

Scientific Visualization In Mathematics and Physics

J. Clint Sprott

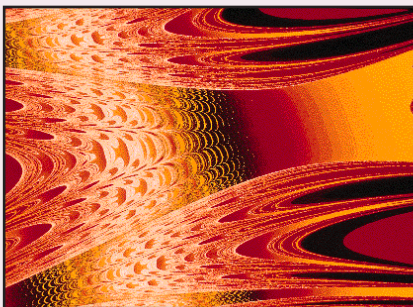
The University of Wisconsin – Madison

Clifford A. Pickover

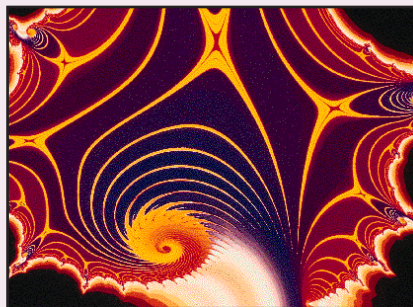
IBM Thomas J. Watson Research Center

Our computer graphics found throughout this issue illustrate their power to reveal the intricate behavior of mathematical and physical phenomena.

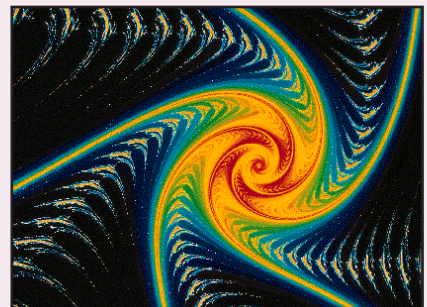
The references give additional details allowing computer hobbyists to reproduce the various patterns.



I



II

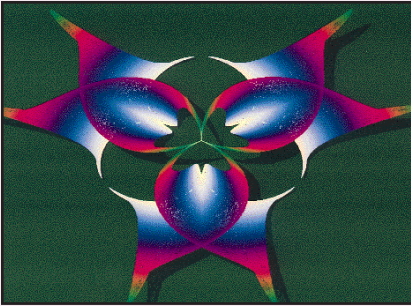


III

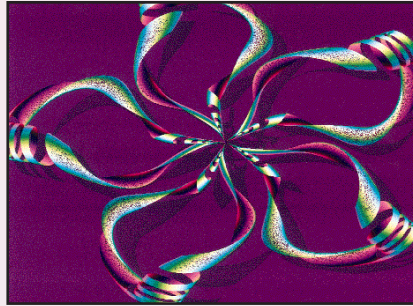
The images (I, II, III) on pages 2-3, 6 and 7 represent the behavior of two-dimensional quadratic iterated maps [1, 2]. As a background to these algorithmic art forms, consider that an infinite number of monkeys with an infinite number of typewriters (word processors, nowadays) will eventually reproduce every work of Shakespeare.

The problem is that someone has to sort through all the gibberish to find the occasional gem. On the other hand, the criteria for visual art are much less constrained than for literary composition. A monkey with a paintbrush has a reasonable chance of producing a pattern that someone would consider artistic.

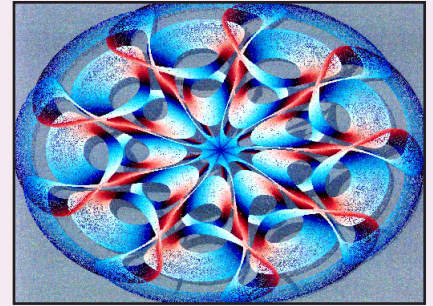
Unlike the monkey, the computer can be



IV



V



VI

trained to select those images that are likely to appeal to humans. One approach is to use several-parameter equations with chaotic solutions. Such solutions are unpredictable over the long term yet exhibit interesting structures as they move about on a strange attractor, a fractal object with non-integer dimension. To produce the images, our computers use simple artificial intelligence methods to automatically locate regions of beauty in the parameter space. The figures (IV, V, and VI) on pages 15, 25 and 31) are produced by this method, except that the patterns are replicated several times in various orientations to produce what we call “strange attractor symmetric icons” [3].

Also derived from mathematics are the works (VII and VIII) on pages 63 and 69 [4]. The former image displays the intricate behavior of a numerical root-finding method called Halley’s method, while the latter represents the behavior of the iteration of a complex-valued function.

Finally, the image on page 80 (IX) is a three-dimensional embedding diagram for a static black hole that shows how space is warped in the vicinity of a black hole. Objects

on the surface of the embedding diagram represent bodies that are being “sucked into” the holes’ hungry maw at the center. The fan shape at the bottom is a portal to another universe. Recipes for creating this form are given in [5].

In much of our works, the line between art and science has become indistinct [2, 6]. We invite readers to visit our homepages to tour a much larger universe of magnificent shapes and forms. ☺

References

- [1] Sprott, J. and Pickover, C. Automatic generation of quadratic map basins. *Computers and Graphics*, 19(2): 309-313, 1995.
- [2] Pickover, C. *Keys to Infinity*. John Wiley & Sons, Inc. New York, NY, 1995.
- [3] Sprott, J. C. Strange attractor symmetric icons, *Computers and Graphics*, 20, 325-332, 1996.
- [4] Pickover, C. *Computers and the Imagination*, St. Martin’s Press: New York, NY 1993.
- [5] Pickover, C. *Black Holes - A Traveler’s Guide*. John Wiley & Sons, Inc.: New York, NY, 1996
- [6] Sprott, J. C. *Strange Attractors: Creating Patterns in Chaos*, M&T Books: New York, NY, 1993.

Clint Sprott

<http://sprott.physics.wisc.edu/sprott.htm>

Cliff Pickover

<http://sprott.physics.wisc.edu/pickover/home.htm>

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J. Clint Sprott and Clifford A. Pickover

VII



VIII



IX

