

USE OF GEOMETRY AT CREATION OR THE ANALYSIS OF DESIGN AND ART OBJECTS

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ABSTRACT: The article deals with the problem of geometry analysis when creating and using the objects of art and design. Currently, topical in the creation and research of art and design objects is the use of Euclidean, projective, differential, and fractal geometry, the theory of sets, the theory of probability, the theory of dilatation, and geometric transformations. Examples are provided. A simplified classification of geometrical models in industrial design is proposed.

Keywords: design; art; geometry.

1. INTRODUCTION

One of the essential objectives of research in industrial design has been to bring the design problems together within a system of strict and logically consistent scientifically founded knowledge.

2. INFORMATION

The majority of researches are carried out basing on Euclidean geometry, which is naturally accounted for by the character of the researchers' educational background, especially in the case of professional creators of design and art objects. Many existing researches can be extended on the basis of geometry branches that are not traditionally used by engineers and architects.

It is natural to begin with the simplest thing, the point. The perception of dynamic and static compositions of points was described, for example, by N. Yakovlev [5], where Euclidean geometry was made use of.

As an example of priority use of points, we may consider pointillism (from French *pointiller*, i.e. "mark with points")—the method of painting, in which separate distinct brushstrokes (shaped as points or small squares) are applied to the canvas to be optically mixed up in the viewer's eye. The formal and rationalistic character of pointillism, the

fractionality of the piece surface, the locality and brightness of each separate color, did not prevent the use of pointillistic technique in the intensive landscapes by P. Signac with their contrast on colors, or in the canvases by G. Seurat that are full of delicate nuances, or in the portraits and space-and-volume genre compositions by T. van Rysselberghe, etc. A similar perception principle works in other art forms as well, where similar methods are employed based on optical intermixture of point sets, as in the Byzantine mosaic art.

In the course of analysing design and architecture products created by means of points, we here consider points to be indefinable space elements. The space presents itself as a logic form (or structure) providing a medium for implementing other forms. This medium is perceived as a set of objects—points—of any nature.

In geometry, axioms define some external interrelations of elements. Elements form unions of sets. The ways in which such unions are formed, as well as the operations, are structurally limited, in order to avoid paradoxes. Elements are primary to sets. One should note the uniformity of understanding images relative to the understanding of elements and sets. We can consider pointillism in terms of the theory of sets. The concept of

set is one of the broadest concepts in mathematics and in logic. Within the so-called "naive" set theory, the set is defined as an aggregate of any objects which are its constituents and have some characteristic property in common. One can consider sets of points either as an inventory—a list of elements; or as a rule, that defines a particular point's belonging to a particular image—for example, to a crown of this or that tree, or to the shimmering water surface, or the soft grass on by G. Seurat's *Sunday Afternoon on the Island of La Grande Jatte* (Figure 1).

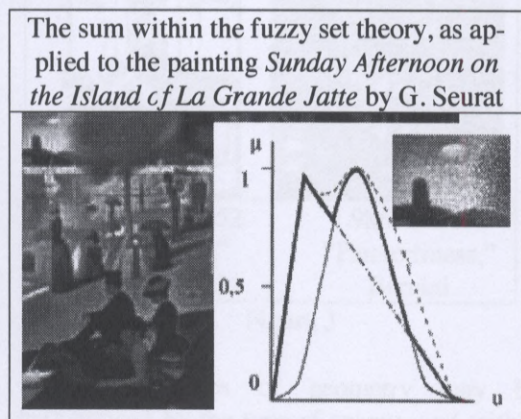


Figure 1

The fuzzy set apparatus appears to be the most acceptable for researching into pointillism.

Following the analysis of point compositions, it is logical to describe the artistic technique of using straight lines in avant-garde painting. This technique is represented by the rayism of M. Larionov, which is considered to be one of the first forms of abstract art and one of the first manifestations of avant-gardism in painting, along with the suprematism of K. Malevich, the futurism of V. Tatlin, and the all-European cubism.

