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The vergence of technology and innovation in modern complex space

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ABSTRACT

The purpose of the study is to conceptualize the phenomenon of vergence of technologies and innovations in the context of building a society as a complex system by modernizing the innovation environment. To achieve the goal, general scientific and special-scientific methods of cognition were used, in particular, dialectical, formal-logical, analysis and synthesis, system-structural. The key methodological principles, spatial-topological and ontological, were presented. It is confirmed that the concept of "vergence" is the state of systems at the point of intersection of divergent and convergent processes, as well as their balancing. Vergence as a method of creative thinking was used in this study primarily to solve problems and tasks related to the synchronism of various contradictory processes (reconciles the processes of "scattering", "acceleration" and "gathering", "braking"). The value of this approach was in finding multiple solutions to ambiguous problems. The results of the study confirmed that the vergent interaction of technologies and innovations, the merging of funds and resources that contribute to the modernization of the innovation space, their analysis and synchronism, excluded the position of rest in the social system and, on the contrary, gave rise to a situation of accelerated but controlled dynamism.

KEYWORDS: Technologies, science, innovations, social systems, space.

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La convergencia de la tecnología y la innovación en el espacio complejo moderno

RESUMEN

El propósito del estudio es conceptualizar el fenómeno de convergencia de tecnologías e innovaciones en el contexto de la construcción de una sociedad como un sistema complejo mediante la modernización del entorno de innovación. Para lograr el objetivo, se utilizaron métodos de cognición científicos generales y científicos especiales, en particular: dialéctico, lógico-formal, análisis y síntesis, sistema-estructural. Se confirma que el concepto de "vergencia" es el estado de los sistemas en el punto de intersección de procesos divergentes y convergentes, así como su equilibrio. La vergencia como método de pensamiento creativo se utilizó en este estudio principalmente para resolver problemas y tareas relacionadas con el sincronismo de varios procesos contradictorios (reconcilia los procesos de "dispersión", "aceleración" y "reunión", "frenado"). El valor de este enfoque reside en encontrar múltiples soluciones a problemas ambiguos. Los resultados del estudio confirmaron que la interacción vergente de tecnologías e innovaciones, la fusión de fondos y recursos que contribuyen a la modernización del espacio de innovación, su análisis y sincronismo, excluyeron la posición de reposo en el sistema social y, por el contrario, dio lugar a una situación de dinamismo acelerado pero controlado.

PALABRAS CLAVE: Tecnologías, ciencia, innovaciones, sistemas sociales, espacio, complejo.

Introduction

Recently, there have been multiple changes in the social space. This is not only due to politics or economic factors in their pure form, but also to the introduction of technology and innovation. These, in turn, intensively influence the quality of politics and economics, as well as the quality of life in general in the long or short term. These trends complicate space. It is commonly thought that technology and innovation are extremely positive factors that enable a civilizational leap into the future. And the only way out for advanced states in science is to incorporate into the cycle of technology and innovation in a timely manner, and to take a leading role in the process. However, "timeliness" is precisely the quintessence of life of technology and innovation. Their harmonious understanding, creativity in scientific research, their implementation and use, based on the principles of humanism and morality, make it possible to improve the life of humanity as a whole, rather than changing individual parts of it.

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Otherwise, the meaning of technology and innovation is negated. Their "life cycle" is disrupted, and the commercial component in the process of intensive "technologization" of the innovation space generates a "distortion" in terms of the distribution of benefits. "The technology and innovation life cycle" as a set of stages (includes the birth of technological innovations and their routinization) should be balanced.

The complexity of society can be characterized as multi-level (polyversum), which is highly synchronized, but in which multiple events or processes are difficult to understand and verify. At the same time, the mechanism of synchronicity is very difficult to understand, since we can never capture the entire being of a society as a whole due to its continuous dynamics. However, it is possible to capture this synchronicity when looking at individual events. Consequently, in the presence of synchronicity, the vergence of different processes also takes place.

