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Machines, Programs, and Aesthetics
A Human-Centered Contemplation

Keywords: Machine; Program; Algorithm; Computer; Beautiful; Art; Algorithmic Art; Computer Art; Walk-Through-Raster; Bauhaus.

Abstract:

The greatest cultural revolution of our times is the Algorithmic Revolution. It replaces all infrastructures by algorithmic, i.e. computable operations, objects, and processes. Machines and programs seem to be capable of performing, at high levels, operations, decisions, and processes that, until recently, were considered to be exclusively human. Growing numbers of human beings believe machines were learning, detecting patterns, deciding more considerately than humans. They trust machines more than themselves in issues of intellectual and artistic creativity. From a human-centred view of the world, it is, however, fact that computers are superior in relentless repetition of micro operations, whereas humans remain superior in macro recognition of patterns. To study some aspects of this general claim, the paper takes a look at Sol LeWitt's famous statement about the idea and the machine. It asks in which sense aesthetics (to avoid "beauty") may become subject matter of computation. And it characterizes two cases of generative art, one from 1966, the other one from 50 years later. Its focus is on how strong algorithmics may be in generative art, and how totally human-made all decisions remain. The argument is in the form of case study, not logical derivation.

1. INTRODUCTION

"Die Programmierung des Schönen" ("Programming the Beautiful"), was the title of an exhibition in memory of Kurt Kranz, an artist who had studied at *Bauhaus* during the last few years of its existence (1930-1933, in Berlin), and who later became a professor at the *Hochschule für Bildende Künste* in Hamburg (1950-1972). The *Stiftung Bauhaus* Dessau dedicated to him a retrospective show of his work from 19 November 2010 to 29 May 2011, celebrating his hundredth birthday.

Kurt Kranz (1910-1997) worked in series and variations. The endless game of change, and processes of transformation in series of images caught his interest more than the individual painting. Eventually, series became his exclusive mode of expression. An exhibition at Kunsthalle Hamburg in 1990, celebrating his eightieth birthday, was tellingly called "The infinite image". In her review of the show, Petra Kipphoff wrote in the German weekly newspaper, DIE ZEIT: Never was he aiming for the individual image; there never was for him a final form, only the experimental series of form, never a masterpiece, only variants.

By that time, algorithmic art (often called "computer art") was already 25 years old and well established. But what Kranz was searching for and what he expressed, belonged to the starting points and important lessons of generative (or, say, programmed, algorithmic, computational) art: The individual work, the static piece on the wall was hardly of any interest any more; it got replaced by the *class of works* the program stands for — always already infinities. We may conclude that, in consequence, there cannot be masterpieces any more. The form of existence of the work is of a double appearance — perceivable by humans, and computable by machines.

Hannes Meyer, the last director of Bauhaus during its Berlin period, had announced that he would work towards connecting three forms of human activity: (i) workshop practice with (ii) free art creation and (iii) scientific research. He was proposing a fruitful cooperation between those three fields of human cultural activities that had developed into different directions. For the Marxist Meyer, as for many innocent practitioners even today, this was a fundamentally wrong development. As a member of Bauhaus, Meyer formulated his position as a critique of the early Weimar phase of Bauhaus (1919-1925). Even more than the founder, Walter Gropius, he emphasized a strict functionalism serving the masses of people instead of serving the needs of the wealthy and rich few living their boring lives of luxury.

