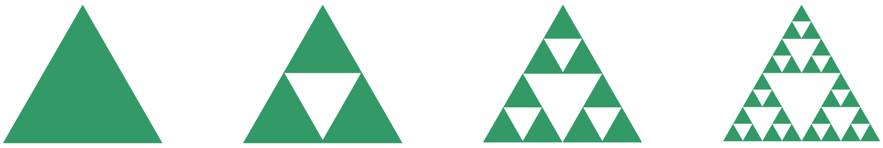
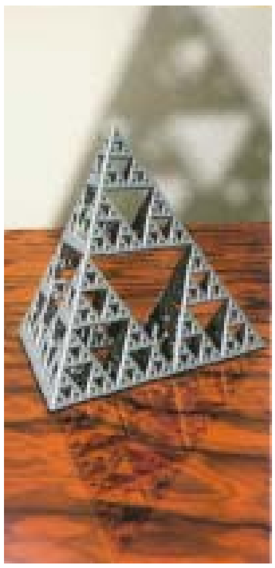
Fractals

Sierpinski Triangle

Fractals are "self-similar": small-scale details have the same geometrical characteristics as large-scale features. A simple rule defined by the mathematician Sierpinski in 1915 illustrates how fractals work, creating what's known as Sierpinski's triangle. Sierpinski's rule says*: "Split each black triangle into four triangles by cutting out a white triangle in the middle.*" It's as simple as that. Yet Sierpinski's rule creates a sequence of self-similar triangular structures rapidly increasing complexity.





The objects in nature, and the nature of virtual worlds, are three-dimensional. And the real power of **fractal geometry** is in describing three-dimensional shapes. One of the challenges of creating virtual worlds with computer is finding efficient ways of describing complex forms. The Sierpinski iteration can be carried out on a three-dimensional object, by subtracting pyramids from with pyramids. The result is called the Sierpinski arrowhead on the right. The example here was fancifully generated on a computer as a "Desktop Tetrahedron" by scientists at the University of Regina in Canada. The arrowhead has more spaces than a sponge and lies about halfway between a two-dimensional surface and a three-dimensional pyramid.

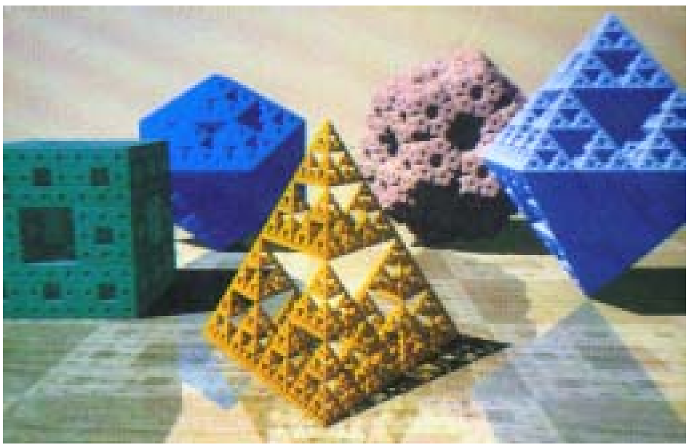


Figure 1

Examples of 3-D fractal of transforming reality generating by computer,
(Ref. Book 1, p152).

Nature's Fractals

The fractal computer program that produced the snowflakes as figure 2, like the dynamical forces that produced the real snowflake in figure 3, combines instructions for six-fold symmetry with the convolutions of feedback that lead to chaos. Notice that even across the microscopic space of the growing crystal there were subtle differences in the forces affecting it. Snowflakes are **fractal** records of the changing circumstances the ice encountered during its descent. No two falling snowflakes will meet precisely the same circumstances.

Another example in figure 5, the process of generating the *fractal maple leaf* using the deterministic algorithm is displayed step by step showing several iterations. Obviously, fractal geometry is a technique for describing the amorphous objects found in nature. The challenge is finding efficient ways to describe complex and evolving forms.

