Harold Cohen and AARON

Paul Cohen

■ *Harold Cohen (1928–2016) was a computer art pioneer and the developer of AARON, one of the most creative AI programs in daily use. This memoriam, written by his son (and AI scientist) Paul, describes Harold Cohen's work and contributions to the AI and art communities. — ed.*

Harold Cohen was the author of AARON, perhaps the longest-lived and certainly the most creative artificial intelligence program in daily use. Cohen's death, on April 27, 2016, ended a lengthy partnership between an artist and an AI. At times, AARON was quite autonomous of Cohen, responsible for the composition, coloring, and other aspects of a work; more recently, AARON served Cohen by making drawings that he would develop into paintings.

Cohen was born in 1928, studied painting at the Slade School of Fine Arts in London, and later taught at the Slade as well as Camberwell, Nottingham, and other art schools. He represented Great Britain at major international festivals during the 1960s, including the Venice Biennale, Documenta 3, and the Paris Biennale. He showed widely and successfully. Then, in 1968, he left the familiar and rewarding London scene to join the Visual Arts Department at the University of California, San Diego. By 1971, Cohen had taught himself to program a computer and exhibited computer-generated art at the Fall Joint Computer Conference. Thereafter, but for his notebook drawings and the occasional birthday card, every image from Cohen's studio in some way involved the AARON program.

Cohen's fundamental question was, "What makes an image evocative?" Can algorithms produce evocative images not rarely and accidentally but consistently? In the early 1970s, Cohen realized that some aspects of marks — open and closed shapes, implied figure and ground, lines that look like they are drawn by hand rather than, say, Bezier curves — gave the impression of intentionality (figure 1). Images from this period look a bit like abstract Native American petro-

Figure 1. An Early Drawing by AARON, 1974.

Colored in pencil by Harold Cohen.

glyphs, or abstract children's drawings, two early influences on the development of AARON. The images were black and white. Cohen colored them by hand.

For the next two decades, Cohen worked on algorithms for color and composition. In 1995, he built and exhibited a painting machine at the Boston Computer Museum. Cohen was a talented engineer: His machine would compose images of people in rooms, then draw them, mix its own dyes, and color the drawings (figure 2). This exhibition turned out to be the apex of AARON's career as an autonomous representational artist. Representational painting was evocative, but not in interesting ways, and although Cohen loved to interact with gallery audiences, he worried that the spectacle of the painting machine detracted from the art itself. Gradually, Cohen and AARON returned to abstraction and simplicity, although their path wasn't direct. For roughly a

decade, AARON produced somewhat representational images of astonishing complexity and breathtaking color that Cohen regarded as superior to his own (figure 3). But Cohen's question had always been, "What are the minimum conditions under which a set of marks functions as an image?" and his work since about 2010 is comparatively minimalist.