Also, society as a complex system consists of many interacting components (subsystems), due to which, like any complex system, it acquires new properties that are absent at the subsystem level and cannot be reduced to the properties of the subsystem level. A complex society as a virtuality contains n-number of complication moments that act asynchronously and, in a wave,-like manner, and technology and innovation are vergent as products of intellectual production (one without the other is practically impossible), but not vergent as "pure ideas".

The complexity of society as a virtuality is determined by the n-number of its constituent intellectual-productive elements and the possible links between them. The degree of complexity is measured by the diversity of intellectual resources and engineering approaches to the continuous reconstruction of the social system. This diversity characterizes the number of all possible states of the system.

1. Objectives

The complex society is presented as a multi-level virtuality with n-number of intellectual-productive elements, synchronized through the vergence of technology and innovation. The virtuality of a complex society can be understood as a property that models innovative space. Consequently, the purpose of this study is to conceptualize the phenomenon of vergence of technology and innovation in the context of the construction of society as a complex system by modernizing the innovation environment.

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2. Materials and Methods

The spatial-topological principle that is presented in this study allows us to look at complex society as a special metric space. It can be called a "topological space or set with an additional relatively unstable structure. This instability exists because it is impossible to accurately predict and calculate the actions of each individual because of the complexity of the individual itself as a physical-spiritual-intellectual construct. A complex society is a "non-empty set" in which there is a distance, a conventional metric, between any pair or group (infinitely-large, large or small) of elements possessing certain properties.

Topology as a methodological principle can be used not only in non-Euclidean geometry or quantum physics, but also in philosophical science and in the socio-humanities. It most accurately indicates that society is becoming a "new complexity". It piles up ontological spaces: culture, civilization, politics, economics, art, science, religion, history, science, technology and innovation, production, everyday life, communication, spirituality, virtuality.

A complex society as a whole "hyperspace" and, as a set with additional structures of a certain type, provides a complex interaction of continuously changing social systems. Each such social system changes within fixed parameters, then there is its "displacement" in some conventional "space". In this case the parameters can be understood as dimensions of space. There can be an infinite number of such combinations of parameters (spaces), both in the cultural-historical context and in the spatio-temporal context. Such parametric spaces can arise at any point in a complex society as an ontological multiplicity.

The spatial-topological principle also shows that modern S&T as well as S&T-innovation processes are complex, non-linear, unstable and asynchronous. The dynamics of these processes have conditional general patterns associated with alternating processes of divergence and convergence, and it is difficult to bring them into a vergent state, and hence to synchronize them. The current level of technological development and innovation indicates a predominance of convergence processes. Consequently, complex society as a topological diversity combines the processes of evolution, co-evolution, devolution, and involution of technology and innovation.

The ontological approach actualizes the connection of complex society as a partly spiritual virtuality with the activities of the intellect, consciousness and logic. Its core is

morality. Spiritual virtuality is displayed with the help of new technologies and innovations technically in digital images, i.e. conditionally materialized. Virtual reality as an attribute of a complex society, if it develops constructively, tends towards the creative person, although it often hyperbolizes the corporeal, material, utilitarian person.

In computer virtual reality, objects are immaterial and non-bodily in the conventional sense, but they are also virtually corporeal and virtually being. And we can state that this model of virtuality (spiritual and digital) also becomes a topological "complexity" when we begin to analyze it.

3. Results

Thus, on the one hand, technology and innovation can be understood as different phenomena denoted by certain terms.

Broadly speaking, "technology" (τέχνη) is "art", "skill", "ability" + (λόγος) "thought", "meaning", "concept", "reason", "methodology", "mode of production". In a narrow sense, technology includes: a set of methods and tools for achieving a desired result; the application of scientific knowledge to solve practical problems; a set of organizational measures, operations and techniques aimed at manufacturing, maintaining, repairing and/or operating a product with nominal quality and optimum cost, and conditioned by the current level of scientific, technical and social development in general. Technology, therefore, envisages any final product of labour on levels – intellectual and material. Their measure is the moral level. Technology only became a common word in the second half of the twentieth century. By then the damage was done, and conceptual confusion meant that the term could be used in either broad or narrow senses, sometimes embracing cultural or social components, sometimes reduced to mere tools or to means-to-ends rationality (Agar, 2019).

