

ISCKMC 2022**International Scientific Congress «KNOWLEDGE, MAN AND CIVILIZATION»****INTEGRATED INFORMATION SPACE AND AUTOMATION AND
COMPUTERIZATION OF ARCHITECTURAL DESIGN**

Nataliya Alekseevna Saprykina (a)*

*Corresponding author

(a) Moscow Architectural Institute (State Academy) Moscow Architectural Institute (State Academy), 11/4, building 1, p. 4, Rozhdestvenka St., Moscow, 107031, Russian Federation, nas@markhi.ru

Abstract

The article discusses the ways of evolution of the formation of architectural design in the context of the informational paradigm of the development of society. The study carried out on the basis objective methods developed in “informology” as a certain system of knowledge about the processes and tasks of the transmission, distribution, processing and transformation of information. The purpose of the article is to identify trends in the formation of an integrated information space interactively connected with the environment. The theoretical platform of the problem and the prerequisites for its solution substantiated: Approaches of the “Society 5.0” strategy to the sustainable development of architecture; Using of “Big Data” technology in the formation of the concept of a Smart City. The tools of interactive technologies for the formation of architectural design justified: Global information system of interaction in architectural design; Formation of an integral space in the information and communication environment; Transformation of integral space in the context of creation, storage and use of information resources. It has established that modern forms of providing information and organizing its consumption can implement when creating the corresponding architecture objects in the global information system.

2357-1330 © 2022 Published by European Publisher.

Keywords: Architectural design, automation, communication environment, informology, Smart City

1. Introduction

New information technologies are changing our understanding of architectural design, as there is an integration of the capabilities of technology with existing human needs. This is due to the presence of a global information system as an integrated space that forms a new communication environment for life, communication and production in various fields of activity. Information networks form a new global information and communication environment of life, communication and production, as well as create opportunities for the formation and development of network structures in various areas of public life. In a dynamically changing society, the role of architecture is being transformed in the context of the new strategy “Society 5.0”, information technologies such as “Big Data” and others (Eroshkin et al., 2017).

Innovative approaches to the provision of information and the organization of its consumption can implement when creating of the architecture objects. In recent years, many developments have appeared in the world architectural theory and practice, which can consider as the formation of a new architectural vision of a sustainable spatial habitat. Using cybersecurity information technologies, artificial intelligence and robotics, the habitat development logic determines an alternative understanding of architecture as a new information-spatial system (Baitenov, 2020). In connection with the relevance of this problem, it seems appropriate to consider new prerequisites and approaches to the formation of architecture in the context of automation and computerization of design.

2. Problem Statement

The purpose of the article is to identify trends in the formation of an integrated information space interactively connected with the environment. It seems appropriate to consider the prerequisites for the organization of architectural design in the context of the information paradigm of the development of society. The study is biasedly on objective methods developed in “informlogy” as a certain system of knowledge about the processes and tasks of the transmission, distribution, processing and transformation of information. This will allow not only to understand the importance and necessity of updating the use of information technology and automation, but also to identify innovative approaches to computer-aided design of the architectural environment in this context.

3. Research Questions

The declining amount of internal resources of the planet determines the need for a qualitatively new approach to solve the problem and further development of society. An effective solution in this situation is to create an interactive and intelligent system for managing the economic development of countries. In this regard, the recently appeared strategy “Society 5.0” to improve the quality of human life is associated with the solution of social problems by integrating the information resources and the physical spatial environment (Saprykina & Vorozhikhin, 2016).

As part of the “Society 5.0” strategy, model is proposed to create integrated intelligent systems in all areas of sustainable development of the economy and society. The main attention is paid to the issues of environmental conservation, rational energy development, the automation of organic farming and

animal husbandry, and the qualitative development of industry. The positions of the “Society 5.0” strategy, according to the developers, are implemented through the use of components that apply technological advances in the following areas: robotics, drive technology, biotechnology, human interface technology, light and quantum technology of innovative measurement methods, information and energy transmission, Internet of things, artificial intelligence (Sharifi, 2019).

These approaches play an important role in solving social problems and transforming society to create comfortable conditions for its existence in the future. Modern technologies give rise to the phenomena of cyberspace and network space, which are combined in the term “info-space”. Some forms of providing information and organizing its consumption can be implemented when creating appropriate architectural objects in a global information system.

Architecture as a system for the formation of artificial space is influenced by the innovative revolution taking place in the world. In the context of the development of scientific and technological progress, new areas of knowledge are being attracted to architectural research, which makes it possible to outline the contours of the formation of a completely new urban space that ensures the quality of life. In this regard, the thoughtful introduction of technological innovations is very important. Therefore, society has faced the problem of ensuring the sustainable coexistence of cities with the environment without causing critical damage to it (Heravi et al., 2017).

