Alternative approaches to information-automated design of architectural objects: precedents of the use

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Abstract. The article is devoted to the topical problem of introducing information technology into architectural activities to find new trends in design. The article aims to identify alternative approaches to the information-automated design of architectural objects that use the latest information technologies and resources. The leading approach to the study of this problem is based on the study of project precedents of the use of automated control and self-management of kinetic systems in the creation of architectural objects. As a result of the study, alternative approaches to the information design of the architectural environment were identified using automated techniques for the formation of space using the information and operating environment of interaction in architecture. The materials of the article can be useful for the theory and practice of habitat formation, as it opens up completely new opportunities in the architectural activity.

1. Introduction
The role of architecture in a dynamically changing society is being transformed. Computer technologies used in architectural activities have significantly changed the possibilities of designing architectural objects. Information design becomes the leading area of architecture, which uses concepts such as interactivity, virtuality, parametric design [1].

With the advent of new technologies began the formation of a new aesthetic. In this so-called free form, the ideas of dynamism, fluidity and synergy become the dominant and active elements of form in architecture. This process is in practice possible through digital technologies and cybernetic mechanisms. Architecture can change, allowing the structure, form and function of an architectural object to acquire interactivity and the properties of automation. There is a simulation of an object as a particular organism based on the idea of self-organization of the evolving system [2].

2. Statement of the problem
The article aims to identify alternative approaches to the information-automated design of architectural objects that use the latest information technologies and resources. This setting of the problem attracts many specialists involved in the formation of architectural habitat in the context of its information modelling.

Among the examples available in the literary and information environment are offers of the research and development [1-3], [7], [10], [13], [16-17], and also presented the specific design solutions and numerous proposals implemented under this concept [4-6], [8-9], [11-12], [14-15]. For finding new trends in computer design, it is advisable to consider the innovative concepts of habitat formation that have emerged in architectural activities. This process allows not only understanding the
importance and necessity of updating the use of information technology and automation but also identifying the alternative approaches to the information design of the architectural environment.

3. Materials and methods

3.1. Techniques of automated control and self-management of kinetics systems in architectural objects

Digital architecture is now presented in practice as an imitation of a normal three-dimensional space. Most architects use digital models to demonstrate to the customer the most spectacular form of their project and as an idea of a future architectural object. Influenced by the development of digital technologies and the Internet in modern architecture, different processes are taking place, and new directions are emerging as opposed to existing original design [3].

With computer control, interactive facades can use mechanical response methods to create a specific effect of a “living” facade. It opens up enormous creative possibilities using reflective metal plates protecting the main facade of the building, which come into motion with the help of pneumatics. In architectural practice, many new solutions help to update approaches to the formation of building facades using kinetic techniques based on solar lighting. The creation of such devices is possible as a result of the joint creativity of architects, engineers, mathematicians and programmers. The organization of a dynamic object is associated with the algorithm of stages of changing its transformable form. The leading feature in the design of such an object is the speed of change in its voluminous and functional parameters. This concept is widely embodied, both in changing the overall shape of the object itself and in the transformation of its elements.

In the kinetic facade of the Brisbane Airport, similar effects are achieved by wind and solar power. Urban Art Projects developed the “Vertical Lake” project (UAP) and Brisbane Airport Corporation (BAC) in collaboration with artist Ned Kahn. The ‘Object’ closes the parking lot building and is a vertical array that every second alters the relief of its facade. The computer system in solar weather launches rotary metal pneumatic elements to make the facade shaded and does not let in unnecessary sunlight [4].

Using kinetic techniques of the formation and existence of an architectural object allows creating a series of buildings and their structural elements, like the organization of living organisms and cells. The “Geno-Matrix” concept is an example of computer management of a system of algorithms to create an architectural form of objects. The peculiarity of the idea is to make as much pre-assembly as possible in controlled factory conditions. In a modular construction system, a large number of volume units are manufactured and assembled into a block system. These units can be positioned with a shift forward or inside, or combined in a modular grid. This process allows the formation of infinite typological possibilities of the form. A figurative solution of the building depends to a large extent on the location of these blocks and the internal composition between them.

This approach to creating a kinetically changing architectural object allows responding to the dynamic needs of the inhabitants, as well as continuously adjust to changes in spatial requirements. By changing local unit ratios, the Geno-Matrix system can function by moving modular units through computer control by patterns and hierarchy, as well as to influence the emotional impression of the Object [5].