In turn, the term "innovation" (innovatio – renewal; innovare – to renew) is the introduction of something new; an innovative thing; modernization; reform; investment in new technology, new forms of work organization and management, covering not only an individual enterprise, but also their totality, a sector; a new formation, a new phenomenon in language, usually in the field of morphology, which appeared in this language in a later era of its development; innovation. Innovation is all-pervasive in this day and age. Innovative companies like Apple and Google are heralded, like scientists and artists in

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previous ages, and inspire a lifestyle in which the status quo is challenged and no limits are accepted upfront (Blok, 2018). Thus innovation can be understood as "movement towards changes".

Figure 1 shows the following differences:

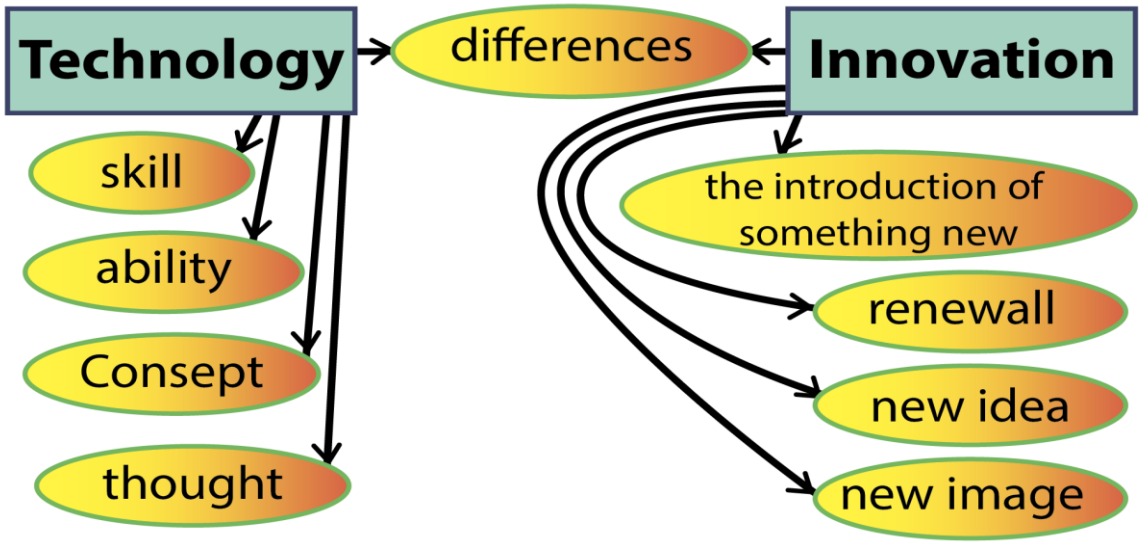

Figure 1. Technology and innovation as ambivalent phenomena (Author's elaboration)

On the other hand, technology and innovation are not only closely intertwined phenomena that perhaps differ little in meaning and purpose, but, in our view, they are in a state of vergence.

Although the term "vergence" is used in medicine (particularly in ophthalmology), it is nevertheless also relevant in socio-philosophical discourse.

We think that the phenomenon of "vergence" is the state of systems at the point of intersection of divergent and convergent processes, as well as their balancing. In this regard, we understand the phenomenon of "vergence" as such, which demonstrates the state of complex or simple systems at the point of intersection of divergent and convergent processes or indicates the existence of some "third", middle state of the system (Kharchenko, 2021). It can be argued that if technology and innovation become vergent, it contributes to establishing the orderliness of social space as a complex system.

