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THE BIG BUNNY HOP TO LOS ANGELES AND JAMAICA • PLUS IAN FLEMING, MELVIN BELLI, ROBERT RUARK

mechanistic muses are expanding their domain to encompass every facet of creative activity

article **BY J. R. PIERCE** TWO REPRODUCTIONS of prints by Harunobu hang on the right wall of my office. I know what I think of these. On the left I have reproductions of paintings by Ingres and David. I know what I think of these, too. When I look at the wall opposite my desk, I am a little puzzled. There I see a buff painting, five feet long and ten and a half inches wide. I understand the inscription in the lower left; it reads: *Pour John Pierce, amicalement, Jean Tinguely, Avril 1962.*

The painting itself consists of strokes of red, turquoise and gray ink, generally to the right and downward. Most of the strokes are accented at the beginning. The pattern of strokes is densest and widest a little above the middle, and the turquoise and gray strokes are nearly vertical toward the bottom of the picture. The general effect is Japanese.

This painting is the product of a stupid machine of clanking metal parts, a machine devised and built by the talented constructor of the jiggling "metametics" which have been shown in many countries, and of the celebrated "self-destroying machine" which partially succeeded some years ago in the courtyard of the Museum of Modern Art. Tinguely once built many painting machines similar to the one that created my picture, and sold them to a variety of people, including Nelson Rockefeller.

If I didn't like the painting on my wall, I wouldn't have it there. I am astonished that in some sense it is the product of a machine. But I am appalled when I think that a few hundred feet to my left there resides a machine, an electronic computer, which is to Tinguely's machine as Newton is to an earthworm. What sort of art can we expect from a comparative genius of a machine when a clanking metal monstrosity can produce a picture of at least dubious merit?

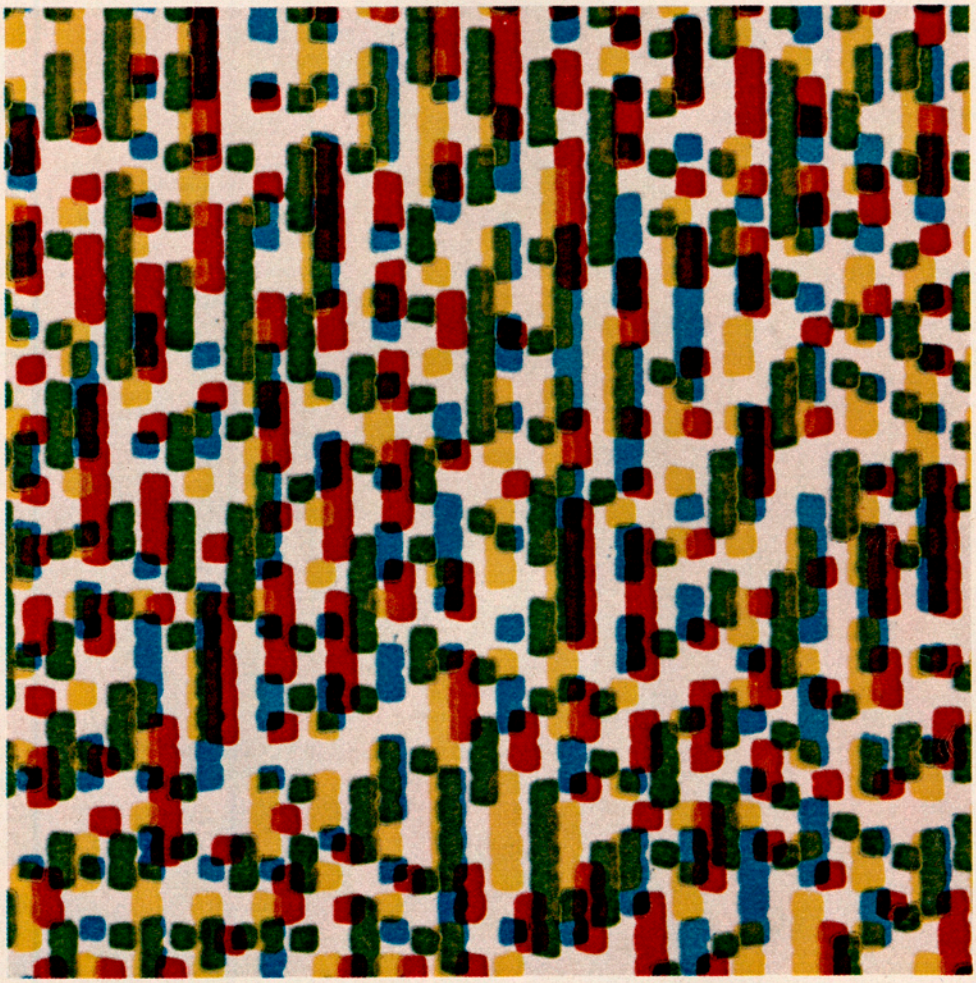
While intellectual visionaries have busied themselves asserting that the computer will outstrip man in his intellectual endeavors, and will manage wisely where the executive now mismanages, a less noisy few have approached the computer with artistic intentions, hoping to elicit from it something more patterned and of greater impact than chaos.

