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MUTUAL ENRICHMENT OF EDUCATION, SCIENCE AND TECHNOLOGY IN POST-WAR UKRAINE THROUGH SELF-ORGANIZED INTEGRATION OF CREATIVE INDIVIDUALS

Purpose *of the work is to search for new ideas of metamodeling of physical and digital reality and the development of interdisciplinary means that increase creative and innovative potential.*

Methodology *includes methods of interdisciplinary analysis and cognitive metamodeling of physical and digital reality.*

Results*. New paradigms, hybrid universals and universities are proposed, as well as the method of formation of integral thinking. Their complementarity opens up new opportunities to increase the efficiency of visual communications dynamics. The connection of the generalized principle of N. Bohr's supplement with the tectonic ordering of fractal nature and the complementarity of the principles of bionics, heuristics and cognitive science, which opens fundamentally new opportunities for the use of different approaches in the design and subject environment of human life, has been revealed. The proposed metamodels of creative thinking, covering key types of design – informational, dynamic and visual. New opportunities for the development of the theory and practice of environment design and its subject filling on the basis of hybrid structures and metamodels are substantiated.*

Scientific novelty*. The first developed meta-methodology of integration of creative personalities, which contributes to the development of creative potential, improvement of mental health and functional safety.*

Practical significance*. An innovative methodology for identifying the peculiarities of knowing the harmony of fractal nature and its application in the process of development of meta-thinking as the ability to know, analyze and change your thinking have been developed. The integrative coefficient of cognitive distortions and integrative criteria for assessing the creative potential of the individual are introduced. An innovative methodology for identifying obvious and hidden cognitive distortions with the help of a AI-transformer is proposed. The complementarity of these results is the basis of a new idea of self-organization of creative personalities, which is aimed at integration of education in post-war Ukraine into a single European space of higher education and the multiplication of human and intellectual capital of Ukraine.*

Keywords: *cognitive visualization, design, metamodels of cognition, design-thinking, heuristic metamodels, self-regulation, self-knowledge, hybrid object environment, environmental design.*

Introduction. The post-war period for Ukraine is characterized by the need for large-scale reconstruction and restoration of all aspects of social life. In these conditions, the mutual integration of education, science and technology creates a synergistic effect that will ensure the rapid recovery and development of the country. An important role in this is played by the development of design thinking, which promotes flexibility, adaptability and quick response to the challenges of time. Self-organized integration of creative individuals based on the use of design thinking is an important prerequisite for effective development and innovation. Creative individuals are able to generate unique ideas and solutions that can be implemented in the educational process, scientific research and technological developments.

Digitization of education, science and specialized generative AI (GenAI) have created global challenges, fundamental problems and many contradictions, which are related to the peculiarities of the brain activity of an individual. On the one hand, individual peculiarities of brain activity are caused by overt and hidden cognitive distortions that affect the cognitive perception of physical reality. On the other hand, the difficulties of their accounting limit the development of specialized GenAI, as

well as the creation of automated and safe CDS. Therefore, metamodeling of thinking and taking into account the peculiarities of the brain activity of a person will allow, on the one hand, to solve the urgent problems of post-war Ukraine (mental health, functional safety and sustainable development), and on the other hand, it opens up new opportunities for the development and management of educational resources by means of GenAI.

The use of specialized AI in education can improve both the efficiency and effectiveness of teaching and research methods. Therefore, a critical analysis of the above problems is relevant, as well as the search for effective tools (approaches, concepts and paradigms). In particular, for:

• searching for related paradigms, universals and universes, the connection of which contributes to integration;

• developing an integrative approach to the perception of physical reality based on the ecology of culture and ecodesign;

• forming holistic thinking based on metasciences, metaphors and integrative knowledge of the differences between physical and digital reality.

At the same time, there is a need to optimize the use of GenAI in education, which is accompanied by a number of new challenges and problems, namely: concerns about the reliability and complexity of content; limited variety in generated materials; inadequate customization for different learning needs. Cognitive complexity increases, which limits the unique capabilities of GenAI in individualizing learning and interdisciplinary integration.

In today's globalized world, the integration of Ukraine into the international community is an important aspect for the exchange of knowledge, experience and innovations to create conditions for the sustainable development of the country based on the activation of design thinking. Cooperation with international partners, participation in joint projects and support programs will contribute to the improvement of the quality of education, scientific research and technological development in Ukraine. This will ensure not only economic growth, but also an increase in the standard of living of the population, development of human capital and environmental safety.

Analysis of previous studies. Currently, one of the main forms of presenting information is its visualization, which takes into account the experience of an individual, distortion of information in a hybrid subject environment and promotes the development of metathinking [28]. This article draws attention to the development of different types of thinking (cognitive, visual, creative, critical, etc.), the complementarity of which increases creative activity. Visualization of information contributes to the selection of relevant information, optimization of its processing and effective meta-analysis [9]. This is important for the development of integral thinking in many types of creative activity, since it perceives physical reality as the relationship between the whole and the particular [6; 14; 15]. However, at the same time, numerous environmental, ethical and aesthetic requirements must be taken into account, which do not contribute to the development of innovative thinking.

The purpose of the work is to search for new ideas and develop interdisciplinary tools for metamodeling physical and digital reality, which develop integral thinking, as well as increase creative and innovative potential.

Statement of the problem. Creative thinking in science, education and design has both common features and professional characteristics. Among the latter, the individuality of perception of harmony, dynamic symmetry and static tectonic orderliness of the unique natural landscape of Ukraine is important [30]. Therefore, identifying and taking into account the characteristics of an individual's brain activity allows us to solve the following tasks and subtasks:

• search for new paradigms, universals and universes in education and science;

• development of an integrative perception of physical reality based on the ecology of culture;

• development of integral thinking based on metasciences, metaphors and integrative knowledge of physical and digital reality.

The complementarity of these subtasks allows us to integrate unique achievements in various fields (architecture, design, ergonomics, computer modeling, materials science, etc.) based on generalized semiotics. This contributes to the mutual enrichment and self-development of an individual's creative activity.

Results of the study and their discussion.

The cycle of an individual's thinking and its structure. As shown in the works [23; 25; 27; 28], dynamic and static complexity depend on the hybrid subject environment, cycle and style of thinking. At the same time, attention is drawn to the fact that the structure of the thinking cycle has common features. They are associated with:

• dynamic similarity of processes of different nature [7];

• analogies in the functioning of the elements of the CDS, based on the Le Chatelier-Brown principle [34];

• ergonomic laws of mutual adaptation and transformation of the functioning of objects of animate and inanimate nature.

Their complementarity in the similarity of the structure of information processing is manifested, which reflects the features of the individual's thinking [5; 38; 35]. In the works [23; 25-28] different metamodels of the structure of thinking are considered, the generalization of which is given in Fig. 1 [33]. All synthesized metamodels are characterized by the form of a hexagon in the form of the Star of David; highlighting the conjugated triads of opposites with natural and additional colors according to Goethe; the balance of opposites, which reflects the harmony of the world (according to Kepler) [28].

In all metamodels, opposites (statics-dynamics, negativism-positivism, involution-evolution) are included in two conjugated triads, the inversion and balance of which are determined by the form of the metamodel in the form of a hexagon [23; 25-28].

Creative thinking in the process of development and learning forms individual experience and emotional intuition, through which emotional patterns of information processing are built [17; 18]. When they are automatically turned on, the features of an individual's thinking are manifested [20; 39].

