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Philosophical and methodological prospects for the future of synergetics in the scientific picture of the world

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Abstract: Aims: The purpose of the scientific research is to determine the formation of philosophical and methodological principles of synergetics' peculiarities in the context of interdisciplinarity of the scientific world picture development. The interdisciplinarity is an innovative format of scientific activity that ensures the universality of scientific and cognitive activity. Philosophy traditionally acts as a kind of arbiter in life research. The study uses the traditional synergistic ideas of the scientific and philosophical community. They correlate with the principles of modern scientific and methodological discourse. At the same time, the guidelines that form a separate cluster of synergistic methodology - the innovative dimension of self-organization, namely: universality, pragmatism, dynamism. The synergetic paradigm in the philosophical interpretation is actualized in the methodological and axiological dimensions. The synergetics' future is associated with the harmonization of theoretical and methodological as well as practical and value components. This interaction is achieved through the principles of interdisciplinarity, which determine the peculiarities of self-organization of the objects of philosophical research. **Methodology:** The interdisciplinarity dictates the selection of methodological tools that were used during the research. Since synergetics covers the scientific, philosophical, and cultural spheres, one used methods that allowed studying all these clusters of social activity. Synergy implies development through interaction, forming a systematic scientific picture of the world. In scientific research, it is proposed to consider synergy as a promising direction not only separately in philosophy, science, or culture, but in the context of a worldview and methodological guideline. Such positioning expands the potential of the interdisciplinary approach,

updating its methodological arsenal and forming value orientations. **Results:** The results of the study are an understanding of the pluralism of philosophical and scientific innovations prospects and the ability of synergy to provide a variety of methodological and value components of the world picture. The philosophical and methodological guidelines of synergetics as a promising component of the scientific worldview are proposed. **Scientific Novelty:** A promising area of research is to provide value constants to the theoretical, methodological, and practice-oriented principles of synergetics, which have already demonstrated their effectiveness. This will create a holistic synergistic paradigm that will become a universal methodology with relevant value dimensions. **Conclusion:** The scientific picture of the world is a dynamic paradigm that requires new ideas and principles. The effectiveness of the scientific picture of the world determines its efficiency. The significance of the study lies in the realization of the benefits of interdisciplinary discourse and the principles of self-organization in the construction of scientific, spiritual, technological, and socio-cultural life. The inclusion of human dimensionality in synergistic constructions allows forming a universal philosophical and methodological paradigm that will meet the requirements of the time and the peculiarities of civilizational development.

Keywords: synergetics, interdisciplinarity, self-organization, scientific picture of the world, philosophy of science, methodology, axiology.

Introduction

The modern scientific picture of the world requires proper methodological support. Philosophy has always offered the scientific community appropriate tools to correlate research activity with cognitive and value aspects. One of the key philosophical and methodological principles of the twentieth century is synergetics (Haken, 2009). The rapid development of science and technology has constantly required updating current methodologies. The scientific picture of the world is constantly reorganised using a wider range of methodological tools. The peculiarity of the modern scientific and philosophical cluster is the work with complex evolving systems. This issue requires an innovative interdisciplinary approach and synergistic principles of interaction and self-organisation.

Research Problem

The problem actualised in the study involves a philosophical understanding of the difficulties of the methodological dimension faced by modern science. The fundamental manifestation of synergetics was the formation of cooperation between science and philosophy in a paradigmatic sense (De Haro, 2020). By fulfilling the mission of bringing science and philosophy closer together, synergetics has resolved the methodological and ideological confrontation between these fields, which allows for the future formation of common principles of methodological, epistemological, and axiological dimensions.

Research Focus

This scientific research focuses on the prospects of synergy in the scientific picture of the world. Today, science and information technology development are inextricably linked. Complex systems with multiple components are increasingly becoming the objects of research activity. Such realities require new methodological research formats. The format in which mono-disciplinarity was the fundamental approach in science gradually lost its relevance. To address new challenges in science, a complex of various disciplinary knowledge and skills was used. For some time, the combination of different scientific fields was situational. At the same time, there was an urgent need for a methodological and, later, an axiological streamlining of the interdisciplinary approach. Synergetics became one of the paradigmatic options, taking on the function of structuring and systematizing research activities. Gradually, the potential and desire to distinguish the synergetic model as the dominant methodological model of the scientific worldview has been outlined.

