

The integrating of architecture and nature into environmental objects in mountainous terrain

I N Maltseva^{1,2}, N N Kaganovich¹ and T A Lorentz¹

¹ Ural Federal University named after the First President of Russia B. N. Yeltsin, 17 Mira st., Yekaterinburg, Russia, 620002

² Author to whom any correspondence should be addressed

3724316@mail.ru

Abstract. The article examines the topical issue of interaction between architecture and nature. This paper considers the basic principles and techniques of nature-integrated design that allow reducing the contradictions between the artificially created architectural and the natural environment, which is a fundamentally important condition for sustainable development. Based on global experience, principal means of harmonization are indicated, such as architectural and landscape composition, visual perception, defining the aesthetics. Special attention is paid to the goals and tasks of creating not only multi-comfortable, functionally expedient and viable buildings, but also the optimal preservation and harmonious inclusion of environment elements in a common architectural ensemble. The implementation of the basic principles is shown by the example of the author's project "The Ezhovaya Mountain Recreation Center" in Kirovgrad, Sverdlovsk region, such as the preservation of a unique natural site, the regeneration and interaction of spaces. Detailed consideration is given to the construction of a building complex in highlands, where specific factors and their influence on the processes of construction and operation were taken into account.

1. Introduction

The history of architecture development is an integral part of mankind evolution from ancient civilizations to the modern society. It apparently starts with the organization of a primitive dwelling - a space for survival in the wild. In fact, it was the first step in creating an artificial habitat and the first confrontation with nature. On the other hand, historically architecture largely borrowed the shape from nature. This contradiction unity, on the one hand, promoted the development of architecture, on the other hand, exacerbated the ecological, technogenic and psychological situation in society, which became especially evident with the development of technical progress, and as its result with rapid industrialization and large-scale urbanization. Today progress has been made in these relations, society drags on to nature, and the current situation can and should be reasonably balanced. The first ideas of organic architecture were enunciated by the architect F. L. Wright [2]. His concept was supported by his followers and become particularly relevant and non-controversial today: the biomorphic structures of the design engineer Santiago Calatrava, green buildings of architects R. Piano [3] and Norman Foster [4], bioclimatic skyscrapers of Ken Yeang [5]. It was Ken Yeang who said, "Eco-design is designing in such a way that the human built environment or our design system integrates benignly and seamlessly with the natural environment" [5]. Creating an enabling and full-fledged environment



for life is the goal of sustainable society development. Also it is the main objective of architecture, designed not only to be aesthetic, energy efficient, economical, ergonomic, and ecological, but also taking into account its duality in relation to nature, to be fully integrated with it. The natural component (landscape) must be a full participant in the design, engineering, functional, and compositional processes, whether it is inclusion into the urban context or, on the contrary, "inscribing" the object into the natural environment. The meaning of the latter is closely related to the concept of nature-integrated architecture. Summarizing modern research, in particular, the work of the famous Russian architect and researcher in this field V.Logvinova, the main principle of the this concept is so-called "eco-logical architecture" [6,7,8,9,10]. This is an alternative to the technocratic approach: the bioclimatic approach to design, the principle of site conservation and regeneration, the principle of the forms use, the principle of habitat interrelation, the interaction of artificial and natural landscapes.

2. The concept of the nature-integrated architecture

The idea of a harmonious combination of an architectural object with a natural landscape is meant to be embodied in a common scale, in the reflection of natural shaping, the natural "filling" of a particular terrain, in its climatic features. The visual connection of internal spaces with the natural environment is important. Specific spaces and areas are especially relevant in the context of active terrain, internal landscapes of "buffer spaces" - courtyards, terraces, atriums, winter gardens. The use of environmentally friendly natural materials, that are historically traditional for a particular region, the volumetric planning approach "building on its own feet", the creation of green zones on the roofs, are all the same principles of organic architecture proclaimed by F.L. Wright and Le Corbusie [1]. V.Logvinov complements this concept, "I am convinced that a full-fledged architecture must at least have three more qualities in addition to the triad of Vitruvius: sculpture - large plastic and silhouette of external forms; spatiality - a complex system of intermittent internal spaces; texture - plastic surfaces of the facade and interiors". Further he generalizes, "The meaning of our search is not in the novelty of approaches and not in the avant-garde of forms, but in the ethics of attitudes toward nature" [11].

Modern examples of "mountain architecture" are numerous and varied, among them the Museum of the Mountain in Italy by architect Z. Hadid [12, 96], an object in the Grace Farms preserve by SANAA [13] and others. The architects of Norway succeeded in this actively "mastering" the mountainous part of the country and the fjords especially. They strictly adhere to the principles of nature conservation. There is less strict state control, because the community sees a national idea in it. This is how the building was designed in 2010 by Snohetta in the archipelago Lofoten - Lofoten Opera Hotel (Fig. 1).