Features of an individual's digital thinking. They have positive and negative properties, which are due to the natural desire of the learner to process information as quickly as possible. Conventionally, the properties of a person's network thinking are divided into positive, when the value of the information received is determined by codes, keywords, and not by content, and negative:

1. Positive properties. Therefore, an individual can freely move from one network to another, and is also able to combine several images that are not related to each other. At the same time, changing their behavior and principles each time.

2. Negative properties: a) The thinking of a network person is clip-based, that is, based on the operational superficial perception of a mass of disparate fragments of information [Mainzer, 1994]. Therefore, the individual does not notice the emerging contradictions. b) Network thinking is stereotypical, template-based and easily programmable, and is also incapable of independent thinking due to the lack of long-term memory. At the same time, the fragmentariness of the information consumed collides with the biological need of the brain to create a holistic image of the world, which is formed on the basis of the readings of all human senses. Thus, network thinking is characterized by one-dimensionality, in which an individual independently completes the missing fragments from individual fragments of information; a constant increase in the information load, which entails a change in the psyche, logic, and memory; an unpredictable

change in behavior patterns. Thus, the formation of predominantly digital (network) thinking creates new challenges to mental health, safety, and viability of the elements of the CDS.

Heuristic value of cognitive distortions. Systematic errors (manifest distortions) and genetically inherited cognitive distortions are considered in the works [23; 26]. As a result, the boundaries of the hybrid environment (brain, information transmission channels), as well as the uncertainties of their perception (cognitive distortions) are blurred. Therefore, the heuristic metamodel of digital interaction has a hybrid dual-triad structure, which naturally combines the balance and harmony of triads of conjugate opposites, as well as the contrast of the colors of opposites and the balance of their inversion (Fig. 2). In this hybrid metamodel, interdisciplinary interaction between different scientific approaches and directions (dynamics of visual communications, tectonic approach to clothing design, cognitive ergonomics) [1; 2], which are based on the principles of industrial design, clothing design and design of audiovisual means, is of particular interest. However, increasing dynamic and static complexity gives rise to cognitive distortions, the consideration and modeling of which opens up new possibilities. They are based on the exchange of research methods and the creative mutual enrichment of creative individuals.

Hybridity coefficient of the environment (HCE) as a cognitive value. In Figure 2, the hybrid cycle of digital interdisciplinary interaction connects all the vertices of the hexagon and is highlighted with green arrows (clockwise) and red arrows (counterclockwise). The interaction is accompanied by cognitive distortions that display the equally blurred boundaries of the interacting elements of the metamodel, and the inversion of their colors displays the contrast of opposites. At the same time, two conjugated triads display the relationship of dynamic and static complexity, the amount of overlap of the blurriness of which the hybridity coefficient of the environment (HCE) displays. In fact, the HCE displays cognitive distortions, which made it possible to associate the independence of the information exchange cycle from the direction of rotation in conjugated triads with creative thinking [23; 26; 28]. Whereas for critical thinking, the dependence of the thinking cycle on the direction of rotation is characteristic. In essence, this is the difference between the transitions from objectivity to subjectivity and back – from subjectivity to objectivity. In the works [23; 26-28] it is shown that in creative thinking the perception of the transition from simplicity to complexity and from order to disorder does not depend on the sequence of cycle consideration – along or against the arrow, but in critical thinking it does. Consequently, the HCE can be associated with not only obvious cognitive distortions, but also with hidden genetically inherited cognitive distortions. They can be determined from the signatures of electrophysiological signals [24], which allows using the HCE and hybrid methods of information processing to develop integral thinking. At the same time, by means of GenAI it is possible to adapt the cycles of experimental learning according to D. Colby with the cycle of integral thinking of an individual.

Transformation of the cycle of thinking in the process of learning from experience according to D. Kolb [16]. In real time, all the relationships between the dynamics and statics of the functioning of the CDS are manifested. Consequently, the structure of explicit and hidden relationships reflects the features of information perception, which the triad creative thinking of the individual reflects. Indeed, intuition forms a composition (image, work); knowledge contributes to reflection; the successful experience of the individual forms intuition (subconscious).

The new methodology of heuristic metamodeling is based on the complementarity of paradigms (synergetic, triadic and semiotic), as well as borrowing new ideas from nature, the beauty and harmony of which are interconnected [31].

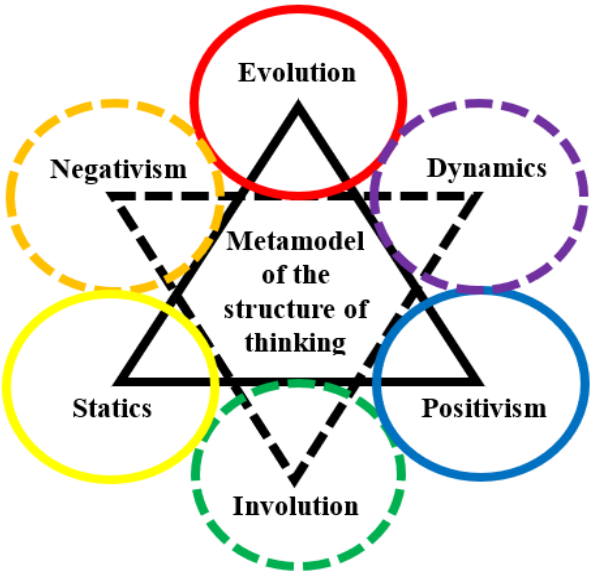

Fig. 1. Generalized metamodel of the ideal structure of creative thinking

Fig. 2. Hybrid heuristic metamodel of the structure of interaction of individuals

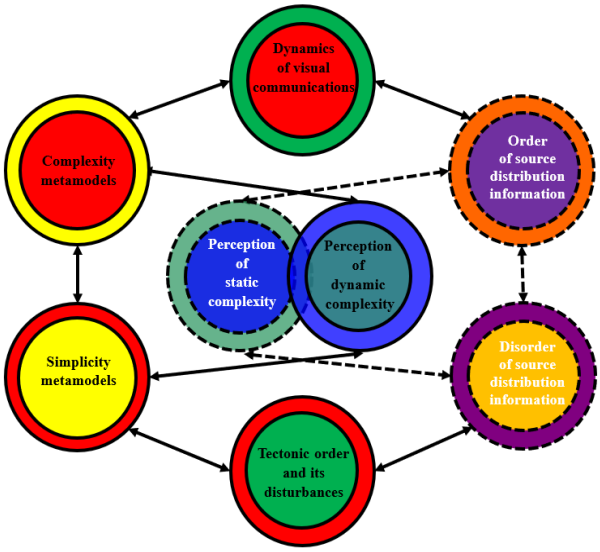

Fig. 3. Cognitive metamodel of information interaction through triads [27]

Their relationship, as well as taking into account the structural and functional asymmetry of the brain, unites physical and social ontology, which contributes to the formation of integral thinking in the learning process [28].

Individuality of creative thinking. In our opinion, individuality is due to the dominance of intellectual intuition (subconscious), which helps to develop your own cycle of thinking and learning style [25; 26]. Thus, a systemic analysis of changes in the cycles of information exchange between conjugated triads in the metamodel (Fig. 2) made it possible to establish that external and internal factors affect the features of creative thinking stress factors have a significant impact. At the same time, stress factors induce complementarity of perception of the dynamic complexity of the models of functioning of the CDS, as well as the static complexity of many of its elements [25; 26]. This made it possible to identify new patterns through inversion, in which explicit and hidden relationships are manifested. Therefore, the use of concepts and metaphors as constructive forms of creative

thinking is relevant for training architects, programmers and psychologists, for whom the analysis of the balance of external and internal information is important (Fig. 3).

