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Kovalev Y.N., *Dr. Techn. science , Professor,*
National Aviation University, Ukraine

WAVE MODEL AND SELF-ORGANIZATION THEORY OF C-SPACE: APPLICATION IN THE ERGONOMICS AND DESIGN

Abstract. Axiomatic wave model and self-organization theory of s– space and their application for modeling and optimization of human–machine systems and person–dwelling–environment systems are considered.

Keywords: Wave model, the theory of S–space self–organizing, optimization, human–machine systems.

Statement of the problem. Creating a comfortable environment of human in the natural and built environment, as well as interaction with machines is an important task of designing. To achieve it, you must have: a) an adequate model of person-environment (LS), a man-machine-environment (EC), human-residential environment (LZHS), b) strategy for solving multi-criteria optimization problems with limited inhomogeneous and partially mal criteria optimization.

Modeling and optimization methods for problems of this kind based on classical mathematical tools are extremely complex problem. Conceptual difficulties arising from the comparison of the properties of open complex systems, and it is to this class of drugs include, EC LZHS - no additive, openness, self-organizing systems, heterogeneity incomparably, unknown components, synergy, selectivity, non-linearity, the presence of a threshold effect of interactions - of the axiomatic foundations of modern mathematics: the case of non-compliance and even opposite. The same applies to the other components of the mathematical paradigm - methods and means output description.

Therefore, the problem of developing adequate mathematical apparatus is extremely urgent. The most fundamental approach to solve it is to create a new paradigm.

Analysis of recent research and publications. Developing a new paradigm and optimization methods promoted in the following ways:

- creation axiomatic model C - space [1];
- the theory of self-organization of C-space and complex systems [2];
- development of methods for modeling (theories of change and invariants) [2];
- a theory of human interaction with the environment (perception, decision making, homeostasis, adaptation, and natural biological rhythms, stress, productivity, disease) [2, 3];
- creating models LS, ES, LZHS, methods of testing and evaluation systems, optimization strategies [3];
- development of the concept of comfortable housing the dynamic [4-6];

Goals of the Article. The aim of the paper is to summarize the results and evaluation of the prospects within this approach.

The main part. Consider the components of a new paradigm.

Axiomatic C-space (Cn) describes the structure of the space relationship and interaction elements - waves and solitons - with each other and with the *environment.* Cn understood as a result of the collapse of the universe into two parts - the subject (S) and object (O), the boundary between C and O. The ratio C and O are called: a bunch of ternary (TC), internal (HR) and external (RH) splitting.

Five axioms of the first group specifies the structure of space and define the role of external influences in its evolution. Axiom second group defines the coordinate changes for all levels of sleep. Nine axioms third group establish a set of valid operations, which are used as abstract wave interactions. Two axioms fourth group set measurement procedure.

Completeness, consistency, unhatchability of axioms for a class of problems checked during the construction of the theory of self-organization [1].

Self-organization determines evolution scenario C-space for various combinations of initial C and O and their relationships. For example, in scenario (1C-1D):

1. Factors that limit the methods of formation of C-sets (bundles) are: symmetry of C and O with respect to sleep and integrity W.

2. Communicated statements: *1. Valid only have the following bundles, which preserve the symmetry of the Spit Sp*. Consequently, distinguished by subjective and objective sleep half. Stratification occurs scenarios for the formation of parallel, perpendicular, or both the second element: *2. Let* P_i *exists for symmetry groups M and* S_{ik} *performed* $S_{ik} = S_{jl.}$ *Then the formation of perpendicular structures will stop when the number of completed group symmetries for each layer L = M, and further education may only parallel structures.* Relationship is there between the laws of the storage groups and symmetry, Noether's theorem is similar.

3. We have *3 statements. Valid is only the bundle features the S-and P-element sets the current stage which are in harmonious relation with the characteristics of the elements and sets the previous stage by a factor equal to the characteristic of "Golden Mean":*

$$\Phi = \frac{\sqrt{5}-1}{2} \tag{1}$$

4. The number of elements *n*, depending on the stage of separation *m:*

$$n \approx \frac{1}{\sqrt{5}}((\Phi+1)^m + (\Phi+1)^{-m}), \tag{2}$$

that expresses Fibonacci numbers (1, 1, 2, 3, 5, 8, 13, 21, ...).