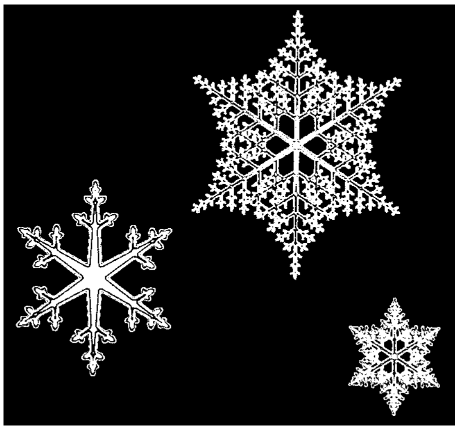


Figure 2
A Fractal Snowflake generating by computer.

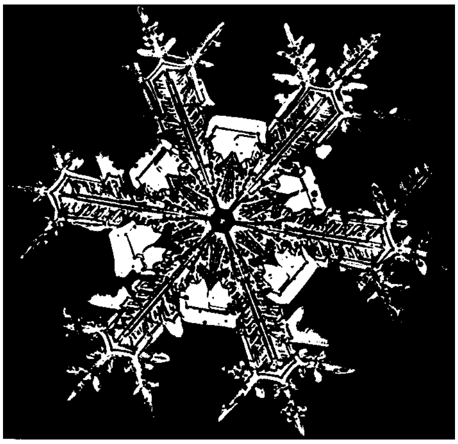


Figure 3 A real Snowflake.

Figure 4
A Snowflake with hexagonal symmetry, (Ref. Book 4, p9).

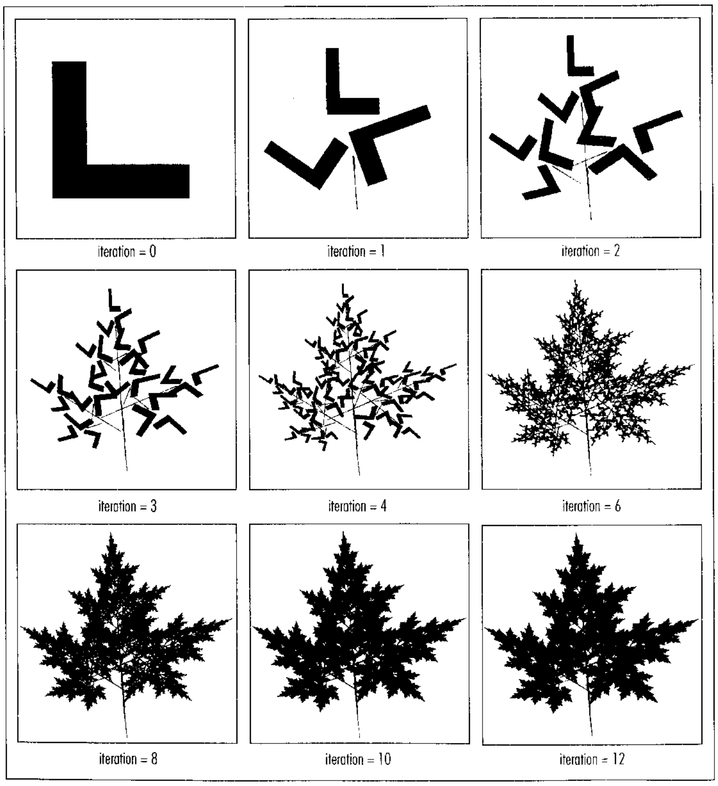


Figure 5
2-D fractal of Maple Leaf by Deterministic iteration algorithm, (Ref. Book 6, p38).

Fractals Diffusions

Perceptions change almost hourly as artistic and scientific investigators peer through the windows of fractals and chaos to discover meaningful patterns of uncertainty everywhere: The surface of some viruses are now known to be fractal. Fractal rhythms and distinct fractal signatures have been found in dopamine and serotonin receptors in the brain, and in enzymes. Fractal geometry is being used to describe the percolation of oil through rock formations. Composers are creating fractal music; programmers are studying the effect of chaos on computer networks; chemists are locating a strange attractor underneath the fluctuations of the Standard and Poors Index; ecologists are using the principles of self-organizing chaos to reconstruct lost habitats; nonlinear models have been made of the international arms race. One enterprising novelist has turned the idea of strange attractor into science fiction story equating chaos with immortality.

