Structural Shaping as the Basis of Designing Children's Playground

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Abstract. The article considers the method of structural shaping in the context of designing a children's developing environment. The revealed characteristics of the application of this method of shaping in design process. A new approach to the topic of structural shaping is presented by using the dynamic properties of individual elements and parts of the structure. A new concept for the theory of design "combined structures" is introduced. The purpose of the scientific article is to demonstrate the possibilities of using structural form-creation in the design of children's playground. The result of the study was the conceptual development of the play object «Hill». It is emphasized that the integration of such objects, based on the structural method, will significantly diversify the children's environment and fill it with new meanings.

1. Introduction

Structural shaping, as the format of the organization of the environment, appeared in the last century, thanks to the constructive developments of R. Fuller, associated with the combination of geometric breakdowns of regular polyhedral. In the 21st century, this direction is becoming more widely used not only to architectural, but also design practices in general. The common meaning of this term is the method of shaping, which is based on one geometric structure, from which the whole form is assembled. Such a structural unit resembles a universal module, on the basis of which fragments of spatial structures are created. In this case, not the image, but the module becomes the primary base of the form. Such spatial and modular structures, as a rule, have a different purpose - from the structural element, the shell of the building, to the fragment of the landscape.

Experiments with spatial structures have broadened this concept and led to the emergence of combined structures in architecture and design. However, taking into account that there is no unambiguous definition of structural shaping in the theory of design, this concept can be formulated as establishing a harmonious relationship between constructive elements and the visual image, which form an integral structure. In the article, this problem is considered more widely than the generally accepted one, demonstrating not only the interaction of structural elements in the design, but also some dynamic properties first applied in the context of the design of the gaming environment.

2. Materials and Methods

Kinetic (dynamic) structures became known in sculpture and architecture thanks to the architectural fantasies of J. Chernikov, and later J. Tengli, R. Foeller. They are characterized by dynamics, movement - sculptures and buildings are designed in such a way that their parts can move relative to each other
without violating the overall integrity of the structure. The mobility of the structure of the building can be used to enhance aesthetic properties, to respond to environmental conditions and to perform functions that would not be appropriate for a building with a static structure. The possibilities of practical application of kinetic architecture sharply increased at the end of the 20th century thanks to advances in mechanics, electronics and robotics.

The use of structural elements in the basis of the designed construction has made it possible to variability the formation of complex design forms, achieving all possible geodetic, plastic and geometric solutions and architectural concepts [4, 16]. When it comes to structural engineering design, including the choice of form, its features and behavior analysis under different conditions, then must be a joint work of engineers and architects. As a result, knowledge is built into a holistic structural concept that synthesizes the optimal aesthetic and functional indicators of the future structure [12]. Similar properties are also used when developing desktop games and gaming panels.

The creation of multi-variant form-building solutions of the object, the elements of which would be variously structured, is dealt with by V. Gamayunov [5]. With its diversity, special orderliness and reliability of display, structural elements are tools for both traditional technical design and modeling in architecture.

From an artistic point of view, consider the structure of A. Yarmolenko and V. Koleichuk [18, 10]. Unlike the technical approach, the artistic approach looks at the structure as a single system of form-building, taking into account a whole set of constructs, transformation possibilities, characteristic for new technologies. Koleichuk's whole activity was devoted to the study of the structure, in which the concrete result could become a design object, a mobile, an object of op-art, sculpture, engineering design, theatrical setting or scientific research [9, 10].

The relationship between the physiology of vision and the form-building aspect is also noted in the writings of researchers. In particular, the necessity of correlating the concepts of structural form formation and visual ecology is emphasized [11]. Visual ecology is a scientific direction that provides the basis for creating a harmonious environment that corresponds to a comfortable visual and aesthetic perception of a person [6].

Demonstrate new principles of shaping and artistic expressiveness in the design of nodes or "NODUS structures". These structures represent "the regular development of periodic knots and links made of elastically flexible linearly extended material, which makes it possible to obtain the shaping structures of a variable point surface" [7].

With the development of kinetic and parametric directions in the design practice, the ability of the form to transform into a response to changes in the environment becomes relevant [8]. Such features can be present in the very structure of the object. This can be, for example, the kinetic facade system or the roof of the house. In this case, the kinetic performance of the facade is not only decorative, but also functional, when the structure can react to excess sunlight, gusts of wind or rain. Experiments with such mobile structural elements in architecture and design began in the last third of the 20th century by R. Piano (Cultural Center in New Caledonia), J. Nouvel (Institute of the Arab World in Paris), S. Calatrava (Milwaukee Art Museum). Now such examples become even more: the exhibition pavilion "One Ocean" in South Korea on the project of the Viennese architectural studio "Soma" (the facade is made of vertical plates that control the penetration of sunlight); the building of the University in Colling from the architectural bureau of Henning Larsen, which also reacts to weather conditions; the facade of the airport parking in Brisbane, reminiscent of the surface of the water (more than two hundred thousand plates are driven by the wind, which provides natural ventilation and lighting the room).

Considering the development of modern design practice in this direction, it can be established that now architecture is perceived not only as a static object in the shell, but increasingly as an ergonomic transformable system that adapts to the needs of its consumers [17].

To date, the creation of a kinetic facade is a fairly complex technological and costly solution, so the dynamic effect is sought through alternative solutions. A. Premier introduces the concept of chromatic strategies, which represent certain color combinations, a game of contrasts and nuances that allow you
3. The results of the study

The experimental play form is based on combined structures and the principle of kinetics, which is manifested in the properties of individual elements and parts of the structure. Such solutions are not yet widely used, but they can be productive not only in the architectural, but also in the children's environment, protecting the child from heat stroke in open areas, or protecting the surface from slipping during rain.