Figure 1. "Lofoten Opera Hotel" (Snohetta Architect)

The hotel with apartments, an amphitheater, a spa, swimming pools and everything necessary for organizing walks was designed as an object on the national tourist route system. The existing landscape has determined a number of factors for architecture: the "critical load" of the new structure, the opportunities for functional access and the need to create an appropriate level of infrastructure, the issues of ecology and sustainable development, the relationship between the artificially created environment and the surrounding nature. The main goal of the authors was the search for patterns in development of ideas that initiates factors for solving functional, architectural and empirical problems taking into account the impressive potential of the site. There are many factors that attach importance to this hotel: low construction in the center that captures the landscape in the circular motion, a form that unites nature, morphology of the relief, national culture and traditions of wooden architecture into a single whole and a stunning view. Senses of architecture duality, protection and at the same time openness, create harmony of internal and external space and naturally includes building into the existing landscape.

Let us consider one more example from the Norwegian practice of the famous bureau: this is a very small structure, in fact a pavilion. The Norwegian Wild Reindeer Center Pavilion is located in the picturesque area of the Dovrefjell National Park on a high plateau Dovre Mountain in Norway (1,2 km above sea level) with a view of the Snohetta mountain range (Snohetta) [14]. Building space of 75 square meters is designed to serve tourists and excursionists. It plays the role of a "high-altitude shelter", in particular, for ecological education of schoolchildren (Fig. 2). Simple construction is not only a good way to integrate design into nature, but a tribute to local historical traditions in shape and building materials. Despite its simplicity, this building is made using the latest 3D modeling technologies to create natural organic forms of pinewood. The frame of the building made of unprocessed steel and rust on the outer walls is in harmony with the shades of the surrounding mountains rich in iron. In addition, it is traditional for Norway to use high-quality and durable materials that can withstand the climate of this place. The concept is based on the principles of sustainability, the preservation of cultural and historical heritage, integration into the natural mountain landscape. Important social tasks are fulfilled, which in general meets the criteria for the sustainable development of architecture.



Figure 2. Norwegian Wild Reindeer Pavilion (Snohetta Architects, 2011.): interior and general view

Observation platforms and recreational complexes play a special role in the architecture of the "Norwegian mountains" and the tourist route, one of which is built on the way to Gaular Mountain on the western coast of the country. It is called "Utsikten", which translates as "view" (Fig.3). A triangular concrete platform 80 cm thick with a complex configuration with elevated angles repeats the bends of the relief and creates conditions for a full observation of the surrounding waterfalls according

to the authors' design (Code Arkitektur). Using traditional materials and technologies, architects achieved expressiveness solely through "extreme" plastics. Smooth to highly textured concrete finish reflects the entire diversity of the surface of the mountain landscape including vegetation and depending on the weather and lighting. This natural cover makes the structure fully integrated into the natural surroundings. The architects define that the finished platform is represented as an independent, geometric and "exact" object in the landscape.



Figure 3. Utsikten's observation platform (Code Arkitektur)

3. Multifunctional complex "Yezhovaya Mountain Recreation Center" in Kirovgrad

The principles of integration of an architectural object in nature, in particular, in mountainous terrain, were considered and applied in the project "Yezhovaya Mountain Recreation Center" in Kirovgrad, Sverdlovsk Region. The following factors served as prerequisites for this work: active development of skiing sports centers and resorts of the Middle Urals, the relevance in the creation of tourist and recreational centers, the solution of problems in the field of popularizing sports, in particular children activities.

The main concept of the project was defined by the authors as the creation of a modern public space integrated into the natural context. This concept is based on:

- preservation of the natural landscape;
- using the morphological potential of the relief as formed horizontal areas and terraces;
- forming of the main volumes and external finish, taking into account the plastic and the "pattern" of the relief;
- possibility of constructing racks solutions;
- providing visual connection of internal spaces with the natural environment.

The location is functionally determined geographically - a convenient location between the cities: Yekaterinburg and Nizhny Tagil, good transport accessibility, bioclimatic - the attraction of the natural and climatic conditions of the mountainous Urals and the morphology of the relief of this place. Currently there is a mountain ski center on Yezhovaya Mountain, at an altitude of 550 m above sea level with differences in heights of the slopes up to 300 m, the only certified track (1500 m) and a children's sports school.

The problems of the existing facility include the undeveloped structure of accompanying and support services, improvements, including parking, poor lighting and quality of most trails, lifts that do not meet modern technical requirements, lack of catering facilities and recreational areas, including children's and wellness zone. In addition, the opportunities for the underprivileged people were not taken into account. Thus, existing facilities on the site do not meet modern engineering, technical,

aesthetic, ecological requirements and cannot be used in a new design solution. A substitute for them is a multifunctional nature-integrated facility of a complex structure and broad social orientation.

All these factors determined *the goal* of creating a high-grade mountain center as a multifunctional year-round structure with further development possibility to the status of an international sanatorium and tourist mountain resort. It can be a great part of the existing ski tourism in the Ural-Siberian region with its unique mountain slopes and climatic conditions. The solution to the social aspect of the problem is assumed due to the commercial component that determines the optimization of the modern infrastructure:

- the possibility of including all age groups and levels into the process;
- creation of recreational facilities, rehabilitation, public spaces and improvements with observation platforms and sports grounds;
- development of the hotel services for affordable and comfortable living, including the “family weekend”.

