Fragments of Infinity, A Kaleidoscope of Math and Art

Reviewed by Anthony Phillips

Fragments of Infinity, A Kaleidoscope of Math and Art
Ivars Peterson
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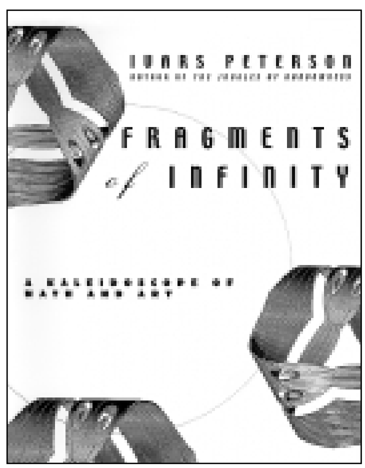
Giorgio Vasari, in his 1550 *Lives of the Artists*, tells us how a papal envoy was sent to Florence to find out if the painter Giotto (1267–1337) was as good as his reputation. The envoy asked Giotto for "a little drawing to send to his Holiness." Vasari continues: "Giotto, who was a man of courteous manners, immediately took a sheet of paper, and with a pen dipped in red, fixing his arm firmly against his side to make a compass of it, with a turn of his hand he made a circle so perfect that it was a marvel to see it. Having done it, he turned smiling to the courtier and said, 'Here is the drawing.' " As far as I know, this is the earliest "documented" example—it may of course be apocryphal—of Math Art. It is mathematical because the object represented is a circle, a simple but completely mathematical locus; it is art because it was drawn by one person for another person to perceive and appreciate as a work of art. In *Fragments of Infinity, A Kaleidoscope of Math and Art*, Ivars Peterson takes us on a survey of the contemporary intersection of those two endeavors. His focus is on the people who work there: "mathematicians who are also artists or whose mathematical thoughts have inspired others to create, artists enthralled by the unlimited possibilities offered by mathematically guided explorations of space and time."



Mathematics has been manifest in art almost as long as there has been art. A quick look at Greek decoration, Mayan friezework, or Indonesian textile design, to pick traditions from three very different places and times, shows a systematic and sophisticated use of symmetries evolving independently of any abstract development. Knots were represented on Roman gravestones as objects of beauty and mystery, and partial self-similarity was used in Tantric art, presumably to represent infinite processes, long before knot theory or a theory of limits existed.

During the Renaissance more explicitly mathematical objects began to appear in art. Paolo Uccello (1397–1475) set the mosaic image of a stellated dodecahedron into the floor of St. Mark's in Venice and surrounded it with an "impossible" toroidal solid (anticipating by 500 years the Penrose and Escher examples). Leonardo da Vinci drew some sixty illustrations for Luca Pacioli's 1509

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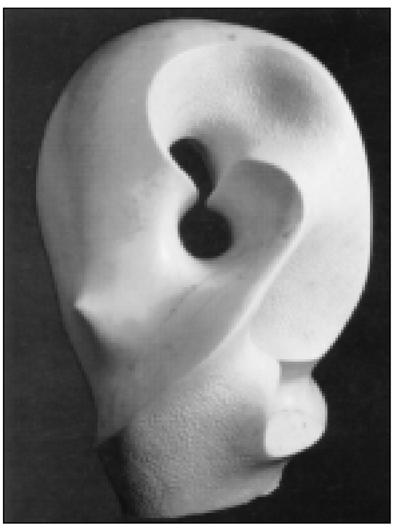
De Divina Proportione, showing regular and semi-regular polyhedra both as solids and as "solid edge" lattices, an effective illusionistic rendering technique he seems to have invented. Albrecht Dürer placed a mysterious granite polyhedron in *Melancolia*, his portrayal of "the dangers of excessive study," along with a Latin square containing the date of the engraving: 15-14. Da Vinci, and Dürer after him, drew enormously complicated knots, although it is very unlikely that either thought of knots as objects for theoretical study; they were intriguing natural phenomena having the same appeal, and decorative potential, as the unicursal mazes drawn in prehistory, antiquity and the middle ages. Around 1935 the sculptor Max Bill (1908–1994) reinvented the Möbius strip and, at about the same time, the painter and engraver Maurits Escher (1898–1972), who had visited the Alhambra in 1922, began his systematic rediscovery of Euclidean planar symmetries. In both these cases the mathematics was "in the air"—it is very difficult to imagine such inventions happening a hundred years before. Escher later (1958) discovered the work of H. S. M. Coxeter on hyperbolic tesselations and began to incorporate them into his designs, probably the first time since da Vinci's collaboration with Pacioli that professionally produced mathematics found its way into art, if we disregard the recently publicized [5], tantalizing hints about a possible Poincaré-Picasso connection. Recently the Bill-Escher tradition of artists who become de facto mathematicians has continued, along with a new breed of mathematicians who produce, show and sell their math-inspired art. These are the people who appear, with their work, in *Fragments of Infinity*.



