Machines Explore Their Sensitive Side:
The Emergence of Robot Art

Within the past few decades, computers have become more…human. Though much still separates man from machine, the gap is narrowing. Computers are now capable of composing poetry, playing chess, creating complex musical scores, and even making art. The emergence of these artistic functions offends the sensibilities because it suggests that humans are no longer unique, and in the eyes of the paranoid, are quickly becoming obsolete. However, this new generation of creative technology is still embroiled in controversy as many people refuse to acknowledge the creations as authentic. Abstract artist Harold Cohen has been stuck in the eye of the storm since the early 1970s when he became obsessed with simulating the highly cognitive process involved in drawing. Fascinated by the potential of artificial intelligence, he threw in the drape cloth to develop an artistic computer program dubbed AARON. Though it has produced thousands of compositions which exhibit "stylistic consistency that reveals an identity as clearly as any human artist's does," people largely refuse to call its creations art (Cohen, "Exploits" 13). Is this resistance a knee-jerk reaction or is there really an inherent quality to art that cannot be mechanically simulated?

Cohen had a simple aspiration. He wanted to program AARON to follow the same rules an artist would use to create a line drawing by mimicking the "lowest-level business of driving a pencil from one place to another" (Cohen, "Material" 16). In order to do so, he had to analyze a "seemingly simple task…so precisely that it could be turned into something a computer could do" (Johnson 207). Cohen had no interest in providing the machine with basic figures to perform transformations on. He often has to explain to disbelievers that "there is no lexicon of shapes, or parts of shapes, to be put together, assembly line fashion, into a complete drawing" ("Image" 3). With the notion that "anything that can be explained can be programmed," Cohen

devised a system that makes the same decisions an artist would based on a hierarchical series of rules (Johnson 209). The highest level, ARTWORK, controls the overall organization, including issues of spatial distribution. The next level, MAPPING, deals with "the finding and allocation of space for the making of individual elements" (Cohen, "Image" 6). PLANNING is then "responsible for the development of these individual figures" ("Image" 6). LINE generates a starting and end point and passes the information on to SECTOR, which "produces a series of 'imagined' partial destinations…designed to bring the line closer to its final end-state" ("Image" 6). CURVES plans the movement of the pen. Finally MOVEMENT CONTROL is responsible for producing the actual drawing. [See Fig. 1] Cohen insists that this mechanical procedure directly corresponds to an artist's thought pattern. One thing that certainly deviates from the human method of drawing, however, is the absence of any form of visual feedback. In order to avoid overwriting, AARON must internally store all information about what he has drawn.

The program today still uses this same hierarchical system. However, AARON's style has evolved dramatically throughout the years as Cohen provides more knowledge. Because of the overarching attempt to mimic the brain processes associated with creating art, it is no surprise that AARON "has gone through several stages of something corresponding to human cognitive development" (Cohen, "Shelf" 3). Though Cohen claims that AARON is solely responsible for the works, many people wonder to what extent programming influences the output. Critics have claimed that the hierarchy extends to the creator—if Cohen wants to call AARON an artist, then he himself has to assume the role of meta-artist. To defend the program's output, Cohen is careful to define the nature of his contribution: "I don't tell it what to do. I tell it what it knows" (Scientific American Frontiers 5).

Originally AARON didn't know much. It was equipped with three fundamental rules: "the difference between inside and outside, between closed and open, and between figure and ground" (Johnson 211). The resulting work was rather abstract, consisting of simple shapes and zigzags. [See Fig. 2] This style suited Cohen's investigation, however. Because art primarily functions to generate meaning, he was intrigued with the amount of marks necessary to appeal to a human audience. He used the program to explore "the minimum condition under which a set of marks may function as an image" (Cohen, "Image" 3). AARON operated on a simple set of "if-then" rules based on Cohen's knowledge of aesthetics which followed the format "if A, B, and C…then P percent of the time do X; Q percent of the time do Y; and R percent of the time do Z" (Johnson 212). These guidelines gave the program flexibility, allowing it a certain range of independence. AARON had a "general sense that under certain conditions it is good to do X a certain amount of the time," but was not utterly bound by these rules (Johnson 212). The first generation of drawings was composed solely on the computer screen. In 1976 Cohen invented a small robot called a "turtle" to execute AARON's drawings using a "real pen…on real sheets of paper" ("Image" 9).   The program tells the turtle to "do the following and then say where you are" ("Image" 10). Plotting AARON's creation may take several hours using this method.

