Demonstration during the exhibition *Manfred Mohr, Computer Graphics, Une Esthétique Programmée*, ARC, Musée d'Art Modern de la Ville de Paris, 1971

Scripted Variations

Alistair Rider

Paris, May 1971, mid-afternoon. A boy, around seven, stands among a group of adults in the Musée d'Art Moderne de la Ville de Paris. He is focused on a motorized box which is gradually inching its way around the tabletop, leaving in its wake a diagonal trail of black ink. He and the adults have gathered at the appointed hour to witness this spectacle. A new and unfamiliar piece of technology, a French-manufactured Benson 1286 flatbed plotter, temporarily loaned to the museum by the company, is producing – unaided – a drawing. Overseeing the demonstration is the artist Manfred Mohr, who, as if to display his non-involvement with the work, is standing with his hands empty, freed up, so-to-speak, to explain to the interested public what exactly they are observing. The motors propelling the stylus buzz away. In itself, hardly a dramatic display: the boy looks slightly bored. We are worlds away from *An Experiment on a Bird in the Air Pump*[1]. No terror and horror here. What is unfolding, though, is nonetheless remarkable, for no human has scripted the pen's next move. This equipment is not a glorified printer, replicating an identical image repeatedly. Instead, it could be set to run a dozen times, and each drawing would emerge visibly different. Something else – a machine – is calculating the composition. Neither the artist, nor any other individual, can predict the precise path of the line. It might change course and veer to the left, or it may head off to the right. Clearly it is following instructions, yet within these rules there are a range of options and, dutifully, it is doing its own thing. In its own rudimentary way, it is simulating cognition. In short, the composition that is unfolding is a manifestation of an intelligence that is artificial.

Now for the backstory. For this, we have to rewind two years, to 1969, when Mohr, then a resident in France, first approached the Meteorological Institute in Paris with a request to use their automated drawing machines. Computers had yet to become integral to everyday domestic experience, and mainframes were hidden away in air-conditioned rooms in government institutions, research institutes or major corporations. Their use was restricted to specialist technicians who deployed them for specific tasks involving substantial calculations. During the day, the equipment was used to produce weather charts, but at night, while it was idle, Mohr was allowed to run his programs. In hindsight it is rather wonderful that they said "yes" to this young German artist, fresh out of the École des Beaux Arts. By all accounts, though, he didn't get up to anything wild: instead, he knuckled down to the terms of the new technology.

Initially, he had to teach himself the machine's specialist language, which in those years was the coding system FORTRAN IV. A demanding, time-consuming undertaking. He purchased the one available textbook, and before long confessed that he practically knew it by heart[2]. But that was only the first step. He still had to familiarize himself with the hardware at the Institute. He learned to input the program statements via a keyboard on the keypunch, which would translate the text into holes on hollerith cards. Once he had these, he fed them into the card reader of the CDC 6400, housed in a separate room, which, at the time, was one of the most powerful mainframe computers in the world. The equipment would then act on these directives, conducting thousands of calculations, and convert the punched code into a graphics language. The processing usually took only a matter of seconds. When it was completed, Mohr would save the outcome onto large reels of magnetic tape. Then he would carry these tapes over to the tape-reader connected to the Benson plotter, which, in turn, converted the saved data into a rather more visually elegant form: a unique, abstract, black-and-white design. So many translations, such laborious procedures. But for Mohr the results justified the effort. It was the absolute precision that appealed to him. Without fail the technology would realise his carefully phrased instructions with impeccable accuracy, although never in the same fashion, since each program could realise his directives in ways that he would not be able to foresee.

The underlying procedure is not difficult to grasp. In these plotter drawings, Mohr's ambition was to generate a basic algorithm that would result in a visual form. Computers are of course designed to respond to long command chains that must be performed repeatedly, with limited alterations at each stage. Alert to this, the artist would come up with a simple geometric form, and then use the computer to calculate innumerable variations on it, based on his algorithm. It would be far too arduous to work out all these combinations manually, but a machine could do it in an instant. Meanwhile, variables would also be integrated into his instructions, which permitted the program to select from a given range of options, ensuring a significant level of unpredictability in the emerging composition. Yet in spite of this integration of randomness, any drawing could still be justified with a clear, objective explanation as to why it assumed the appearance that it did.