5. During the stratification changes the type and status of items: $\cup \to \bullet \to \to \cup$; influences C and O is its prerequisite.

6. When separation of C-sets of potential π each element is transmitted potential $\pi_{n:}$

$$\pi_n = \frac{\pi\Phi}{n}, \tag{3}$$

where n - the index of the current layer.

This implies assertion *4. All is related to the potential characteristics of layer different value characteristics of these layers, and cannot be expressed by them, that differ qualitatively. On the contrary, to characterize these layers can be used by properties of the current layer.* Importantly result: *Shennonivska estimate the amount of information coded using C-elements must be carried out for each layer separately.*

7. The potential of the π–$\omega\alpha\varpi\varepsilon$ length l and amplitude A is determined by:

$$\pi = f\,(l / 2, A), \tag{4}$$

where f - the function of proportionality, determined experimentally.

8. Length l_k wave current layer k from the previous layer:

$$l_k = \frac{l_{k-1}}{2n}, \tag{5}$$

if layers include elements of the same type, the denominator is equal to n.

9. As a unit of measurement of time t taken the time equal to the period of the wave. Each layer has its own k t $_{k:}$

$$\frac{t_k}{t_{k-1}} = \frac{l_k}{l_{k-1}}, \tag{6}$$

where k - number of layers, and l_k and l_{k-1} are linked by (4).

The following bundles, for which the existence of each layer, expressed in relative units, the same:

$$\forall k, \frac{T_k}{t_k} = const, \tag{7}$$

where T_k - During the existence of k-th layer.

There is a limited time bundle, due finitude lifetime of the first wave sleep - the stratification and rolls with total length equal to the lifetime of the first wave. It follows that the stratification is possible if and only if:

$$_{\forall K,}\, Tk < T_{k-1} \tag{8}$$

Finally, if time is the time convolution bundle, T_{0k} - the time remaining until the end of the bundle k-th layer is equal to:

$$T_{0k} = \frac{T_1}{2} - \sum_{j=2}^{k-1} T_j \tag{9}$$

Thus, the time for the C-space is characterized by: 1) "arrow of time", expressing the irreversibility of evolution, 2) bundle.

10. We introduce features elements: potential π; length l; amplitude A, frequency o, phase F; period T; modality ⁄,), ↓; signs and //□^. Depending on the characteristics of the output value conditions implementing C operations.

11. A list of characteristics that can be defined in different dimensions, describes procedures for selecting and measuring Ks.

Graphical model (OM) and invariants. Introduced the concept *calibration vibrational invariants* (independent of the nature of systems) and *calibration* (lock to physical units of measurement). Produced classification: OM_1 - static models that preserve identity and sequence of formation of the elements, number of elements and operations; dimension, group and order of symmetry, the distribution of the relative values of π and t_0 and are represented as C-graphs or diagrams RH) OM_2 - dynamic models that store, except invariants OM_1, dynamic structures Cn, OM_3 - calibrated models that retain absolute values. Carried out the classification schemes of different definitions of C-mappings. Since OM_1 invariants are topological and projective for their reproduction requires appropriate representation. Statement *5. Family {Ps} I subfamily includes topological {TRZ} and {projective ïðç} reflections. Each external stratification is a result of their consistent implementation:*

*Ps = TRZ * ïðç* (10)

