

PAPER • OPEN ACCESS

Dynamic architecture. Interaction with city, nature, man

To cite this article: T V Belyaeva 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **687** 055015

View the [article online](#) for updates and enhancements.

You may also like

- [Million-city site plan problems \(Voronezh Case\)](#)
A N Gorbunova
- [Digital census of Upper Kama towns architectural and urban environment](#)
A E Semina and S V Maximova
- [Rotunda church in Russia as typological phenomenon](#)
O B Tereshina



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Dynamic architecture. Interaction with city, nature, man

T V Belyaeva

Department of engineering and computer graphics, South Ural State University, 76,
Lenin Avenue, Chelyabinsk 454080, Russia

E-mail: beliaevatv@susu.ru

Abstract. The article analyzes organization mechanisms of a contemporary architectural facility, discusses the directions and methods of constructive transformation of buildings and structures in the light of the development of the modern dynamic architecture. The features of its development are presented in examples. The definition of mobile architecture is given, current problems are highlighted, issues related to the evolution of mobile structures are considered, its past, present and future are revealed. A variety of manifestations of dynamic transforming architecture is presented. In today's trends, the broad multidirectionality of the development paths of a dynamic architecture is especially apparent. The article systematizes the leading directions of this topic, considered spatial, constructive, light-colored, interactive methods of transforming objects. The presented design methods remain relevant, and the direction of development of a wide range of this type of architecture in general is becoming increasingly important.

1. Introduction

A distinctive feature of our time is the ever-increasing dynamism of society. The world around us is changing, and the modern man, not noticing this, is daily confronted with transformations of the environment. The architecture must meet the needs of the person, as well as quickly change its appearance.

Considering architecture as a living organism, responsive to the needs of people, an understanding of architecture is formed as a changing artificial environment adapted to the dynamic processes of reality and meeting the requirements of society. The times of clearly established canons and rules are a thing of the past. Today's architecture is actively seeking new images and visions that can correspond to rapid and global changes around us.

The rapid pace of development of modern architecture and trends in construction allow us to use both the proven principles of static nature and the techniques of dynamic architecture that have been developed today, that humanity has been building transforming buildings and structures for many years, enough to recall movable bridges. However, today the dynamic architecture has reached a new level [1,2].

2. Methods

The concept of "dynamic architecture" in the 60s of the 20th century was proposed by the architect A.A. Haiduchenia and on the basis of this, the projects existing at that time and his own development identified four vectors [3].



The dynamic or transformative architecture is a type of architectural objects capable, depending on the set goals and objectives, to change the volume, composition, internal structure of construction, planning decisions.

A characteristic difference of such structures is the possibility of everyday regular and periodic changes, transformation of the layout and space of buildings and structures for a certain time, in accordance with the requirements of the functional processes conducted in the building.

In general, transformation techniques can be classified into spatial, constructive, light-colored and interactive.

Spatial transformation techniques are a “qualitative” change in an architectural object by transforming internal elements while maintaining its overall constant dimensions.

Constructive transformation techniques - “quantitative” change in the overall dimensions of the building (transformation of developing buildings with the help of drop-down coatings, telescopically moving apart parts of the building, sliding walls, etc.).

In this case, the processes of external adaptation of an architectural object occur by changing its outer shell, which regulates the relationship between environmental conditions and controlled internal elements (Figure 1).



Figure 1. Moscow. Zaryadye Park has a unique translucent coating here - the “glass bark”.

They maintain the relationship of the premises with the environment and the landscape. Thus, clear boundaries of architecture are erased. Depending on the nature of the obstacle, the dynamics of a person-object-environment relationship is taking shape.

Light-colored transformation techniques allow to change the visual and semantic characteristics of the light environment, forming a new, more complex, dynamic artistic and virtual image.

Interactive transformation techniques are a self-organizing system in which, due to the interaction of a person with his environment, an external or internal transformation of the architectural envelope occurs.

The ability to change shape is often used in buildings to increase comfort and communication with the external environment, they change the degree of isolation of the internal space due to changes in the elements of the coating and other enclosing structures. [4,5] It can be shopping and entertainment complexes, sports facilities, theater arenas, agricultural and industrial buildings. [6-8]. The mobile ar-

chitecture is part of modern design and construction technologies, a huge global industry specializing in prefabricated structures.

A striking example of the mobile, transformative architecture is the membrane or, as it is sometimes called, awning or textile architecture, it was created thanks to the enthusiasm of Otto Frey, the German architect, who first drew attention to the effectiveness of covering large spaces with flexible shells – membranes (Figure 2).