Research Aim and Research Questions

The purpose of the scientific research is to highlight the peculiarities of the philosophical and methodological support of the synergistic paradigm in the modern scientific picture of the world. The future of synergetics is directly related to the relevance of the functionality of this philosophical and methodological principle.

The objectives of the article are to define the guidelines of synergetics as an innovative methodology: universality, pragmatism, and dynamism. A separate element of the study is to identify the format for the development of synergetics functionality in the scientific picture of the world: from methodological to epistemological and axiological dimensions.

Literature Review/Theoretical Overview

Traditional ideas about the synergistic model in science were formulated by Haken (2009), who revealed the meaning of the concepts of complex evolving systems and self-organization theory. Synergy in the joint interpretation of science and philosophy is associated with the concept of cooperation (Haken & Portugali, 2021). In the modern philosophical and scientific discourse, synergetics is associated primarily with conceptual changes that are focused on progress (Sherin, 2021).

Plath (2022) describes the history of synergetics in scientific discourse in his study. Such works help to trace the evolution of the synergetic model in the context of various worldviews. Modern studies point to another humanistic reorientation of philosophical discourse (Melnik et al., 2022). At the same time, synergetics accompanies the ethical turn in philosophy (Klenk, 2019). Synergetics is gradually finding its niche in this philosophical and ideological cluster.

Classical scientific methodology is not able to provide an unprecedented flow of information and new knowledge (Fouad et al., 2021). Therefore, the scientific paradigm is reorienting the format of scientific activity. Complex evolving systems or the self-organization of these systems involve providing researchers with information about the nature and characteristics of these processes. That is, the information structure of scientific research is changing, in which the system independently updates the necessary data for science. Scientific discourse is increasingly seeking to extend the research to complex systems (Nagatsu et al., 2020).

In modern philosophical thought, the processes of self-organization are described quite thoroughly. Currently, there are both general principles of self-organization in complex systems and individual aspects of this process, including the element of self-improvement (Kryshtanovych et al., 2021).

Interdisciplinarity in the philosophical and methodological dimension is highlighted by Danermark (2019), who identifies several practice-oriented steps in the interdisciplinary research process. At the same time, the problem of value constants of interdisciplinarity remains poorly understood in philosophy. Along with axiological issues, the problem of research ethics is usually raised (Leget et al., 2019).

Research Methodology

General Background

The research methodology is somewhat non-standard, as it focuses on synergy, which is an independent philosophical and methodological principle. Therefore, the format is essentially actualised: “method about method”, which is actively used in philosophy and consists in determining the dominant

components in a particular methodology or in highlighting the priority methods in the methodological paradigm. Further correlation of the methodological arsenal of synergetics is one of the key tasks of the philosophical study of this problem.

The task of synergetics is to control “inconsistent uncertainties” (Ahifar et al., 2020). This function involves the use of the modelling method. In this article, modelling is used as an auxiliary element to achieve a systematic approach to positioning synergetics in research activities. Kapiton et al. (2021) emphasize the relevance of such methods in the study of a synergistic model as forecasting and modelling theories (dynamic or deterministic chaos).

Modern computer modelling technologies and simulation effects form a potential paradigm of “human modelling” (Shults & Wildman, 2019). Scientific research on the prospects of synergetics is intended not only to state the technological ability for such modelling but also to offer human-dimensional guidelines for its functioning in the scientific picture of the world.

The use of elements of statistical power or validity construction in research is standard in modern scientific activity (Eliot & Hirumi, 2019). The synergistic model organises modern scientific activity in the context of building relationships between the philosophy of form and the philosophy of content, shaping the design of the science of the future (Watkins et al., 2020). The scientific research is based on this approach, presenting the philosophical and methodological guidelines of synergetics within the framework of this model. The synthesis of data from different networks becomes a source of a synergistic approach to the organisation of scientific knowledge (Jones et al., 2021).

In the modern synergistic paradigm and in the perspective dimensions of its development, attention is focused on the transdisciplinary content of scientific activity (Tasdemir & Gazo, 2020). Interdisciplinary methodological approaches in the synergistic paradigm have two manifestations: academic and progressive integration of knowledge (Chaika, 2021). The self-organization and complex systems are the problem field in which multidisciplinarity and transdisciplinarity can be fully realized. Scientific interpretation is organized within the structure of the epistemology of interdisciplinary research (IDR) (Boon & Van Baalen, 2019).

Research Results

The philosophy of the future is positioned as a way to form a worldview paradigm that will be characterized by the pluralism of views and efficiency in organizational and methodological dimensions. The study proposes guidelines (Table 1) that will characterize the key aspects of the worldview in the short and long term.