Outcome: *Displays the family {Ps} are functors.*

We have statements *6. Let the functor T:* $p_i \to K^1$ *provides one-to-one mapping of C-elements in the top and consistency bundles - the edges of the linear complex so that one layer corresponds to one star. Then* $\in \{T\}$ *trz.* Example The possibility graphical modeling scenarios type 1C-1D. For scenarios where self-organization is influenced by a number of C or O, so that there are interaction elements and topology changes, we have the statement *7. Let the function* $T_{and}\{p_i\} \to K^1$ ** provides one-to-one mapping of C-elements in the top and the sequence of bundles - in rib* K^1 *so that one layer of each bundle corresponding to not less than one star, and each operation that changes the scenario - one simple cycle. Then* $T_i \in \{trz\}$. Consider the possibilities of graphic expression of the results of calibration, for example, the distribution of π - using planes of vertices (l and A are depicted as the length of the rectangle-top), t - lengths of edges; modality condition - different colors and so on. We investigate the possibility of saving deals. The sequence of construction OM: 1) determine the dimension of $E^{n;}$ 2) abstraction of Hm with a view to present it as a P-graph (RH diagrams) in $E^{n,}$ so that they may be saved invariants, 3) topological transformation (curves with line segments etc.) in order to simplify the graphical representation, and 4) conduct local reaming to simplify projection 5) construction of the image to 6) metryzatsiya, 7) the addition of graphic text Om explaining analytical dependencies, and so on.

Means descriptive names *holistic languages* $_{(mx)}$. Making $_{M's}$ based on the method of limits. Given the communication function of language, it should be interpreted as a C-space system subject (S) - S-space - the object (O), which in turn specifies the structure and content of individual levels and structures. Structures of

this form of "context" to read at the next level and specify the content of the previous levels. For each level has its own means of expression.

The means and the output of the verification *method is intuitive design, which refers to the theoretical and experimental methods [1].*

The study of the "human factor." Model of interaction of man with the environment (MDR). The analysis of the evidence leads to the conclusion that sleep is formed by the interaction of {C} and {O} and integrity conditions take the form:

$In \rightarrow (\{C\}_{o,} Cn \{O\}_{p)} \rightarrow SR\ SR \vee^{*} \vee CP^{**,}$ and (11)

$SR \rightarrow n\ (\{C\}_{i = 1, ..., n,} \sim_{xy,} \{O\}_{i = 1, ..., n)}$ (12)

$CP^{*} \rightarrow (m\text{-}n)\ (\{C\}_{i = n+1, ..., m,} \sim_{ixy,} \{O\}_{m\text{-}n)}$ (13)

$CP^{**} \rightarrow (o\text{-}m)\ (\{C\}_{o\text{-}m,} \sim_{i = o\text{-}m, ..., o,\ j = p\text{-}m, ..., pxy,} \{O\}_{p\text{-}m),}$ (14)

where CP display type scenario; n, m, o, p, o> p denote the number of S and O; i, j - serial number Cn bundles corresponding to the interaction of various C and E; x, y - numbers of layers and of their C - elements and C-sets.

According to (1-14) are defined and calculated:

- level of organization, consistency and priorities of their occurrence. Set of compliance with physical, mental, physiological and anatomical structures;
- weights for each of the levels (proportional potential);
- the number of items in each level and the number of independent parameters (derived from the Fibonacci numbers);
- boundaries change characteristics that do not lead to disruption of the system (the condition to prevent further separation-rolls);
- exchange mechanisms (the conditions of symmetry and the laws of life).

Mechanism of relations and exchanges. Let the result of external impact damaged one of the elements of the *i-layer* $^{+}$ Sp. Then, as integrity is violated, the system will cease to exist, or restore integrity through redistribution of potential between the layers $Cn^{+\cdot}$ This redistribution is possible within certain limits, consistent phenomena of regeneration, autoregulation and fatigue. For layers with numbers smaller *i,* the impact of the stimulus will be less significant. To sleep, due to symmetry, there will be similar changes. Potential sleep decreases. In the process of redistribution will change the modality and condition of existence, will be converting $\bullet \rightarrow \cup$ *and* $\cup \rightarrow \bullet$, and the interaction of the C-elements. This will lead to the emission of waves and moving solitons, ie processes of exchange between man and environment. Since the quality characteristics of layers are different, qualitatively different processes are exchanging layers *i* and *i* +1 to Cn Cn^{+} and $^{-\cdot}$ Storing dynamic balance, recovery or destruction of systems and operations can be described by **{DIX}.** Since the implementation of operations due to limitations associated with potential, this leads to the separation of interaction according to the stratification of Cn. Within each of the layers will be performed keeping the laws, due to the inherent symmetry. The most sensual interaction will be at the resonant frequencies. From this statement *8. The reason being: homeostasis and regeneration, forward and backward linkages, qualitative*

differences of the exchange between the components of the system "man - environment" in terms of unbalanced external influences is the need to keep its integrity and *9. Favorable to be considered are environmental effects that contribute to the restoration of the integrity of* $Cn^{+;}$ *adverse - effects that violate the integrity of* $Cn^{+.}$

