About the Cover

Aesthetic Selection: The Evolutionary Art of Steven Rooke

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Steven Rooke's artwork is really a gallery of portraits from families with relatively short, entirely mathematical lineages. He creates each image through a simulated evolutionary process, starting from what he calls a "virtual primordial soup." The soup consists of dozens of mathematical functions, from which a genetic program spawns a generation of about 100 images that fill the available space in computer memory.

In the biological metaphor of this process, the math functions lie "somewhere between the level of DNA base pairs and simple genes," Rooke said. Some are as simple as an add operator; others are composed of hundreds of computer instructions. The genetic program, a population simulator, uses these functional building blocks to create the image-organisms, each with its own "genetic structure." Both the soup and the genetic program are Rooke's creation, seeding and feeding the diversity that is the underlying condition for a Darwinian model of natural selection.

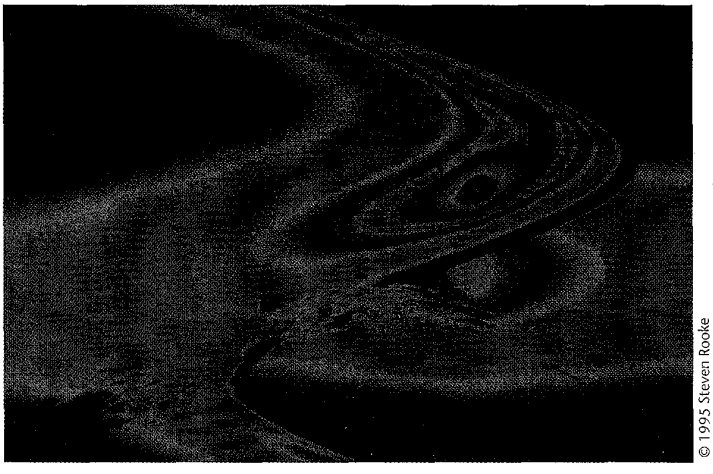
The first generation is random. Thereafter, Rooke assigns an "aesthetic fitness" score to each member of each generation, generally giving higher scores to the images he likes and the lowest scores to those he intends to "weed out" of future populations. In a breeding cycle that usually takes a day or two, the images "mate" probabilistically according to their fitness score—that is, the most "aesthetically fit" mate more often, increasing the likelihood of passing their genotypes to the next generation of 100 organisms. Thus, Rooke himself provides the selection pressure that fuels Darwinian "survival of the fittest." Hence, the term "aesthetic selection."

The resulting images resonate with still, primordial forms—the mask in the cover image, "Inside Looking Out," the crystalline marsh of "Primal Emergence," the aurora borealis of light in the Final Focus image, "Accretion Kiss."

Artificial evolution

Rooke said it usually takes "about 30 generations to enter aesthetically interesting territory." His genetic program includes a variety of reproductive processes. "A combination of mostly forms of 'sexual' reproduction with a lesser amount of mutation usually works best," Rooke said, though he occasionally throws in a "spore from space for good measure." Rooke can also vary the primordial soups of different breeding cycles with what he calls "digital amber"—the saved genetic structure of interesting images from previous cycles. He generally saves 60 to 80 images from each cycle for post-production. Each image featured in *CG&A* this month has a different lineage.

Rooke implemented his simulator in C and optimized it for the Silicon Graphics Indigo R3000 system he works on. His original inspiration to write the program was a Karl Sims' 1991 Siggraph paper, "Artificial Evolution for Computer Graphics," which described techniques for "enabling 'evolution' of procedural models using 'interactive perceptual selection'." (*Computer Graphics*, Vol. 25, No. 4, July 1991, pp. 319-328). Another seminal work in this field, he said, is John Koza's *Genetic Programming* (MIT Press, Cambridge, 1992). In these genetic programming systems, Rooke explained, "the genetic structure, produced during evolution, determines the nature of the organism, allows it to reproduce, and provides a set of instructions for carrying out a task. In evolutionary art, the task is to create a visual image."



"Earth Wave"

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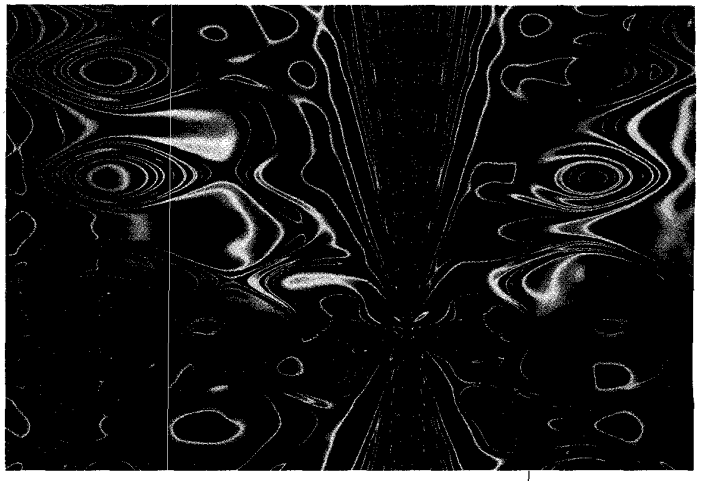
A different kind of reproduction

Rooke uses a separate program to render his images at high resolution. Although his work is available as archival-quality Iris prints, he wanted a process that would achieve the maximum resolution of these 294-million-pixel images. Ultimately, he selected a Kodak LVT recorder that uses 16 × 20-inch sheets of film.

To shoot the 890-Mbyte images directly to the film, however, he eventually had to work directly with the lead programmer for the LVT driver software at Kodak headquarters in Rochester, New York. He has now produced 10 images using this process. Displayed in light boxes, they achieve a level of detail and subtlety in tonal gradation that may be unrivaled in digital imagery.



"Untitled"

Evolution of a life

Rooke has bachelor's and master's degrees in geology. He has traveled widely, working in places as far flung as Africa and the Northern Mariana Islands. He is basically a self-taught programmer, but his skills were overhauled and honed under the tutelage of Doug Tody, chief programmer at the National Optical Astronomy Observatory in Tucson, where Rooke worked from 1984 to 1991. "I thought I was a hot-shot programmer when I got there," Rooke said, "but this was my intellectual boot camp for programming."

He left NOAO in 1991 to pursue his own research projects. "I had, and still have, a notion about using high-end computer graphics to test superorganism theories," he said. "Geology had given me a special perspective on time, and astronomy now gave me a similar perspective on space, drawing me into an obsession with the mystery of our origins." His evolutionary simulation software emerged from this work. "Image evolution became a fascinating detour," he explained. "The software and my interaction with it took on a life of its own."

Rooke makes an interesting point about evolved images, namely, that each pixel is produced from exactly the same program as any other. "What is different is its location in space," he said. "High plants and animals exhibit a similar phenomenon: the DNA in every cell (except reproductive cells) is exactly the same. What is different is the cell's location in the body. There is no way any person could either infer the underlying genetic structure of a complex evolved image or deliberately design a structure to create such a desired pattern."

Rooke is now refining his software to model the co-evolutionary processes that affect interdependent species. He also plans an exhibit of his current work. ■

"Primal Emergence"