Table 1

Philosophical and methodological guidelines of synergetics as a basis of the scientific picture of the world

1. Versatility	1. Synergistic interaction involves the use of various methodological approaches in order to ensure the completeness of research activities
2. Pragmatism	2. The interdisciplinary approach ensures efficiency and effectiveness of scientific innovations
3. Dynamism	3. The self-organization in complex structures implies a focus on continuous development and improvement

Source: author's own development

The difficulty of interpreting synergies lies in the dynamism of this principle. Evolving systems have different dimensions - natural, technological, social, which also interact with each other (Halchenko, 2019). The internal and external interactions of complex systems indicate the need for methodological support, taking into account the dynamism of these processes.

New information and technological dimensions of science actualise a certain extremity of research activity in the segment of data fluidity (Lee et al., 2022). This is another proof of the dynamism provided by the synergistic paradigm. Synergetics is relevant in the context of dynamic development as a kind of arbiter between the fundamental and innovative components of science (Ridei, 2021).

The dynamism of the principles of synergetics largely depends on the transition from the traditional scientific consideration of objects or systems in a state of equilibrium to research in a state of instability (Yakimtsov, 2018). Modern civilizational development is quite rapid and in no way indicates the possibility of some kind of calm. Under such conditions, instability is the starting point for research activity. Synergetics as a philosophical and methodological principle works proactively - not only by studying an object or system in conditions of instability but also by modelling its potential states and anticipating transformations.

Stability or sustainability is increasingly being replaced by deviations, provoking system instability (Kharchenko & Kharchenko, 2021). The need for new research protocols has led to the actualisation of self-regulation of the components of the scientific system.

The advantage of synergetics is the ability to operate both in conditions of order or harmony and in conditions of chaos, in which something new is born (Rizaev, 2022). The pragmatism of synergetics lies not only in the ability of this methodology to function in different conditions but also to demonstrate effectiveness.

In the socio-cultural dimension, the pragmatic approach is manifested in the ability of synergetics to break down barriers and introduce new principles of cooperation between people or communities (Andrushchenko & Andrushchenko, 2021). The interdisciplinarity becomes the basis of philosophy, forming practical wisdom (Swartwood & Tiberius, 2019). This is a kind of interaction between engineering and behavioral science in the methodological support of synergetics (Karlan & Allen, 2022).

Himmelreich (2019) emphasises synergistic pluralism, which is the basis for the universality of this methodology. The principle of integrated development of the key competencies fully outlines the content of synergetic universality (Yao et al., 2023). The universality of synergetics is designed to

overcome the problem of eliminating the socio-cultural dimension from the natural science and technology cluster of science (Ali et al., 2022). The traditional neglect of the humanities and sciences dimension has significantly limited the development of the integrity of knowledge. The principles of self-organization are inherently systemic and coordinate all dimensions of knowledge in their construction.

Using the example of natural science knowledge, the ability of synergistic elements to engage the principles of adaptation are indicated (Ludwig & El-Hani, 2020). This is another proof of the universality of synergetics in the modern scientific picture of the world.

A feature of synergy is the ability to add new solutions to a problem or development projects. A characteristic feature of the synergistic approach is the formation of innovative solutions from the existing surplus of scientific ideas and achievements (Leydesdorff, 2021). Philosophy in the synergistic model acts as a “context of discovery” is actualising the creative element of science and the desire for progress and development (Mazzocchi, 2019).

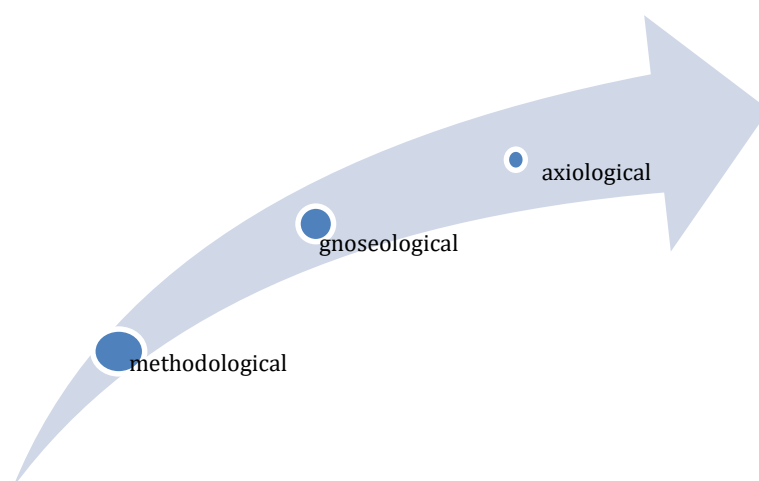
After all, synergy in a purely scientific sense forms systemicity. Systemic and synergistic aspects are actualised in various formats (Lazorko et al., 2021). The individual is not actually the subject of synergetics research, since in any case, this individual interacts either at the level of its subsystem (internal self-organization) or in an external manifestation (interconnection of systems). It should be noted that the guidelines of dynamism and universality of synergetics indicated in the study contribute to the sustainability of the scientific landscape (Liao et al., 2020).