The limits of self-regulation determined based on the need to maintain a dynamic equilibrium that is formalized as to prevent separation or rolls. We have *10 statements. Limits of changes in one level should not exceed the ratios equal to 1: F for the script (1C, 1D)*. When the adaptation process takes several levels, we have statements 11. *If the latter involved in the process of adaptation levels exceed the limits changes in satisfying statement 10 then the previous (1, 2, ..., k, counting from the last one) are calculated as follows:*

$$\frac{\pi_{i,n} \cdot i_n}{\Phi^k \cdot i_{n-k}} \div \frac{\pi_{i,n} \cdot i_n}{\Phi^{k-1} \cdot i_{n-k}}, \qquad (15)$$

where i - number of elements in the last layer n.

This position arising directly

12. Terms of origin pathology is the excess referred to in (15) limits.

13. Terms of regeneration are external influences that can return potential indicators of life within the boundaries defined in (15).

A model of perception (MS). Structure of the human psyche, levels, channels and the sequence of perceptions described scenario (1C, 1D):

Level 1 - unity. Man and the environment is not distinguished as separate parts, but the potential that exists. Channel perception of unity is *intuition;*

Level 2 - separation. There is awareness of themselves as self-sufficient and isolated nature, expressed *his own "I",* the unique patterns of the human body structure and parameters constancy of internal environment (homeostasis). Similarly, the integrity of the universe is governed by laws of nature, not just a set of individual objects;

Level 3 - impacts and responses. The existence of the external world, influences and reactions expressed in terms of "good" and "bad" *intelligence* recognized the need to perform a natural solution, which requires *freedom*. For this level is characterized by binary division: for a man - bodily and psychological makeup, the right and left half, male and female, for the universe - matter and field of attraction and repulsion, space and time, etc.;

Level 4 - space and time. With the emergence of impacts and responses is ordering in two categories, called space and time. Based on the scenario of self-organization, each of them should be attributed to three options. That's right: the space is three-dimensional, time is divided into past, present and future. Trojisti divisions characteristic of the *mind;*

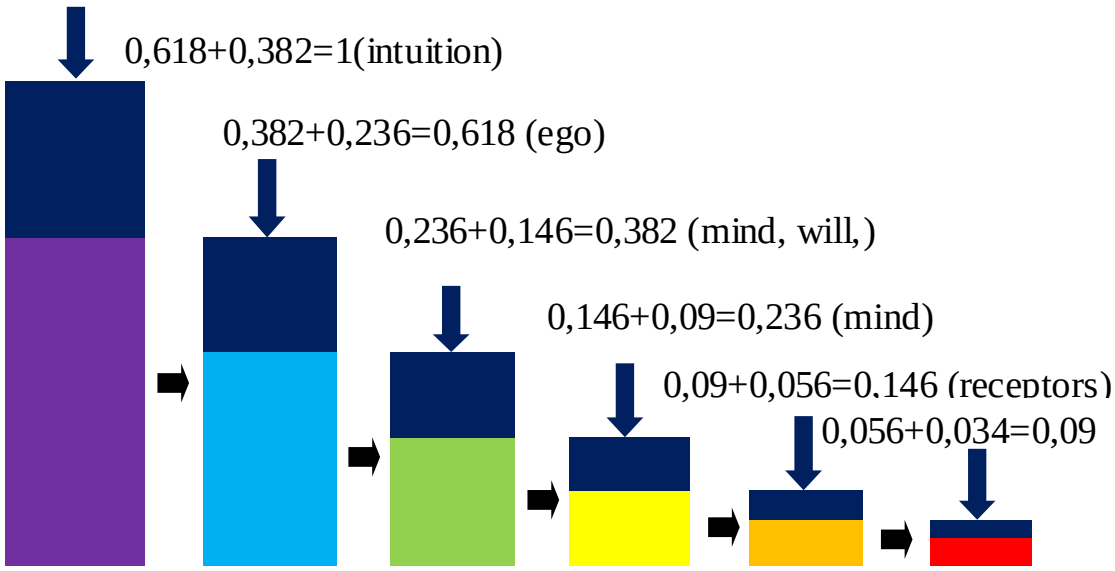
Level 5 - receptors and feelings. From scenario implies the existence of three groups of five senses elements. Indeed, differentiate*interoreceptors, proprioceptors and eksteroretseptory*. It is not known how many are internal or