Figure 2 represents an illustration from M. Larionov's book *The Donkey's Tail and The Target* and his picture *The Radiant Rooster*. M. Larionov provided the theory of the new artistic trend (1912—1914). Larionov commented

on the "fourth dimension" in art—the radiant and energetic dimension—particularly emphasized by rayism. The idea of multidimensional perception was voiced by many artists, but the multidimensional geometry apparatus appears too complicated to be used for studying art perception.

We may assume though that rayism is based on the apparatus of projective geometry. This geometrical apparatus was also used by other authors of design and art objects. For instance, the whole composition of the *Lord's Supper* by S. Dali is built on the bunches of projective geometry sheaves.

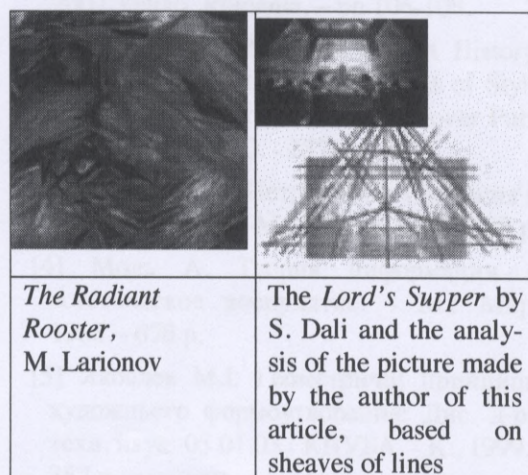


Figure 2

The author of this article has proposed a system of differential equations [1], the first one describing the rotation of the styles' cyclic recurrence ("linearity" vs "painterliness," in terms of H. Wölfflin [2]), and the second one reflecting the longitudinal motion of information.

In the general case of a differentiated dynamic system, a phase space is a differentiated manifold which, in turn, is a locally Euclidean space possessing a differential structure. To define a locally Euclidean space we need to correlate it with a Hausdorff topological space. At this stage of research, the author proposes to carry out a comparative analysis of design,

decorative, applied, and graphic arts objects based on the Hausdorff dimension in order to provide a practical solution to the problem of predicting changes in their visual perception.

The second half of the 20th century is characterized by the growing interest in fractal geometry. Fractals are objects with the topological dimension that is smaller than the Hausdorff dimension. In art, there exists a fractal ratio known as the Golden Section.

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| 1.8814323652 "Linearity," Michelangelo | 1.9865897112 "Painterliness," Bernini |

Figure 3

Many branches of geometry may be characterised by the type of spaces, and within these spaces, by the type of objects that represent the subject of research.

A number of researches may be pointed out in industrial design, that are connected with explicit or inexplicit use of various sections of geometry.

3. CONCLUSION

At the current stage, the basic techniques of geometrical modeling in creating and studying the objects of design imply the use of

1. Euclidean geometry

2. theory of sets
3. probability theory
1. differential geometry
4. projective geometry
5. fractal geometry
6. dilatation theory
7. geometric transformations.

REFERENCES

- [1] Kuznetsova I. Creating a Set of Differential Equations to Predict Changes of Visual Perception of Design Objects // Proceedings of the 2nd International Conference on Engineering Graphics and Design, June 7-10 2007, Galati, Romania. — pp.106-108.
- [2] H. Wölfflin, Principles of Art History. The Problem of the Development of Style in Later Art. New York, USA: Dover Publication, Inc., 1950. - 237 p.
- [3] Голицин Г.А., Петров В.М. Гармония и алгебра живого. -М.: Знание,1990. -128 p.
- [4] Моль А. Теория информации и эстетическое восприятие. - М.: Мир, 1966. - 678 p.
- [5] Яковлев М.І. Геометричні принципи художнього формоутворення: Дис. д-ра техн. наук: 05.01.03 / КНУБА. - К., 1999.- 352 p.