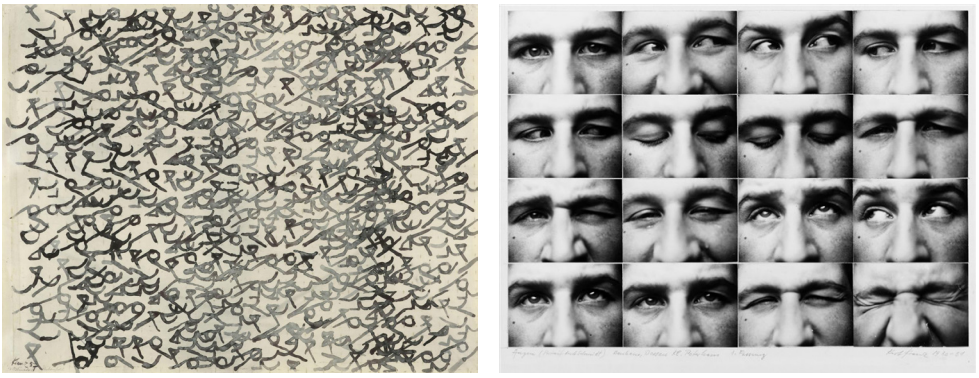

Fig. 1. Kurt Kranz, Two photographic works. "Ostinato" 1957 (left) and "Augen" 1930/31.

Following Petra Kipphoff's review mentioned above, Kurt Kranz learned from Josef Albers who was teaching the introductory course (*Vorkurs*) at Bauhaus, that creative and scientific work did not exclude each other, and that art could also be carried out as a research activity. Many of us would join in and welcome such a position. It essentially claims that research, the rational and enlightened approach to the world (as nature and culture), is not per se alien to the creative artist. For this is exactly what many are propagating nowadays and that they are trying to do in their actual work.

If the same was already suggested and proclaimed decades ago, it could only be welcome. However, it *is* now more than eighty years later. Has much changed? And if we rightfully notice and claim to see change, how does it actually show up? To which extent the concept of the present day, "artistic research", is really research, when compared to high levels of scientific research, to me remains an open question. To which extent does the word "artistic research" cover up more than reading some books, speculating about strange statements from physics, or developing a piece of software?

If this is so, we should ask ourselves why there is still no unification in sight of art and science happily collaborating. We do read a lot about similar goals and approaches, and about fruitful cases of cooperation. But yet the marvelous journal *Leonardo*, despite its many efforts in bringing together artists and scientists in joint adventures, has not really torn down walls. Only occasional odd projects may correctly be classified as requiring cooperative or transdisciplinary efforts. Usually in such cases, a small number of dedicated research-scientists struggle hard to generate results of creative works that are accepted as genuine results in both of those worlds.

The question may be, after all: Is *truth* and the search for it, the scientific goal and method, not fundamentally different from *beauty*[1] and interpretation of its claims, the artistic goal and method?

1. The word "beauty" appears here as a general formula standing in for other terms artists and critics are using for the values of art and aesthetics.

We may also ask what is different now with the basic infrastructure of, at least, Western-style societies that did not exist in the 1930s of Kurt Kranz and Bauhaus? To give an answer to this question, and a number of related ones, I know of nothing better than to point at the one technology that did then not exist at all, but that is now ubiquitous both in breadth and depth of its distribution. I mean, and everyone will share this with me: *computing technology* in all its variants. With only a tiny bit of exaggeration, we can say that today nearly everybody is roaming his or her city or village, home or workplace, morning or evening, individual or social activity, always already equipped with a computing machine of small and handy size, of enormous local and global power, and appearing as possessing tool-like and medial qualities at the same time. Computing technology, the *semiotic machine,* as Mihai Nadin called it (2007), is with us and upon us and underneath everything we do.

What is different, we may say, is that the deepest and most widespread cultural revolution of all times has taken place and is still conquering the seemingly last refuges, and discovering huge new areas of life, still to be turned upside-down such that the young generations rejoice, and the old ones mourn. This permanent revolution must correctly be called "The Algorithmic Revolution"[2]: The revolution of transforming into machinic computable form everything that *is already* computable, and of reducing to computable form everything that is *not yet* computable. This enormous epochal task has started its path through cultures soon after the founding scientists had come up with their ground-breaking results: Kurt Gödel,[3] Alan M. Turing,[4] and John von Neumann.[5] More and new works are still under way for the algorithmic revolution to creep into all the arteries of human individual and social life. In fact, it is on its way at an accelerating speed, and with an enormous impact. Much of it is devastating. In the rest of the paper, I want to contemplate two or three aspects or cases that, without necessarily thinking of computing, shed some light on that revolution.