Indeed a similar quest goes back well beyond the digital computer. Many years ago Marcel Duchamp, who painted *Nude Descending a Staircase,* allowed one-meter-long white threads to fall from a height of one meter upon a flat surface. Some were framed and I have seen them. In the curved order imposed by the stiffness of the thread and the random configuration resulting from its passage through the air, there is a mixture of the graceful and the unexpected. Too, by adding a repeated symmetry to a random pattern of bits of colored glass, the kaleidoscope has pleased many generations of children and adults.

From the remote past to the very present, human beings have incorporated geometrical forms and psychological tricks in their art. The straight lines and rectangles of Mondrian have a geometrical regularity which we might associate with a machine, and the subtle curves of Op Art remind us both of mathematical curves and of the psychological texts on perception and optical illusions from which they are drawn. When the artist approaches science and the machine, will the machine perhaps approach the complexity and surprise which we associate with the human artist?

I don't know who first used the electronic computer to produce patterns of some originality and interest, but it may have been Dr. Bela Julesz of the Bell Telephone Laboratories. In studying properties of vision, Dr. Julesz caused the computer to generate patterns of black and white dots within squares, in which just a *(continued on page 150)*

PORTRAIT OF THE MACHINE AS A YOUNG ARTIST



The eye-jangling pointillistic painting above is the creation not of a contemporary abstract impressionist but of an electronic computer programed as part of a research project on the properties of vision. Below: This delicate pattern of Japaneselike brush strokes, likewise, was conceived and executed not by man but by a freewheeling machine constructed by far-out artist-sculptor Jean Tinguely.

MACHINE *(continued from page 124)*

little order was imposed upon randomness. The result was so pleasing that a Japanese publisher used the pattern on the cover of a translation of the book in which it appeared.

Others have invoked the computer as an artist with more direct motives. Thus, the computer has been used not only to solve the equations of motion of a particular kind of satellite in orbit around the earth, but also to create an animated motion picture showing the satellite at first tumbling around in its orbit and finally aligning itself radially so that it points at the earth. Another programmer has caused the computer to produce a whole animated instructional motion picture showing rolling balls, the operation of the computer itself and titles that rise across the screen, expand and dissolve. The result is far from Walt Disney in skill, but much cheaper in cost. And one ingenious programmer did manage to make the computer draw pictures of Mickey Mouse's head as seen from any chosen direction.

This is serious work. Scientists and engineers want to present data in graphical and even in moving form, and they want to see what proposed devices and structures will look like from various angles. In some cases, the computer can produce the required drawings, or sequences of drawings, much more quickly and cheaply than could the most skilled draftsman.

But people have been tempted beyond these practical essays in computer art. In fact, one ingenious man, A. M. Noll, caused the computer to generate drawings in the style of Piet Mondrian, drawings consisting of short, heavy vertical and horizontal lines rather randomly arranged on a sheet of paper. Then Noll carried out a psychological experiment. He showed 100 people an original Mondrian drawing and a drawing made by the computer in the style of Mondrian. He asked them to decide which drawing was artistically better, and which was produced by a machine. Of all those asked, only 28 percent correctly identified the computer picture, and 59 percent preferred it to the Mondrian. However, people who said they disliked or were indifferent to modern art were equally divided in preferring the computer picture or the Mondrian; but people who said they liked modern art preferred the computer picture three to one. I don't know whether this is overestimating the computer's artistic ability or underestimating Mondrian's.