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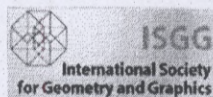
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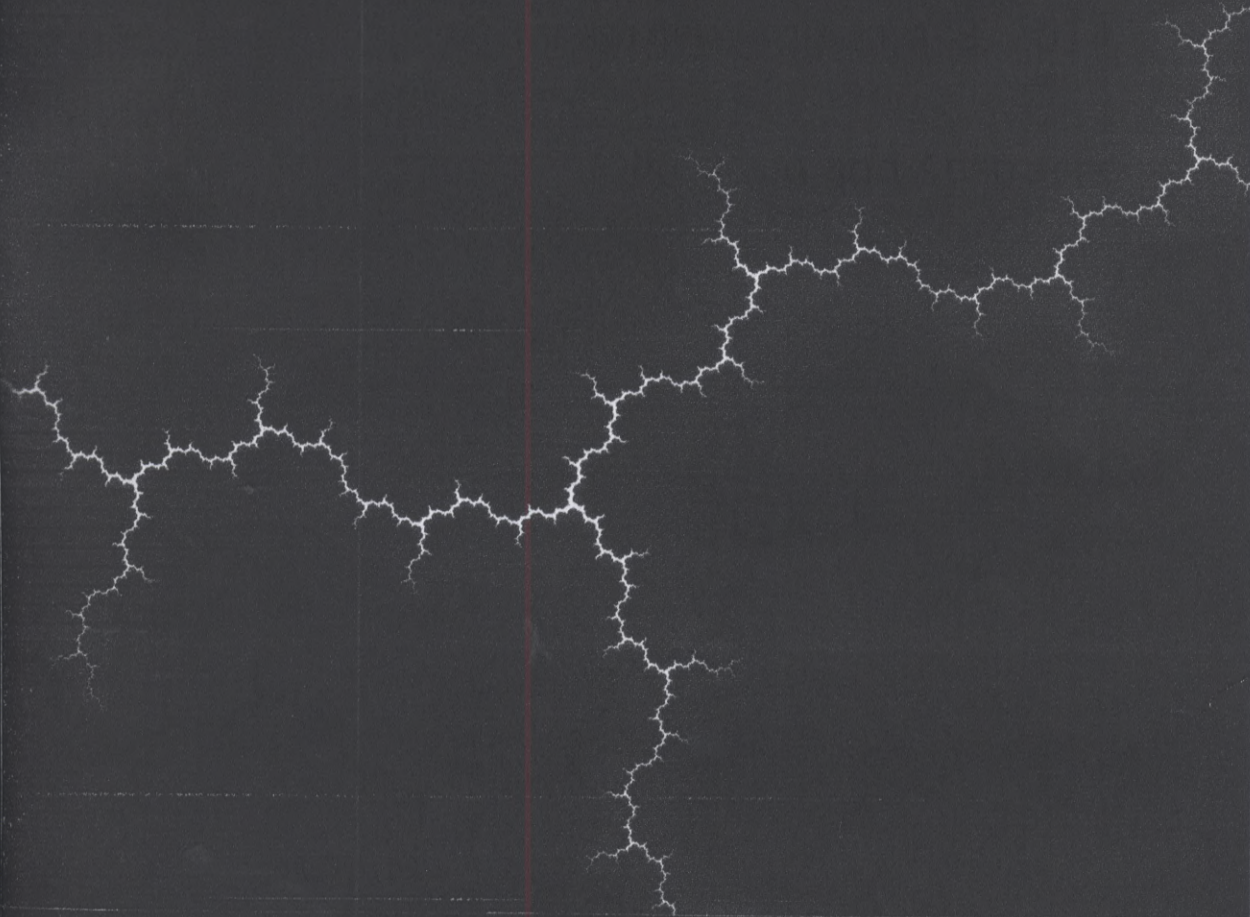
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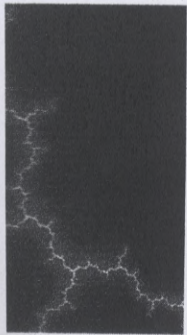
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