibility of introducing any detailed description of them into this thematic list. Here, something else is essential. There is a synergistic nature of the arising effects, which is quite traceable by an observer, both during the synthesis, processing of GIS, and when they are perceived by users. These technologies are dynamic, multicolored, and multidimensional, and have pronounced features and scalability, and therefore should be considered primarily from a synergistic standpoint.

Multidimensional computer graphics does not need additional definitions, as a well-known visualization tool, which is primarily an important part of data analysis, allowing you to combine several dimensions in one model representation[7] [20]. The dynamic properties of the processes associated with it and, especially, the multidimensionality that goes beyond the boundaries of the conceptual perception of images (computer graphics models with a large number of dimensions) are the most difficult, science-intensive, and promising task for the further development of the theory and practice of graphics virtualization. An example of virtual mastering of a multidimensional space is shown in the illustration of a six-dimensional tutorial[7]. This is an elegant but private solution. According to the authors, the way of creating and putting into practice a universal model of virtual adapters, transformers and clones of multidimensional N-graphics ISs with an unlimited number of measures should rely on methods and mathematical descriptions of increasing or decreasing the complexity measures of infologies and morphologies of the original virtual layered structure possessing a certain set of confluent properties and features that is stable and unchanged in the process of variation.

Fractal graphics (fractal reality). The fractal picture itself can be positioned as an image, graphics. At the same time, the contours, outlines, and color gamut (RGB) of a fractal image are significantly dependent and changeable depending both on the image processing editor and on the technological means of its screen or print display. Thus, it is proposed to understand, that computer fractal graphics directly is a graphic formation, which momentarily in this particular implementation has the corresponding particular manifestations of contours and color gamut. Any editorial influences and/or changes in the technological package of image processing inevitably lead to changes in the informative essence of fractal images. At the same time, there is a synergistic effect of a negative property in assessing the status of emergence. The measure and the very possibility of mixing certain informative features in the graphics of fractal images can vary widely and most of all depends on the set of scaling factors and relationships between the virtualization layers, and the consequences and results are determined via the confluence function of the transformations taking place. The dynamics and implicit discreteness of the ongoing processes bring to the fore their evaluativeness from the standpoint of *functional synergetics*, where the mechanisms and methods of synergetics are described by appropriate models.

Holographic graphics, both flat and volumetric, manipulates the synthesis, perception, and transformations of incorporeal images similar to reality, that is, with holograms and holography. Holography (ancient Greek: ὅλος is whole and γράφω is graph) is a set of technologies for accurate recording, reproduction, and reformulation of optical electromagnetic radiation wave fields. Holography is a special photographic method in which laser images of three-dimensional objects, extremely similar to real ones, are recorded and then restored. A hologram is the acquisition of images using wavefront reconstruction. All of the above regarding fractal graphics and multidimensional computer graphics can be attributed to holographic graphics.

[6] What is mixed reality? URL: https://docs.microsoft.com/ru-ru/windows/mixed-reality/discover/mixed-reality. Accessed August 16, 2021 (in Russ.).

[7] Multidimensional graphs in Python – from 3-D to 6-D. URL: https://habr.com/ru/post/456282/. Accessed August 18, 2021. (in Russ.).

Here, removing each layer from the system (part of the hologram) to a certain physical limitation within a wide range of scaling preserves the integrity of the images, but with a possible decrease in quality indicators. This phenomenon is the best illustration of the presence of a functional synergistic effect in what is happening. Evaluating and using the essence of this effect in the synthesis procedures for design ontologies of information processes and holographic graphics systems (and in other similar cases) elevates the traditional ideas about synergetics as a descriptive entity to the level of a certain function of analyzing and managing information processes and systems.

This definition is well illustrated by the following specific case. Windows Mixed Reality is a mixed reality platform, presented as part of the Windows 10 operating system, and provides a holographic embodiment of objects in mixed reality in technical implementations with appropriate helmets (Windows Holographic)[8, 9].