See figure 2:

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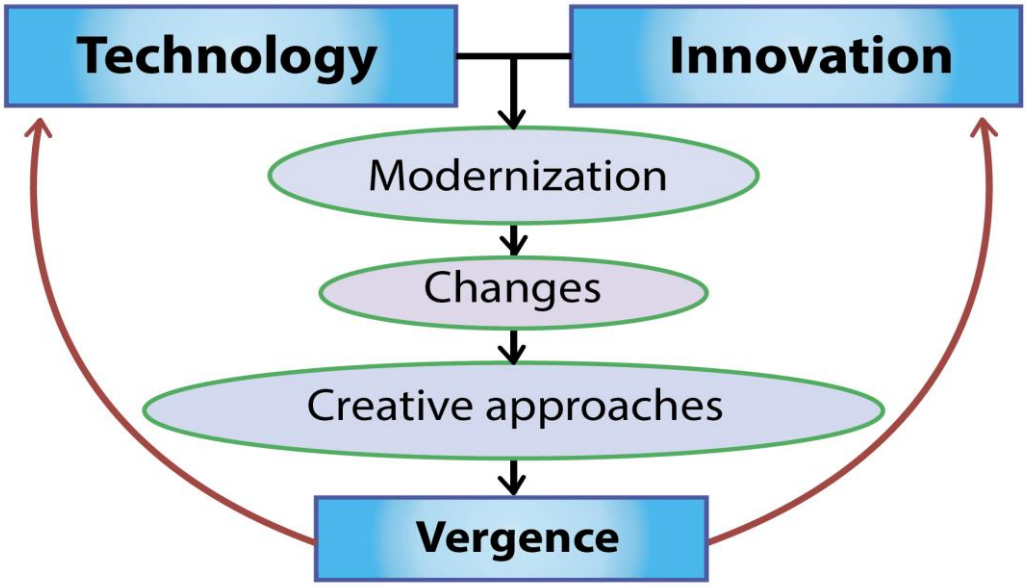

Figure 2. Vergence as a tool for synchronizing technology and innovation (Author's elaboration)

Research on technology and innovation tends to use a range of approaches and methods developed by sociology, as well as theories from economic and psychological sciences, and the tools of political science fields of knowledge. Each particular study uses a limited set of these methods that corresponds to the objectives and strategy of the given research. In social philosophy, technology and innovation are also considered in an increasingly substantive way. In this context, we propose a vergent approach.

Vergence as a method of creative thinking is applied in this study primarily to solve problems and challenges related to the synchrony of different contradictory processes (it reconciles the processes of "scattering", "accelerating" and "gathering", "slowing down"). The value of this approach lies in finding multiple solutions to ambivalent problems.

J. Schumpeter used the scientific terms "technology" and "innovation" in the context of economic theory and believed that a depressed phase of economic development is followed by a recovery phase, bringing the economy back to equilibrium through another accumulation of innovations and innovations (Schumpeter, 2007). Innovation is therefore understood by the author as the introduction of new processes, new organizational forms, and the opening up of new markets. While inventions are also innovations, but at the level of technology.

DOI: http://dx.doi.org/10.46925//rdluz.39.26

A key requirement of our time is the rapid transformation of technology and innovation and its qualitative transition to ever higher levels of technology and progressive innovation. High-tech today includes such high-tech industries as microelectronics, computing, robotics, nuclear power, aircraft, space technology and microbiology.

The "timeliness" factor points not only to the significance of the space-time complex continuum, which is also a changing social space, but also to the "future" as a key goal of innovative development, contributing to the construction of new images of technology and innovation.

However, such a transition is not always possible, since most innovative activities involve the use of ever newer modifications of existing technology, in a narrowly applied sense. And so far this excludes the scientific and technological revolution or, if it is already underway, it levels its significance because the commercialization of its results does not contribute to a spiritual understanding of it. Only a smaller proportion of humanity, using high technology, is conventionally included in the future. The majority of the world's inhabitants are, at best, in the present, and, for example, some Third World countries and some countries in Africa are in the past.

Social space, as a complex space, is a fundamental concept, along with social time, encompassed by collective human consciousness (social awareness). This model of space depicts the world in its multiplicity, diversity and heterogeneity.