'Une esthétique programmée' ('a programmed aesthetics') was the title of Mohr's display of twenty-eight plotter drawings at the Musée d'Art Moderne. The term turns the focus to the code that underwrites this work, as well as to the artist's dispassionate, carefully calculated aesthetic outlook. Its strangeness deserves our attention. In his explanatory statement, which was included in the accompanying catalogue, he argued that we should consider creative work as itself an 'algorithm', and that our task should be to investigate its underlying mathematical

laws[3]. This is hardly a conventional outlook on artistic motivation. Certainly, he is not aiming to use computers to help him realise anything resembling personal expression or creative intuition. The venture is rather more ambitious. In its place, computation is being set the task of isolating and clarifying how we understand art.

Mohr's Paris exhibition in 1971 was the first ever solo display of such work to be seen in a public museum. However, he was not operating in isolation, and his artistic ambitions acquire additional significance when understood in the context of ongoing trans-continental conversations. Philosophers, scientists, engineers and artists in many North American and European institutional centres were actively debating the relationship between aesthetics and informatics. Yet already by the late 1960s differing positions had emerged. In the United States, active audience interaction with 'real time systems' had been earmarked as a core goal for technologically-oriented art practices. Works inspired by these objectives tended not to look anything like traditional sculpture, drawing or painting: instead spectators were confronted with displays of hi-tech electronics that insisted on their active involvement, forcing them to engage in a mediated experience of the here and now.[4] Mohr's art has little to do with these concerns. Instead, his work is inspired by another set of conversations that had been emanating from mainland Europe since the 1950s. Advances in information technology over the course of the decade made these viewpoints all the more relevant, and influential.

The key interlocutors included Abraham A. Moles, Professor of socio-aesthetics at the University of Strasbourg, and the philosopher Max Bense at the Technische Hochschule in Stuttgart: it is the latter's views in particular that Mohr has acknowledged as especially pertinent to his art. Essentially, Bense's ambition was to establish aesthetics as a mathematical science, a project specifically intended to reinstate the principles outlined by Alexander Baumgarten over two centuries earlier. Baumgarten's objective was to apply logical reasoning and deduction to the analysis of beauty.[5] Intellectually, this stance had not fared well, and, within a few decades, Immanuel Kant dismissed it as a misdirected objective.[6] Yet in the aftermath of the Second World War, there was increasing openness in West Germany to the clear-minded rationalism that Baumgarten had exemplified. Indeed, Bense looked to the value-neutral language of science as the definitive panacea to the emotive ideologies which had fuelled European fascism, with such evidently devastating results. Bense was steadfastly committed to the goal of reinstating an objective method for measuring the aesthetic. In short, he wanted to formulate the underlying mathematical principles of 'the beautiful'.[7]

The philosopher's line of reasoning goes something like this: aesthetic objects need to satisfy a demand for unpredictability; they have to appear innovative and singular and thus fulfill our expectations for artistic originality. Usually this leads to the conclusion that the divide between rational computation and creative intuition is insurmountable. But Bense was adamant that both could be brought together by approaching the aesthetic quality of unpredictability in a highly abstracted way, as 'disorder' and 'complexity'. This means that it should be possible to conceive of a formula that would enable an aesthetic object to be programmed artificially 'through a methodical combination of planning and chance'.[8] Bense outlined his approach to art and aesthetics in many publications from the 1950s onwards, and his perspective predates any active engagement with information technology.[9] But it was soon clear to him that the computer could become an invaluable tool in the production of aesthetic forms. He realized that in principle it should be possible to write a program that would artificially generate countless artistic variations on a given norm, and he began to champion the efforts of those committed to this objective. In this context, then, the computer, with its combinatorial iterations and statistical principles, stands for much more than the relatively rudimentary technology that it then was. It represents a perfect fidelity to an impersonal rational order and control.[10]