As follows from the analysis of Fig. 3, the peculiarity of an individual's creative thinking is search for a balance of triads of conjugate opposites; establishment of harmony of triads of opposites; application of structure inversion to search for new patterns. Their complementarity reflects the dominance of knowledge (consciousness). Indeed, conservation laws (balance), symmetry (harmony) and structure inversion in design, physics, biology and computer science contribute to the search for new patterns.

Creative thinking based on bionics and successful experience. In particular, in creative thinking, the perception of the transition from simplicity to complexity and from order to disorder does not depend on the sequence of consideration of the cycle – clockwise or counterclockwise.

Consequently, creative thinking is based on independent cycles of perception of dynamic and static complexity, which allows hybrid online and offline learning to be implemented through:

• transformation of experiential learning according to D. Colby [16];

• use of hybrid methods of information processing;

• borrowing new ideas from nature, the beauty and harmony of which are interconnected [31].

In real time, all relationships between dynamics and statics are manifested. Consequently, the structure of explicit and hidden relationships reflects the features of information perception, which the triadic creative thinking of an individual reflects.

Indeed, intuition forms a composition (image, work); knowledge contributes to reflection; the successful experience of an individual forms intuition (subconscious). The new methodology of heuristic metamodeling is based on the complementarity of paradigms (synergetic, triadic and semiotic). Their relationship, as well as taking into account the structural and functional asymmetry of the brain, unites physical and social ontology, which contributes to the formation of creative thinking in the learning process [28].

Metamodeling of second-order thinking. In our opinion, the individuality of creative thinking is determined by the dominance of intellectual intuition (subconscious), which necessitates second-order thinking [12; 32; 35]. Awareness of one's knowledge determines the effectiveness of learning, the evolution of which can be studied using the heuristic metamodel of second-order thinking (see Fig. 3 at article [27]).

This model demonstrates conjugate triads that reflect the awareness of the evolution of thinking of three individuals during their transition from physics to metaphysics, from ergonomics to meta-ergonomics, from design to meta-design [26-28]. At the same time, the evolution of the subconscious through self-training, self-knowledge and self-reflection contributes to the development of second-order meta-thinking. It is based on the perception of harmony, balance and stability through the similarity of the structure of information flows of various natures.

Consciousness, subconsciousness and creative thinking are linked by emotional experience, which determines the nature of interaction in the digital world [19; 22]. Indeed, the subconscious of an individual determines the nature of interaction in the digital world, and its increasing complexity creates new cognitive problems and global challenges. At the same time, the complementarity of the metamodels of physical and digital reality in the form of the Star of David has cognitive and heuristic value.

Heuristic value of the evolution of thinking. Analysis of the evolution of thinking and the formation of metathinking generates new ideas, among which the following three ideas turned out to be the most relevant:

• the idea of a hybrid cognitive space on a transdisciplinary basis, which allows the search for hidden connections between consciousness and the subconscious to be carried out;

• the idea of developing integrative thinking based on semiotics, which was transformed into a search for hidden cognitive distortions through hybrid universals;

• the idea of teaching a strategy for solving creative problems on an interdisciplinary basis, which develops integral thinking.

They are based on semiotic analysis, which contributes to the search for new ideas and the development of the creative potential of an individual [5; 23; 28].

Cognitive value of hybrid universals. The structure of the semiotic triangle displays the unity of form, representing and replacing some object, as well as information about it. On the one hand, the universal triangle as an archetype of three-dimensional reality and a unique ancient sign-symbol stimulates the development of mathematics and physics. On the other hand, the structure of the hybrid of the pentagon and hexagon is inherent in unique materials of living and inanimate nature, which contributes to the development of an integrative perception of fractal nature. Cognitive value of hybrid universals interdisciplinary interaction simplifies, and also provides new information about:

• inversion of spatio-temporal relations in real time, which cause dissonance;

• cognitive distortions, which hidden spatio-temporal relationships display;

• complementarity of the dynamic and static description of the functioning of the elements of the CDS in extreme conditions.

It should be noted that in real time the triadic structure of hybrid universals is most evident in the hybrid space of dynamic events, which is based on the transdisciplinary metaphysical approach [4; 40; 38].

The universe of world harmony: movement, functioning and development in nature. The concept of the universe as a set of objects and phenomena considered as a single system; objective reality in time and space, which is used in philosophy, psychology and discrete mathematics; a category that denotes the basis of nature (cosmos, the fullness of being, the creative origin of the world, the fusion of subject and object).

Hybrid universals and universes are considered in the work, where it is shown that inversion and harmonization allow studying the complementarity of the dynamic and static description of the functioning of the elements of the CDS [23; 25-28]. The individuality of the evolution of their structure is most evident in the discrete cognitive space of dynamic events, in which the relationship of key paradigms (synergy, emergence and self-organization) is manifested. In the hybrid environment of the brain, their complementarity allows cognitive universals to be identified, with the help of which it is possible to evaluate:

• the dynamic complexity of the hybrid physical reality (symmetry, structure and orderliness);

• the static complexity of the distribution of multiple sources of information (defects, inhomogeneities and fluctuations);

• hidden connections between dynamic and static complexity, orderliness and chaos, as well as symmetry and asymmetry.

The stability of the hexagon – as a universe. Pierce initiated the study of the structure of signs and how it affects the thinking process. It turned out that the division of semiotics into three components: 1) semantics, which studies the relationship of signs to what they denote; 2) syntax, which studies the relationship of signs to each other; 3) pragmatics, which studies the relationship to the subjects who use them, expands the possibilities of interaction. In particular, the hexagon – as a universal allowed us to overcome interdisciplinary barriers and synthesize metamodels of the functioning of fractal nature in the form of the Star of David. Their systemic analysis in a single cognitive

space of dynamic events contributed to fruitful joint creative activity. In particular, to expand the scope of application of Niels Bohr's complementarity principle for interconnected cognitive and heuristic metamodels of synthesizing thinking [8; 9; 27], supplementing this process with new ideas, meanings and know-how.

From numerous interpretations of the Star of David, it follows that it surprisingly combines an idea and a paradigm, as well as the connection of the structure of a sign-symbol-code with functionality. Indeed, the hexagonal form of the Star of David displays:

• conjugate triads of opposites, which are the basis for the complementarity of metamodeling methods for physical and digital reality;

• structural balance, which is widely used in the natural sciences, computer science, art and psychology (life sciences);

• inversion, which is widely used in the natural sciences, computer science, culture and life sciences.

Therefore, the hexagonal shape of the Star of David is a universal of stability, which allowed the structural-functional approach to various types of creative activity to be implemented within the framework of a single cognitive space of dynamic events. It should be noted that the space of dynamic events is synthesized on the basis of interconnected extreme principles of natural science, dimensional theory and the Gauss method [8; 9; 27]. The consequence of the complementarity of the approaches is the relationship of cognitive and heuristic metamodels, which are based on the similarity of the processes of natural information processing in nature and the brain. In general, the use of a semiotic structure in the form of the Star of David as a universal has opened up new opportunities for us for survival, cognition and an increase in creative potential.

Metamodeling of hybrid physical reality [21]. It develops integral thinking and is considered in the works [23; 25-28]. In our opinion, natural dynamic and static information should be obtained online using semiotic tools, the complementarity of which contributes to the integrative perception of physical reality and the development of integral thinking. Indeed, the most effective algorithms are "inspired by nature", and these are cellular automata, evolutionary computations, swarm intelligence and others. There are also many developments of computing systems that rely on the key principles of biomimicry (bionics). Many designers, architects and researchers believe that we do not copy nature, but are inspired by it [31]. Therefore, metamodeling of physical reality (fractal nature) makes it possible to change the ways of growing crystals or breeding organisms, storing information or self-coding, self-healing or self-learning.