2. Under this title, Peter Weibel organized an exhibition at ZKM (Center for Art and Media) in Karlsruhe, Germany, from 31 Oct. 2004 to 6 Jan. 2008. Unfortunately, he is now also using the term "Digital Revolution". — No publication directly came out of this.

3. (Gödel 1931)

4. (Turing 1936)

5. (von Neumann 1945)

2. FACTS FROM CURRENT TIMES

You find an entry in Wikipedia about *Deep Style*. A Google search generates hundreds of thousands of hits. We know that currently everything you do with a computer must lead to something "deep". It's the new word for "intelligent". You find around half a million hits in Wikipedia on *style*. The Google search for *style* generates 6 or 8 billion hits.[6] Restricting the search to "style in fine art" delivers about 194,000 hits, and 34,000 for "'deep style' in fine art".

6. Searches done on 11 February 2018, and again on 11 June.

Do such cheap experiments tell us anything? Not really. Such use of computing power is rather helpless, primitive, and stupid exercise. All I want to say here is this. An algorithm was published recently under the title of "A neural algorithm of artistic style" (Gatys et al. 2015). It immediately sparked an explosion of interest and work. The article is about separating — in fine art or anywhere else — *content* of a painting from its *style*. That separation is what the algorithm does.

That's not really interesting for us, with one exception, perhaps. For the exception, take a look at Figure 2. There you see on the upper left a photographic image of a scene in the town of Tübingen, Germany. To the right of it you see the style of William Turner applied to the Tübingen scene. In addition, the lower row displays the same for Vincent van Gogh's and Edvard Munch's styles. ("Style" here always is what the authors of the study have defined such that an algorithm may work with it.)

Parts of the world get excited about this, a large part of the population at least. Do you share this? I do not. If I were excited about this, what might be a reason for my excitement? I guess it would be something like this, a mixture, maybe, of ingredients from the following components.

> Oh, they have identified what a painting style is? That's absolutely fantastic. They can now separate contents from style, think of it! These categories have become manageable things. It's all done by computer. Is this computer not getting better than us? Deep neural networks! Think of it, that's our brains. It's great and fantastic, gorgeous, rough.