The computer-generated outcomes produced by those who were sympathetic to Bense's goals are still, even now, sometimes dismissively referred to as 'sub-Mondrian geometries'.[11] It is easily presumed that the engineers of these projects clung to conventional artistic formats (producing drawings, composing haikus, and so on) because they were unwilling to open up more radically to the logic of the new technology. But this ignores the extent to which Bense's approach allowed for the fundamental demythologization of the creative process and the status of the work of art. For instance, in 1967 A. Michael Noll dispassionately reported that when viewers were invited to compare Mondrian's *Composition with Lines* from 1917 with a similar image generated by a computer, only 28% were able to identify the Dutch artist's work correctly, while 59% actually preferred the computer-generated picture.[12] If unique, creative individuality was so painfully mistaken with a printout, then what role remained for the artist? Abraham A. Moles already had a clear answer. Certainly they were not expected to engage with colour, material or objects. Instead their task was 'to *construct algorithms* or programs for the *systematic exploration of a field of possibilities* defined by a certain number of constraints that constitute one of the definitions of *functionality*'.[13] Not much respect for personal expression or innate genius here. At base, many of the computer-generated experiments from these years were motivated by the desire to liberate art from all vestiges of human expression and the limitations of personal intuition.[14]

Most of the individuals committed to programmed art would never have seen their resulting work as intentionally antagonistic, or as avant-garde provocation. Mohr has written that he regards information technology as purely an 'amplification' of consciousness, or what he terms 'high-speed visual thinking'.[15] Before computers became ubiquitous, he regarded it as his mission to promote computing as an extension of our capacities, rather than as a dangerous menace to human civilization. Nonetheless, the impersonal, logical embrace of the machine does unsettle assumptions as to what art is. Established artistic formats might well have been

out in force, but they only accentuated the underlying challenge more forcibly. By default, the premise of so-called 'computer art' is threatening. That which you cherish as the most intimately human form of expression is replicable by nothing more mysterious than a mere string of digital code.

Throughout his career, Mohr has remained committed to media that predate the digital, most notably painting and drawing. In fact, he started out as a painter, following a brief successful career as a professional jazz musician. His earliest pictures are full of marks of free expression – dabs of paint laid down seemingly spontaneously in a fashion reminiscent of musical improvisation. Yet relatively quickly he turned to a more hard-edged style, and his personal idiom firmed up into a repertoire of black-and-white forms. His aim was to make his work as detached and as neutral as he could, although at this stage there was no underlying program rationalizing the composition. A defining moment came in 1967, when he heard a lecture by the French composer Pierre Barbaud, who had already been producing computer assisted 'algorithmic music' for about eight years. They established a strong intellectual friendship, and Mohr has often credited the composer with encouraging him to turn to programming as a way of structuring his own art. An important transitional work is his artist's book *Artificiata I*, from 1969, which, while not produced by a computer, provides an indication of the direction that he would take.[16] It contains roughly two dozen pages of abstract shapes, arrayed between parallel horizontal lines in a fashion reminiscent of text. Scanning the publication, readers can identify formal echoes and stylistic reverberations, but no coded meaning nor even an overarching structure. Barbaud wrote the preface, in which he promised that the next volume would be all the more rigorous in its composition because a computer would eliminate the 'weaknesses, cowardliness and compromises inherent in human nature'.[17]

A second publication was never to materialize: already the artist was working on his plotter drawings at the Meteorological Institute, which made a follow-up book project redundant. The computer-generated algorithm replaced all vestiges of human composition, and before long the artist would begin to explain his work simply by detailing the instructions which he had programmed the computer to follow. It is a convention he has followed right up to the present. For instance, he has explained his drawing *P-36 (White Noise)*, which is 1970-72, as an alphabet of lines of all angles greater than five degrees. The program he used has randomly generated elements consisting of anything between zero and seven lines, and no element can be repeated more than three times. The work is so precisely explained that it permits no room for further interpretation. It is an array of randomly generated code: nothing more. Indeed, much of Mohr's work from this period reflects his interest in the abstract nature of language, and this drawing might remind us of the many translations that signs undergo during the process of automated computation. One machine language is translated into another vocabulary, eventually resulting in an equally abstract graphic configuration.