The new paradigm of sustainable urban metabolism implemented in the concept of the formation of a Smart City as a new integrated environment, which includes a set of environmental problems aimed at finding new forms of urban space using innovative engineering technologies (Saprykina, 2018). For the integrated formation and management of a Smart City, it is advisable to use Big Data technologies in urban planning, territorial zoning, as well as in solving transport problems, security issues and social comfort (Kurcheeva & Klochkov, 2018).

4. Purpose of the Study

The professional community of architects and urban planners get a unique opportunity to influence the life and organization of cities with the help of such a tool as “Big Data”. According to some researchers, the use of these systems in the future will allow creating complex objects and systems in almost all parts of the functioning of the city. Engineering equipment will become part of the infrastructure network (Volynskov, 2017). Therefore, in order to apply Big Data technology in the formation of the concept of a Smart City, it is necessary to have innovative structures, the restructuring and adjustment of which will be similar to editing the program code, which will open a new direction in the construction industry (Gnevanov & Ivanov, 2018). This will allow on this basis to come to their synthesis and to develop an integral model of the information system in the context of the social dynamics of society.

5. Research Methods

New information technologies are changing our performance of architectural design, which is a multicomponent system. This necessitates the development of a new holistic *hybrid architectural design*

environment, where the object, space and process are combined in the design environment. A communication environment is emerging that includes means of presenting a project idea, tools of project process management and information support systems.

The architectural design environment plays the role of an active intermediary, combining three main elements - the *real environment*, a *person* and a *computer*. The main principle of the hybrid architectural design environment is interaction through a computer, and not interaction with a computer. Such a hybrid design environment stimulates the emergence of ideas in ways that are impossible in a normal physical workspace (Ptichnikova, 2020).

In this case, there is a shift in emphasis and a modification of the phenomenon of architecture away from its materialization into a virtual, unreal architecture. An informational approach appears in architecture as a relationship between two spaces: *architectural* and *informational*. Inclusion of the digital world into the real world requires consideration of the model of interaction between these two spaces and the model of the language of communication, as well as the model of the architectural design process (Kurcheeva et al., 2020).

Thanks to the interaction of digital modeling and the “info model”, the design goes to a new level by systematizing and generating the parameters of the factors. A model is creating based on the use of integral principles put into the digital modeling program. This requires the creation of a unified system of data obtained during the design process for ordered models that allow you to get a complete picture of the object. These models contain all data regarding building geometry, function, materials, maintenance and more (Kalyanov et al., 2017).

The methods and methods of such shaping exceed the cognitive abilities of the designer. The possibilities of digital design are practically unlimited and operate at all stages of project forecasting and creation of an architectural object: from a sketch to construction management. It is possible to create “live models” – computer objects that are in a unifying dynamic state, open to constant changes in the range set by the author of the project and determined by the participants of the construction process.

These design methods imply the creation of an integrated space that interacts interactively with the environment, has the ability to adapt and combine real and virtual elements of the space itself, depending on changing conditions, and is in constant motion and change. This is because the living space, which ensures the formation of people's daily lives and their interaction, is undergoing significant changes under the influence of the development of information technologies (Gogolkina, 2018).

When using these technologies, a new aesthetics is forming, the so-called free form, where the ideas of dynamism, fluidity and synergy become the dominant and active elements of shaping in architecture. This allows the structure, form and function of an architectural object to acquire interactivity and automation properties during design. In the work of an architect, opportunities created for the materialization of innovative ideas using information design methods, which has become an actively developing direction in architecture.

The development of electronic communication and information systems can significantly reduce the dependence between spatial proximity and the performance of many functions of everyday life. This is due to the currently actively developing ultra-fast and ultra-long range means of communication. At the present stage of social development, the formation of *communication links* is of global importance as the

most important elements of the sociocultural space that influence the formation of the entire system of spiritual values and needs of humankind (Dutsev, 2020).

The information resource becomes a socially integrating factor and radically changes the conditions for cultural exchange and interpersonal communication in the city, and erases spatial, temporal, social, linguistic and other barriers. This leads to the possibility of creating new forms of virtual communities, united only by their own sociocultural preferences. The impact of the new communication environment on the personal, social and cultural structure of human existence sets the task of developing a *communicative ecology* (Batabyal & Beladi, 2019).

Thanks to new forms of information and communication, the nature of the relationship between the individual and society is changing. The information space of the city, as part of the socio-cultural space, provides new opportunities for the development of the individual and put forward of the city new requirements for the individual consciousness and behavior of the inhabitant, in connection with his “*information activity*”. The intensification of communication through information technology leads to the emergence of a virtual, parallel environment as a model of an alternative to the social world.