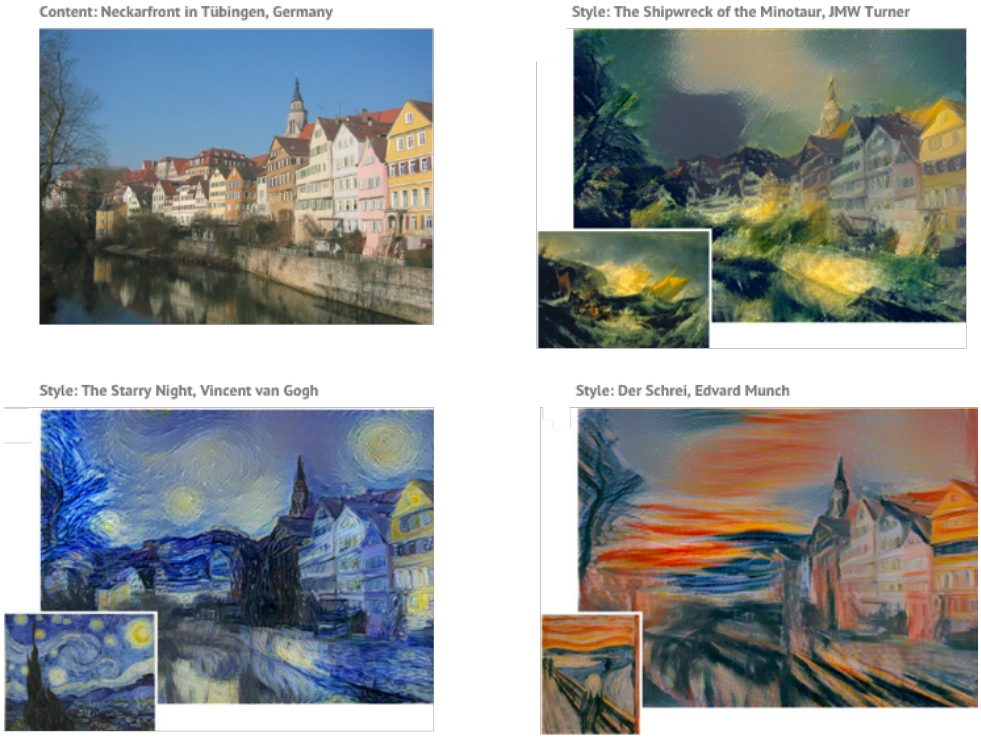

Fig. 2. Gatys et al., Three examples of mixing contents with style, 2015.

What Gatys, Ecker, and Bethge have done is, indeed, fantastic. They must be congratulated for their success. A success of courage. A success that, if we take it at face value, solves an issue that dozens of art historians were not able to solve over centuries. The books they have written, the ever new interpretations they have tried, the concepts and subtle arguments they have developed would now disappear and shrink to nothingness — if we take at face value what the Tübingen crew offers us.

This crew starts from the observation that painters have developed "skills to create unique visual experiences through composing a complex interplay between the content and the style of an image." (Gatys et al. 2015) Without hesitation, we are willing to study a painting and discuss it in terms of its content and its style. The form vs.

content dialectics has been most important and controversial throughout the history of all kinds and genres of art. But are we capable of giving a precise definition of the two concepts, *style* and *content*? Are we capable of doing this in a way that satisfies the requirements of computability and, at the same time, is rich enough to help us continue the discourse we are engaged in? That's freely taking up aspects from history, from aesthetics, from sociology or psychology, from the artist's life, from our personal tastes? All of them are aspects of style.

Our authors continue by deploring the fact that "the algorithmic basis of this process [between content and style] is unknown". That's a fantastic move in the development of a scientific investigation. The statement contains a hidden assumption that is essential to the entire work but void of plausibility. In order to make sense, the observation must be re-phrased into something like "As far as we know, nobody has tried to find out if algorithmic methods can take us closer to some more insight into the content / style dialectics. With the necessary caution, we want to try this." Without a section on the concept of *style*, however, nothing would make sense.

But none of this is in the paper! The three researchers have made a fantastic contribution to the technology of what they (with dozens of others) call *neural networks*. They are not more than an arrangement of layered and connected computations that have become feasible to be carried out because of technological progress. They know how to do this, so they do it. And they interpret what they do in bold terms that throw into the garbage bin entire conferences and libraries in the humanities. Only take a single look at the 800 pages of the collection on style (Gumbrecht & Pfeiffer 1986). Content and form have been discussed since Aristotle. Entire journals have been dedicated to the issue. It is so rich that in philosophy and the humanities you don't believe that there will ever be final answers.

Does this devaluate the work of Gatys, Ecker, and Bethge? Not at all. All it devaluates is the attitude the three authors take on. They have written software. They have applied it to images. Now they show the results. That's it. There is nothing but trivia when it comes to the issue of style. The authors seem to feel this. For they do not write, in their paper, what style should be. Neither do they say what content is, in their research. The two are just results of applying convolutions to images, a mathematical transformation of considerable complexity. The far-reaching interpretation of a separation of style from content does not seem to lead to anything new in the theory of style, and to *kitsch* only in creating new images.

3. PROJECTION BY MAX BENSE

Between 1954 and 1960, the German philosopher Max Bense (1910-1990) published four small books on aesthetics. In 1965, they were collectively re-published as one volume in slightly revised form (Bense 1965a).