As I mentioned in the above paragraph, fractal theory could be applied to improve the design thinking. The following patterns generated by starting out with a single defector. There is an especially powerful method of rules for describing and generating complex visual structures, both realistic and abstract.

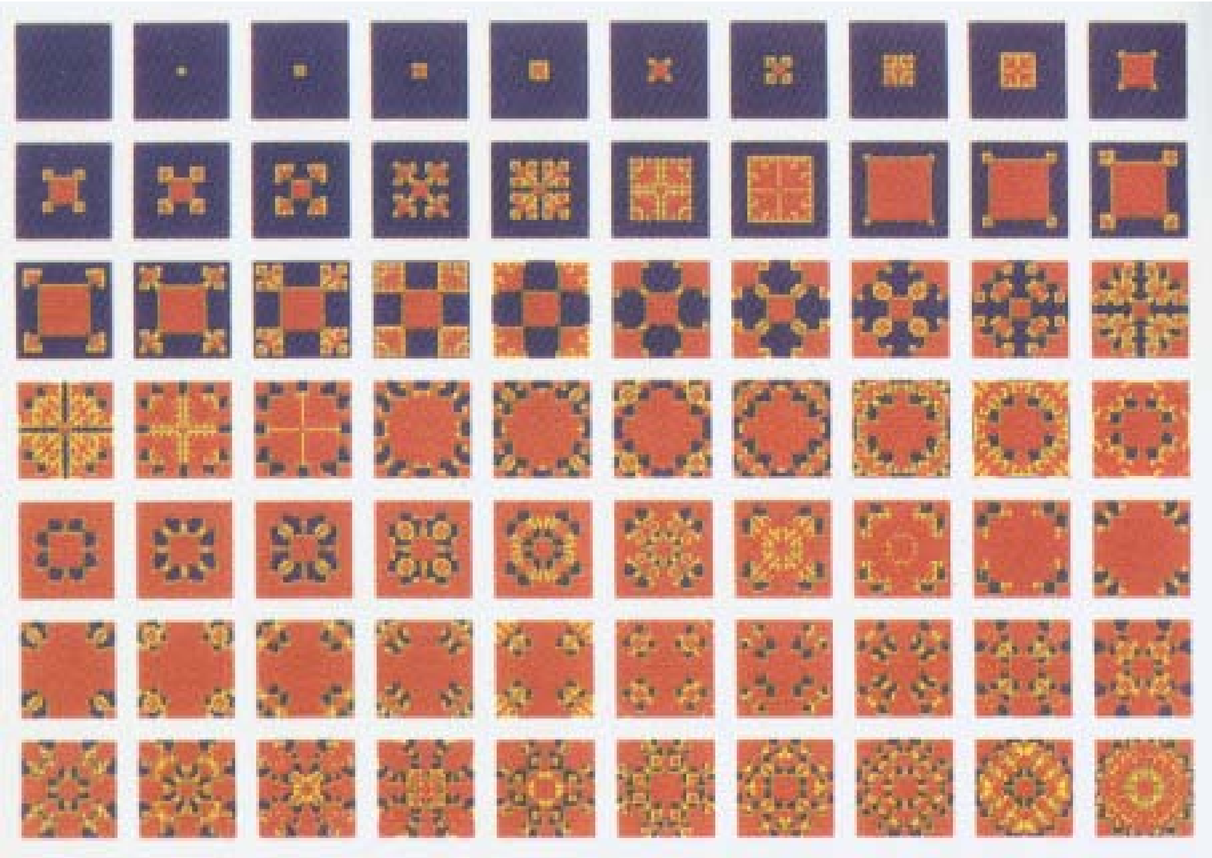


Figure 6 Patterns design by computer, (Ref. Book 3, pp206-207).

Fractal's Art

Programs to produce fractals appeared as early as 1985, this media coverage was to some extent responsible for their popularity, but because they have become rather overexposed, much of the visual quality of fractals has been dissipated. Artists and designers seem to have taken relatively little interest in their development. But some artists are using fractal design in their works. In figure 7, here is a beautiful image example of fractal photo for book cover design, (Ref. Book 7).

