

# Chapter 17

## Science within the Art: Aesthetics Based on the Fractal and Holographic Structure of Nature

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### ABSTRACT

*This chapter discusses how both art and science proceed from an appreciation for and application of the natural proportions and forms associated with nature. Brief descriptions of the Golden Ratio, fractals, and the holographic metaphor are presented with illustrative examples from geometry, nature, science, and art. This material is followed by an outline of a personal theory of aesthetics based on emulation of natural form, and concepts from Thomas Aquinas and James Joyce. Application of the aesthetics are illustrated with art from a series of collage entitled, *The Elements in Golden Ratio*. A discussion of the four classical elements (earth, air, fire, and water) and application of the Golden Ratio forms used in the art underscores how the emulation of form in nature is central to the author's artistic process. The author, an artist and scientist, concludes with personal observations on the commonalities between art and science.*

### INTRODUCTION

Science and art are creative vocations, and form and structure are important aspects of both. Form will be defined here as the organizing structure, geometry, and causality we observe in nature. The scientist may use mathematical equations to describe the behavior or structure of a system where mathematics is used to emulate or model the form observed in nature, and the success of a scientific

theory is judged according to the elegance and simplicity of its mathematical equations, the falsifiability or refutability of the hypothesis, and how closely the theory actually emulates nature. Form to an artist refers to the geometric arrangement of elements (color, line, shape) in a work of art that defines composition, and I would suggest that the composition of a successful work of art should emulate the forms and structures that appear in nature (Boles & Newman, 1987; Ghyka, 1946).

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Science and mathematics have revealed that nature is sublimely organized from the subatomic to the cosmic scale (Mandelbrot, 1977; Ball, 1999; Gazalé, 1999). Many of the structural forms in nature embody the Golden Ratio, a universal constant that has been known and used by artisans, architects, and artists since antiquity (Livio, 2002; Herz-Fischler, 1987; Cook, 1979). The development of fractal mathematics and computer graphics has revealed that nature also creates forms that have a fractal structure (Mandelbrot, 1977). If we observe nature at different size scales, we often see similar fractal structural forms repeated: windblown clouds, wood grain, and sand may all exhibit herringbone patterns, and protein molecules on cellular membranes show structural branching similar to trees (Bak, 1996; Doczi, 1981). Wilbur (1982, 1992) and others have also observed that subtle structures in nature might be organized in a holographic manner, where the structural form of the part suggests the structural form of the whole. For example, the model of the atom (electrons orbiting a nucleus) is repeated at the solar system as well as the galactic scale. Metabolic and excretory functions within the cell are repeated at the organismic and societal levels.

This chapter will discuss how both art and science may benefit from an appreciation for and application of the natural proportions and forms associated with the structure of nature. Brief descriptions of the Golden Ratio, fractals, and the holographic metaphor will be presented along with examples of each from nature, science, and art. I will then outline my theory of aesthetics based on the structure of nature and illustrate the application of the theory using images from my collage series, *The Elements in Golden Ratio* (Craft, 2010a). A discussion of the Golden Ratio forms used in my art work and the classical elements (earth, air, fire, and water) will underscore how the emulation of form in nature is central to my art process. As an artist who is also a scientist, I will conclude with some personal observations of the commonalities

between art and science and how an appreciation of natural form can enhance the practice of both.

## **THE STRUCTURE AND FORMS OF NATURE**

Some of the important structures and forms of nature that both artists and scientists see, hear, feel, and touch may be summarized by reference to the Golden Ratio, fractals, and the holographic metaphor. Form in nature is a profound and humbling subject that has been studied by many great minds since antiquity. As a student of the subject, I recommend Theodore Andrea Cook's 1914 book, *The Curves of Life* (Cook, 1979) and D'Arcy Wentworth Thompson's 1917 book, *On Growth and Form* (Thompson, 1961), as excellent introductory sources and reference material. I hope reading this chapter might encourage the reader to begin or expand upon their personal study of nature's forms by considering the work by scholars, scientists, and artists who made the observation and elucidation of nature's forms their life's work.

### **The Golden Ratio**

Many forms in nature feature a very special mathematical constant: the Golden Ratio, or Golden Section (section referring to a cut or division). The Golden Ratio is an irrational number equal to 0.618034... (where the dots indicate that the decimals continue infinitely with no repeated number patterns), and is usually represented by the Greek letter *phi*,  $\phi$ , after the sculptor Phidias, one of the architects of the Parthenon. I will begin by showing the algebraic derivation of  $\phi$ , discuss some unusual mathematical properties of  $\phi$ , describe Fibonacci and Lucas numbers, discuss examples of  $\phi$  in simple polygons studied by the classical Greeks, and then provide examples how  $\phi$  appears in nature and art.

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