Figure 2. A variant of application of membrane architecture.

The French firm FERRARI, which is similar in writing to the brand of a famous automotive corporation, for the first time in the construction world applied special polymer fabrics to floors and attracted such a cult architect as Norman Foster to the development of methods for designing membrane structures. As a result, the tent architecture spread to ubiquity.

The main objectives of this solution are the possibility of frequent movement of an object with a short installation time in hard to reach places. Light houses, removable or in the form of hotel rooms do not require significant material costs, as well as time for installation work, so they are cost-effective. [9,10].

In the direction of evolutionary-adaptive architecture, buildings and systems are designed with a previously planned reserve for subsequent dynamic development in the context of changing environmental and human factors.

3. Analysis of approaches

The urgency of the problem of building adaptation to constant changes in the surrounding reality is only increasing. With the acceleration of the pace of modern life, the need for continuous change of images increases. It is not expedient, from the point of view of economics and ecology, to erect a building for a shorter period than the time of its physical deterioration.

Reconstruction, in order to preserve the original appearance of the building is not always the best solution. This solution is suitable for buildings that are truly of historical and aesthetic, cultural value for the city. But there is also a large number of typical projects in which there is no individuality, for example, typical building of the second half of the 20th century. Today, such buildings are visually obsolete and do not represent any artistic value. Therefore, in order for the appearance of the building to remain modern throughout its service life, a transformation of its appearance is necessary.

Transformation can be complete, for transportation of a structure or its elements in a disassembled form to the place of construction, or partial, for example, for regulating the microclimate of a room due to reversible movements of structural elements (enclosing surfaces, roofing). The transformation of the object can be carried out by changing the internal elements while maintaining its overall constant dimensions.

This refers to the adaptation of the object to the new conditions: social or economic status, changes in family composition, change of generations, or just a change of housing “in the mood”, without changing the overall volume-constructive parameters, by transforming the internal space of the object, its interior. One of those who attract attention is the architects Atsushi and Mayumi Kawamoto from the architectural bureau “mA-style” (Figure 3).



Figure 3. Riverbank House has the shape of an isosceles triangle and is located on a tiny patch near the river.

The architecture of total movement combines all the best from other areas of architecture. The bionic architecture is turned to the person, the internal space of such a building positively influences the state of health, the mood of the person, reveals his creative abilities. The bionic architecture involves the creation of houses that are a natural extension of nature [11].

Bionics in architecture is not just the curvature of the outlines of forms, the external similarity to mollusk shells, bird shells, honeycombs, branches of forest thicket, etc. First of all, it is more comfortable, more harmonious, more reliable spaces of human activity. This is an example of a combination of design and other technological advances in science [12].

Creating a new architectural style is a complex and lengthy process. Its elements and techniques arise in the depths of the old style and, over time, occupy leading positions. One of the important features of the new direction can be considered a constructive change [13]. Dynamics in architecture can be expressed both by artistic methods and by the creation of structures capable of movement.

Studio Urban Art Projects developed the concept of Vertical Lake (“Vertical Lake”). It is a structure of 250 thousand aluminum elements, dependent on the wind. The project is based on the idea of natural kinetics. Air flows change the angle of each element and form a constantly changing relief of the facade, which resembles a ripple of water. The facade provides shading of the building and allows you to adjust the temperature (Figure 4).

Dynamic architecture has its own characteristics. These include functional, structural and aesthetic changes. After all the transformations, the structure receives not only a new composition, but also other characteristic features. Thus, dynamic constructions create the possibility of implementing changing processes. The principle of planning variability allows you to create large spans, to free the area from the supporting structures and move to the use of lightweight partitions. The implementation of this

technique allows you to change the interior space, which allows you to optimally manage the building. Continuous development allows you to implement a single functional process. Any changes in it lead to the need to reconstruct the building with the involvement of a large amount of resources, since in new conditions the construction cannot fully comply with the operational requirements. Dynamic transformations allow you to take responsibility for changes in the functional process that takes place in the surrounding landscape and the environment created around the building. The complex of such solutions allows to successfully solve various aesthetic problems. [14,15].



Figure 4. Facade of the parking at the airport of Brisbane.

