Ivars Peterson

Fragments of Infinity: A Kaleidoscope of Math and Art

(New York: John Wiley & Sons, 2001).

Reviewed by Vera W. de Spinadel

Ivars Peterson is the mathematics writer and online editor of *Science News*, a weekly newsmagazine of science, where he has published many articles highlighting the increasing use of visualization in mathematics, and especially the role of computer graphics in exploring mathematical ideas that extend from soap-film surfaces, fractals, knots, and chaos to hyperbolic spaces and general topological transformations. He is the author of the book *The Jungles of Randomness* [1998], also printed by John Wiley & Sons, among many other books, and he lives in Washington D.C.

In the Preface to *Fragments of Infinity*, Peterson relates that in 1992 he was invited by Nathaniel A. Friedman, the well-known mathematician and sculptor, to present the opening address at a meeting devoted to mathematics and art at the State University of New York at Albany, USA. The meeting brought together about 150 mathematicians and artists and Friedman introduced him to many people who are fascinated by intersections between art and mathematics. Since then, Peterson attended and participated in related meetings. (Indeed, Friedman organized seven annual conferences on Art and Mathematics (AM92-AM98), until he decided to create the International Society of the Arts, Mathematics and Architecture (ISAMA). Then he attended the very successful Mathematics and Design (M&D-98) conference held in San Sebastian, Spain, in 1998. This motivated Friedman to organize the First Interdisciplinary Conference ISAMA 99, which was held at San Sebastian, Spain, June 7-11, 1999. The *Proceedings* of this conference were published in a beautiful volume edited by Nathaniel Friedman and Javier Barrallo and include an extensive range of original papers relating the arts, mathematics and architecture.)

Even though I knew beforehand many of the illustrations and most of the authors presented in Peterson's new book, I still read it with great pleasure. It is a visual and creative book, presenting the multiple and unimaginable intersections of mathematics and art. Containing more than 250 illustrations and photographs of artworks—28 in full color—produced by many contemporary mathematicians who are also artists working in media spanning from metals to glass to snow, *Fragments of Infinity* draws us into the surprising mysteries of this rich intersection.

The book's poetic title echoes thoughts of the Dutch graphic artist M.C. Escher, who sought to capture the elusive notion of infinity in visual images. As Doris Schattschneider states in her splendid book *Visions of Symmetry* [1992], written after more than fifteen years of research: "Infinity—humans can only imagine it, never experience it." In 1959, in his essay "Oneindigheidsbenaderingen" ("Approaches to Infinity"), Escher referred to his famous and well known parade of reptiles as follows:

Not yet true infinity but nevertheless a fragment of it; a piece of the 'universe of reptiles'. If only the plane on which they fit into one another were infinitely large, then it would be possible to represent an infinite number of them. However, we aren't playing an intellectual game here; we are aware that we live in a material three-dimensional reality, and we cannot

possibly manufacture a plane that extends infinitely in all directions. What we can do, of course, is bend the piece of paper on which the world of reptiles is represented fragmentarily and make a paper cylinder in such a way that the animal figures on its surface continue to fit together without interruptions while the tube revolves around its lengthwise axis.

The contents of Peterson's book include "Gallery Visits"; "Theorems in Stone"; "A Place in Space"; "Plane Folds"; "Grid Fields"; "Crystal Visions"; "Strange Sides"; "Minimal Snow"; "Points of View"; and "Fragments." In the first chapter of the book, the fascinating torso carved from limestone by Nat Friedman appears as an intriguing example of the series in which Friedman explores the "combination of form, space and light." The second chapter, "Theorems in Stone", is dedicated to the original sculptor and mathematician Helaman Ferguson, who not only works with computers but also carves marble and moulds bronze into wonderful mathematically inspired networks.

"A Place in Space" starts with the famous book *Flatland: A Romance of Many Dimensions*, written in 1884 by Edwin A. Abbott [1992], where everybody and everything is trapped in a two-dimensional realm. The chapter then moves to our real three-dimensional world, arriving finally to Thomas F. Banchoff, a mathematician at Brown University in Providence, Rhode Island, who is fascinated with visualizing four-dimensional objects. In 1978, Banchoff presented his animated film *The Hypercube: Projections and Slices* at the International Congress of Mathematicians in Helsinki, Finland. The hypercube was the starting point. Using computer graphics, Banchoff and other mathematicians experienced with highly interactive windows through which many four-and higher-dimensional objects were explored.

"Plane Folds", the fourth chapter, is dedicated to the art of origami. Many interesting origami tessellations are presented, not only made folding paper but also pleating silk or other textile materials. In the fifth chapter, "Grid Fields", the vast mosaic of square tiles at the entrance to the Downsview subway station in Toronto, Canada, designed by Arlene Stamp, is exhaustively analyzed. Few people noticed that her remarkable design is based on the decimal digits of the number π . An important influence on Stamp's art was the concept of "fractal", a word introduced by the polish mathematician Benoit B. Mandelbrot to indicate self-similar configurations so irregular that their fractal dimension may have a non integer value.

"Crystal visions" is, in my opinion, the most interesting of all chapters, starting from the painted canvases and three-dimensional models of architectural structures designed by Tony Robbin up to Roger Penrose famous non-periodic tilings that explain the strange five-fold symmetry found in quasi-crystals. Following from this, the seventh chapter is based on the intriguing mathematical form known as the Möbius strip, which has inspired beautiful giant sculptures. These sculptures lie mostly in plazas and gardens and were made of different materials like re-painted steel, granite, wood, stainless steel, stone, by artists such as Charles O. Perry, Benigna Chilla, John Robinson and many others.

"Minimal Snow" presents minimal surfaces, which are those for which any distortion, no matter how small, increases its area. A soap film is a model of such a surface. In 1999, the international Snow Sculpture Championship was held at the Rocky Mountains of Colorado, USA. The chosen shape was the central portion of the Costa surface, named for the Brazilian mathematician Celso J. Costa, who discovered the equations of this minimal surface in 1983. The chapter also includes bronze versions of the surface by Helaman Ferguson.

Chapter 9, "Points of View", is dedicated to different sorts of complex and beautiful sculptures that look startlingly different from different viewpoints. Among them are the spiroclateral designs

generated by Robert J. Krawczyk of the College of Architecture at the Illinois Institute of Technology in Chicago, USA. A spirolateral is a line design such that if the first line is one unit long, each successive line is one unit longer than the previous one.

The last chapter considers interesting applications of hyperbolic geometry, starting with Escher's well-known *Circle Limit* series of prints up to Douglas Dunham computer program to transform one hyperbolic tiling pattern into another. The book ends with a long list of Further Readings for each chapter, opening a wide road for future investigations in this domain of mathematical art.

References

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About The Reviewer

Vera W. de Spinadel is President of the International Mathematics & Design Association and with Javier Barrallo from the University of the Basque Country directed the second Mathematics and Design (M&D-98) conference that was held in San Sebastian, Spain, June 7-11, 1998. The first one was held at Buenos Aires, October 1995 and the third one was held at Geelong, Australia in June 2001. The fourth will take place at Mar del Plata in Buenos Aires in June 2004.