This is due to the fact that the living space that ensures the flow of people's daily life, their interaction and the way of direct existence is currently undergoing significant changes under the influence of the development of information technologies. Therefore, when forming the environment, it is necessary to use information technologies for automation and computerization of architectural design.

Further development of these trends is found in proposals to create a protected archive for the preservation of world heritage and the achievements of the brightest minds in the world. This will ensure the long-term preservation of documents of special cultural and historical significance not only by means of conservation, but also by transforming them into electronic form.

An example is the project of the object “*Data Cemetery Skyscraper*” (authors Joanna Targowicz and Mateusz Binkowski) 2017 (Poland), which is based on the concept of a constantly changing world that needs a new kind of environmental object to perpetuate the cultural impact of people on society. This is due to the fact that over the centuries many cultural relics, works of art and manuscripts have been destroyed in social and economic conflicts.

The proposed architectural object is presented as a memorial “tree”, which can be preserved in harsh natural conditions and natural disasters due to its structural integrity. Denser branches are a sign of a natural cataclysm, war or epidemic, thinner ones represent peacetime. The “cloud” archive in its diamond memory stores data in the form of the most vivid memories of people, which can be represented using holographic technologies. After the global cataclysm, according to the authors, he will remain a silent witness to the history of our society and will become a guide for laying the foundation for another civilization (Targowicz & Binkowski, 2017).

Another trend of obtaining and using knowledge and information resources is associated with the transformation of science into a leading element of productive forces, where scientific activity turns into a leading branch of social production. Priority is given to obtaining knowledge that generates new knowledge, and in a geometric progression. This immaterial paradigm forms the *information economy*, which has always been and is the basis of the evolution of society (Aletdinova & Bakaev, 2018). It is

impossible to implement and use this concept without the formation of powerful information centers for the creation, storage and use of information resources.

An example of this trend is the design development of the self-developing, socio-economic and architectural structure “*Inform-city*”. The main objective of the facility is to fully provide and manage the infrastructure of the regions based on advanced information and environmentally friendly technologies. In addition to the main information and management task, the entire range of industrial, household and leisure issues can be comprehensively solved in the facility, as well as many modern acute environmental problems. In the project “*Inform-city*” technologically merges three areas of formation: the cultural and historical component, high information technologies and progressive socio-economic technologies (Saprykina, 2020).

Such info centers can have an intercontinental, regional and national level, can be located at a considerable distance from each other and do not require a large number of maintenance personnel. The use of information technologies allows the forming of cities without direct spatial dependence on developed infrastructure, that is, without the creation of large transport highways and power grids (Barcaroli et al., 2015). Intellectual and information resources have a small material component and energy intensity, as well as dynamism, easy replication and social integration. Therefore, the transition to the information economy opens up fundamentally new and extremely effective prospects for the socio-economic development of society.

6. Findings

Because of the study, the directions of using information technologies in architectural activity that appeared in scientific and design developments, which significantly changed the possibilities of designing architectural objects, are considered. This made it possible to determine the tools for their formation and to identify some concepts for solving this problem in the following areas.

1. Theoretical platform of the problem and the prerequisites for its solution:

- *Approaches of the “Society 5.0” strategy to the sustainable development of architecture* are associated with a new architectural vision of a sustainable spatial environment using cybersecurity information technologies, artificial intelligence and robotics.

- *Use of “Big Data” technology in the formation of the concept of a Smart City*, as a new integrated environment, is implemented using intelligent automated control systems. This technology is a tool for its territorial zoning, security, solving transport problems, security issues and social comfort.

2. Interactive technology tools for shaping architectural design:

- *Global information system of interaction in architectural design* is associated with the development of a new holistic hybrid communication environment, which includes means for presenting a project idea, tools for managing the project process and information support systems.

- *Formation of an integral space in the information and communication environment* radically change the conditions for cultural exchange and interpersonal communication in the city, and erases spatial, temporal, social, and linguistic, and other barriers. This must take into account in architectural design using information technology.

• *Transformation of integral space in the context of creation, storage and use of information resources* occurs through the creation of electronic architectural information centers in the global system, which opens up fundamentally new and effective prospects for the socio-economic development of society.

7. Conclusion

An information resource, unlike material resources, is not subject to any laws limiting social development. This makes it possible to meet the needs of a dynamically developing society, which using the latest information technology developments. During the transition to the information paradigm, the typology of architecture is updated with new types of scientific and intellectual objects with interactive properties. Innovative ideas of using information methods of computer design and automation materialize in the architect's work.

The results of the conducted research can be useful for the theory and practice of the formation of the living activity space, as they open up completely new opportunities in the development of architectural design methods. Thus, the phenomenon that began long before the use of information design methods has now turned into an actively developing direction of architecture with the potential to dominate contemporary art in the near future.