Discussion

A debatable issue is the prioritization of synergetics’ philosophical components. The study notes (see Fig. 1) that the fundamental philosophical dimension of synergetics is its methodological component. At the same time, the elements that form the cognitive and value orientation of synergetics in the scientific and worldview paradigm should not be ignored. Innovation and modernization have become companions of the synergistic model, giving it a value dimension (Karpan et al., 2020).

Figure 1

Philosophical Components of Synergetics in the Scientific Picture of the World



In modern science, synergetics is beginning to actively study human beings, society, and all systems related to them (Klymenko & Yeniekeyeva, 2022). This format automatically includes epistemological and axiological dimensions, which are traditional for anthropological topics in

philosophy and science, in the fundamental methodological principles. In scientific discourse, the status of the noospheric power of man is increasingly clearly defined (Sytnyk et al., 2022). In every cultural and historical epoch, human dimensionality has been a litmus test for the relevance of a scientific or philosophical methodology. The development of science or philosophy has always been correlated with human-centered principles. Thus, synergetics, being at the beginning of its establishment in the scientific picture of the world focuses on the problems of natural science and technological knowledge, faces verification by human-dimensional principles.

The synergistic paradigm allows identifying key aspects of the current functionality of the scientific cluster. Identification, complementation, and verification - this is the triad of the philosophical and methodological dimension of the modern worldview (Racine et al., 2019). The scientific paradigm is in constant search of new methodologies and in the process of updating existing methodological approaches. The relevance of synergetics in this context lies in the fact that methodological innovation is ensured almost online, and two key synergistic factors contribute to this:

- The self-organization involves constant transformations, which automatically leads to the application of new methodological approaches based on a combination of scientific, philosophical, and worldview knowledge and beliefs;
- Complex, evolving systems by their very nature cannot use fundamental stable methodological principles, requiring flexible methodological interactions.

Under these conditions, a new contradiction emerges, that synergy is not able to ensure the sustainability of the scientific paradigm. And this situation is common for any model of knowledge since science must form certain stabilizing points of its progress. At the same time, synergetics offers a radically new approach to the algorithm for establishing a scientific paradigm. Bifurcation points and attractors are relatively new concepts in the philosophical and methodological arsenal and relate mainly to specific natural science models.

However, if the scientific and philosophical community manages to universalize synergistic concepts, adapting them to different types of knowledge, technologies, social consciousness, cultural and ethical dimensions, this paradigm could potentially become dominant at a particular stage of civilizational progress.

It should be noted that the axiological goal of the synergistic model is to harmonise, and if possible, combine the social, technological, and natural components of science in the format of an “ideal of the future” (Giovanopoulos et al., 2020). The institutionalisation of the community is a direct consequence of the synergistic model of scientific development (Tripathi & Kumar, 2020). The reorientation of value priorities from the individual to the systemic and general is one of the promising areas of synergetic development. Interdisciplinarity has the potential to study complex systems. At the same time, it is worth noting that synergetics does not eliminate a single dimension, but studies it in the context of all existing and potentially possible interrelationships that an object realises in complex systems.

Synergetics, like any other philosophical methodology, has its own peculiarities in the context of positioning its status in the scientific picture of the world. The task of the philosophical aspect of synergetics is to organize complex, self-developing systems. Making this development systematic and oriented complements the natural science basis of synergetics. Synergistic principles form the philosophy of harmony (Chang, 2020). A worldview paradigm that achieves the status of a universal, balanced dimension claims to be the dominant one in the world picture.