Noll has taken the computer far beyond imitation. In his use of the computer, he always prescribes some order but leaves the drawing partly to chance. By these means he has produced a weaving pattern formed by a self-intersecting line, patterns of lines splattered over a page, and even pairs of drawings which, when viewed through a stereoscope, give the effect of many lines hanging in space, much like the *Orpheus and Apollo* of Richard Lippold in the foyer of the Philharmonic Hall in Lincoln Center, but without any supporting wires at all. I feel driven to the fatuous comment, it's fascinating, but is it *art*?

Whether the computer, man, or both together create the art of the future, it is likely that man rather than the computer will enjoy it, and the place of a good deal of art is in the home. Today we have books and magazines, TV, slides and primitive forms of 3-D. But the future holds something better in store for us. Emmet Leith and his colleagues at the University of Michigan have produced a visual effect as real as looking through a window.

By illuminating an object to be "photographed" with a coherent beam of light from a laser, that much-vaunted marvel of quantum electronics, Leith produces what is called a hologram, a wavy pattern of ultrafine lines on a photographic plate. When this hologram is illuminated by a laser, a person looking through it sees behind the hologram what appears to be a very solid three-dimensional version of the object that was used in producing the hologram. The whole object is represented in all parts of the hologram. When one moves his head, it is just as if he were looking through a window. If a less interesting detail is in front of an interesting part of the object, one merely has to move his head to see around it. Imagine such solidity, such rotundity, which goes far beyond that of 3-D movies or the old-fashioned stereoscope. At present, one can achieve this effect in only one color, and in still pictures, but who knows what the future will bring?

A computer is blind, deaf and dumb, and it produces visual art only because someone forces it to. A computer can just as well produce a numerical description of a sound wave—in fact, a description of any sound wave. Don't think that people who are ear-minded rather than eye-minded have neglected to make computers produce sound. In the earliest attempts, a computer was made to play simple tunes in buzzes or squeaks, but we are now far beyond that point. A Decca record of 1962, *Music from Mathematics*, shows that the computer can play tunes in a variety of tone qualities, imitating plucked strings, reed instruments and other common effects, and going beyond these to produce shushes, garbles and clunks that are unknown in conventional music. Further, the computer can even speak and sing. In the record I refer to, the computer actually sings *A Bicycle Built for Two*—to its own accompaniment.

Today, scientists and musicians at MIT, Bell Telephone Laboratories, Princeton University and the Argonne National Laboratory are trying to make the computer play and sing more surprisingly and more mellifluously. As a musical instrument, the computer has unlimited potentialities for uttering sound. It can, in fact, produce strings of numbers representing any conceivable or hearable sound. But as yet, the programmers are somewhat in the position of a savage confronted with the grand piano. Wonderful things could come out of that box if only we knew how to evoke them.

While some mathematical musicians, and musical mathematicians, are trying to use a computer as a super orchestra, others are following a much older line of endeavor, which goes back to Mozart. Mozart provided posterity with a collection of assorted numbered bars in three-eight time together with a set of rules. By throwing dice to obtain a sequence of random numbers, and by using these numbers in choosing successive bars according to simple rules, even the nonmusical amateur can "compose" an almost endless number of little waltzes, which sound something like disorganized Mozart. Joseph Haydn, Maximilian Stadler and Karl Philipp Emanuel Bach are said to have produced similar random music.

In more recent times, the inimitable John Cage has used a random process in the selection of notes. Indeed, there is a whole school who believe that chance is better than judgment and that a composition would be freshest if the composer guided it in a general way only, letting the individual notes fall where they will.

Some of the early experiments in this direction were as primitive as shaking a pen at a sheet of music paper and adding stems to the ink dots. Since the coming of the computer, chaos has entered music more scientifically. In 1956, the Burroughs Corporation announced it had used the computer to generate music, and in 1957 it was announced that Dr. Martin Kline and Dr. Douglas Bolitho had used the Datatron to write popular melodies. Jack Owens set words to one—which was played over the ABC network as *Pushbutton Bertha*. In 1957, F. P. Brooks, Jr., A. L. Hopkins, Jr., P. G. Neumann, and W. V. Wright published an account of the statistical composition of music on the basis of extensive statistical data on hymn tunes.