Computer teletype games (intellectualized computer games) are implementations of functional connections with game partners or a substitution of a partner by means of IS intellectualization, optionally implemented on computer displays or spatially, in holographic performance, in augmented and other realities based on the initiation of specially created resource-intensive computer programs for multivector execution of transactions that serve to organize the game process (gameplay). The latter refers to the most popular and promising area of the development of computer games—to intellectualized games. It features game artificial intelligence, i.e., a set of software techniques that are used in computer games to create the illusion of intelligence in the behavior of computer-controlled characters. This development is especially promising in the actualization of interactive, Bell–Lancaster, and distance learning and self-study. There is no need to re-enumerate everything that is referred above to the abundance of variety of virtualizations from the standpoint of synergetics. All these signs and properties are not only present, but to a large extent exacerbated by a large number of development trajectories of modern games, and therefore, by the synergistic effect arising for each option, each "move" of a player, or the IS itself. In addition, everything that happens in computer games is carried out in the conditions of their so inflated dynamics that these effects overlap one another. This leads to the emergence of new, even more unexpected emergent consequences. There are signs of *functional synergetics* with its emergent dynamic manifestations, that is, derivatives of certain current values of emergencies [21–23].

X-reality is a set of orientational images and their models adding the development of all the varieties of virtualizations indicated above. X-reality is a kind of generalization of both already known and practiced design solutions, and those whose appearance in the near future can only be predicted, and even then, very generally.

Let us define *a priori*: X-reality has the highest indicators of dynamic properties in transformations of synergetics, the power and emergence of synergies from the entire list above, which predetermines the description of the ontologies of X-realities as a kind of universe of basic ontology (core of ontologies) of the entire direction of IT multimedia development discussed here.

Thus, here is an assembly of updated and systematized concepts of design ontologies of modern information processes and systems in the field of virtualized highly dynamic multimedia from the standpoint of synergetics in its somewhat updated interpretation—*functional synergetics*. This concept, apparently, needs clarification of its interpretation and additional disclosure of properties, signs, and manifestations, which is carried out further in this article in relation to multimedia information fields.

DEFINITIONS AND PROPERTIES OF *FUNCTIONAL SYNERGETICS* IN THE METHODOLOGY OF VIRTUALIZATION OF MULTIMEDIA FIELDS

The first thing that needs to be done in the formulation of the preparation of this section of the article is to define the updated concept of synergetics. There are many different interpretations of this capacious concept in details. Common transcription is as followes: synergetics (from the Greek συν- is a prefix with the meaning of compatibility and ἔργον is energies) is the interdisciplinary field of science that studies the general laws of phenomena, processes, and development in complex nonequilibrium systems (including ISs) based on inherent them self-organization principles. The main concept of synergetics is the definition of a structure as a

[8] A Taxonomy of Mixed Reality Visual Displays. URL: https://search.ieice.org/bin/summary.php?id=e77-d_12_1321. Accessed August 16, 2021.

[9] Multidimensional graphs in Python – from 3-D to 6-D. URL: https://habr.com/ru/post/456282/. Accessed August 18, 2021. (in Russ.).

state that arises as a result of the multivariate and ambiguous behavior of such multielement structures or multifactorial media that do not degrade to thermodynamic type averaging which is standard for closed systems, but develop due to openness, energy inflow from the outside, nonlinearity of internal processes, and the appearance of special modes with exacerbation and the presence of more than one stable state. The conceptual circle of synergetics also includes the idea of conformity (measure of conformity) between form and content.

It is to be considered what is true here for the spectrum of virtualized multimedia systems described above, and what requires additional rethinking and, perhaps, rebuilding. Let us list:

- *Interdisciplinarity*—the feature and properties are obvious from the very list of virtualized multimedia systems.
- *Signs of complexity and disequilibrium* take place in an expressed form, since everything opposite in the theory of information processes and systems is only partial simplified cases.
- *Regularities of phenomena, processes and development* are observed in synergistic descriptions of approaches to the list given here, but they require quantitative evaluations and the construction of appropriate mechanisms and controls for ongoing or expected information processes. This position requires development and most obviously fits into the concept of *functional synergetics*.
- *Variability and self-development under the influence of internal factors and external influences* is characteristic of the multimedia spectrum discussed here.
- *Conformity and measure of conformity of the form to the content*. This is essential, must be uniquely, and quantitatively, be determined and ordered.
- *Determination of the structure as a state.* Exactly like that, but along with this, within the life cycle of an IS, their state changes repeatedly and continuously, while the structure, architecture, and infology at some intervals of the life cycle trend can remain unchanged, but most likely, are subject to either drift or abrupt changes up to the occurrence of collapses. In this view, the question also fits into the conceptual nature of synergetics as *functional synergetics*.