At the same time, synergetics is not yet ready for such positioning, since synergetics philosophical and methodological activity has not acquired the mentioned balance. First of all, the question of the

practical application of methodological synergistic approaches in humanities and science remains open. The process of integrating synergistic methodology into social science knowledge can serve as a benchmark for the perfection of the synergistic model and its coverage of the humanities cluster of science.

Smaldino (2020) emphasises that the synergistic model is primarily a theoretical and methodological achievement. At the same time, the rapid development of science demonstrates the need to provide practical guidance to the synergistic methodology. The question arises whether synergetics can be a practically oriented methodological arsenal. The answer is obvious since synergistic ideas have already proven themselves to be positive in the natural and technological fields of science, where practice-oriented elements are crucial.

The modern philosophical and scientific discourse is characterised by increased cooperation between humanitarian knowledge and synergetics (Dobronravova, 2022). The application of the norms of non-linear research in natural science has demonstrated a positive effect. If it is impossible to realize the integration of humanitarian knowledge into the synergistic paradigm, so, one can clearly outline the prospects for the development of holistic science.

The integrity of science implies not only the relevance of methodological approaches separately in different scientific clusters. Interdisciplinary interaction leads to methodological interconnections. The principles that were relevant for research activities in the natural sciences are used in studies of social problems, and the concepts of technological knowledge are transferred to human research. As an example, let us cite the resonance caused by the emergence of artificial intelligence. This is a vivid demonstration of the interaction of methodological approaches from different scientific clusters. Thanks to interdisciplinary synergistic principles, a common methodological paradigm is achieved. In this context hitherto irreconcilable scientific aspects can be explored.

The gradual departure from the symbolism of humanitarian knowledge in favour of its practical orientation only contributes to the formation of a single scientific picture of the world with synergy as the dominant philosophical and methodological principle (Wildgen, 2023). Synergistic principles transform anthropological elements in the existential and value dimensions (Morska, 2022). This gives this philosophical methodology the status of a strategic perspective of science.

There is no doubt in the scientific and philosophical community that sooner or later the scientific paradigm will achieve integrity. However, this will not mean the end of methodological confrontations within the scientific and philosophical system. In the end, empirical and rationalist methodological approaches successfully coexisted in New European philosophy, forming a universal scientific paradigm at that time, focused on the rule of knowledge.

The question remains whether synergy, based on the principle of cooperation and interaction, can achieve the same effect in the system of general scientific knowledge. The answer will depend on the results of the coordination between different areas of scientific knowledge and the ability to form a holistic scientific picture of the world.

Conclusions and Implications

Thus, synergetics is one of the most important philosophical and methodological approaches of the modern scientific worldview:

- Synergy has already demonstrated its relevance and effectiveness in the natural science and technology cluster of the world picture.

- The potential for synergy in humanities and science is being actively developing.
- The human dimensionality is actually the last condition for the synergetics formation as a universal methodology of modern science.
- It is a complex evolving systems and the self-organization of natural technological and social elements are the basis for the synergistic methodology.
- The interdisciplinarity as a practice-oriented tool of interaction strengthens the position of synergetics as the dominant methodological strategy of the scientific picture of the world in the short term and in the global civilization perspective.
- Synergetics' guidelines (universality, dynamism, pragmatism) are the key to the innovation of this philosophical methodology.
- The inclusion of the epistemological and axiological components in a synergistic context allows us to form a holistic methodology in the scientific picture of the world.
- Giving synergy its intended purpose distinguishes it as a unique philosophical and methodological paradigm of the present and future science.
- The synergistic model is relevant for the scientific, philosophical, and socio-cultural cluster of social activity, as it uses an innovative methodological arsenal.
- Synergetics has all the possibilities for philosophical and methodological regulation of information technology post-industrial society development.