Integral perception of differences between physical and digital reality. Features of thinking in science, art and design, as well as the connection of an individual's worldview with the perception of the harmony of nature, heuristic thinking and cognitive flexibility form [23; 25-28]. With the help of neurosciences (neuroergonomics, neuropsychology, etc.), it has been established that the manifestation of cognitive problems depends on the psychophysiological state of a person [29; 36; 37]. Within the framework of the structural-functional approach to the thinking of a designer, attention is drawn to the heuristic significance of combining physical and social ontology [23; 25-28].

The key principles of integral thinking are holism (the world is a single whole), contextuality (perception of the world depends on the subject environment) and systematicity (consideration of a problem as a complex system that cannot be solved by adding up parts). Therefore, the interrelation and complementarity of cognitive and heuristic metamodels allows us to take into account the peculiarities of an individual’s brain activity and to further develop the structural-functional approach to the perception of physical and digital reality [8]. The research methodology is

based on the post-neoclassical paradigm of scientific knowledge, a dialectically developing subject-object system of relationships in a hybrid innovative educational environment, and also includes new methods of interdisciplinary research and metamodeling of reality that combine physical and social ontology. Their complementarity contributes to the harmonization of the data (information) structure, which is widely used in the natural sciences, computer science, art and life sciences.

Cognitive value of developing interdisciplinary connections. The heuristic metamodel of integrating different types of perception of physical reality in the form of conjugate triads of opposites is shown in Fig. 4.

On the one hand, the hexagonal form of the metamodel simplifies the choice of universal tools for its analysis, namely:

• the inversion method, which is widely used in the natural sciences, computer science, culture and life sciences;

• data harmonization methods, which are widely used in the natural sciences, computer science, art and life sciences;

• the structural balance method, which is widely used in the natural sciences, computer science, art and psychology.

On the other hand, the hexagonal form of the heuristic models shown in Fig. 4 and Fig. 5 allows us to study the evolution of an individual's thinking and the formation of second-order thinking. Analysis of hidden relationships that reflect the integrative perception of reality opens up new possibilities. Such integration of metamodels contributes to the development of integral metathinking, which has cognitive and innovative value.

Nonlinear dynamics of physical reality. Universal mechanisms of functioning of CDS of various nature, in order to be implemented, must be simply arranged. On the one hand, simple structures are few in number and therefore universal. The universality and simplicity of the structure of complex dynamic systems is the key to their knowability. Synergetics combines ontology (the study of being) and epistemology (the study of cognition) [10-12], and its key paradigms are:

• self-organization – the identification of order parameters – a small set of leading variables, to the dynamics of which all the others adapt;

• dynamic chaos – non-periodic behavior in deterministic systems;

• complexity – existence at the junction of order and chaos.

It is their complementarity that leads to complexity, which in turn manifests itself in:

• scale invariance – the absence of characteristic dimensions in phenomena;

• spatio-temporal consistency of the behavior of elements of the integral CDS;

• stability of course (qualitative) features in relation to fine features.

Thus, the physical expression of complexity is scale invariance and integrity, and the mathematical expression is power probability distributions and correlations. Complexity arises either due to artificial organization (initial integrity or fine-tuning of parameters), or as a result of self-organization into a critical state.

Hybrid universe of integration. On the one hand, the universe is also a unity of order (regularity, proportionality, harmony), and on the other hand, chaos (disorder, disorganization, lack of laws, disharmony). Therefore, in cognitive visualization of physical reality, the connection of emotional experience (subconscious) with awareness of one's knowledge (consciousness) contributes to better understanding and production of new ideas. Thus, in the works [23; 25-28] a new idea is developed about the complementarity of explicit and hidden relationships in a hybrid environment [13], which is based on balance of triads of conjugate opposites; harmony of perception of hidden relationships; transitions from triad to duality and back from duality to triad.

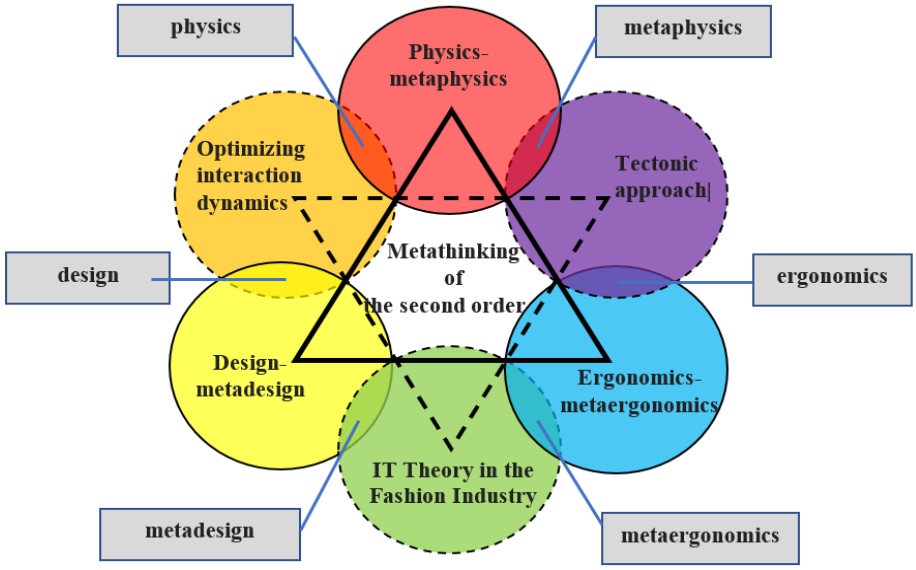

Fig. 4. Heuristic metamodel of integration of different types of perception of reality with interdisciplinary metasciences [27]

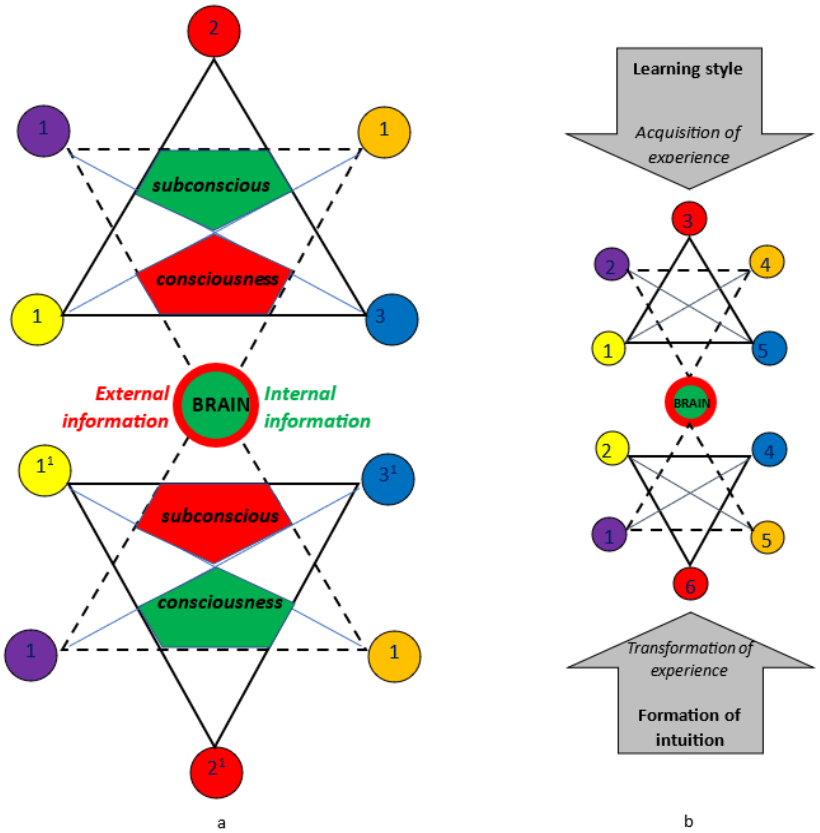

Fig. 5. Metamodels: a – cognitive 3M metamodel of spatial perception of relationships in a hybrid environment; b – heuristic 3S metamodel of the structure of self-regulation in the process of acquiring experience and its transformation [27]

The consequence of this is the complementarity of cognitive 3M metamodels, which is achieved through the use of the double Star of David as a universe, and heuristic 3S metamodels, which is achieved through the use of a hybrid structure (hexagon-pentagon) as a universe [23; 25-28].