It is also possible that the parts of the general gaming structure can be divided into small play forms. In this case, the main thing is to preserve the compositional and semantic balance so as not to violate the integrity and not lead to the monotony of the solution. As for the plasticity within the organization of the structure itself, it is achieved by adding additional play forms to the primary structure.

The playing structure is such an arrangement of elements and parts, in which consistency and coherence within a certain artistic form is achieved. Harmonization of the form of the play object is achieved not only by comparing the elements relative to each other, but also by demonstrating the properties of each element by means of composition: contrast or nuance.

Artistic way to develop the structural composition were the individual elements of the objects of transport design (Fig. 1). The choice of this image was due to the location of the objects of the play environment in the city of Togliatti, where the Automobile Plant is located. Structured play forms using transport elements represent a contrast in creating a useful environment that has a positive
impact on its users. Such objects are of particular interest to children, in their constant desire to touch, twist, open, in other words, explore the object of attention.

As a basis of the construction, pipes, blades, gears, rivets are used. The following factors influenced the formation of the final image: the existing context - the industrial urban environment, the graphic representation of the future object - the choice of the most harmonious design, the analysis of the functional component of the structure - the definition of the actions and ways of implementing these actions (lifting, descent, retention, etc.).

Figure 1. Children play form "Hill". Frontal view of the structure.

Figure 2. Children play form "Hill". Perspective view of the structure.

The main functions of this play form: cognitive and communicative, which encourage communication during use. The name "Hill" emphasizes not only the imagery of an object that resembles a certain elevation, but also points to a specific goal - the Hill, to be on top of which, it is possible only if to ascend, to climb on it. Having reached the goal, you can make the descent in the same way as the climb to the hill was made (on the rope mesh or on the stairs) or slide down the hill.

The dynamism of the play object is achieved thanks to such elements as: a rotating weather vane, wheels and a moving arrow. The decorative graphical element was the figures that turned the railing of the structure into a protractor, as well as colored glazing in separate fragments of the structure. Considering that the upper level, from which the descent on the hill is located at a height of almost four meters, there is a closed hill for safety of descent. To give dynamics and entertainment at the time of being in the "steel sleeve", fragments of translucent plastic of three colors were integrated into the structure of the hill. Another type of descent is carried out on an inclined rope ladder and hanging ropes with knots. The basis for the rope ladder, almost 7 meters long, is a synthetic rope. The ends of
the rope are provided with steel hinges, preventing the unwinding of the rope strands. The spiral staircase is located in the center of the composition. Each stage of the spiral staircase is covered with rubber anti-slip overlays on the entire surface of the tread.

Such interaction of components allows creating an original children's play form. Typically, typical solutions for the children's playground, which do not have an original artistic image and function, are practically not of interest to children, and the yard space is extensively replaced by cars. In order that this does not happen it is necessary to make every yard unique, by means of a unique filling of the environment. Such a design, in view of the inherent lightness and laconicism of the image, can be inscribed in virtually any urban context without violating it.

In addition, there is a direct relationship between the viewer and the surrounding dynamic space. It is obvious that the children's consciousness is itself changing and actively developing in the process of growing up. Consequently, the dynamism in the surrounding space of children will provide an alternative in the choice of gaming activities, according to their age characteristics and interests. It is important to note that dynamics in the gaming environment can be interpreted not only in the literal sense of the movement, the mechanics of objects, but manifested in the complication of certain objects in the game space or in an unusual color solution, more complex color combinations, etc.

The basis for the child's play object is a metal frame structure made of metal pipes and profiles, which represent a circle and a rectangle in cross section. Folding of individual sections of metal pipes is carried out hydraulically. On the basis of this structural skeleton of stainless steel, sheathing, overlapping and isolation of individual fragments by additional details and materials is carried out.

The playing structure must be installed on a previously leveled ground surface. For greater stability and reliability of the object in the course of operation, a fastening to the reinforcing mesh is made and the foundation of the main supporting elements is poured. After fixing the parts in a concrete base, the hard surface is evenly covered with unpainted rubber chips. As the final layer is a colored rubber crumb.

During the installation of metal structures, it is also important to consider the type of attachment and assembly of individual sections. The main and most reliable type of connection is welding. The project uses butt, angular and T-welded joints. In the visible weld joints, post-processing is performed by grinding to avoid injuries and scratches during play.

In some cases, when assembling metal profiles, threaded joints using bolts and nuts are used. Fastening of steel sheets to the frame for some walls is carried out by means of permanent riveted joints. Inside the object, the overlap is carried out using an anti-slip coating - sheets with rhombic corrugation. In open areas exposed to rain, a rubber coating is used.

4. Conclusion
Space-spatial play structure is a holistic form that exists in consistency with the surrounding urban environment. The whole structure becomes due to the subordination and interactivity of all components within the structure itself. In the case of observance of all the features, a comfortable impact on the psychoemotional state of the child is achieved.

In this article, the structural method is highlighted. Because exactly in the process of separation, layout, correlation - the search for a logical form, reflecting the essence of structural shaping, the most harmonious relationship between the elements of the design was achieved. The interdependence of the factors listed above, determines the importance of the structural approach, as a priority direction, which we took as a basis, when developing forms for the children's play environment.

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