Mohr's mature work has developed sequentially. This is as true for his career trajectory as it is for individual works. His way of proceeding has involved developing a program that establishes multiple sets of forms. For him it is preferable to display an entire series: it allows for a more value-neutral analysis of each component's visual properties than would a selection of shapes and configurations based on intuitive, personal preference. One work might lead on to another, yet, over time, Mohr has wanted to shift his parameters, and these larger developments in his practice he calls 'work phases'. Over the course of his long career there have been about a dozen such stages.

A key transition came in 1972 when Mohr decided to work with the graphic form of the cube. Its advantage for him was its immediately recognizable appearance: the symmetry is so neutral and familiar to us that all manner of randomly generated rotations, distortions, dissections and subtractions can be performed on it without the shape ever entirely disappearing from consciousness. The range of permutations that can be strung from its twelve lines is immense, as Mohr's programs amply demonstrated. Throughout the 1970s, cubes unfolded in his art like fugues. Indeed, he has never ceased working within its framework, although in 1976 he made an important modification. His attention turned to hypercubes. These are used by mathematicians and theoretical physicists as a means of graphically representing multiple dimensions. But drawing one would hardly help you to grasp what the fourth or eleventh dimension actually looks or feels like. After all, the twelve lines that make up a cube barely give you a genuine impression of 'depth'. While it is possible to conceive – rationally – of the existence of multiple dimensions, they remain resolutely beyond our sensory experience. The schematic two-dimensional representation of the four-dimensional hypercube which Mohr first deploys in the 1970s consists of one cube overlapping another with all the corners connected. It is a logical extrapolation of our convention of drawing a single cube by joining two squares.[18] The arbitrariness is worth holding on to. This allusion to multiple dimensions might invite us to think of the hidden recesses of the universe, yet Mohr has no interest in attempting to evoke this. His turn to hypercubes is merely a means of expanding his repertoire of abstract forms.

As the decades have passed, Mohr has extended the reach of his programs and currently he is operating with hundred-dimensional hypercubes. For much of his career, he had chosen to avoid colour, but in 1999 he began to program his works to incorporate randomly generated pigments, purely to clarify the immense complexity of the shapes' relationships. Within a few years, he introduced moving digital displays. The algorithms are more involved and sophisticated than ever before, yet the underlying logic that has guided all his work remains intact. As we stand, gazing at these slowly rotating, angular shapes, it is hard not to think back to that small boy in the photograph staring at the automated motions of the plotter. We might actively engage with these displays, and attempt to grasp the guiding logic of their motion. But just as easily, they elicit our distracted absorption. The scripted difference is banal, eventless, endless. What draws us to it? Here, the aesthetic is presented as hardly a mysterious, heightened state. It is more like a basic, low level of cognition. And, at its most profound, perhaps this is what Mohr's art accomplishes: it invites reflection on what it is to be an intelligent being.

1.
Joseph Wright of Derby, *An Experiment on a Bird in the Air Pump*, 1768 (National Gallery, London).

2.
Manfred Mohr in conversation with Barbara Nierhoff, in *Manfred Mohr: Broken Symmetry*, exhibition catalogue, ed. Wilf Herzogenrath, Barbara Nierhoff and Ingmar Lähnemann (Kunsthalle Bremen, 2007), p. 36.

3.
Manfred Mohr, in *Manfred Mohr: Computer Graphics, Une esthétique programmée'*, exhibition catalogue (Musée d'Art Moderne de la Ville de Paris, 1971), p. 36.

4.
John Cage's *Variations VII* is a good example of this type of work. Performed in October 1966 at the '9 Evenings' Art and Technology festival at the Amory, New York, it comprised multiple live sound recordings, which were fed into a sound system and modulated by performers and members of the audience. A key advocate of audience interaction with technology in art was the American sculptor and critic Jack Burnham; see his essay 'Systems Esthetics', *Artforum 7*, no. 1 (September 1968), reprinted in *Great Western Salt Works: Essays on the Meaning of Post-Formalist Art* (New York: George Braziller, 1974), pp. 15-25. In 1970 Burnham's curated the group exhibition 'Software' at the Jewish Museum in New York which included a wide array of interactive exhibits. For instance, Theodosius Victoria's *Solar Audio Window Transmission* (1969-70) allowed visitors to listen to live radio broadcasts powered by solar cells positioned on the museum's rooftops. For a recent assessment of Burnham's legacy, see Caroline A. Jones, 'System Symptoms', and Anne M. Wagner, 'Data Almanac', both in *Artforum 51*, no. 1 (September 2012), pp. 113-16 and 430-33.

