Chapter 14
Mathematics-Related Visual Events

ABSTRACT

A mathematical way of thinking may often involve the visual processes while the beauty of forms derived from mathematical formulas may become an inspiration and a source for creating art works. This text examines organic/geometric forms present in nature, mathematics, and art, symmetry, fractals, artists' responses, and computational solutions in the form of visual presentations. This is followed by some aesthetical and critical notions about mathematics-derived art.

INTRODUCTION: VISUAL APPEAL OF MATHEMATICS FOR MATHEMATICIANS AND ARTISTS

Visual mathematics uses appealing computer graphics for constructing models and as a guide for intuition. Mathematics helps to explain the world. Mathematicians describe nature by using approaches from within geometry, topology, analysis, and also the theoretical computer science. They study natural structures and properties of space: shapes, sizes, distances, positions of figures and their conjectures, and thus investigate change in natural forms. They develop methods for analysis, applications, and technologies. We can realize how much the mathematical way of thinking is a visual process and how often the beauty of forms derived from mathematical formulas becomes an inspiration and a source for creating art works. This idea may provide a common language for mathematicians, visual artists, architects, musicians, crystallographers, cartographers, computer scientists, and many other professionals.

Before we can develop further statements we have to accept axioms – universally established propositions, truths that are accepted without proof. For example, a symmetry axiom tells that for all points A and B, AB = BA. Axioms seem to be self-evident for human reasoning; however, many of the inventive and significant discoveries, such as the Heisenberg's uncertainty principle in quantum mechanics resulted from the questioning of axioms and mixing an investigation of a subject with an object. As Julian Voss-Andreae wrote, "Quantum theory remains philosophically problematic because 'objective realism' turns out to be incompatible with quantum theory offered by Albert Einstein, Boris Podolsky, and Nathan Rosen in 1935. There is no accurate space-time

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representation of, say, an electron: It is neither a particle nor a wave or any other 'thing'" (Voss-Andreae, 2011, p.14. Also, Ball, 2009). (The Heisenberg's uncertainty principle is a part of quantum mechanics. This principle states that we cannot know precisely about certain pairs of physical properties, such as a particle's position and momentum – the product of the mass of a particle and its velocity at the same time, because the measuring process involves interaction, which disturbs the particle. For example, a photon of light used in a measurement is bouncing off the particle. Thus, one cannot, even theoretically, predict the moment-to-moment behavior of a system consisting of the subject and the object of examination – somebody who makes an observation and an object observed. There is a theoretical limit for simultaneous measuring at an atomic scale because the more precisely is figured one amount the more uncertain is the other one).

With another point of view, intuition, along with knowledge and calculations has been stressed as a leading force in problem solving. Arthur Loeb (1993) in his book entitled "Concepts & Images – Visual Mathematics" claimed that mathematical intuition is a form of non-verbalized knowledge. Some scientists and artists use their knowledge and intuition in such a way that their abstract reasoning takes form of images, rather than words or formulas. Helmer Aslaksen (2005) identified four types of conditions relevant to the coexistence of mathematics and art: mathematics in art (where he includes perspective, symmetry, and musical scales – appreciated by the art connoisseurs); mathematical art (as created by artists, for example by Escher – often ignored by art community); mathematics as art (visual mathematics such as a Mandelbrot set – however art museums are usually not interested); mathematics is art (for example, the Euclid's axiom – which is also not appreciated by the art connoisseurs). Teaching is focused on a small number of topics, such as Escher, perspective, tilings, golden ratio, and polyhedra, at the expense of mathematical art in general. Study of geometric two-dimensional shapes and three-dimensional forms resulted in works of art done in various media, both traditional and digital, including painting, sculpture, printmaking, and architecture. Computer programs and computer graphics produced with the use of software packages give a boost to such studies. They make a separate category of digital art and, at the same time, serve as a tool for creating works in other media. Teams working on visualization or simulation projects usually include a mathematician, and the direct results of their work look many times like artistic productions.

ORGANIC/GEOMETRIC

Natural and Calculated Patterns

Golden section, rectangle and triangle reflect the ways nature presents itself by creating self-similar forms. Hence the flow patterns in tile, steel and glass, and fractal poetry look at nature in metaphoric terms (Bernstein, 2005). Testimony about the order of the world would be incomplete without showing the mathematical solutions that are invisible in natural forms. They are often enjoyable and pleasing to the eye, maybe due to intuitive understanding of their origin.

In art and design domains, pattern is an artistic or decorative design made of lines. Pattern is based on the repetition of units coming from the natural or artificial origin. Patterns make a basis of ornaments, which are used in decorative arts and architecture and have distinctive styles, specific for each culture or ethnic group. In cultural anthropology, a study of decorative patterns, ornaments, and their characteristics support the detailed analysis of an individual culture.

Art forms that present solutions of mathematical equations may be derived from random selection of numbers, permutations resulting in more or less regular patterns, equations visualized as sculptures (for example, a Möebius knot), or ste-