All the advantages of a dynamic architecture are already widely used in the construction of modern sports facilities. Until recently, most of them were divided by seasons. In summer, if climatic conditions permit, most sports are held outdoors. In winter, summer stadiums are not fully or partially used. The use of dynamic elements in modern facilities causes an increase in the cost of work at the stages of design and construction, but this is incomparable with the costs in the case of a complete or partial reconstruction of the structure for its effective operation. An example of this approach to the design of a sports facility is the London stadium of water sports (architect Zahi Hadid), built for the 2012 Olympic Games. Transformed in the course of further work in the socio-cultural center. This reconstruction was incorporated into the concept at the design stage. [16,17].

The concept of design change has deep historical roots in Japan [18]. On the example of the people's dwelling of this country, the advantages that it gives are clearly visible. Characteristic features of the principles of variability and design changes, which make them an integral part of the new architectural style, are dynamic transformations in the supporting structures. Such changes do not fundamentally change the nature of the work of the main bearing elements and do not affect the static operation of the whole structure and allow you to rearrange individual parts for the effective management of this structure. [19,20].

4. Conclusion

The new architecture should be like a puzzle - to be made up of many complementary parts. The ability to crumble and assemble again in a new form and in a new quality, manifesting its quality - adaptability. The mobile architecture capable of moving in space and adapting to changing conditions through structural or qualitative changes may become a new step in evolutionary development. The architecture of the future must meet all the requirements of people in a global world and change quickly depending on environmental changes and human needs. The dynamics of modern life often require the creation of transformable, multifunctional architectural forms and spaces. Modern architectural technologies in design and construction allow using both proven concepts of static solutions and methods of dynamic architecture that are being developed today. It largely depends on the creative

potential of architects and designers, on their aesthetic preferences, designer finds and creative ambitions.

References

- [1] Loshakov P *Pulsating architectural environment. Philosophy and form* (Electronic Materials) loshakov@mail.rcom.ru
- [2] *World architecture. History since the beginning of time* (Electronic Materials vol 2)
- [3] Gaiduchenya A 1983 *Dynamic architecture: the main directions of development, principles, methods* (Kiev: Budivel'nik) pp 11–20
- [4] Akbaraliev R 2010 Principles of building flexible architectural spaces *International Scientific and Practical* (Bishkek: KRSU) pp 101–107
- [5] *The kinetic architecture of the future is a new trend in radius and dynamic execution of the facade of transforming buildings* 2016 Preprint gr-qc1813182
- [6] Yanovskaya Y 2006 *Architectural object: image and mythology: theses of Dr. of Architecture* (Moscow: Stroiizdat)
- [7] *Dynamic Beauty: Kinetic Art* 2016 <http://thewallmagazine.ru/kinetic-art/>
- [8] *Modern trends in architecture* 2016 vol 1 <http://artyhomes.ru/sovremennyye-tendentsii-v-arhitekture/>
- [9] Durneva D 2014 Description of the first stage of a theoretical study on the creation of transformable objects for growing cities *Architecture and modern information technologies* **1** p 14
- [10] Danilova O 2005 *Arkhitektonika ob'emnykh form. Arhitektonika volumetric forms* (Vladivostok: VGUES) p 100
- [11] Arnheim R 1974 *Dynamics of architectural forms* (Moscow: Stroiizdat) pp 58–61
- [12] Devid Fisher 2015 *Dynamic architecture of the future. Strelka institute* <http://strelka.com/ru>.
- [13] Karasev N 1987 *Mobile buildings and complexes on the basis of open constructive systems* (Moscow: Stroiizdat) pp 12–35
- [14] Yanovskaya Y 2013 The concept of adaptability of sports facilities *Academic Bulletin Uralniiproekt RAASN* **3** 70–74
- [15] Saprykina N 2005 *Foundations of dynamic form-building in architecture* (Moscow: Architecture) pp 312–317
- [16] Temnov V 2001 *Constructive systems in nature and construction equipment (resource-saving design technologies)* (SPb: Computerburg) p 34
- [17] Gidion Z 1984 *Space, time, architecture* (Moscow: Stroiizdat) p 8
- [18] Zitte K 1993 *Artistic foundations of urban planning* (Moscow: Stroyizdat) pp 19–25
- [19] Sidorov V A 2009 Architecture of the Japanese dwelling of the canonical type. The world of science, culture, education **4** 41–45
- [20] Saprykina N 2005 *Basics of dynamic shaping in architecture* (Moscow: Architecture) p 6

Acknowledgement

The article is supported by Law No. 211 of the Government of the Russian Federation of March 16, 2013, contract No. 02.A03.21.0011.