The many processes and objects with which human perception deals are both divergent and convergent. They only gravitate towards synchronicity and form a complex spatial image of the world. The vergence of these contradictory qualities of the world is a prerequisite for human orientation in space and for the effective organization of human activity (See figure 3).

We defined "social virtuum" as a singular space-time continuum that exists as a unit, generating many bifurcation points in the evolutionary process of its self-development. Micro-social areas within the whole virtuum do not change in time and space synchronously, which leads to divergent processes of repulsion, rejection, inconsistency. However, over time, the system comes into equilibrium (Kharchenko, et al., 2020). Lack of synchronicity generates spatial bifurcations, but does not add complexity because the world is already complex, but adds inconsistency due to human error and increases the

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confusion of social processes. Technology and innovation, if used lopsidedly, will not fix the problem.

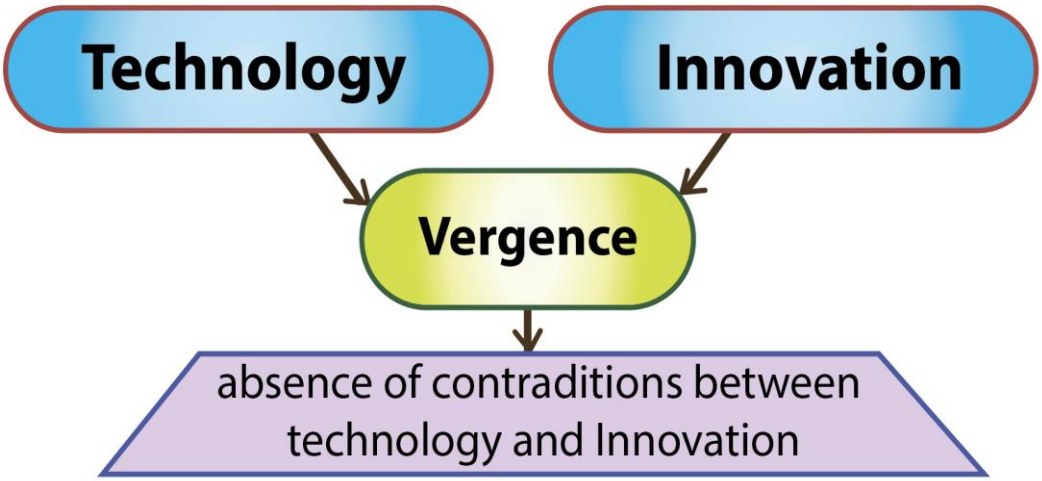

Figure 3. Vergence as a tool for resolving contradictions in the innovation space (Author's elaboration)

We are sure that an unstable system does not return to the state of equilibrium, from which it left for one reason or another, but continuously moves away from it or makes unacceptably large fluctuations around it. Unstable systems are practically unsuitable for normal life in society. They are used only under artificial conditions. It is important, therefore, to understand that the functional dependence between random phenomena and quantities under conditions of social instability is possible as stability of a different kind. Randomness and illogicality are derivatives of certain rational actions in the past (Drotyanko, et al., 2021). The vergence of random and non-random events in social space is highly problematic, but possible in innovation space.

We investigated that random events are transformed into non-random events, since this is logical for the human mind and necessary for a comfortable life in society. The carrier of such energy is a person who survives more effectively in a sustainable model of society. If the social system becomes emergent, then applicable to historical time and the situation, appropriate approaches, evaluation criteria, methods, strategies and tactics are developed

DOI: http://dx.doi.org/10.46925//rdluz.39.26

to minimize fluctuations (Kharchenko et al., 2021). Technology and innovation is a set of actions that are predictable or predetermined.

For example, the stipulated terms of reference are agreed on the basis of technical possibilities and proposals. It stipulates optimum costs as the minimum possible means that do not entail deterioration of working conditions, sanitary and environmental standards, technical and fire safety standards, excessive wear and tear on tools, and financial, economic, political, and reputational risks.