Fullerene – a hybrid of a hexagon and a pentagon – unique properties. This hybrid was noticed in the 16th century by the

astronomer, mathematician, creator of the theory of music and poet Kepler. A new type of existence of carbon molecules – C60, is a regular polyhedron, consisting of 20 hexagons and 12 pentagons. The new form of carbon was named fullerene in honor of the brilliant American architect Buckminster Fuller, who is known for his completely unearthly, but amazingly stable structures of pentagons and hexagons. Hexagonal structures are best adapted to external influences, providing the greatest strength with the least material costs. At the same time, the hexagon, as a closed system, retains energy, order and information during integration. On the one hand, the hybrid of the hexagon and pentagon plays a dominant role in the formation of living organisms and in the growth diagrams of living systems. On the other hand, such a structure is contained in DNA and all psychotropic substances, viruses and modern stimulants. Therefore, the hybrid of the hexagon and pentagon promotes:

• self-organization, self-knowledge and self-regulation in 3S metamodels;

• metamodeling, metacognition and metathinking in 3M metamodels;

• hybrid integration of education, science and the technosphere through the use of the AI metamodel 3M – 3S. which is a unique universe of integration of individuals.

Synergy of 3S and 3M metamodels for creative development potential. In the work [23], the 3M metamodel is considered as a universe of cognition of static reality by an individual. In this case, the structure of the relationships of the dynamic balance of opposites in the generalized metamodel is achieved by means of: inversion of conjugated triads of opposites, the use of Goethe's natural color circle when coloring the graphic model, as well as spatial perception of the structure of relationships in a hybrid environment (Fig. 5a).

The 3S metamodel of the structure of relationships of information exchange is shown in Fig.5b. As we can see, its structure is also represented by conjugated triads, the number of relationships between which is 9, which coincides with the number of styles of experiential learning in the cycle of David Kolb [16; 27]. Indeed, the acquisition of experience and its transformation in the process of self-regulation includes self-development, self-knowledge and self-reflection [18; 41]. These processes are studied by second-order metathinking, which, as one of the emergent properties of an individual, is associated with the ability to:

• change in a positive direction one's inner spiritual world and effectively adapt to the learning environment;

• self-realization, through personal efforts and creative work;

• resolve internal contradictions not only with the natural subject environment, but also with the social one, including spiritual life (art, poetry, etc.).

Depending on the direction of the worldview, its self-development can be realized in the unity and interaction of three levels: social adaptation, social self-regulation and self-organization. In essence, the 3S metamodel of the structure of relationships is a temporal universe, the use of which contributes to the development of the skills of creative activity of the individual.

Self-organized integration of creative individuals (SICI). On the one hand, the phenomenon of self-organized criticality [3] is known, as well as the influence of 1/f noise on it. On the other hand, in our works [24] we have shown that noise, jumps and inhomogeneities of the environment are new sources of information. War, the Covid-19 epidemic and disasters (technical, environmental and space) contributed to a heightened perception of physical reality and the search for new ideas, methods, paradigms and technologies.

Thus, the relationship and complementarity of cognitive and heuristic metamodels are the basis of a new idea – self-organized integration of creative individuals (SICI), the implementation of which is extremely important for the restoration of the destroyed Ukraine. Moreover, it is a consequence of the

intellectual search for means of adaptation, survival and social justice. SICI is based on the integration of 3S and 3M metamodels: a semiotic approach to the unification of physical and social ontology; taking into account the characteristics of an individual's brain activity; a structural and functional approach to the perception of physical and digital reality.

Optimization of creative activity cycles and the use of 3S and 3M metamodels to expand the intellectual database by transforming an individual's EEG and ECG signals into cognitive graphic images allows us to create a multifunctional GenAI-transformer that allows us to solve the pressing problems of post-war Ukraine, namely:

• improve the mental health of students and teachers through objective criteria for the creative activity of individuals;

• based on universals and universes, establish objective criteria for creative activity and develop a quantitative assessment of it;

• quantitatively assess creative activity using objective criteria.

Hidden cognitive distortions and development of integral thinking of an individual. The influence of hidden cognitive distortions on learning, as well as the use of GenAI in education and science, has not been sufficiently studied [28]. According to Kolb's theory, knowledge and skills are acquired during 4 phases of the cycle, during which the acquisition of experience and its transformation form a balance of creative and critical thinking (Fig. 5b). At the same time, the inversion of the structure of relationships does not change the functionality of metamodels. Consequently, the complementarity of the 3S metamodel of self-regulation, self-reflection and self-knowledge and the 3M metamodel of reality allows the learning activities of students to be optimized. At all stages of the learning cycle, it is important to have a creative vision of problem solving, which requires the development of integral metathinking by all students, which allows maintaining a balance by weighing all the pros and cons. It is important to emphasize that the learning style is a certain state at each stage of life, the evolution of which reflects the change in the relationship of consciousness to the subconscious. At the same time, a huge number of images, metaphors, and other artistic tools simplify work with the subconscious.

Universality and complementarity of hybrid methods of information processing and learning technologies. Due to the total spread of neural networks, students already have difficulties with the development of critical thinking, since they solve many problems using artificial intelligence. In order to minimize any risks and get only advantages from using AI in education, an individual needs to develop integral metathinking. The search for hybrid universals (methods, technologies and signs) allows the GenAI-transformer to be created. On its basis, integrative thinking can be developed taking into account the individual cognitive characteristics of an individual, which opens up qualitatively new opportunities for individualization of the trajectory (strategy) of learning using GenAI.

Overcoming interdisciplinary barriers between the authors contributed to the evolution of thinking and the development of metathinking, which was manifested in our fruitful joint work. Our innovative activities are reflected in patents and know-how, among which the following know-how are of particular interest for education, science and design:

• method for determining the features of second-order thinking of an individual;

• method for determining the stressful psychophysiological state of an individual;

• method for identifying the transitional psychophysiological state of an individual.

On the one hand, the greening of education is important for sustainable development, for which the innovative focus of training is important. On the other hand, it is necessary to take into account the cognitive characteristics of an individual, the evolution of which contributes to the search for new ideas. Therefore, innovations (patents and know-how) for the development of integral thinking of an

individual are relevant, which can be implemented with the help of a personal GenAI-transformer.

Synergy of 3S – 3M metamodels as a hybrid universe of integration. The idea of self-organization made it possible to understand the development of the complex from the simple and the emergence of order from chaos. Therefore, emergence explains complex phenomena in various fields (thermodynamics, biology, digital technologies, etc.). The use of the cognitive mind metamodel (3M metamodel) in the form of a double Star of David in the process of creative activity demonstrates:

• optimization of balance when moving from one Star of David to another through inversion, which reflects the harmony of physical reality and the fractality of nature;

• instability of the relationship between consciousness and the subconscious, the inversion of which reflects the transition from one pentagon to another;

• the influence of the asymmetry of the cerebral hemispheres on the formation of metathinking, which indicates the stability of oppositely oriented hexagons and pentagons.