All positions listed here assume adherence to ergodic principles. Among the most important principles are the calculability of processes and phenomena, the repetition of the results of calculations and their at least conditional predictability, which should become a supporting position for the formation of ideas about synergetics as *functional synergetics*. The components of the vision of synergetics named in this way are responsible, therefore, for the identification, declaration, model (including mathematical) description, and application in the procedures of analysis, modeling, design, and maintenance of all varieties (separately and jointly) of quantitative indicators and regulators of all of the above the synergistic features, properties, and manifestations inherent in the statics and dynamics of information processes and systems.

Three obvious additional investments in the conceptual apparatus of *functional synergetics* of highly dynamic multimedia information processes and systems follow from this capacious universe.

First. *Functional synergetics* as a tool for analyzing and influencing these processes and systems works in interrelated areas **signs, properties, and manifestations** in the functioning of processes and systems and the means of their creation and maintenance.

Second. Correspondences of forms to contents from the standpoint of majority (minority), confluence, and autopoiesis are included in the evaluative characteristics and tools for ordering synergetic properties, manifestations, and features in a quantitatively calculated and simulated form, thereby representing the functional essence of synergetics as a tool for creation and management. Let us clarify: **content** here is predetermined by the actual component of virtualization and its object; **form** is a consequence, the observed virtual, synthesized, artificial, and drawn image of an object that displays content. This is the connection between content and image in a synergistic view of multimedia virtualized systems. Functionally, virtualization refers to a real primordial object as a mirror or pseudo-mirror image of it, which has a mandatory feature **chiral purity** in relation to the source of creation. At the same time, virtualization must meet a number of additional attributes and properties assigned to it, which are not necessarily present in a real source, namely: meeting the requirements of cognitive semiotics; ensuring a rationalized balance of harmonization and standardization of content (especially educational and scientific content initiating basic subject ontologies of information processes and multimedia systems). It is also necessary to analyze the totality of technical, aesthetic, ergonomic, psychophysical requirements, etc. The emergence and manifestation of all these properties and features in virtualizations, new in relation to the object, is nothing more than

a polynomial of emergent bursts as a result of virtualization, the dynamics of which gives rise to the concept of derivatives of emergent contributions that form the specified polynomial.

Third. The generalizing idea of the dynamics and complexity of the changes occurring in the balance of these signs (architecture, infology, morphology, etc.) inherent in this approach requires the introduction of components into the tools of *functional synergetics* of the IS that reflect, along with traditionally used for this purpose, emergent estimates derived from the aggregate emergencies, which, based on the use of systems of differential equations or some other mathematical apparatus (for example, matrices of a planned experiment, Monte Carlo method, etc.), allows one to evaluate, improve, and optimize the indicated synergetic indicators both from the standpoint of achieving conformity of the form to the content, and in parts related to the inextricable triumvirate of signs, properties, and manifestations, including in dynamics.

CONCLUSIONS

Functional synergetics used in evaluative and regulatory actions in virtualized multimedia systems and fields of a wide variety of composition is designed to display and provide the ability to influence the signs, properties, and manifestations of an IS in models of quantitative measures throughout their entire life cycle, as well as to assess and organize the necessary conformity of the form to the content of the ongoing systemic processes and transformations.

The functional synergy of information processes and systems, including in relation to multimedia, manipulates the triple set of its main **categories: signs, properties, and manifestations** coupled with ensuring adequate **conformity of form and content.** Moreover, all this plot has quantifiable meanings in the models and methods synthesized for this.

The concepts and functionality of *functional synergetics* disclosed in the study can be an extension of the core of the basic design ontology of information processes and systems in the multimedia section.

In combination with cognitive semiotics, functional synergetics becomes a powerful science-intensive tool for the further development of the theory and practice of modern multi-faceted intensified multimedia ISs and their information fields, described by both the imperative and conventional paradigms.

Authors' contribution

R.G. Bolbakov—systematic construction of the nature and results of the research displayed in the article, editing, participation in writing the article.

V.A. Mordvinov—ideomatics, analysis of sources, participation in writing the article, information management of the research shown in the article.

P.V. Berezkin—formalization of semantic and synergetic features based on existing synergetic classifiers of information processes and systems, editing, participation in writing the article.

I.I. Sivitsky—systematic structuring of the sources introduced in the article, analysis and collection of materials, editing, participation in writing the article.

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