References

- Ahifar, A., Noei, A. R., & Rahmani, Z. (2020). Finite-time terminal synergetic control of a class of nonlinear systems with unmatched uncertainties. *IMA Journal of Mathematical Control and Information*, 37(3), 765–776. <https://doi.org/10.1093/imamci/dnz014>
- Ali, T., Buergelt, P. T., Maypilama, E. L., Paton, D., Smith, J. A., & Jehan, N. (2022). Synergy of systems theory and symbolic interactionism: a passageway for non-Indigenous researchers that facilitates better understanding Indigenous worldviews and knowledges. *International Journal of Social Research Methodology*, 25(2), 197–212. <https://doi.org/10.1080/13645579.2021.1876300>
- Andrushchenko, T., & Andrushchenko, T. (2021). Culturology as the system of synergetic approaches. *Interdisciplinary Studies of Complex Systems*, 18, 61–70. <https://doi.org/10.31392/iscs.2021.18.061>
- Boon, M., & Van Baalen, S. (2019). Epistemology for interdisciplinary research – shifting philosophical paradigms of science. *European Journal for Philosophy of Science*, 9, 16. <https://doi.org/10.1007/s13194-018-0242-4>
- Chaika, Y. (2021). Integration of sciences in modern synergetic discourse. *Global Prosperity*, 1(2), 3–15. <https://doi.org/10.46489/gpj.2021-1-2-6>
- Chang, Y.-F. (2020). Development of Entropy Change in Philosophy of Science. *Philosophy Study*, 10(9), 517–524. <https://doi.org/10.17265/2159-5313/2020.09.001>
- Danermark, B. (2019). Applied interdisciplinary research: a critical realist perspective. *Journal of Critical Realism*, 18(4), 368–382. <https://doi.org/10.1080/14767430.2019.1644983>
- Dobronravova, I. (2022). Processes of self-organization as a topic of philosophical comprehension in the Ukrainian philosophy of science. *Almanac of Ukrainian Studies*, 87–95. <https://doi.org/10.17721/2520-2626/2022.31.12>
- De Haro, S. (2020). Science and Philosophy: A Love–Hate Relationship. *Foundations of Science*, 25, 297–314. <https://doi.org/10.1007/s10699-019-09619-2>

- Eliot, J. A. R., & Hirumi, A. (2019). Emotion theory in education research practice: an interdisciplinary critical literature review. *Educational Technology Research and Development*, 67, 1065–1084. <https://doi.org/10.1007/s11423-018-09642-3>
- Fouad, H. Y., Raz, A. K., Llinas, J., Lawless, W. F., & Mittu, R. (2021). Finding the Path Toward Design of Synergistic Human-Centric Complex Systems. In Lawless, W. F., Llinas, J., Sofge, D. A., Mittu, R. (Eds.), *Engineering Artificially Intelligent Systems. Lecture Notes in Computer Science* Springer, Cham. https://doi.org/10.1007/978-3-030-89385-9_5
- Haken, H. (2009). Synergetics: Basic Concepts. In Hutt, A., Haken, H. (Eds.), *Synergetics. Encyclopedia of Complexity and Systems Science Series*, Springer, New York, NY. https://doi.org/10.1007/978-1-0716-0421-2_533
- Haken, H., & Portugali, J. (2021). Synergetics: A Short Reminder. In *Synergetic Cities: Information, Steady State and Phase Transition* (pp. 17–30). https://doi.org/10.1007/978-3-030-63457-5_3
- Halchenko, M. (2019). Self-organization and creativity: modes of synergistic reasoning in cognitive and educational activity. *Economics & Education*, 4(1), 72–76. Retrieved from: <http://www.baltijapublishing.lv/index.php/econedu/article/view/1043>
- Himmelreich, J. (2019). Ethics of technology needs more political philosophy. *Commun. ACM*, 63(1), 33–35. <https://doi.org/10.1145/3339905>
- Giovanopoulos, C., Kallianos, Y., Athanasiadis, I. N., & Dalakoglou, D. (2020). Defining and Classifying Infrastructural Contestation: Towards a Synergy Between Anthropology and Data Science. In Athanasiadis, I., Frysinger, S., Schimak, G., Knibbe, W. (Eds.), *Environmental Software Systems. Data Science in Action. ISESS 2020. IFIP Advances in Information and Communication Technology*, 554. Springer, Cham. https://doi.org/10.1007/978-3-030-39815-6_4
- Jones, J. A., Groffman, P. M., Blair, J., Davis, F. W., Dugan, H., Euskirchen, E. E., Frey, S. D., Harms, T. K., Hinckley, E., Kosmala, M., Loberg, S., Malone, S., Novick, K., Record, S., Rocha, A. V., Ruddell, B. L., Stanley, E. H., Sturtevant, C., Thorpe, A., White, T., Wieder, W. R., Zhai, L., & Zhu, K. (2021). Synergies among environmental science research and monitoring networks: A research agenda. *Earth's Future*, 9, e2020EF001631. <https://doi.org/10.1029/2020EF001631>
- Kapiton, A., Baranenko, R., Tyshchenko, D., & Franchuk, T. (2021). The theory of synergetics as a methodological basis for the development of nonlinear processes in industry. *Control, navigation and communication systems. Collection of scientific works*, 4, 20–22. <https://doi.org/10.26906/SUNZ.2021.4.020>
- Karlan, B., & Allen, C. (2022). Engineered Wisdom for Learning Machines. *Journal of Experimental and Theoretical Artificial Intelligence*. Retrieved from: <https://philpapers.org/archive/KAREWF.pdf>
- Karpan, I., Chernikova, N., Motuz, T., Bratanich, B., & Lysokolenko, T. (2020). Conceptual Principles of Education for Sustainable Development. *European Journal of Sustainable Development*, 9(2), 99. <https://doi.org/10.14207/ejsd.2020.v9n2p99>
- Kharchenko, Yu., & Kharchenko, S. (2021). Reasons for bifurcation of the legal discourse basis (synergetic and philosophical-linguistic approaches). *Bulletin of NAU. Series: Philosophy. Culturology*, 1(33), 36–40. <https://doi.org/10.18372/2412-2157.33.15639>
- Klenk, M. (2019). Moral Philosophy and the Ethical Turn in Anthropology. *ZEMO*, 2, 331–353. <https://doi.org/10.1007/s42048-019-00040-9>