Cohen recognized that "art is valuable to human beings by virtue of being made by other human beings" (Cohen, "Image" 1). Therefore, if his experiment was going to be successful, he understood that AARON must provide "a convincing simulation of human performance" ("Image" 5). By the 1980s, Cohen had provided AARON with knowledge of the physical world. It began drawing humans and plants. Cohen's inspiration for teaching AARON to draw people came from his observations of the way young children drew. He noticed that they would make a scribble and draw a circle around it. Believing this action "corresponds to their notion that they

are making a representation—that the marks they make 'stand for' something" (*Scientific American Frontiers* 1), he taught AARON to do the same. Like children, it would first draw a scribble representative of the core of the figure and base its drawings around that. The figures were still very crude. [See Fig. 3] There was no sense of movement, nor was the program even capable of drawing overlapping forms. It had the most basic understanding that an oval represents a head, and that once a head is drawn, a neck must also be drawn, etc. It was also equipped with more general knowledge like a plant can be in a pot, but a person cannot. And while blocks can be stacked on top of each other, people must remain on the ground.

Cohen spent several years programming more detailed information of how the human body connects and how the parts move together. The figures had become much more advanced by the 1990s as Cohen provided AARON with knowledge of "articulation points, muscular attachments, and, more generally, points designed to present an appropriate profile" (Cohen, "Exploits" 5). Each person was rendered using a generic "cloud of points in space" ("Exploits" 6). The more Cohen programmed, the thicker the cloud grew and the more realistic the figure became. Several hundred points now represent AARON's knowledge of a human body. Cohen stresses that this only provides a skeletal structure, but that AARON itself "had enough knowledge to generate from it a varied population of highly individualized physical and facial types, with a range of haircuts to match" ("Exploits" 9). It was this "interplay between planning and chance" that made the figures both realistic and unique (Johnson 217). Cohen also gave AARON knowledge of perspective. It was now able to place one figure in the foreground and others in the background and it knew enough to make these forms overlap if desired. The figures became most realistic with the programming of contrapposto. When Cohen taught it how the body parts correspond to positioning of the torso, the pictures themselves became alive. [See

Fig. 4] The method for physically composing the drawing has advanced as well. In 1990 the turtle was replaced by a Cartesian model. Now "a small robot arm carried on a large flatbed xy-plotter" can churn out a painting every two minutes ("Exploits" 7; Cohen, "Colouring" 1). The most recent addition to AARON's knowledge is the ability to use color. Cohen programmed a reasonable range to use for people, plants, and the background. AARON performs the rest, including mixing its own paints and cleaning its own pots. It even knows how many inches a dab of paint will last for. In order to demystify the artistic process for patrons, AARON is present at all its shows. Unfortunately, some people are more intrigued with the various stages of creation than the actual content of the paintings themselves. People will spend some time viewing the wall hangings, but they spend a majority of the visit watching AARON at work. [See Fig 5]

Although AARON has booked several art shows in the United States and around the world, the general public is still largely unwilling to call its creations art. Cohen anticipated public resistance when he first began. The primary assumption is that, as a machine, AARON cannot connect with a human audience. It cannot be programmed to understand death, nor can it experience sorrow. At this fundamental level, man and machine cannot relate. However, Cohen is prepared with a counterargument. He begins by giving a personal account of his experience with Native American petroglyphs in 1973. [See Fig 6] When he first viewed the symbols, his mind began to search for the meaning within, as anyone would with any work of art. Suddenly he was "struck by the fact that [he] really had no idea who [those] people were" because they were part of a culture so far removed from his own (Johnson 206). As such, he had no basis for interpreting the symbols. Yet he couldn't stop himself from attempting to interpret. AARON evolved into a philosophical experiment to study how meaning is generated. With the belief that

"all cultural conditions are remote from us, and differ only in the degree of their remoteness" Cohen created AARON to simulate the works of a foreign culture Yet AARON's works do involve elements that are recognizable to our culture, such as plants and the human body. Unlike Cohen and the petroglyph symbols, we do have a context through which to interpret the markings that AARON makes. Nor does AARON itself really "come from" another culture, like the Native Americans. Perhaps another sentence could be inserted explaining Cohen's point? (Cohen, "Image" 11). He argues that we have nothing more nor less in common with AARON than we do with the remote peoples behind the petroglyphs.