marginal experiences, but outside exactly five. In nature, there are also events and processes that have p'yatyrychnyy division, for example, five states of matter, the five fundamental interactions, etc.;

Level 6 and the next - and tons of nuances. For each of the receptors must be eight rozrivnyuvan one feeling (not having separate agencies). It pleased about. For example, 7 is distinguished by colors (eight in ergonomics attached - yellow-green), 7 sound tones, etc.Notable among Miller (7-9) - number of similar items that can simultaneously take the average person. It can be noted that the system beyond level 6 yet formed. therefore there is no need for further development of the model.

We give quantitative estimates of each of the *levels*. Observe that the sum of the potentials -1.472 2-6 levels - more than the potential of the first level - 1, from which there is self-organization. This is explained by the first group of axioms that assert the impossibility of self-organization without external influences. The value of the potential, which is replenished through the influence at every level (marked dark) obeys the harmonic ratio (Ill. 1.).

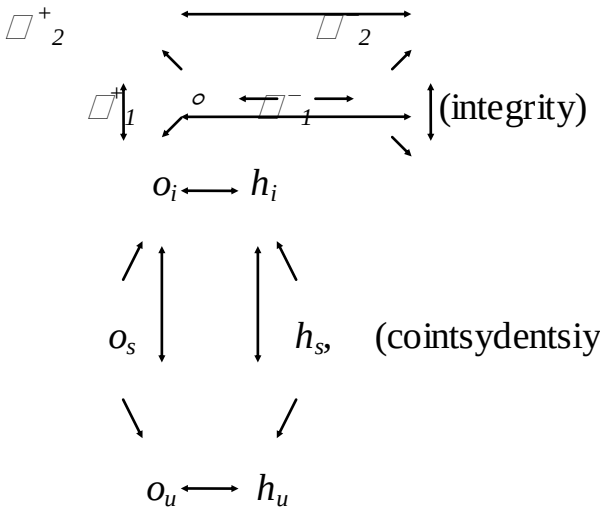
Hence the weights of each of the channels - they must be proportional to the number 1, 0.618, 0.382, 0.236, 0.146, 0.09. Since the potential of the prior than the elements of the next, *there is a qualitative difference in their performance, which makes it possible to use diverse data in a single model.* Consequently, the age-old question of gnostic awareness of the world, we can give the following answer:*the world is knowable so far as the same laws self-organization of the universe and man*.



Ill. 1. The impact of the environment on the self perception

Model identification and decision-making (MRR). The general model of information processing is specified as a set of exchanges MLS, which have specific forms of user-specified reactions, reflexes and thinking. Construct a conceptual MRR. We introduce a specific definition of compactness of the image, informative and similarity image coding accuracy, reliability, recognition [2].

Simulation and optimization of ergodic systems is based on these models, as well as general scenario of self-organization. The organization of the EU is in accordance with the formal schemes, which correspond to different degrees of integration components, namely:



Set of characteristics for each component layer and $\{ O_{and}, O_u, h_{and}, h_u \}$ are determined depending on the scenario of self-organization that takes place in the case. Estimated justified ergonomic recommendations for:

- compensation of negative external effects to the operator;
- optimal choice of operators and sub-IS;
- configuration information display systems (SRI).

Calculation of EC component is interpreted as the realization of the calibration. We use normative data and safety requirements, including those that provide anthropometric, biomechanical and informational compatibility, other calculations using valid values of temperature, vibration, electromagnetic and other influences.