Obviously, the 3S metamodel displays a double cycle of the pentagon in the hexagon, which makes their superposition an effective means of cognition, management and evaluation using the GenAI-transformer. Thus, the complementarity of the 3S and 3M metamodels is associated with the inversion of the structure and the balance of conjugated triads, as well as the harmony and balance of opposites. Their synergy allows creative and innovative thinking to be formed in the learning process based on successful emotional experience.

Conclusions. On the one hand, the complementarity of approaches, methods and technologies in design, ergonomics and technical aesthetics, and on the other hand, the relationship between metadesign, metaergonomics and metamodeling has cognitive and heuristic value. Thus, the application of the generalized principle of complementarity of N. Bohr for the integration of different types of creative activity based on hybrid universals and universes opens up new possibilities. In particular, the integrative knowledge of physical reality contributes to the development of integral thinking, which allows us to see the relationship between the whole and the particular of the hybrid subject environment.

The main results of the work are:

• New paradigms, universals and universes, based on hybrid signs-symbols, as well as a combination of means (smell, light, color and sound). Their complementarity and interrelation open up new possibilities for increasing the efficiency of the dynamics of visual communications through their structuring and combination.

• The connection of the generalized principle of complementarity of N. Bohr with the tectonic ordering of fractal nature, as well as the complementarity of the principles of bionics, heuristics and cognitive science, opens up new opportunities for the development of the methodology of functional clothing design in post-war Ukraine.

• New opportunities for the development of the theory of clothing design, functional design and second-order metasciences based on hybrid structures and metamodels, in which the hybrid of the pentagon and hexagon is the universe of integration.

The interrelation and complementarity of these results are the basis of a new idea of self-organization of creative individuals, for the implementation of which a new toolkit is proposed.

Ideas for discussion:

• integration of scientific schools based on sciences (philosophy, psychology, second-order metasciences), which allow you to better understand how thoughts and actions affect the world around you;

• based on semiotics, unification of curricula, the interrelation of which removes

interdisciplinary barriers and expands the worldview of designers;

• in the process of learning from experience, develop integral metathinking, which will help to better understand problems and find original solutions.

On this basis, ***it is necessary to implement:***

• bring design education in line with the European classification;

• use the unique capabilities of the personal AI-transformer and the emergent properties of the 3S and 3M metamodels to acquire integral thinking skills in the process of learning from experience according to D. Colby;

• development of integrative indicators of criteria for assessing harmony, order and balance in design objects using the GenAI-transformer.

Література:

1. Ергономіка і дизайн. Проектування сучасних видів одягу: навчальний посібник / Колосніченко М. В., Зубкова Л. І., Пашкевич К. Л. та інш. Київ: ПП «НВЦ «Профі», 2014. 386 с.

2. Скляренко Н. В., Колосніченко М. В. Стікери: засоби проєктування динамічної візуальної комунікації. *Мистецтвознавчі записки*. 2021. Вип. 40. С. 22–28. https://doi.org/10.32461/2226-2180.40.2021.250322.

3. Bak P. Self-organized criticality. *Physical Review A*. 1988. Vol. 38. No 1. P. 364–374. https://doi.org/10.1103/PhysRevA.38.364.

4. Bird A. Nature's metaphysics: Laws and properties. New York: Oxford University Press, 2010. 246 p.

5. Edwards A. W. F. Maximisation principles in evolutionary biology. *Philosophy of Biology*. 2007. P. 335–347. https://doi.org/10.1016/B978-044451543-8/50017-4.

6. Fahmy S., Bock A. M., Wayne W. Visual communication theory and research: A mass communication perspective. New York: Palgrave Macmillan, 2014. https://doi.org/10.1057/9781137362155.

7. Forrester J. System dynamics – the next fifty years. *System Dynamics Review*. 2007. Vol. 23. No 2. P. 345–356. https://doi.org/10.1002/sdr.381.

8. French S. The structure of the world: Metaphysics and representation. Oxford: Oxford University Press, 2017. 414 p.

9. Gilbert K. J. Visualization in science education. *Springer Science & Business Media*. 2006. 346 p.

10. Haken H. Principles of brain functioning: A synergetic approach to brain activity, behavior and cognition. Berlin: Springer-Verlag, 1995. https://doi.org/10.1007/978-3-642-79570-1.

11. Haken H. Synergetics as a bridge between the natural and social sciences. *Evolution, Order and Complexity*. London: Springer, 1996. P. 241–265.

12. Haken H., Portugali J. Information adaptation: The interplay between Shannon information and semantic information in cognition. Cham: Springer, 2015. https://doi.org/10.1007/978-3-319-11170-4.

13. Hu Y. Research on the design method of traditional decorative patterns of ethnic minorities under the trend of AIGC. *Journal of Electronics and Information Science*. 2023. Vol. 8(5). P. 58–62. https://doi.org/10.23977/jeis.2023.080509.

14. Kaufman J. C., Plucker J. A., Baer J. Essentials of Creativity Assessment. Hoboken: John Wiley & Sons Inc., 2008. 240 p.

15. Kim K. H. The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal*. 2011. Vol. 23(4). P. 285–295. https://doi.org/10.1080/10400419.2011.627805.

16. Kolb A. Y., Kolb D. A. The Learning Way: Meta-cognitive Aspects of Experiential. *Simulation & Gaming*. 2009. Vol. 40. No 3. P. 297–327. https://doi.org/10.1177/1046878108325713.

17. Krampen G. Promoting creativity (divergent production) and convergent production through systematic relaxation exercises: Empirical evidence from five experimental studies with children, young adults and older adults. *European Journal of Personality*. 1997. Vol. 11(2). P. 83–99. https://doi.org/10.1002/(SICI)1099-0984(199706)11:2<83::AID-PER280>3.0.CO;2-5.

18. Leventhal H. Emotions: A basic problem for social psychology. *Social psychology: Classic and contemporary integrations* / Ed. Nemeth C. Chicago: Rand McNally, 1974. P. 1–51.

19. Lu Y., Xu S., Liu S., Wu J. An approach to urban landscape character assessment: Linking urban big data and machine learning. *Sustainable Cities and*

Society. 2022. Vol. 83. Article 103983. https://doi.org/10.1016/j.scs.2022.103983.

20. Mainzer K. Thinking in complexity: The complex dynamics of matter, mind, and mankind. Berlin Heidelberg: Springer-Verlag, 1994.

21. Mandelbrot B. B. The fractal geometry of nature. Times Books, 1982. 468 p.

22. Mieth L., Schaper M. L., Kuhlmann B. G. et al. Memory and metamemory for social interactions: Evidence for a metamemory expectancy illusion. *Cognitive Psychology*. 2021. Vol. 49. P. 14–31. https://doi.org/10.3758/s13421-020-01071-z.

23. Mygal S. P., Mygal V. P., Mygal G. V. A Hybrid Approach to Learning Based on Emotional Experience and the Development of Innovative Metathinking in Post-War Ukraine. *Art and Design*. 2024. Vol. 3, No 27. P. 86–97. https://doi.org/10.30857/2617-0272.2024.3.7.

24. Mygal V. P., But A. V., Mygal G. V., Klimenko I. A. An interdisciplinary approach to study individuality in biological and physical systems functioning. *Scientific Reports*. 2016. Vol. 6. Article 29512. https://doi.org/10.1038/srep29512.