As Cohen demonstrated, the mind naturally searches for meaning, even in "images whose original meanings we cannot possibly know" (Cohen, "Image" 12). We willingly take the mental leap that a line and two dots constitute a face because the mind is "devoted primarily to establishing symbolic relationships" ("Image" 19). After his experience with the petroglyphs, Cohen realized that meaning does not arise based on what the artist intended. Rather, meaning is generated by each individual who experiences the artwork. He calls his theory the paradox of insistent meaningfulness. He believes that "the intended meanings of the maker play only a relatively small part in the sense of meaningfulness" ("Image" 12). This crucial discovery gave Cohen hope that artificial intelligence could one day create meaningful art. He believed that "the minimum condition for generating a sense of meaningfulness did not need to include the assumption of an intent to communicate" ("Image" 12). Therefore, if AARON could create images that "take full advantage of the viewers' predispositions" the viewers themselves would generate an appropriate meaning, just as they did for the petroglyphs ("Image" 21). While this theory seems logical, it has not held true. Though AARON's style has "a distinct sense of humor

and a marked tendency towards narrative," people do not connect to it (Cohen, "Symbols" 11).

All meaning is nullified when they learn that the images have been generated by a machine.

There are valid reasons why people should be reluctant to call AARON's output art.

Cohen himself never expressly calls AARON an artist, nor does he even think the machine is

creative. However, he believes that artificial intelligence will one day be able to produce

genuine artworks. The first step would be to program a means of self-evaluation. AARON lacks

"critical judgment that would enable it to declare that one of its drawings was 'better' than

another" (Cohen, "Image" 3). For exhibits, Cohen has to intervene and choose which works

were most successful as well as give the selections names. In that sense, AARON cannot be

called an artist independent of its creator. However, the primary disadvantage of AARON is that

it has no mechanism for self-modulation. Though it produces the artworks based on a series of

aesthetic rules, it is only as creative as its program allows, and lacks the ability to mature

independently. In order to overcome these restrictions, the program would have to incorporate a

mechanism for self-reflection. As of now, its past experiences have no impact on its art; with

each new creation, it has already erased the knowledge of past ones. For people, art serves a

more recursive function as the "artist uses art in some way to redefine, i.e., modify himself"

(Cohen, "Purpose" 2). Cohen has similar hopes for his machine. In the future he would like

AARON to "judge what it is doing in terms of its own output and say, 'Well, I know that there's

a rule that says X, but that appears not to be a very good rule, and I should now be able to modify

that'" (Johnson 220). Until that time comes, the thought of an artistic machine will remain

science fiction.