Helaman Ferguson fleshes out his shapes with personally inspired, emotionally charged form: *Figureight Knot Complement II* (marble, 34", 1990). Williston Library, Mount Holyoke College. Photo: Cosby and Bower. Image used with permission.

The idea for the book is a very attractive one, especially for the mathematics community. Michele Emmer's beautiful *L'Occhio di Horus: Itinerari nell'immaginario matematico* [2] was published in a small edition, in Italian, in 1989 and could not reach the large, international audience that this topic deserves. What better way to introduce newcomers to the beauty of mathematics than by showing them objects or images which manifest it directly to their senses? In particular, how better to combat the image of the out-of-touch mathematician than by showing men and women unafraid to take up brush, chisel, or welding gun and make abstract ideas come to physical life? Peterson is fortunate in having found talented and eloquent type specimens for the species he studies. Each of them is interviewed at length in what turn out to be the best parts of the book, where we hear these unusual people talk about their lives and their work.

Helaman Ferguson is the prototypical mathematician artist. Beginning at age six, he lived in the home of a stone mason. There he learned the stonecutter's trade. Later these skills, combined with his professional scientist's insight, engendered his remarkable dual career as mathematician and as mathematical sculptor. Ferguson the mathematician works on algorithms (his Ph.D. topic was in harmonic analysis); the sculptor takes his subject matter from topology, and this makes a difference. The mathematical meaning of a topological shape is invariant under any deformation that does not tear it apart. Ferguson has been able to capitalize on this flexibility to flesh out his shapes with personally inspired, emotionally charged form.

Thomas Banchoff represents the mathematician as historian and promulgator of mathematical art. He grew up a Catholic. When he was in high school and first encountered the fourth dimension, he tells us, it brought on a kind of mathematical-religious epiphany, in which he understood the several aspects of the Trinity as three-dimensional cross-sections of a single, inconceivable, higher-dimensional Being. In his life as professor of mathematics, Banchoff has become the high priest of the fourth dimension. He has brought it to life in movies—starting in 1975, among the first high-quality mathematical animations—and he has championed Edwin Abbott, the whimsical author of *Flatland*—an 1884 primer on the understanding of higher dimensions, disguised as an elaborate Victorian science-fiction story. His enthusiasm came to the attention of Salvador Dali, who earlier (1954) had painted a Crucifixion where the Cross is replaced by an unfolded hypercube. Dali and Banchoff hit it off as fellow transcendentalists, and their relation continued until the artist's death in 1989.

Charles Perry is the mathematical artist with no mathematical training. An architect turned sculptor, he specializes in large outdoor works. His creations can be seen in almost every large American city, in front of a corporate headquarters, a museum, or a Federal office building. Perry may be mathematically uneducated, but he has the mind and the hands of an inventor and an uncanny sense of the rhythm and richness implicit in three-dimensional geometry and topology. The shapes he invents are as mathematical as Giotto's circle: loci pre-existing their equations.