Acknowledgments

This paper was funded by the Program of Fundamental Researches of the Ministry of Construction, Housing and Utilities of the Russian Federation and the Russian Academy of Architecture and Construction Sciences 2021-2022, the Research Project 1.1.6.3..

References

- Aletdinova, A., & Bakaev, M. (2018). Cultural and environmental factors promoting innovative activities in digital economy. *Korea and the World Economy*, 19, 169–191.
- Baitenov, E. (2020). Modern challenges and the outline of the future of architecture. *Proceedings of the 2nd International Conference on Architecture: Heritage, Traditions and Innovations (AHTI 2020)*. <https://doi.org/10.2991/assehr.k.200923.002>
- Barcaroli, G., Nurra, A., & Salamone, S. (2015). Internet as data source: Istat Survey on ICT in enterprises Austrian. *Journal of Statistics*, 44, 31–43.
- Batabyal, A., & Beladi, H. (2019). The optimal provision of information and communication technologies in smart cities. *Technological Forecasting and Social Change*, 147, 216–220.
- Dutsev, M. (2020). The city as an art integration space. *Proceedings of the 2nd International Conference on Architecture: Heritage, Traditions and Innovations (AHTI 2020)*. <https://doi.org/10.2991/assehr.k.200923.061>
- Eroshkin, S. Y., Koryagin, N. D., Kovkov, D. V., Panov, D. V., & Sukhorukov, A. I. (2017). The paradigm of the integration of different types of management information systems in investment and construction company implementing the project approach. *Procedia Computer Science Volume, 12th International Symposium Intelligent Systems (INTELS) (5–7 October 2016)*, 103, 605–608.
- Gnevanov, M. V., & Ivanov, N. A. (2018). Big Data technologies and their application in urban planning. *Industrial and Civil Construction*, 4, 83–87.

- Gogolkina, O. V. (2018). Parametric architecture in the formation of recreational complexes. *IOP Conference Series: Materials Science and Engineering (MSE)*, 463, 1–6. <https://iopscience.iop.org/article/10.1088/1757-899X/463/2/022066/meta>
- Heravi, G., Fathi, M., & Faeghi, S. (2017). Multi-criteria group decision-making method for optimal selection of sustainable industrial building options focused on petrochemical projects. *Journal of Cleaner Production*, 142(4), 2999–3013. <https://doi.org/10.1016/j.jclepro.2016.10.168>
- Kalyanov, G. N., Kuprianov, B. V., & Fiodorov, I. G. (2017). The role of decomposition in organizational system modeling. *CEUR Workshop Proceedings, 2nd International Scientific Conference "Convergent Cognitive Information Technologies", Convergent, (24–26 November, Lomonosov Moscow State University Faculty of Computational Mathematics and Cybernetics, Moscow) 2064*, 380–387.
- Kurcheeva, G. I., Bakaev, M. A., & Klochkov, G. A. (2020). Hierarchical approach to artificial intelligence. *Journal of Physics: Conference Series*, 166, 012179.
- Kurcheeva, G. I., & Klochkov, G. A. (2018). Comprehensive approach to smart urban development based on Big Data application. *Journal of Physics: Conference Series*, 1015, 042025.
- Ptichnikova, G. (2020). Hybridization in architecture. *Proceedings of the 2nd International Conference on Architecture: Heritage, Traditions and Innovations (AHTI 2020)*. <https://doi.org/10.2991/assehr.k.200923.044>
- Saprykina, N. A. (2018). Forecasting technology as a method of modeling and building Smart City concept. *IOP Conference Series: Materials Science and Engineering*, 365(2), 022068. <https://doi.org/10.1088/1757-899X/365/2/022068>
- Saprykina, N. A. (2020). Alternative approaches to information-automated design of architectural objects: precedents of the use. *IOP Publishing Journal of Physics: Conference Series*, 1661, 012189. <https://doi.org/10.1088/1742-6596/1661/1/012189>
- Saprykina, N. A., & Vorozhikhin, V. V. (2016). “Society 5.0” as humanity's response to the challenges of global development. Financial system of Russia: development trends and alternatives. *Collection of scientific papers of Materials of the IV All-Russian Scientific and Practical Conference (November 9–11, Sevastopol: SevGU)*, 309–313.
- Sharifi, A. (2019). A critical review of selected smart city assessment tools and indicator sets. *Journal of Cleaner Production*, 233, 1269–1283.
- Targowicz, J., & Binkowski, M. (2017) *Data Cemetery Skyscraper*. <http://www.evolo.us/featured/data-cemetery-skyscraper/>
- Volynskov, V. E. (2017). “Big Data” in urban planning. *Academia. Architecture and Construction*, 3, 99–102. <https://cyberleninka.ru/article/n/bolshie-dannye-big-data-v-gradostroitelstve>