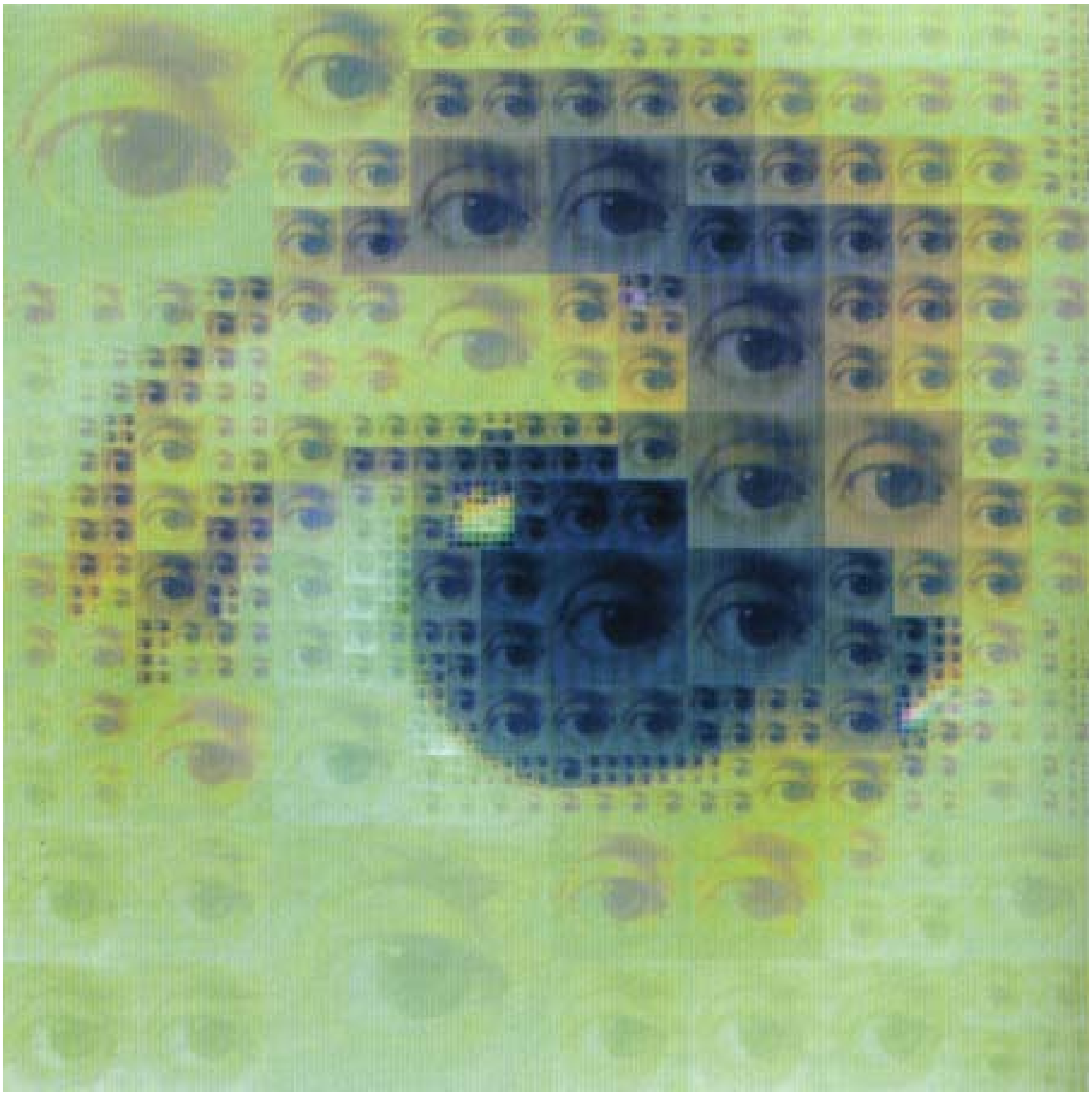


Figure 7 The Reconfigured Eye, 1992, Photograph by Yasuyo Iguchi,

Reference Books:

(1) Baker, Robin
Designing the Future
Thames and Hudson, 1993.

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Logic and Design in art, science & mathematics
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(5) Gregory, Richard; Harris, John; Heard, Priscilla & Rose, David
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Fractal Imaging
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Breaking the Mind Barrier
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