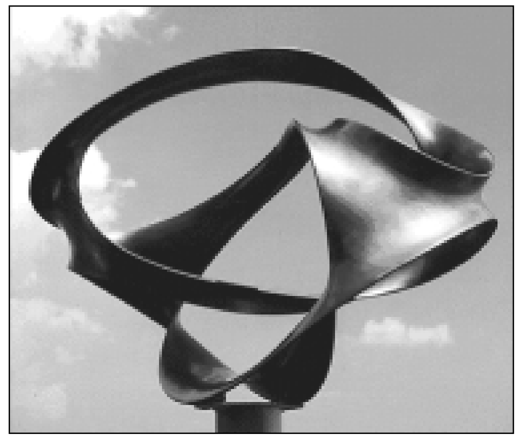
Tony Robbin began as a painter "interested in ways of experiencing and depicting space." His conversion to mathematics dates from a 1979 visit to Brown University, where he experienced Banchoff's interactive computer displays of the four-cube. His recollections are unmistakably of the period. "For three nights, I woke frequently from dreams of the images I had seen: the green screen, the quivering geometric figure,…I had seen the fourth dimension directly." He soon realized that he needed to learn enough mathematics and computer programming to write his own software and harness this science and this technology to his art work. He went back to school. His new knowledge allowed him to absorb the lore on quasiperiodic tilings and their associated quasicrystals. Now he has a patent for the concept of "an architectural body having a quasicrystal structure," and a book explaining his radical ideas.

The study is rounded out with portrait sketches of several other denizens of the math-art intersection, among them Harriet Brisson ("Light is my medium. Geometric forms are my inspiration."), Brent Collins (who says of mathematics: "It's a language of nature I've appropriated for aesthetic purposes."), and Nat Friedman ("Art and Mathematics are both about seeing relationships. Creativity is about seeing from a new viewpoint.").

Ivars Peterson is the most prolific of the handful of scientist-journalists who have specialized in popularizing mathematics. His works include *The Mathematical Tourist*, *Islands of Truth: A Mathematical Mystery Cruise*, *Mathematical Treks: From Surreal Numbers to Magic Circles*, and *The Jungles of Randomness: A Mathematical Safari* [6, 7, 8, 9]. As the titles suggest, his role is the mathematical tour leader, organizing itineraries with stops in scientifically exotic locations.

In *Fragments of Infinity* the tour has become an art show, with Peterson taking the part of curator and guide through the galleries. Mostly, he stands back and lets his people and their work explain themselves. His own contributions are like the catalogue for the show: biographical material about the artists, tours of their studios, descriptions of installations. Understandably, since Peterson selected the participating artists and since each is virtually standing by as we go through his or her part of the show, the works are presented in a uniformly warm light. There is a minimum of what could be a valuable analysis of the interplay between medium and subject matter, and there is no criticism. In undertaking a book on the synthesis of mathematics and art, Peterson has ventured out of his domain of expertise (just as I have in undertaking this review). He is excellent at presenting mathematics to a general audience, but showing art is different. A piece of mathematics may be presented in many different ways, but an art work must speak for itself; and some speak much better than others.

A work of art needs emotional and visceral or kinesthetic resonance if it is to survive beyond the classroom. This is part of what Bernard Berenson [1] meant by "tactile values," the feeling that we are, body and psyche, co-involved with the maker in a shared aesthetic experience. Of course not all of mathematics is susceptible to a "tactile" representation. "Euclid alone has looked on Beauty bare" starts the often quoted sonnet by Edna St. Vincent Millay, which goes on to speak reverently of mathematics as "nothing, intricately drawn nowhere." The ethereal, Apollonian side of mathematical creativity is central to the subject but defies artistic expression except as music; and music is not on the agenda here.

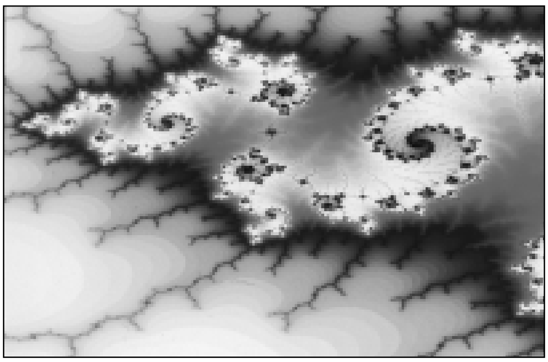


The shapes Charles Perry invents are as mathematical as Giotto's circle: loci pre-existing their equations. *Duality* (bronze, 3 feet, 1982). Perry Residence, Norwalk, Connecticut. Image used with permission.

Luckily, we're all human. Mathematics grew out of sensory data and is still connected to its roots: Most (but not all) mathematicians feel a need to clothe bare Beauty in visual, geometric trappings. Here the personal and the emotional can come into play. The ideal torus is indeed drawn nowhere, but each mathematician draws the torus in his or her own way; individual style is the way the human element enters into graphic or plastic representations of mathematical objects, the way they can turn into art.