- Klymenko, O., & Yenykeyeva, S. (2022). Synergetic Linguistics as a New Philosophy of Language Studies. *Theory and Practice in Language Studies*, 12(2), 417–423. <https://doi.org/10.17507/tpsls.1202.28>
- Kryshtanovych, S. & Chubinska, N., Gavrysh, I., Khltobina, O., & Shevchenko, Zh. (2021). Philosophical and Psychological Approach to Self-Development of Scientific and Pedagogical Workers. *WISDOM*, 20. 139–147. <https://doi.org/10.24234/wisdom.v20i4.560>
- Lazorko, O., Virna, Z., Brytova, H., Tolchieva, H., Shastko, I., & Saienko, V. (2021). Professional Safety of Personality: System Regularities of Functioning and Synergetic Effects of Self-Organization. *Postmodern Openings*, 12(2), 170–190. <https://doi.org/10.18662/po/12.2/302>
- Lee, A., Inceoglu, I., Hauser, O., & Greene, M. (2022). Determining causal relationships in leadership research using Machine Learning: The powerful synergy of experiments and data science. *The Leadership Quarterly*, 33(5), 101426. <https://doi.org/10.1016/j.leaqua.2020.101426>
- Leget, C., van Nistelrooij, I., & Visse, M. (2019). Beyond demarcation: Care ethics as an interdisciplinary field of inquiry. *Nursing Ethics*, 26(1), 17–25. <https://doi.org/10.1177/0969733017707008>
- Leydesdorff, L. (2021). *The Evolutionary Dynamics of Discursive Knowledge Communication-Theoretical Perspectives on an Empirical Philosophy of Science*. Springer Cham, 274. <https://doi.org/10.1007/978-3-030-59951-5>
- Liao, C., Qiu, J., Chen, B., Chen, D., Fu, B., Georgescu, M., He, C., Jenerette, D., Xia, L., Xiaoyan, L., Xin, L., Bading, Q., Shi, P., & Wu, J. (2020). Advancing landscape sustainability science: theoretical foundation and synergies with innovations in methodology, design, and application. *Landscape Ecology*, 35, 1–9. <https://doi.org/10.1007/s10980-020-00967-0>
- Ludwig, D., & El-Hani, C. N. (2020). Philosophy of Ethnobiology: Understanding Knowledge Integration and Its Limitations. *Journal of Ethnobiology*, 40(1), 3–20. <https://doi.org/10.2993/0278-0771-40.1.3>
- Mazzocchi, F. (2019). Scientific research across and beyond disciplines. Challenges and opportunities of interdisciplinarity. *Science & Society*, 20, e47682. <https://doi.org/10.15252/embr.201947682>
- Melnyk, O., Shakun, N., Herasymenko, O., Nitchenko, A., & Kolievatov, O. (2022). Theoretical and Methodological Aspects of the Humanistic Reorientation of Modern Society. *W I S D O M*, 2(22), 59–67. <https://doi.org/10.24234/wisdom.v22i2.756>
- Morska, N. (2022). Ontology of human rights in today's globalized world: the philosophical dimension. *Amazonia Investiga*, 11(60), 264–271. <https://doi.org/10.34069/AI/2022.60.12.27>
- Nagatsu, M., Davis, T., DesRoches, C. T., Koskinen, I., MacLeod, M., Stojanovic, M., & Thorén, H. (2020). Philosophy of science for sustainability science. *Sustainability Science*, 15, 1807–1817. <https://doi.org/10.1007/s11625-020-00832-8>
- Plath, P. (2022). Images from the History of Synergetics. In P. J. Plath, E.-C. Haß, & H. Linde (Eds.), *Imagery Synergetics – Science of Cooperation*, Springer. https://doi.org/10.1007/978-3-030-95607-3_1
- Racine, E., Cascio, M. A., Montreuil, M., & Bogossian, A. (2019). Instrumentalist analyses of the functions of ethics concept-principles: a proposal for synergetic empirical and conceptual enrichment. *Theoretical Medicine and Bioethics*, 40, 253–278. <https://doi.org/10.1007/s11017-019-09502-y>