The difference between technology and innovation is that modern technology involves: the design and production processes of various technical calculations; the choice of materials and means of production; the design of complex plants and the organization of production. Technology goes through certain stages of its "life cycle": *an emerging technology* is a qualitatively new model with high potential; *an advanced technology* is a fairly current model; *a modern technology* is a standard model with increasing demand; *a not new technology* is a useful proven model, along with more current variations of it; *an obsolete technology* is a model that has completely lost relevance (See figure 4).

Innovations, involve: the introduction of a new or significantly improved product (material and intellectual) or process; the use of a new method or a new organizational method in the practical field; the organization of work in small and large scientific teams, groups; the organization of logistics in the innovation space, internal and external links. An innovation is not every innovation or novelty, but only one that significantly increases the efficiency of the existing social system. Innovations must be consistent with current socio-political, socio-economic, spiritual and cultural needs.

What is similar is that both technology and innovation form a broad class of fundamental and humanistic disciplines related to the management, accumulation, processing and transfer of valuable scientific information. Technology and innovation involve the process of using modernized means and methods of data accumulation to produce a product of new quality, new information about the state of an object, process or phenomenon.

See figure 5:

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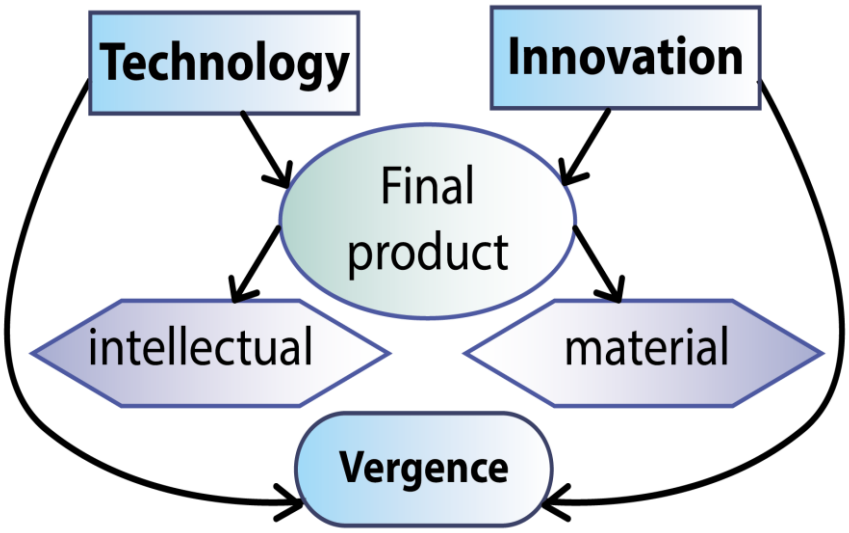

Figure 4. Vergence of technology and innovation as a result of the design and implementation of new ideas. (Author's elaboration)

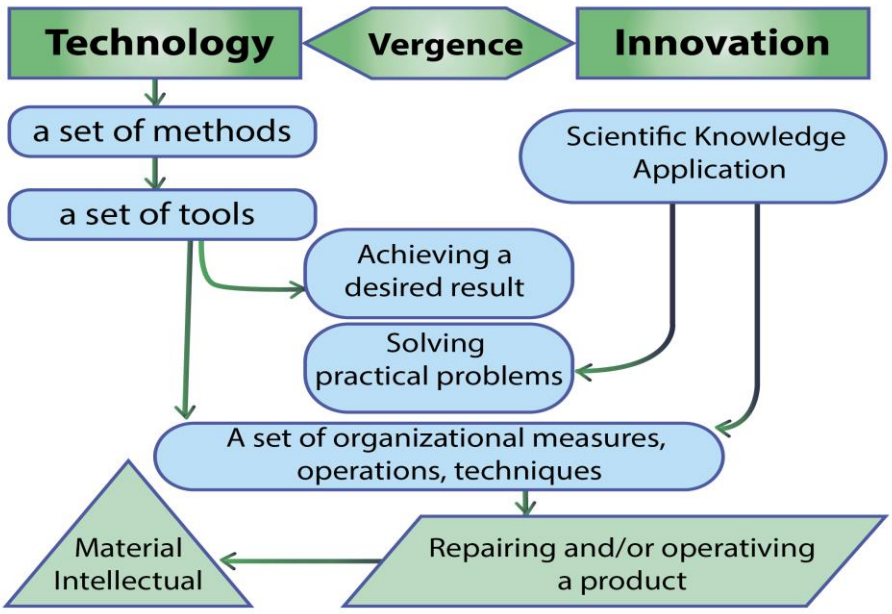

Figure 5. Constructing of complex social space through the vergence of technology and innovation (Author's elaboration)