25. Mygal V. P., Mygal G. V., Mygal S. P. AI: Unique opportunities and global challenges – A hybrid approach to modeling reality and its perception. *Qeios*. 2024. Vol. 5. P. 1-37. https://doi.org/10.32388/GIJ3RI.4.

26. Mygal V. P., Mygal G. V., Mygal S. P. Complementarity of heuristic and cognitive metamodels – hybrid approach. *J. Nano-Electron. Phys.* 2024. Vol. 16. No 4. Article 04024. https://doi.org/10.21272/jnep.16(4).04024.

27. Mygal V., Mygal G., Mygal S. Cognitive and heuristic modeling of reality, developing innovative thinking: A semiotic approach to training an individual. *The Educational Review, USA*. 2024. Vol. 8. No 11. P. 1379–1392. http://dx.doi.org/10.26855/er.2024.11.017.

28. Mygal V., Mygal G., Mygal S. Cognitive space for online and offline learning: A convergent approach. *The Educational Review, USA*. 2022. Vol. 6. No 4. P. 109–123. https://doi.org/10.26855/er.2022.04.001.

29. Parasuraman R. Neuroergonomics: A review of applications to physical and cognitive work. *Frontiers in Human Neuroscience*. 2013. Vol. 7. Article 889. https://doi.org/10.3389/fnhum.2013.00889.

30. Pashkevych K., Yezhova O., Ostapenko N., Gerasymenko O., Protsyk B., Skliarenko N. Study of the properties of linen fabrics for the design of clothing decorated with embroidery. *Man-Made Textiles in India*. 2024. Vol. 52, Iss. 4. P. 153–162.

31. Passino K. M. Biomimicry for Optimization, Control, and Automation. London: Springer-Verlag, 2005.

32. Ranko M. A., Jaeger J. J. A Standard Definition of Creativity. *Journal of Creativity Studies*. 2012. Vol. 24, No 1. P. 92–96.

33. Rigolot C. Transdisciplinarity as a discipline and a way of being: Complementarities and creative tensions. *Humanities and Social Sciences Communications*. 2020. Vol. 7. Article 98. https://doi.org/10.1057/s41599-020-00598-5.

34. Russel J. S., Norvig S. Artificial intelligence: A modern approach. Prentice Hall, 2003. URL: https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf.

35. Sawyer R. K., Henriksen D. Explaining Creativity: The Science of Human Innovation. Oxford University Press, 2024. 592 p.

36. Schaper M. L., Bayen U. The metamemory expectancy illusion in source monitoring affects metamemory control and memory. *Cognition*. 2021. Vol. 206. 104468. https://doi.org/10.1016/j.cognition.2020.104468.

37. Schwartz B. L., Metcalfe J. 2.23 – Metamemory: An Update of Critical Findings. *Learning and Memory: A Comprehensive Reference* / Editor(s): John H. Byrne. Academic Press, 2017. P. 423-432. https://doi.org/10.1016/B978-0-12-809324-5.21056-0.

38. Stöltzner M. The principle of least action as the logical empiricist's Shibboleth. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics*. 2003. Vol. 34(2). P. 285–318. https://doi.org/10.1016/S1355-2198(03)00002-9.

39. Sungkhasettee V. W., Friedman M. C., Castel A. D. Memory and metamemory for inverted words: Illusions of competency and desirable difficulties. *Psychonomic Bulletin & Review*. 2011. Vol. 18. No 5. P. 973–978. https://doi.org/10.3758/s13423-011-0114-9.

40. Terekhovich V. Metaphysics of the principle of least action. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics*. 2018. Vol. 62. P. 189–201. https://doi.org/10.1016/j.shpsb.2017.09.004.

41. Vaccaro A. G., Fleming S. M. Thinking about thinking: A coordinate-based meta-analysis of neuroimaging studies of metacognitive judgements.

Brain and Neuroscience Advances. 2018. Vol. 2. 2398212818810591. https://doi.org/10.1177/2398212818810591.

References:

1. Kolosnichenko, M. V., Zubkova, L. I., Pashkevich, K. L. et al. (2014). Erhonomika i dyzain. Proektuvannia suchasnykh vydiv odiahu [*Ergonomics and design: Designing modern types of clothing]*. Study guide. Kyiv [in Ukrainian].

2. Skliarenko, N., & Kolosnichenko, M. (2021). Stikery: zasoby proiektuvannia dynamichnoi vizualnoi komunikatsii [Stickers: design tools of the dynamic visual communication]. *Mystetstvoznavchi zapysky*, 40, 22-28 [in Ukrainian].

3. Bak, P. (1988). Self-organized criticality. *Physical Review A,* 38(1), 364–374. https://doi.org/10.1103/PhysRevA.38.364.

4. Bird, A. (2007). *Nature's metaphysics: Laws and properties*. New York: Oxford University Press.

5. Edwards, A. W. F. (2007). Maximisation principles in evolutionary biology. *Philosophy of Biology*. 335-347. https://doi.org/10.1016/B978-044451543-8/50017-4.

6. Fahmy, S., Bock, A. M., & Wayne, W. (2014). *Visual communication theory and research: A mass communication perspective*. New York, NY: Palgrave Macmillan. https://doi.org/10.1057/9781137362155.

7. Forrester, J. (2007). System dynamics – the next fifty years. *System Dynamics Review,* 23(2), 345–356. https://doi.org/10.1002/sdr.381

8. French, S. (2017). *The structure of the world: Metaphysics and representation*. Oxford: Oxford University Press.

9. Gilbert, K. J. (2006). Visualization in science education. Springer Science & Business Media.

10. Haken, H. (1995). Principles of brain functioning: A synergetic approach to brain activity, behavior and cognition. Springer-Verlag Berlin Heidelberg. https://doi.org/10.1007/978-3-642-79570-1.

11. Haken, H. (1996). Synergetics as a bridge between the natural and social sciences. In *Evolution, Order and Complexity* (pp. 241–265). London: Springer.

12. Haken, H., & Portugali, J. (2015). *Information adaptation: The interplay between Shannon information and semantic information in cognition*. Cham: Springer. https://doi.org/10.1007/978-3-319-11170-4.

13. Hu, Y. (2023). Research on the design method of traditional decorative patterns of ethnic minorities under the trend of AIGC. *Journal of Electronics and Information Science,* 8 (5), 58–62. https://doi.org/10.23977/jeis.2023.080509.

14. Kaufman, J. C., Plucker, J. A., & Baer, J. (2008). *Essentials of Creativity Assessment*. Hoboken, NJ: John Wiley & Sons Inc.

15. Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal,* 23(4), 285–295. https://doi.org/10.1080/10400419.2011.627805.

16. Kolb, A. Y., & Kolb, D. A. (2009). The Learning Way: Meta-cognitive Aspects of Experiential Learning. *Simulation & Gaming*, 40(3), 297-327. https://doi.org/10.1177/1046878108325713.

17. Krampen, G. (1997) Promotion of Creativity (Divergent Productions) and Convergent Productions by Systematic Relaxation Exercises: Empirical Evidence from Five Experimental Studies with Children, Young Adults and Elderly. *European Journal of Personality,* 11 (2), 83-99. https://doi.org/10.1002/(SICI)1099-0984(199706)11:2<83::AID-PER280>3.0.CO;2-5.

18. Leventhal, H. (1974). Emotions: A basic problem for social psychology. In Nemeth, C. (Ed.), *Social psychology: Classic and contemporary integrations* (pp. 1–51). Chicago: Rand McNally.