Overall optimization strategy. *purpose of optimization* is to build an efficient, safe and reliable EU, the result is measured by hygiene, anthropometric, physiological, psychological, biomechanical, informational and aesthetic values. So: 1) the composition of these parameters for a particular system, the projected number of arguments previously determined by optimizing $x = x_{\{and\}}^{n=1}$ and 2) conducted grouping $'s_{and}$ on levels of MDR, based on quantitative and qualitative characteristics of the layers is determined by the number of bundles Cn and specified number n of arguments based on projected for each of the layers, and 3) based on the projected number of operators and subsystems, as well as the degree of compatibility or integration integrity, self-determined scenario 4) group and order symmetries and dimension Cn are determined from previous data specified in the self-organization, and 5) the potential distribution and other parameters are calculated and expressed, up to a gauge invariant in the form of OM. This pattern is a regular expression optimization goals. Changes parameter values should not lead to irreversible system integrity violations. This requirement is interpreted according to the MLS, which allows to calculate the changes in the

limits of incomplete or inaccurate data. Calibration shall be made by the regulations. Estimates options formalized as FIT, reflecting deviations from the target design options. Weights taken proportional to the relative value of the potential. Take into account the coefficients of the terms and priority of perception. The recommendations for optimizing the Designer action and calculate CF.

Professional selection, monitoring productivity, ergonomic calculation of indicators, training of operators. construct graphical OM subjective operator input space kvazimetrychni ratio as links psychological characteristics.

Defined as a professional and get methods of psychological testing. Describe instruction requirements for material handling procedures, graphical representation of the psychological portrait conclusion of professional competence. [3]

Control of productivity based on the fact that the organization of measurements must satisfy the axioms of measure, number and weight of measurable indicators - MLS answer, can reduce the number of measurements, with the stipulation that the correlation of various parameters according to MLS. [3] are examples of calculation of ergonomic parameters, modeling of stress and pathological changes, planning ergonomic measures. MLS is also used for planning training provider **.** Teaching as a set of relations and exchanges sleep that rolled to the state **P** (C, TC, O) operator - as Cn^{+} "learning environment" - like $sleep^{-}$. The number of stages of learning,based on the number of levels SRI - 5-7.

Psychophysiological comfort and dynamic concept of housing are based on MDR and MRR. comfortable'll call the human condition in the system LZHS of the following symptoms: the integrity of the system; psychosomatic integrity of the person, there is enough capacity for adaptation, the presence of lead time of the system. Uncomfortable condition characterized by opposite signs. The psychological component correlates with comfort channels received and states of consciousness (Table 1.).

Locality and globality performance comfort / discomfort are measured as the sum of the potentials involved MLS levels, expressed relative to the potential of the first layer.

Table 1.

Correlations of indicators of psychological comfort and discomfort

Levels	**Objects perception**	**Feeds**	**Indicators comfort / discomfort**
1	integrity of the people - Housing - Environment	intuition	feeling luck, favorable course of events, and harmony with the environment / feeling of "black bars" not grateful, disharmony
2	ego, internal environment, nature as a separate entity	intuition	feeling of self-sufficiency, health, peace, joy, optimism, faith in future / feeling of illness, internal conflict, frustration, pessimism, sudden death, malformations of the landscape and people of the flowing world

3	relation to the world; binary evaluation and impact	plus- prudence and will	a sense of freedom, a sense of superiority, self-range goal / feeling of depression, anxiety, worry, uncertainty, weakness
4	space and time, the ternary organization	plus mind	feeling of space-time ordering "correctness" of the external and internal world, their intellectual awareness as regular / feeling of chaos outer and inner world, their intellectual beyond recognition, randomness
5	sensory stimuli: light, sound, etc.	Plus receptor Torah (3 groups)	a sense of balance, strength, comfort touch "elements of harmony" at the level of intellectual constructs and direct perception of the world / feeling of imbalance, exhaustion, fatigue touch, "Hate elements"
6-7	basic colors, sounds, and their graduation.	the same	feeling and common vision, hearing and / feeling poor vision, poor hearing, etc.