Many of the works in Peterson's gallery do not manifest this human touch. He shows us intricate planar graphics generated by the "algorithmic artist" Bob Brill. We see startling computer images of three-dimensional loci made by Banchoff and by George Francis, both mathematicians. (He does not show us any of the hand drawn, eerily anatomical diagrams from Francis' *A Topological Picture Book* [4].) He shows us an origami lobster, complete, folded from a single sheet by the physicist Robert J. Lang. These impressive achievements will elicit a well-deserved "Wow!" from their audience, but no more: They are inert. Cliff Pickover, another of Peterson's featured artists, zooms in on one region of the Mandelbrot set, fixing the orientation, the resolution, and the palette of colors. These are aesthetic choices, but of a very low-level, impersonal nature. Fractal art can be as beautiful as a sunset, but it cannot succeed in competition with works of art that bring us into communion, "though once only and then but far away" (Millay's words), with another human being.

Fortunately many of the images in *Fragments of Infinity* do show us such work. Sculpture has an intrinsic edge on "tactile values" in an obvious sense but also because the act of perceiving it in the round automatically engages our physical attention. (Peterson slips into his exhibition a couple of Henry Moore works, which are textbook examples of the coercive potential of sculpture, although totally innocent of mathematics.) Perhaps this is why Ferguson's, Robert Engman's, and Perry's works, even on the page, are among the most convincing and involving in Peterson's collection.



A fractal can be as beautiful as a sunset. Clifford Pickover, *Mandelbrot Madness*. Image used with permission.

Judged as an art show, *Fragments of Infinity* is uneven; one can also quibble about who got left out and especially about the almost exclusively United States East Coast provenance of the collection. In particular, there is no mention of Anatolii Fomenko [3], by far the most prominent representative of the mathematician-as-graphic-artist. But many good pieces are there to see; and for many readers, even those familiar with mathematics, it may be a first gaze at an unsuspected universe. As a book about mathematics, beyond showing us often dazzling incarnations of mathematical phenomena, it has deft sketches of background material. Here Peterson is at his best. *Fragments of Infinity* will be useful in presenting the visible, tangible, and often playful side of mathematics to a nonmathematical audience, while anchoring it to the underlying science. The publisher, John Wiley & Sons, deserves praise for the layout, which ingeniously and gracefully accommodates the huge number of illustrations: Almost every page has one, most have several, in many different formats. The dust jacket is an especially witty use of a transversely bisected Möbius strip, Escher at his wackiest, most reptilian, most mathematical, and most charming.

It may be unfair to ask a book subtitled *A Kaleidoscope of Math and Art* for sustained thought about the difference between art and mathematics, but that investigation could have set these many experiments on a broader intellectual stage. It is likely that no one person could carry off this assignment, but that it would require the unlikely collaboration of experts in art criticism, in mathematics, and in philosophy to chart the expanse between the two cultures. Meanwhile we have this attractive book to help us see across.

References

[1] Bernard Berenson, *The Florentine Painters of the Renaissance*, G. P. Putnam's Sons, New York, 1896.

[2] Michele Emmer, *L'Occhio di Horus: Itinerari nell'Immaginario Matematico*, Istituto della Enciclopedia Italiana (Treccani), Roma, 1989.

[3] Anatolii T. Fomenko and Richard Lipkin, *Mathematical Impressions*, American Mathematical Society, Providence, RI, 1990.

[4] George K. Francis, *A Topological Picturebook*, Springer-Verlag, New York, 1987.

[5] Arthur I. Miller, *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc*, Basic Books, New York, 2001.

[6] Ivars Peterson, *Islands of Truth: A Mathematical Mystery Cruise*, Freeman, New York, 1990.

[7] ____ , *The Mathematical Tourist: Snapshots of Modern Mathematics*, Freeman, New York, 1988.

[8] ____ , *The Jungles of Randomness: A Mathematical Safari*, John Wiley & Sons, New York, 1998.

[9] ____ , *Mathematical Treks: From Surreal Numbers to Magic Circles*, Mathematical Association of America, 2001.