5.
For an account of Baumgarten's philosophy, see Howard Caygill, *Art of Judgement* (Oxford: Blackwell, 1989), pp. 152-171.

6.
On Max Bense's relationship to Alexander Baumgarten, see Carolyn L. Kane, 'Programming the Beautiful: Informatic Color and Aesthetic Transformations in Early Computer Art', in *Theory, Culture & Society*, (2010), p. 74. For another useful account of Bense's role in European programmed art, see Christoph Klütsch, 'Computer Graphic-Aesthetic Experiments between Two Cultures, *Leonardo* 40, no. 5 (2007), pp. 421-425.

7.
Between 1954 and 1965 Bense published five volumes of his aesthetic theories under the title *Aesthetica* – the name a direct reference to Baumgarten's famous treatise from 1750.

8.
Max Bense, 'The Projects of Generative Aesthetics', in *Cybernetics, Art and Ideas*, ed. Jasia Reichardt (London: Studio Vista), p. 60.

9.
For a short overview of Bense's theories and publications, see Elisabeth Walther, 'Max Bense's Informational and Semiotical Aesthetics' (2000), http://www.stuttgarter-schule.de/bense.html.

10.
See Margit Rosen: The Art of Programming: The New Tendencies and the Arrival of the Computer as a Means of Artistic Research', in *A Little-Known Story about a Movement, a Magazine, and the Computer's Arrival in Art: New Tendencies and bit international, 1971-1973*, ed. Margit Rosen (Cambridge, MA: MIT Press, 2011), p. 34.

11.
See Anne M. Wagner, 'Data Almanac', p. 432.

12.
A. Michael Noll, 'The Digital Computer as a Creative Medium', *IEEE Spectrum* 4, no. 10 (October 1967), reprinted in 'Cybernetic Serendipity: The Computer and the Arts', special edition, ed. Jasia Reichardt, *Studio International*, (1968), p. 74.

13.
Abraham A. Moles, 'Introdution to the Colloquy', *bit international* 3, ed. Boris Keleman and Radoslav Putar (1968), reprinted in *A Little Known Story about a Movement*, p. 263.

14.
It is also worth noting that Bense, Moles and others provided a vocabulary for discussing aesthetics that was sufficiently empirical for artists and engineers to meet on an equal footing. Inside the computing institute, the category 'art' could almost be forgotten, replaced instead with a mutual respect for rationalism, scientific objectivity, and an overarching commitment to 'visual research'. What this meant in practice is that many of the individuals who produced important early examples of programmed art are not easily described as 'artists'. At the famous 1968 exhibition of computer art, 'Cybernetic Serendipidy', at the Institute of Contemporary Arts in London, only a third of the contributors came from an established artistic background. The remainder were either engineers, doctors, computer scientists or philosophers. See Jasia Reichardt, 'Cybernetic Serendipity: Getting Rid of Preconceptions', *Studio International* 179, no. 905 (November 1968), p. 176.

15.
See *Manfred Mohr, Drawings*, exhibition catalogue (Galerie Weiller, Paris, 1974), no page numbers, and *Manfred Mohr, Divisibility, Generative Works, 1980-1981*, exhibition catalogue (Galerie Gilles Gheerbrandt, Montreal, 1981), no page numbers.

16.
Manfred Mohr, *Artificiata I*, (Paris: Édition Agentzia, 1969).

17.
Pierre Barbaud, in *Artificiata I*, no page numbers.

18.
The Wikipedia entry on the hypercube explains this clearly. See in particular the section 'Construction', http://en.wikipedia.org/wiki/Hypercube.