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4. Discussion

The construction of a complex social space consists of a clearly regulated sequence of operations and actions performed by participants in the innovation process. They all vary in their degree of complexity.

In this regard, A. Lyovkina emphasizes that much is said today about innovative development of society, innovative development of territories and innovation in general, in the context of the need for sustainable (balanced) development of society. In practice, however, many contradictions arise. Already at the design stage of the state innovation policy for sustainable development, differences in the values and attitudes of government, business and society emerge. Difficulties in developing tools, adequate to the current socio-economic system of innovation development, arise when identifying priorities for innovation development. Identifying these tensions allows a more informed approach to innovation policy development, but understanding their underlying causes requires an understanding of the relationship between the phenomena of power and innovation (Lyovkina, 2017). The components of innovative technologies for the production of new products of intellectual activity are upgraded technical and instrumental tools, mathematical and information support for this process.

A. Lyovkina emphasizes the importance of the humanities and observes that every researcher, consciously or unconsciously, makes a fundamentally important choice of research focus by establishing and maintaining the focus of his work. In this way, the mechanisms of social and psychological adaptation to the current social reality are improved. The role of research of the mental resources of the individual, free thinking, creativity, self-identification, and the role of creation of organizational resources for constructive influence on social reality are enhanced. Today, most contemporary humanitarian research is concerned with the optimal "adjustment" of the human psyche, activities, social relations, innovation and other socio-psychological aspects to the norms of contemporary culture and the "rules of the game" of the current socio-economic system, without critically revising them. Such studies aim to address only its tactical and operational problems (Lyovkina, 2017). Thus, we cannot see innovative technologies only as a set of methods and tools that artificially accelerate the stages of innovation and are reduced to narrow applications – implementation, training (training and incubation of

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small businesses), consulting, transfer, and engineering. Also we cannot focus only on consumers of technology.

There is a certain amount of conceptual substitution today. Sometimes "innovator" and "laggard" may not live up to their names. The innovator is not the one who merely follows or tries to be the first to access technological innovations before they are widely available on the market. And the laggard is not the one who does not follow or has not had time to make use of these innovations. The only problem is the material capacity of the "innovator" and "laggard".

The choice of technology and innovation should be based on creativity. The innovator is fully aware of the extent of his or her responsibility as a result of introducing a new technology. He or she assesses, through scientific analysis, the advantages of new technologies and innovations, their practical significance and their future prospects. The laggard tends to be limited by the living conditions in which a particular socio-political and socio-economic model is developing.

The innovation sphere, as one of the type of spatio-temporal reality, generates a variety of ways and means of implementing new ideas and approaches. We think that the innovative space has a complex structure and configuration, but its space-time frame is uncertain due to the high dynamics. At the same time, it is presented as a kind of virtuum – multidimensional and multi-level formation, forming a new image of society and, at the same time, generating and combining new knowledge. In today's society a so-called "new effect" acts because there is a search for qualitatively new ideas and solutions, and there is a conflict between old and new ideologies, generations, and images of thought (Kharchenko et al., 2020). In a complex social space, a "concerto" of divergent and convergent processes takes place.

One image of it overlaps with another, as we have discovered "ecological space", "semantic space". "communication space", "geographical space", "conscious and unconscious space", "symbolic space", "virtual space", "topological space", "spiritual space" as well as "innovation space" and many more. A complex society is also made up of parts that we have yet to discover. Innovation space as a part reflects the dynamics of a complex whole space.