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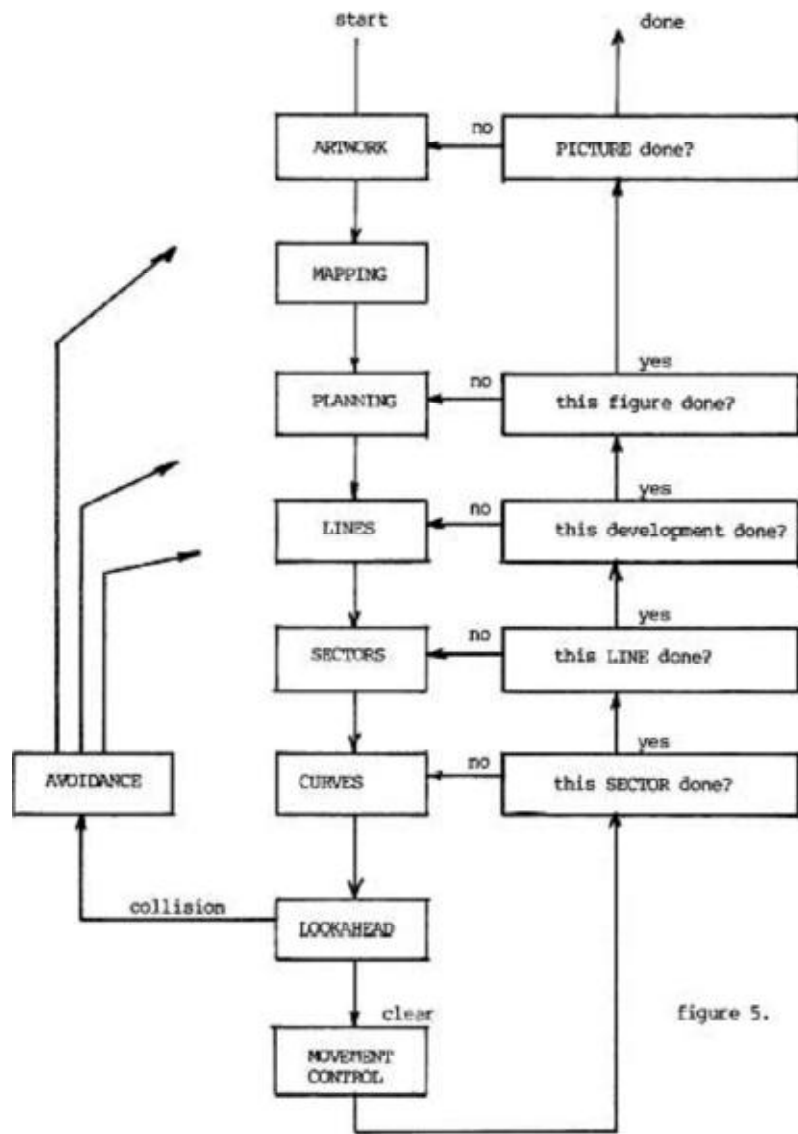
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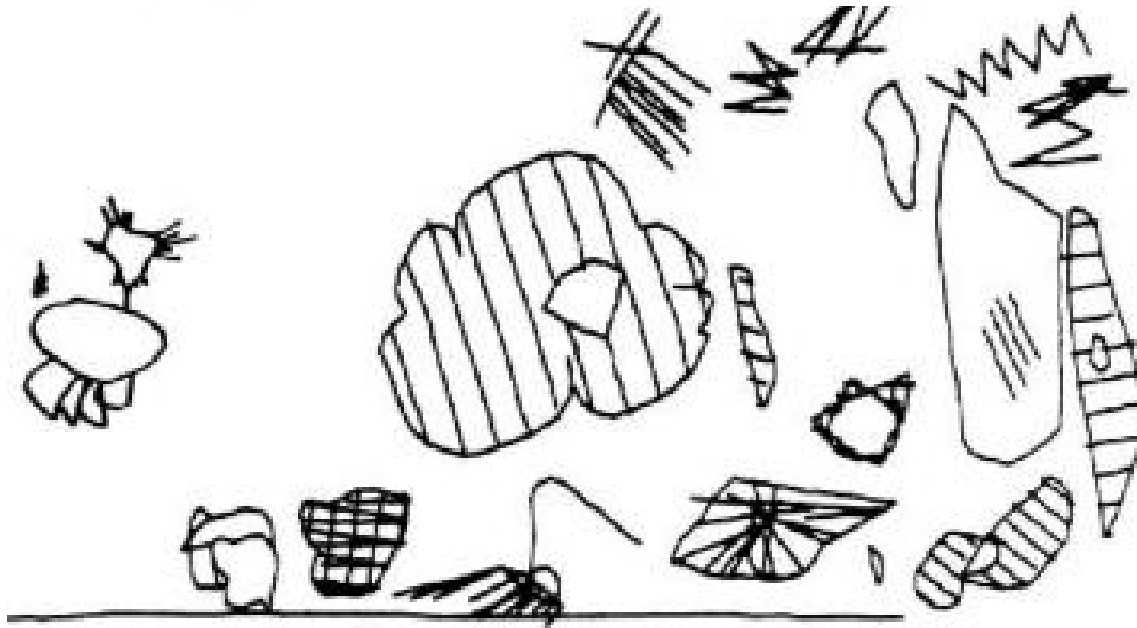Fig. 1-AARON's Hierarchical Decision Process
(Cohen, "Images" 7)