The significance of the rate coefficient is expressed by k_1, for each of the layers involved in the borders $0 \div 1$. Factor conditions of perception k_2 utrudnenosti expresses the degree of perception, for each of the layers is in the boundaries of $0 \div 1$. In summation parameters should ascribe the "+" sign if they are in accordance with performance features, and the sign "-" otherwise. Then *"formula of comfort"* that characterizes expressed in units worth indicators comfort at all levels with appropriate coefficients p becomes:

$$p = \sum_{i=1}^{n} \sum_{j=1}^{m_i} \pi_{ij} \cdot k_{1ij} \cdot k_{2ij} \ , \qquad (18)$$

where n - number of levels,

m_{and} - the number of indices i-th level

Best comfort here corresponds more important , *the*

The table directly derive conditions that should be provided in the design and construction of housing. Details outlined in [3].

Rate the quality of housing can be (18). The condition is the presence of features flexible management totality of expressive and technical means of housing. Understanding this leads to the *concept of dynamic housing* . At the present stage of development of building technologies to realize this concept can only partially. However pursuit of its implementation can provide a powerful impetus to the development of technology and construction related sciences.

Conclusions. The scientific problem of constructing geometric modeling apparatus, adequate properties of complex open systems can be considered solved. In this approach implemented based on non-classical paradigm. Apply Hm Cp in the fields of ergonomics and design showed the adequacy of the system.

Prospects for future research related to the practical use of the device in order to clarify the limits of its application and accuracy of the models have been proposed.

Literature

1. *Ковалев Ю.Н.* Геометрическое моделирование эргатических систем: разработка апарата / Ю.Н. Ковалев.– К.: КМУГА, 1996. – 134 с.
2. *Ковалев Ю.Н.* Эргономическая оптимизация управления на основе моделей С– пространства / Ю.Н. Ковалев. – К.: КМУГА,1997. – 152 с.
3. *Мхитарян Н. М.* Эргономические аспекты сложных систем / Мхитарян Н. М., Бадеян Г. В., Ковалев Ю. Н. – К. : Наукова думка, 2004. – 599 с.
4. *Ковальов Ю.М.* Забезпечення психологічного комфорту при проектуванні житла на основі теорії самоорганізації С–простору / Ю.М. Ковальов, Н.О. Гірник, В.В. Калашнікова // Праці Таврійського державного агротехнологічного ун–ту,2010.–Вип.4. Прикладна геометрія та інж. графіка.–т.46.–С.58–67
5. *Ковальов Ю.М.* Психологічно комфортне житло для «збалансованої особистості» та «споглядача»: гармонія з навколишнім середовищем / Ю.М. Ковальов, Л.В. Шевель, О.Є. Дувалкіна, В.В. Калашнікова // Технічна естетика і дизайн. – 2010. – Вип. 7. – С. 151–158
6. *Ковальов Ю.М.* Психологічно комфортне житло для «винахідливого дослідника» / Ю.М. Ковальов, О.Є. Дувалкіна, В.В. Калашнікова // Технічна естетика і дизайн. – 2010. – Вип. 8. – С. 150–155

Аннотация

Ковалев Ю.М. Дизайн интерьера как объект теоретических исследований. *Волновая модель и теория самоорганизации С–пространства. Применение в области эргономики и дизайна. Рассмотрены аксиоматическая волновая модель и теория самоорганизации С–пространства, их применение для моделирования и оптимизации эргатических систем и систем человек–жилище–среда.*

Ключевые слова: Волновая модель, теория самоорганизации С–пространства, оптимизация, эргатические системы.

Анотація

Ковальов Ю.М. Дизайн інтер'єру як об'єкт теоретичних досліджень. *Хвильова модель і теорія самоорганізації С-простору. Застосування в області ергономіки і дизайну. Розглянуто аксіоматична хвильова модель і теорія самоорганізації С-простору, їх застосування для моделювання та оптимізації ергатичних систем і систем людина-житло-середу.*

Ключові слова: Хвильова модель, теорія самоорганізації С-простору, оптимізація, ергатичних системи.