19. Lu, Y., Xu, S., Liu, S., & Wu, J. (2022). An approach to urban landscape character assessment: Linking urban big data and machine learning. *Sustainable Cities and Society,* 83, Article 103983. https://doi.org/10.1016/j.scs.2022.103983

20. Mainzer, K. (1994). Thinking in complexity: The complex dynamics of matter, mind, and mankind. Berlin Heidelberg: Springer-Verlag.

21. Mandelbrot, B. B. (1982). The fractal geometry of nature. Times Books.

22. Mieth, L., Schaper, M.L., Kuhlmann, B.G. et al. (2021). Memory and metamemory for social interactions: Evidence for a metamemory expectancy illusion. *Cogn*., 49. 14-31. https://doi.org/10.3758/s13421-020-01071-z

23. Mygal, S. P., Mygal, V. P., & Mygal, G. V. (2024). A Hybrid Approach to Learning Based on Emotional Experience and the Development of Innovative Metathinking in Post-War Ukraine. *Art and design*, 3(27), 86–97. https://doi.org/10.30857/2617-0272.2024.3.7.

24. Mygal, V. P., But, A. V., Mygal, G. V., & Klimenko, I. A. (2016). An interdisciplinary approach to study individuality in biological and physical systems functioning. *Scientific Reports, 6*, 29512. https://doi.org/10.1038/srep29512.

25. Mygal, V. P., Mygal, G. V., & Mygal, S. P. (2024). AI: Unique opportunities and global challenges – A hybrid approach to modeling reality and its perception. *Qeios*. 5. 1-37. https://doi.org/10.32388/GIJ3RI.4.

26. Mygal, V. P., Mygal, G.V., & Mygal, S. P. (2024). Complementarity of heuristic and cognitive metamodels – hybrid approach. *J. Nano-Electron. Phys.,* 16(4), 04024. https://doi.org/10.21272/jnep.16(4).04024.

27. Mygal V., Mygal G., & Mygal S. (2024). Cognitive and Heuristic Modeling of Reality, Developing Innovative Thinking: A Semiotic Approach to Training an Individual. *The Educational Review,* USA, 8(11), 1379-1392. http://dx.doi.org/10.26855/er.2024.11.017.

28. Mygal, V., Mygal, G., & Mygal, S. (2022). Cognitive space for online and offline learning: A convergent approach. *The Educational Review,* 6(4), 109–123. https://doi.org/10.26855/er.2022.04.001.

29. Parasuraman, R. (2013). Neuroergonomics: A review of applications to physical and cognitive work. *Frontiers in Human Neuroscience,* 7, 889. https://doi.org/10.3389/fnhum.2013.00889.

30. Pashkevych, K., Yezhova, O., Ostapenko, N., Gerasymenko, O., Protsyk, B., & Skliarenko, N. (2024). Study of the properties of linen fabrics for the design of clothing decorated with embroidery. *Man-Made Textiles in India*, 52(4), 153-162.

31. Passino, K. M. (2005). *Biomimicry for Optimization, Control, and Automation.* Springer-Verlag London.

32. Ranko, M. A., & Jaeger, J. J. (2012). A Standard Definition of Creativity. *Journal of Creativity Studies*, 24(1), 92–96.

33. Rigolot, C. (2020). Transdisciplinarity as a discipline and a way of being: Complementarities and creative tensions. *Humanities and Social Sciences Communications,* 7, 98. https://doi.org/10.1057/s41599-020-00598-5.

34. Russel, J. S., & Norvig, S. (2003). *Artificial intelligence: A modern approach*. Prentice Hall. URL: https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf.

35. Sawyer, R. K., & Henriksen, D. (2024). *Explaining Creativity: The Science of Human Innovation*. Oxford University Press.

36. Schaper, M. L., & Bayen, U. (2021). The metamemory expectancy illusion in source monitoring affects metamemory control and memory. *Cognition*, 206, 104468. https://doi.org/10.1016/j.cognition.2020.104468.

37. Schwartz, B. L., & Metcalfe, J. (2017). 2.23 – Metamemory: An Update of Critical Findings. Editor(s): John H. Byrne, *Learning and Memory: A Comprehensive Reference*. Academic Press, 423-432. https://doi.org/10.1016/B978-0-12-809324-5.21056-0.

38. Stöltzner, M. (2003). The principle of least action as the logical empiricist's Shibboleth. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics,* 34 (2), 285–318. https://doi.org/10.1016/S1355-2198(03)00002-9.

39. Sungkhasettee, V.W., Friedman M.C., & Castel A.D. (2011). Memory and metamemory for inverted words: Illusions of competency and desirable difficulties. *Psychonomic bulletin & review*, 18(5), 973-978. https://doi.org/10.3758/s13423-011-0114-9.

40. Terekhovich, V. (2018). Metaphysics of the principle of least action. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics,* 62, 189–201. https://doi.org/10.1016/j.shpsb.2017.09.004.

41. Vaccaro, A. G., & Fleming, S. M. (2018). Thinking about thinking: A coordinate-based meta-analysis of neuroimaging studies of metacognitive judgements. *Brain and neuroscience advances*, 2, 2398212818810591. https://doi.org/10.1177/2398212818810591.

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ВЗАЄМНЕ ЗБАГАЧЕННЯ ОСВІТИ, НАУКИ ТА ТЕХНОЛОГІЙ В ПОВОЄННІЙ УКРАЇНІ ШЛЯХОМ САМООРГАНІЗОВАНОЇ ІНТЕГРАЦІЇ ТВОРЧИХ ІНДИВІДУУМІВ

Мета роботи: *пошук нових ідей метамоделювання фізичної і цифрової реальності та розробка міждисциплінарних засобів, які підвищують творчий та інноваційний потенціал.*

Методологія *дослідження включає методи міждисциплінарного аналізу і когнітивного метамоделювання фізичної та цифрової реальності.*

Результати. *Запропоновано нові парадигми, гібридні універсалії та універсуми, а також методику формування інтегрального мислення. Їх взаємодоповнюваність відкриває нові можливості для підвищення ефективності динаміки візуальних комунікацій. Виявлено зв'язок узагальненого принципу додатковості Н. Бора з тектонічною впорядкованістю фрактальної природи та взаємодоповнюваністю принципів біоніки, евристики та когнітивної науки, який відкриває принципово нові можливості для використання різних підходів у дизайні моди та предметного середовища життєдіяльності людини. Запропоновані метамоделі творчого мислення, що охоплюють ключові типи дизайну – інформаційний, динамічний і візуальний. Обґрунтовано нові можливості для розвитку теорії та практики дизайну середовища та його предметного наповнення на основі гібридних структур та метамоделей.*

Наукова новизна: *вперше розроблено метаметодологію інтеграції творчих особистостей, яка сприяє розвитку творчого потенціалу, покращенню психічного здоров'я та функціональної безпеки.*

Практична значущість. *Розроблено інноваційну методологію виявлення особливостей пізнання гармонії фрактальної природи та її застосування в процесі розвитку метамислення як здатності пізнавати, аналізувати та змінювати своє мислення. Впроваджено інтегративний коефіцієнт когнітивних спотворень і інтегративні критерії оцінки творчого потенціалу індивідуума. Запропоновано інноваційну методологію виявлення явних і прихованих когнітивних спотворень за допомогою ШІ-трансформера. Взаємодоповнюваність цих результатів є основою нової ідеї самоорганізації творчих особистостей, яка спрямована на інтеграцію освіти в післявоєнній Україні до єдиного європейського простору вищої освіти та примноження людського та інтелектуального капіталу України.*

Ключові слова: *когнітивна візуалізація, дизайн, метамоделі пізнання, дизайн-мислення, евристичні метамоделі, саморегуляція, самопізнання, гібридне предметне середовище, дизайн середовища.*

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