Fig. 2-An example of AARON's first works, 1970s
(Cohen, "Images" 2)

Fig. 3-An example of AARON's work in the
1980's
(Cohen, "Garden" 6)

Fig. 4-Examples of AARON's work in the 1990's
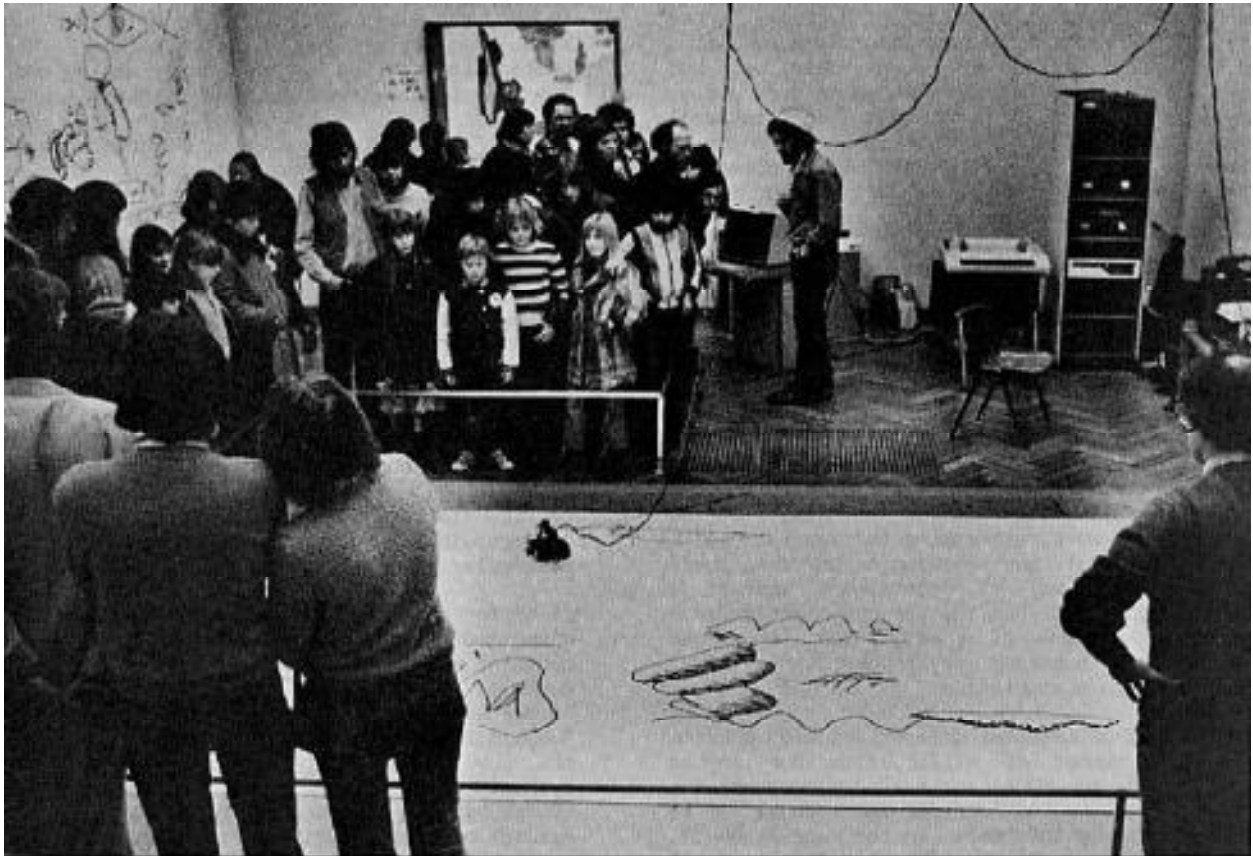(Cohen, "Exploits" 13)

Fig. 5-AARON entertains the crowd, who ignores his art hanging on the wall (back left)
(Cohen, "Image" 4)

A sample of the mysterious petroglyphs from which Cohen developed his theory of the
paradox of insistent meaning
(Cohen, "Image" 22)