Consider an example of constructing a modern transport infrastructure that requires the creation of a special living space. So, the studies on wellbeing and quality of life have a

well-established practice of combining environmental objective measures and individual subjective experiences (Boffi et al., 2022). In modern developments more in depth the interaction between micro-mobility and different transport modes are considered (Comi et al., 2022).

Some conclusions are drawn regarding the many variations in the design of transport infrastructure. Firstly, designing shared space schemes does not necessarily mean creating a balance in spatial behaviour or movement among different road users (Batista et al., 2022). Secondly, transport infrastructure development and management have to be integrated to ensure optimal maintenance and economic viability through its whole lifecycle. Coupled with the emerging need for twinning physical and digital infrastructure, management becomes more complex and requires additional synergies to be established. This, however, will empower cities with new opportunities to enhance services and improve accessibility overall (Yannis et al., 2022).

We agree with the opinion that promoting the use of sustainable modes of transport and analyzing their interactions is the basis of the various processes involved in transport planning (Giuffrida et al., 2022). Technology and innovation planning is a key factor that influences the construction of various visions of the future.

M. Demidova (2019) has defined the innovation space of modern society from the perspective of philosophy. As a result, the author found the main factor of socio-economic and social interaction in the innovative space of society – "symbolic capital" as "trust credit", because trust determines the involvement (inclusion) of people in the social process. Trust in innovation, including social innovation, contributes to the development of society. For the first time, the author defined the notion of "innovative space of society" as "a form of social self-organization aimed at the development of social relations, carried out through innovative transformations". The conclusion is made that innovation space is an invariant of social space. Due to the social determinacy of innovation space, it should be defined on the basis of the features of social space functioning. Then it is possible to obtain a more comprehensive view of the innovation system, which in the long term will make it possible to develop models for managing the innovation space that contribute to the progressive development of society. The subject of the smart society of modern media discourse should adapt to this environment in the context of global challenges, develop the psychological

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stability of the subject to the influence of negative (entropic) destructive manifestations of this environment, be able to protect their internal and personal information field (Voronkova et al., 2022).

Consequently, the innovation space in which technology and innovation coexist is presented as a multitude of alternative definitions and models of it.

Conclusion

Vergence of technology and innovation works as the sum of the approaches, acting on the system. Even individual singular changes generated by the introduction of innovations in a local area of space rather than across the board have a cumulative effect.

Vergence of technology and innovation is also based on respecting a certain number of existing approaches and possibilities within a given moment in time, with an arbitrary number of innovative ideas and an infinite multiplicity of them.

In the normal and harmonious development of the system, vergence controls the movement of technology and innovation. It stimulates their coherence in the space-time continuum, controls the system in case of ambivalent processes of divergence and convergence, and removes contradictions when replacing obsolete technologies with innovative technologies.

The vergent interaction of technology and innovation, the fusion of means and resources, contributing to the modernization of the innovation space, their analysis and synchrony, rules out a position of rest in the social system and, on the contrary, generates a situation of accelerated but controlled dynamism.

The focus of vergence of technology and innovation on the behaviour of the innovation space as a whole means striving to subordinate this system to the needs of the management core (subject to constructive, creative approaches are taken). If technologies and innovations are produced asymmetrically or are the result of coercion, then vergence fails because of the mismatch between creative intentions and the natural development of the system.

Vergence of technology and innovation is also possible when the subject of cognition represents creative stimuli for the purpose of the scientific search for new ideas and solutions. Such vergence can be called the vergence of volitional control of the innovation space.

The vergence of technology and innovation is also labelled according to its direction. There is horizontal vergence, vertical vergence and cyclovergence. Horizontal vergence is divided into convergence (positive vergence) and divergence (negative vergence). Convergence allows us to compare and generalize technologies and innovations by looking for commonalities between them. Divergence, on the other hand, allows us to see the differences between them, which essentially enriches them. Vertical vergence is the construction of a management core. Cyclovergence allows the "life cycles" of technology and innovation to be captured to some extent.

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