The techniques of automated control and self-control of kinetic systems are illustrated by the project concept of the “Kinetic Wall” in Barkow Leibinger. It redefines the utopian dream of the 20th century about kinetic architecture and is a prototype of the concept of an object that can move and transform. The movement of the wall and the change of its surface is activated by a number of motorized points that expand and decrease. The movement of the elements changes the exhibition corridor for the visitor between the “Kinetic Wall” and the adjacent glass partition into a differentiated arc-shaped space. Digital control of algorithm to motion provides endless images of changing surfaces. The effect of the optical surface is further enhanced by two layers of mesh fabric [6].
3.2. Techniques of reflecting information flow over time with automated management of algorithms to create an impression of the Object

The most common virtual techniques used in real-world projects are computer-projecting slides and videos on special screens and vast surfaces of houses walls. By summarizing the international experience of creating the latest concepts, one can imagine how the principles of interactive architecture can be applied, solving many problems of adapting space [7].

The «Urban Image» concept, created by Jakub Klask (Czech Republic) in 2007, is based on the fact that a high object can become a landmark in the context of almost every European city. The Urban Image project is based on this concept and is located on a narrow and long urban strip with open space. The facility serves as a guide for the formation of the place of culture, traditions and spatial context of the district. The building consists of two very thin square slabs that use different information programs. The image is created by the interactions of visible images of these two plates in accordance with the light or its absence. This object becomes an information source for a large surrounding space [8].

As examples of the information navigate in architectural environments, many objects can be cited. For example, the temporary «Religious Idols» Pavilion is designed to house idols at the largest socio-cultural and religious festivals in India. The main idol is placed along the longitudinal axis and is framed by steel racks. The use of high-tech equipment does not contradict religious traditions and gives a sense of holiness when entering the pavilion [9].

The interactivity of virtual objects opens up many opportunities in almost all areas of urban life. According to the projects already implemented, it is possible to speak with some certainty about the gradual virtualization of architecture and living space. The methods and ways of formation exceed the cognitive abilities of one designer, as the possibilities of the computer, design are practically unlimited and operate at all stages of the creation of an architectural object: from sketch to construction management. Also, the architectural product benefits from the ever-increasing perceptibility of virtual technologies [10].

3.3. Alternative free-movement strategies with using automated habitat development techniques

Some trends of free movement in the habitat space are embodied in modern developments that use innovative methods of management with the help of information technology. Thus, the formation of the habitable space of skyscrapers is associated with the invention of the elevator, which completely limited their evolution in terms of software and formal alternatives. The concentration of vertical circulation in the form of ladders or mechanical devices is mistakenly perceived as an agent of free movement in space. However, the range of motion of the elevator is completely connected with the trajectory of its movement, which limits the possibilities of the evolution of the building.

Proposal of «Zero Restrain Mobility» by Eduardo McIntosh (United Kingdom)’s 2007 is to separate the vertical circulation of users from the main structure of the building. An important feature is that a mechanical device to move people inside a building can free up this building from the constraints imposed by vertical circulation. An autonomous free-moving device is a transport mechanism that can move on the outside of the building and carry users or objects inside the capsules. Mobile automated agents can work as a system that is controlled by a minimum route algorithm to reduce each user's time. Energy to these agents is provided through applications on the surface of buildings. The advantage of this type of movement is also to ensure rapid evacuation from any part of the building [11].

An example of the same concept is the project «House of the Future Inspired by the Matrix» by Kuangyi Tao, which is response to the problems that arising in our time: overpopulation, lack of resources. The author, using the concept of "cell body", proposes a project of the house, which is based on the system of exchange of energy and information controlled by its inhabitants. The mainframe of the house is created from the infrastructure of plates of memory, which can be located apart from each other at a distance. The functional shell used in this project acts similarly to the shell of the heart. The material used has electro-sensitivity and can expand or contract when various
electrical stimulation, as similar to heart muscles. The spatial concept of the house is similar to a living organism, able to organize and function independently depending on the changing needs of its inhabitants [12].

3.4. Global information and operating environment the interaction in architecture

The current level of development of telecommunications systems is sufficient to build global information and operational environment of interaction. In this regard, it is particularly important to use the world's communication capacity, which is closely linked to the information system. To use the information resource requires a different technological level, improved storage and transmission tools, the information, as well as its full interactivity [13].