For architects, it was important not only to create a modern multifunctional facility for all age groups and levels of athletic training, but also to design a building integrated into the existing natural environment as much as possible; the idea of preserving the natural landscape and the “pattern” of the relief became the main one when choosing the overall layout and then space planning (fig. 4). The use of natural horizontal platforms, terraces and racks system determined the constructive structure. It gave dynamics to the overall composition consonant with the natural context and the principles of eco-stability, in particular architecture integrated into nature. The restraint and expressiveness of the architectural image, the methods of shaping are a tribute to the natural and climatic features of the Ural Mountains.



Figure 4. ‘At the foot’ complex general view

Functional filling of the center implies division into two main blocks: on the lower and upper levels of the mountain, connected by a system of lifts with technological pavilions. In the lower block there is a hotel for 270 people with a restaurant and recreational facilities. In the upper block (“Shelter at the top»), it is proposed to organize premises for various purposes - cafes, public spaces for communication, recreation, entertainment, including interactive attractions, sports and health complex. The project provides for the creation of a children's sports school. The public spaces for communication and the “family weekend” program have been developed (fig.5). The off-season time is ensured in the project including not only skiing, but also other types of outdoor activities: tourism and visiting observation platforms, which is typical for similar facilities in Europe.

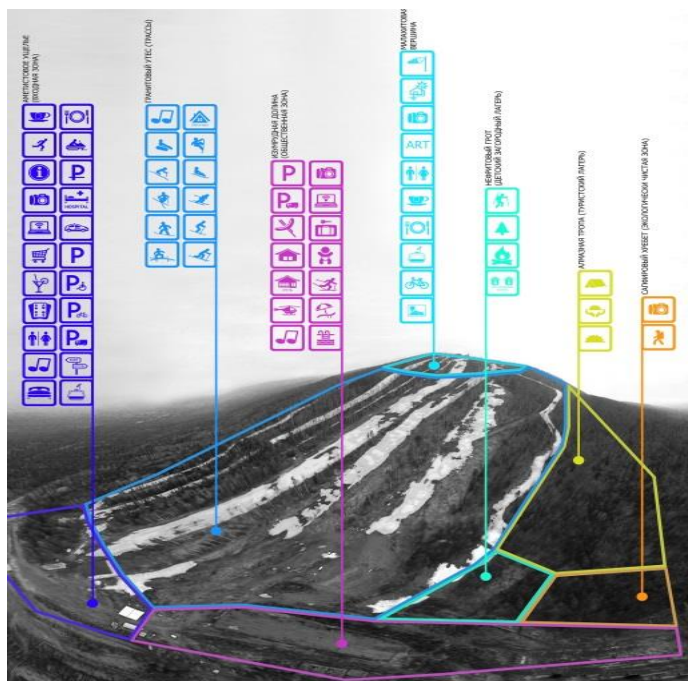


Figure 5. Functional filling of the complex

According to the authors, important tasks in the consideration of this topic are energy efficiency issues as a parallel development vector of an eco-sustainable and viable architecture. The thermal shell of the buildings is designed as secure and airtight envelope, joints are without heat bridges. For glazing architects use Saint-Gobain Glass coatings with ultra-high resistance to heat transfer ($R = 1.2 \text{ m}^2 \cdot \text{K} / \text{W}$). The coefficient of total solar energy transmittance (g-value) is 0.62. Frames Endl - ONTOPPLUS (+SwisspacerV) are with a low coefficient of heat transfer. Roller shutters are with automated control system Somfy Animeo IB + assume to control the heat input and loss when interacting with the ventilation system. In this case, the optimal orientation of the building on the cardinal directions is accomplished. Large glazed surfaces are oriented to the south, the area of glazed surfaces in the north and the west is permissible. The ventilation system is also designed using energy-efficient house technology (even close to passive) [15]. Cold air supplied in a room from the street passes through an underground heat exchanger, which pipes run 1 meter below the foundation slab of the building, and a recuperator. Thus fresh air is heated to $+5 \dots 10 \text{ }^\circ\text{C}$ even at very low temperatures in winter. For sports clean and fresh air is needed, especially for children, so authors use a hygienic duct, a high-quality fine filter (F7 or F8 filter's class) and install it directly into the area after fresh air intake.

4. Conclusion

First of all, the architects see the innovative nature of the project solution in the complex multifactor approach: the idea of creating a unique multi-functional public facility within the corresponding infrastructure of the Urals region. This is an object with a wide range of sports, tourism, active and family rest. Potential for the development of professional sports is also considered. At the same time, the authors consciously use the actual method in practice - the building integrated into the natural environment and inscribed in the relief, using the architectural forms and climatic features of the Ural Mountains. The combination of multifactor conditions, the diversity of project tasks, the relevance of the topic and the social needs introduces a certain novelty in the creative process of designing nature-integrated facilities in Russia

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