Perhaps the most ambitious early attempt was that of Lejaren A. Hiller, Jr., and Leonard M. Isaacson, of the University of Illinois, who succeeded in formulating the rules of four-part first-species counterpoint in such a way that a computer could choose notes randomly and reject them if they violated these rules. Music so generated, together with other

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partially random, partially controlled music, was published as the *Illiac Suite for the String Quartet* in 1957.

Since that time the computer has come to function in a dual capacity: as an orchestra playing its own compositions. J. C. Tenney, who is now in the music department at Yale, has been a strong advocate of this approach. As a composer, he provides general guidance to the computer as to high or low, slow or fast, loud or soft, and some guidance as to timbre. Within specified ranges that change with time, the computer chooses the notes at random and plays them according to its own directions. The results are surprising in many ways. However unpredictable chance may be, it has a sort of uniformity that seems to preclude the kind of surprise one finds in Haydn's *Surprise Symphony*, that is, a carefully calculated loud effect following a soft passage. Perhaps the composer should provide the computer with more or less guidance, or perhaps guidance should be built into the computer.

Musicians of the modern school condemn, or at least wish to depart from, traditional musical devices and forms, but this hasn't kept musical scholars from analyzing music to see just what the form consists of. Harry F. Olson and his coworkers at RCA have already put Stephen Foster's melodies through the wringer and caused a computer to generate Fosterlike tunes. In principle, what makes Mozart like Mozart, Haydn like Haydn, Wagner like Wagner is not beyond analysis. I would be very surprised if someone could cause a computer to produce good and original Mozart at the push of a button. I wouldn't be surprised at someone's making the computer sound something like Haydn or Mozart or Bach.

As in the case of the visual arts, new science and technology have much to offer in the reproduction as well as in the creation of the sounds of the future. It's a commonplace that listening to a stereo system, however good, isn't like hearing an orchestra in a concert hall. Yet it is not beyond the ability of science to create in one very particular place in a room the exact environment of sound that one would experience in a concert hall. Manfred Schroeder at the Bell Telephone Laboratories has shown how this can be done. He uses the computer to process the sounds that will be played over a pair of loudspeakers, so that in the vicinity of a person's head he creates the exact acoustical environment of a huge reverberant hall. This effect is uncanny. It is much fuller than a stereo system, and it is very different from hearing something through headphones.

The ability to localize sounds outside of one's head, the feeling of being immersed in sound, depends on the way in which what one hears changes as he moves his head slightly. Schroeder cleverly simulates the sound near the head so that when one turns his head slightly, this has just the effect on the sounds he hears that it would if he were in an auditorium. At present this has to be carried out at great cost in an anechoic or echoless chamber, a large and expensive room with sound-absorbing walls. But who is to say that at some not-distant date it may not be possible to create exactly the same effect in any easy chair at home?

The question of whether a computer can be made to *write* as well as to draw, compose and play is no less provocative. The manufacture of *meaningful* prose and poetry, as of art and music, is a challenge that may or may not be beyond the capacity of the computer, but the composition of striking new words and sentences is certainly well within the realm of mechanization. As part of a linguistic experiment conducted at the Bell Telephone Laboratories in 1961, for example, Dr. Melvin Hinich caused a computer to generate a number of rather compelling sentences which, considered as a single composition, might be said to substantiate my belief that the artistic utterances of mechanical chance and of contemporary avant-garde writers are approaching one another so closely as to come into competition. Wrote the computer:

> this is shooting
> this seems to be sleeping
> a vapid ruby with a nutty fan lies seldom below this tipsy noise
> this cute snake by that wet pig is clawing coolly to a weak pig
> any black otter below a holy fan is poking hotly in that furry ape to killing from this tipsy bat
> a fake mud on this cute hero is seldom sipping that bad moose below a tipsy house in moving from this tipsy creep.

Rather vivid imagery, I think, if a bit less than illuminating. But one doesn't need a computer, or even a beat poet, to generate such literary gems. One can do it with a pencil and paper and dice, or even with a group of cooperative human beings. C. E. Shannon, the inventor of information theory, demonstrated this many years ago when he chose letters on the basis of the probability that they would follow preceding letters. This led to the creation of some new words: *deamy, ilonasive, grocid, pondenome.* To me *deamy* has a pleasant sound. If someone said I had a deamy idea, I would take it in a complimentary sense. On the other hand, I'd hate to be denounced as ilonasive. I would not like to be called grocid, perhaps because it reminds me of gross, groceries and gravid. Pondenome is at least dignified.