An example of this approach is the «Data Skyscraper» project proposal as the Sustainable Data Center in Iceland, which is designed to host different servers used by many types of companies to store and process all the daily information. Modern data centers consume much electricity and have a large «carbon footprint», and the equipment needs to be continuously cooled to avoid overheating. Proximity to the Arctic Circle allows using the cold and fresh sea breeze to cool servers, avoiding the cost of a traditional cooling system. Outside, the centre is a cylindrical tower, on the outer facade of which all the hardware components are attached. Also, the facade of the tower is a flexible and continuously developing system, changing the density and position of the equipment, if necessary, allowing freely changing and increasing the height of the tower [14].

Modernization and globalization symbolize the progress of humanity, but despite all the conveniences it brings, it also absorbs people's feelings, sensory information and emotions, i.e. the key components of life. The «Sensory Skyscraper» project was conceived on an island in the Yangtze River in the municipality of Chun-ting, by V. Mercuri and M. Merletti (Moldova, China). This project is a multifunctional laboratory of scientific research on human feelings, perception, rehabilitation of sensory information, rehabilitation of the effects of experience and rehabilitation of motivations and expectations [15].

This laboratory is a cube that creates a combination of 6 pyramids that reflect how works the human brain when processing different senses. Within each pyramid, specific templates show functional sectors, each of which is an open space for different types of perceptions and feelings. Pyramids can move vertically separately, as the cubic form is controlled by magnetic force, and the mobility of the pyramids is fully fixed. Magnetic energy is invisible and strictly controlled without harming the environment, so the Object looks like a vessel floating in the air [16].

The development of information technology for information transmission allows for new opportunities for access to and maintenance. It is unthinkable to implement and exploit these opportunities without essential information centers, the creation and use of information resources. A well-established system and logistics in storing information are essential for users to quickly acquire specific information to gain new knowledge and create a new intelligent product. This circumstance ensures a long life of documents of particular cultural and historical significance not only using preservation but also by transforming them into electronic form.

4. Results and Discussion

Alternative approaches to the information-automated design of architectural objects in this review are outlined in the context of the following directions discussed in the article:

1. Techniques of automated control and self-management of kinetics systems in architectural objects. Identifying alternative examples of the use of kinetic systems of architectural objects has allowed identifying new directions for their formation as opposed to the existing original design. Approaches to creating a kinetically changing shape of an architectural object allow responding to dynamic needs and continuously adapt to changing spatial requirements. The precedents for using these approaches prove that the creation of such devices is possible as a result of the joint creativity of architects, engineers, mathematicians and programmers.
2. *Techniques of reflecting information flow over time with automated management of algorithms to create an impression of the object.* Using the principles of interactivity as the latest alternative concept in architecture opens up a lot of opportunities in almost all areas of urban life and solves many problems of adapting habitat space. These examples of information navigators of the architectural environment allow speaking with certainty about the gradual virtualization of architecture and living space. The main condition is the tactful embedding of virtual images in the historical environment. Here, the architectural object benefits from the ever-increasing visibility of virtual technologies.

3. *Alternative free-movement strategies with using automated habitat development techniques.* Using automated spatial organization techniques using information technology allows mobile agents operating as a system that, for the convenience of each user, is controlled by a routing algorithm. The use of the energy-information exchange system controlled by its inhabitants allows forming a spatial concept of the building similar to a living organism, capable of self-organizing and functioning depending on changing the needs of its residents.

4. *Global information and operating environment the interaction in architecture.* The concept of developing the technical possibilities of transmitting information allows for new opportunities for access and maintenance. To use these opportunities in architectural activities allows the creation of powerful information centers for storage, creation and use of information resources. The using interactivity techniques in architecture allows to creating an area of activity in which objects interact with each other, with space and with the person. They can change under changing needs or the influence of external factors, both physically and virtually.

5. **Conclusion**

The rapid advances in information technology and telecommunications around the world are making information and automation one of the primary economic resources for society's development in the new environment. Information networks create new global information and communication environment for life, communication and production, as well as opportunities for the formation and development of network structures in various areas of public life. The development of information technology significantly reduces the relationship between a person's spatial location and the functions of everyday life.

Traditional architecture can no longer meet the needs of dynamic humanity using the latest technological developments. Architecture should be interactive, responding to interactions that adapt to everyone's needs. The identified alternative interactive techniques should be considered in close contact with each other and with the environment, as well as in conjunction with the basic principles of progressive concepts. Because intellectual and information resources have a small material resource component and energy intensity, as well as dynamism, natural reproduction and social integration, they can be used in architecture, creating a comfortable habitat.

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