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POSSIBILITIES OF SHAPE MODELING IN DESIGN WITH THE HELP OF KNOTS
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New primary principles of form formation in design and ways of their application in real object-spatial and design activity, as well as within the sphere of design itself, its history and related fields of art, in mathematics and natural sciences have been explored.
Key words: principles of shape formation, geometry, knots, design.

Introduction. Nowadays the research of new opportunities for the development of form formation in design is increasingly becoming interdisciplinary, combining science, technology and art, which is a consequence of the search for the primary principles of form formation, allowing to abstract from specific stylistic techniques and methods and reach the essential level of object-spatial creativity.

Results. A significant part of the author's concepts of shape formation, created since the birth of design in the early XX century, was based on geometric principles. Some mathematical concepts such as point, line, plane, volume, the simplest geometric figures and their combinations were transformed into the primary principles of form in the work of many prominent architects and designers: I. Itten, J. Albers, L. Mokhoi-Nadia, Le Corbusier, B. Fuller, K. Snelson, D. Emmerich, F. Otto and others. Organic integration of mathematics, art and design was most successfully carried out in those areas of each of these spheres of activity, where visualization and figurative representation are possible simultaneously with mathematical formalization and logical structure. Such related areas of mathematics and art have long been ornaments, symmetry, theory of proportions, various systems of perspective, geometry of polyhedrons, and at the end of XX century - also topology, fractal geometry, computer graphics. At the same time, additional feasibility criteria, established by practical design, sharply reduce the number of potentially possible borrowings of form-formation principles from the field of visual mathematics. An important source of search for the primary principles of form formation in design is the study of the history of artistic design of certain types of products from ancient times to the present day.

As a rule, in the basis of traditional methods of shaping also lie geometrical principles, which the ancient masters discovered from consciously or unconsciously made experiments. Many centuries, and sometimes millennia, passed since the origin of traditional principles of shaping, contributed to the selection of the most effective and economical ways of their practical realization.

The search for new primary principles of form formation in design and ways of their application in real object-spatial and design activity is possible both within the sphere of design, its history and related fields of art, and directly in mathematics and natural sciences. The invariant regularities discovered as a result, having passed through the ex-perimental verification by the triad "material-technology-construction", can become the basis for the emergence of new systems of form formation in design. One of the fundamental principles of shaping are knots, known to mankind since the birth of material culture itself, and for many millennia have become not only convenient and perfect tools and technical devices, but also a subject and a part of traditional arts and crafts.

Knots are one of the first human inventions. Most of the tools and products that made up the object environment of ancient man included knots as a means of fastening and connecting heterogeneous objects. Knots were widely used in marine engineering and construction as fasteners and elements of lifting mechanisms.

The need for a variety of knots for practical needs contributed to the invention of their numerous varieties. Rare archaeological finds of knots testify that in ancient times people used the same knots that are used today. Ancient Egyptians knew arbor knot, found on the scraps of gear ship Pharaoh Cheops, and vyblenochnychny knot, which was tied rope, fastening the handles of the doors of the third room of the tomb of Pharaoh Tutankhamen. Straight and scotovy knots knew the ancient Incas, who used



them in the construction of hanging bridges. Inca civilization also invented knot writing, called "kipu". Knot writing was known in many other cultures. The people of Northern Europe - the Celts and Scandinavians - for many centuries developed a special culture, in which an important role played knots.

Knots occupied a special place in the spiritual culture of many peoples, performing a symbolic and modeling role in traditional metaphysical representations. Emerged in the late XIX - early XX century. mathematical theory of knots, already in the second half of the XX century. found a variety of practical applications in the natural sciences, where knots are considered as a form of self-organization in animate and inanimate nature.

Knotting as a principle of form formation is found in living nature, where it performs the functions of spatial self-organization of molecules, in particular DNA, individual microbes and some multicellular organisms. There were also proposals to use the principle of the knot in various areas of technology.

The study of knots has become a branch of topology that is closely related to algebra, geometry, group theory, matrix theory, number theory, and other areas of mathematics. In topological terms, a knot is a one-dimensional curve arranged in a regular three-dimensional space such that it starts and ends at the same point and does not intersect itself. The theme of knots began to penetrate into modern art: sculpture, computer graphics, design of decorative products. Modern artists, sculptors and designers (J. Robinson, G. Jones N. Friedman, S. Yablan) turn to knots as an effective means of expression, the forms of which generate imagery and expression of perception of a closed line in space.

Conclusion. It follows from the above that there is a need for further research and development of the principles of knot development in the field of artistic shaping, which will contribute to the expansion of the aesthetic expressiveness of design and related fields of art. It is necessary to consider expansion of possibilities of artistic expressiveness of design at the expense of application of new means of shaping on the basis of geometrical structures of knots.

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