Shannon carried this further, and

"Are you crazy? Move out of the neighborhood just when it's starting to deteriorate?"

chose words on the basis of their probability of following other words. Anyone can carry on a similar process easily, as a sort of parlor game. You can write, say, three grammatically connected words in a column at the top of a slip of paper. You can then show these to a friend and ask him to make up a sentence in which the three words occur and to add the next word of this sentence. You then fold over the top word of the four, show the remaining three to yet another friend and get an additional word from him, and so on. After I had canvassed 20 friends, I had the following: "When morning broke after an orgy of wild abandon, he said her head shook vertically aligned in a sequence of words signifying what."

One can invent more complicated means for producing grammatical sentences that wander over the same ground but never exactly repeat. By using a chart of phrases and flipping heads or tails, I obtained the following interesting item: "The Communist Party investigated the Congress. The Communist Party purged the Congress and destroyed the Communist Party and found evidence of the Congress." This could go on forever, always grammatical and never exactly repeating, but I don't know to what end.

There have been other experiments with random language, of various sophistication and success. In 1946, a Yale undergraduate walked into the Sterling Memorial Library at Yale, picked a direction at random, took a book off a shelf at random, selected a page and a sentence on that page at random, and repeated the procedure until he had produced a 20-line "poem." This was accepted for publication as a legitimate man-made composition by the *Yale Poetry Review*, but the young man got cold feet at the last moment and withdrew the manuscript.

Though the Yale poem is long since lost, I can regale you with the following poem of my own, which I "composed" in about ten minutes by gleaning random quotes from a book selected at random from my shelves: *Great Science Fiction by Scientists*, edited by Groff Conklin.

The Dictator shoved his plate aside with a petulant gesture
The homely smile did not dismay him
He was still not quite sure what had happened
"I doubt if they starved," said Pop quietly
The needle was near the first red mark
Well, I merely pose the question.

Author William Burroughs is less painstaking and squeamish than was the student at Yale. He writes his books by cutting up already-written material and pasting the pieces together after mixing. With this montage technique he has written five or six books; the best known is *Naked Lunch*. Recently, I read in the press that a young student had succeeded in producing quite effective modern poems by a process that involved choosing lines or phrases entirely at random. I found the effect striking, but I am too old-fashioned to prefer it to Milton.

A group up at MIT some years ago tried another tack. They asked the computer to plot a simple story, choosing at random, for instance, whether the shot fired by the sheriff killed the bad man or vice versa. To my mind, Zane Grey did better; but then, this was a very early MIT effort.

Matters of art aside, there is no question that machines other than computers, and computers themselves, have made pictures, have played music, have made music, and have constructed a semblance of English. What I am to think of this I find as hard to know as what I am to think of Jean Tinguely's painting that hangs on my wall. Some of what has come out of the computer isn't as bad as the worst of man-made art, but it certainly isn't as good as the best. The computer is a great challenge to the artist. It enables him to create within any set of rules and any discipline he cares to communicate to the computer. Or, if he abandons discipline, he may leave everything to chance and produce highly artistic noise.

I am sure that time will extend all the possibilities and opportunities for artistic creation and reproduction that I have described, and will bring them economically within the reach of the general public. Come tomorrow, we will be able to close our eyes and hear in our living room something completely indistinguishable from what we might hear in a concert hall or a theater. And it may be that we will also be able to open our eyes and *see*, in all its solidity, what we might see in the concert hall or the theater. What will we see? What will we hear? We may hear a poem written by a computer, sung in a computer voice, to an accompaniment of computer-generated and computer-played music. Perhaps we will see a ballet of computer-generated figures dancing in computer-generated patterns.

Scientists can only provide the means for doing this. Artists must school the computer if this is to become reality. I think that it isn't too early for artists and programmers to study man and his arts on the one hand, and for the computer and its potentialities on the other, hotly and realistically. We must decide whether men and machines should work together gravely or wackily to produce works that are portentous or delicious. The choice is open, and I hope it won't be made too solemnly.