The early AARON was developed at the Stanford AI Laboratory, where Cohen was a sabbatical guest of professor Edward A. Feigenbaum. AARON was an expert system that encoded Cohen's knowledge about composition and color. Even in these early days there were hints — such as the freehand line algorithm — that art might be made by algorithms that have little in common with artists' expertise. Composition and color were eventually realized by startlingly simple algorithms. Cohen said that AARON was a distinctly different kind of intelligence from his own and he puzzled over its surprising success.
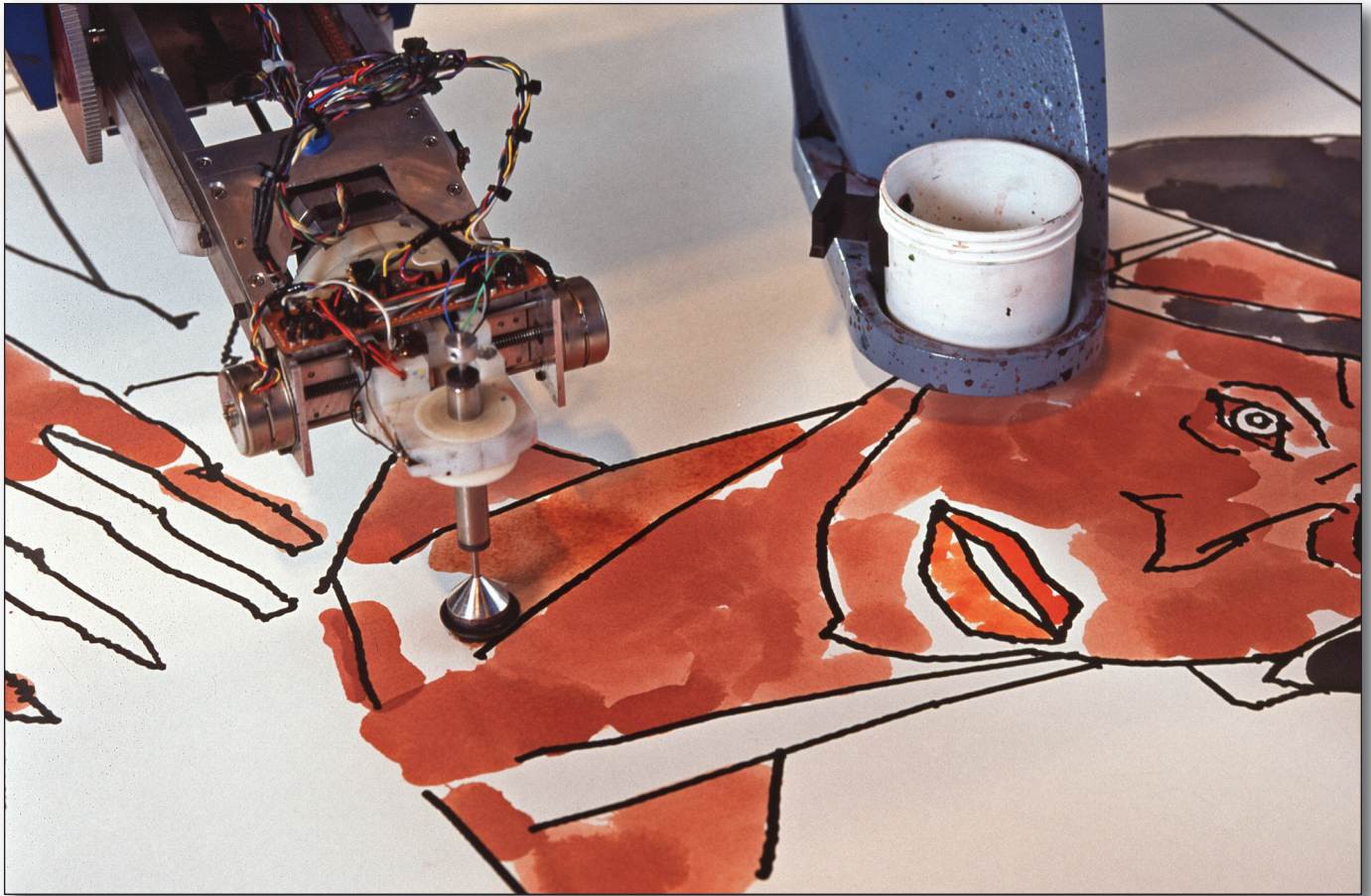
Figure 2. A Close-Up of One of Harold Cohen's Painting Machines.

On the left is an effector that grips, raises, and lowers brushes, attached to the beam of an *x-y* plotter. The paint cup on the right is also attached to the beam. To color an area, AARON would select a brush of appropriate size and mix dyes in the cup.

Cohen quipped that he would be the first artist in history to have a posthumous exhibition of new work, though he realized that the joke hinged on the word "new." Each of AARON's images is both unique and instantly recognizable as originating in a particular version of the code. Cohen toyed with the idea of making AARON modify itself, but in fact he reduced AARON's autonomy. Why was this? He had little faith in machine learning, he believed that only an artist could make AARON, he wanted to retain control of AARON's development; most importantly, AARON was how he made art. The final version of AARON draws images that were extremely challenging for Cohen to paint: few marks, lots of white space, no hints about color (figure 4). As an artist who never erased, Cohen would think for hours and days about how to paint these drawings. AARON became not an artist in its own right but a poser of problems to an artist. And Cohen, having demonstrated that AARON could function as an artist in the world's galleries, museums, and science centers — the Tate, the Stedelijk, the San Francisco Museum of Art, the Ontario Science Center, and many others —

Figure 3. Harold Cohen with an Installation at the San Diego Museum of Contemporary Art, 2007.

The drawing and coloring were done entirely by AARON. The painting was printed on a wide-format inkjet printer in seven panels.

Figure 4. "Wakl in Rio."

Drawing by AARON, coloring by Harold Cohen, 2015. Cohen painted some of these drawings in oil paint, but eventually built yet another drawing machine: a six-foot display with touch sensors and custom software to allow Cohen to mix colors and paint with his fingers directly on the display. The finished images were printed on canvas.

spent his final years doing what he liked best: using AARON to think about color and composition and the conditions under which marks function as images.

AARON's images and Cohen's essays and videos can be viewed at www.aaronshome.com. The book

Aaron's Code by Pamela McCorduck documents the first phases of AARON's career.

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