- Ridei, N. (2021). Analysis of professional competencies in the characteristics of the teacher of the future: global challenges of our time. *Futurity Education*, 1(1), 22–32. <https://doi.org/10.57125/FED.2022.10.11.3>
- Rizaev, I. (2022). Synergetics in Social Systems and its Possibilities. *Global Scientific Review*, 10, 62–69. Retrieved from: <http://scienticreview.com/index.php/gsr/article/view/87>
- Sherin, B. (2021). Where Are We? Syntheses and Synergies in Science Education Research and Practice. In: Levrini, O., Tasquier, G., Amin, T. G., Branchetti, L., Levin, M. (Eds.), *Engaging with Contemporary Challenges through Science Education Research. Contributions from Science Education Research*, 9, Springer, Cham. https://doi.org/10.1007/978-3-030-74490-8_17
- Shults, F. L., & Wildman, W. J. (2019). Ethics, Computer Simulation, and the Future of Humanity. In Diallo, S., Wildman, W., Shults, F., & Tolk, A. (Eds.), *Human Simulation: Perspectives, Insights, and Applications. New Approaches to the Scientific Study of Religion*. 7, Springer, Cham. https://doi.org/10.1007/978-3-030-17090-5_2
- Smaldino, P. E. (2020). How to Build a Strong Theoretical Foundation. *Psychological Inquiry*, 31(4), 297–301. <https://doi.org/10.1080/1047840X.2020.1853463>
- Swartwood, J., & Tiberius, V. (2019). Philosophical Foundations of Wisdom. In R. Sternberg & J. Gluek (Eds.), *The Cambridge Handbook of Wisdom* (pp. 10–39). Cambridge University Press. Retrieved from: <https://philpapers.org/archive/SWAPFO.pdf>
- Sytnyk, O., Kravtsova, I., Andreev, S., Denysyk, B., & Bezlatnia, L. (2022). On the question of the philosophical foundations of the geocotones theory: synergetics, anthropocentrism, geosystem paradigm. *Journal of Geology, Geography and Geoecology*, 31(3), 547–553. <https://doi.org/https://doi.org/10.15421/112251>
- Tasdemir, C., & Gazo, R. (2020). Integrating sustainability into higher education curriculum through a transdisciplinary perspective. *Journal of Cleaner Production*, 265, 121759. <https://doi.org/10.1016/j.jclepro.2020.121759>
- Tripathi, R., & Kumar, A. (2020). Humanistic leadership in the Tata group: the synergy in personal values, organisational strategy and national cultural ethos. *Cross Cultural & Strategic Management*, 27(4), 607–626. <https://doi.org/10.1108/CCSM-01-2020-0025>
- Watkins, C. R., Gray, C. M., Toombs, A. L., & Parsons, P. (2020). Tensions in Enacting a Design Philosophy in UX Practice. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference (DIS '20)*. Association for Computing Machinery, New York, NY, USA, 2107–2118. <https://doi.org/10.1145/3357236.3395505>
- Wildgen, W. (2023). Morphogenesis of Symbolic Forms: Meaning in Music, Art, Religion, and Language. <https://doi.org/10.1007/978-3-031-25651-6>
- Yakimtsov, V. (2018). History and development of Haken's synergetics. *Scientific Bulletin of UNFU*, 28, 119–125. <https://doi.org/10.15421/40280923>
- Yao, J. X., Liu, Y. X., & Guo, Y. Y. (2023). Learning progression-based design: advancing the synergetic development of energy understanding and scientific explanation. *Instructional Science*. <https://doi.org/10.1007/s11251-023-09620-0>