The fourth of those *aesthetica*[7] had the title, *Die Programmierung des Schönen* (Programming the Beautiful). In the early 1960s, not everybody immediately thought of the computing machine and its operation when reading the word, "programming". But some certainly did. I assume this was Bense's intention. In a way, his title was a provocation. *Rationally* approaching in, perhaps, formally planned methods, the *beautiful* — this sounded like a contradiction in terms.

Also in 1965, for the occasion of the opening of the first exhibition of so-called computer art, Bense wrote a short essay under the title *Projekte generativer Ästhetik* (Bense 1965b). In a very general and abstract style, Bense here lays out a terminology that he intended to accompany the emerging algorithmic generation of works of aesthetic appeal. His essay does not directly address issues of programming. But some words are injected that indicate his expectations and intentions. Insofar, it appears justified to take this text as the founding document, the manifesto of algorithmic art.

7. Bense had borrowed the title, *Aesthetica*, for his books from Alexander Baumgarten's (1714-1762) great *Aesthetica* of 1750.

Be this as it may be, to program some aspect of the artificial world means to turn it into a rational kind of operation that can be carried out independently by many who do not understand in detail what the whole is to be. They must blindly follow systems of rules that, in their operational results, may be surprising even to those who have cooperated in following the rules.

It cannot come as a surprise to the reader to learn that the famous Swiss designer, typographer, and artist, Karl Gerstner (1930-2017), had in 1964 published his *Programme entwerfen*, a thin and greatly inspiring volume on programs that were not computer programs. However, each case of design the book dealt with was of programmatic kind. Gerstner offered a motto for what he meant by this: "Instead of solutions for problems, programmes for solutions." (Gerstner 2007) Given a problem, a programmatic way of solving it is, not to solve it, but rather to write something that constitutes a systematic, rational, clear way or instruction to find a solution. You take a step back in a more abstract direction, and describe characteristics and steps that the solution (*any* solution!) must obey.

By the way, when Gerstner in 1965 heard that in Stuttgart someone was writing computer programs to generate parameterized drawings, he immediately decided to insert a note on "programme als computer graphik" into the second edition of his book (which has in 2007 appeared in its third, now English, edition.)

But back to Bense's *existential rationalism*, as he himself called his philosophy. It was his intention to bridge the gap between the historic, social, scientific, and aesthetic approaches by the human mind to understand the world as it is and as it is made. He starts from the assumption that the world is artificially makable or constructable. Civilization is not a state, but a process. A process engraved into humankind. That process never stands still. It is in permanent exchange with nature and innovation. Metabolism and innovation build the basic occupation of humankind.

The development of Western civilization, in important areas, leads to a need of precision. Precision is the condition of engineering work and processes. Precision's technological correlate is measuring. Measuring, in turn, is a means of rationality. And rationality is analytic: it divides the phenomena into parts that are easier to treat in isolation. Only, when in the early Renaissance the human mind had reached this level and, thereby, the level of fundamental *makeability*, only then the description of physical processes reached the point of controllability and constructability by technology.

Such is Bense's basic assumption about humankind, an assumption that, in the mid-20th century, has led to decrease the distance between technology and aesthetics. Processes of information are responsible for this and, we should add, for processes of signs: *semioses*. Thus, the beautiful enters[8] the realm of machinic construction, of algorithmic description, and even of mathematical, computable optimization. Gaps may be closed by the rational mind.

Bense's own thinking, and the more concrete work by his disciples — Helmar Frank (1964) and Rul Gunzenhäuser (1962) — have established a theoretical framework within which such radical thinking makes sense. Further historical development has raised doubts against such extreme trust in the options of the rational mind. Semiotic description of computable semioses makes sense and is helpful. But not everything in aesthetics can be turned into computable form.

8. Using the term "the beautiful" is due to the historic account of Bense's writing. One of the reviewers has pointed out that it is rather old-fashioned. He or she is right.

4. PROJECTION BY SOL LEWITT

six-inch (15 cm) grid covering each of the four black walls. White lines to points on the grid. 1st wall: 24 lines from the center; 2nd wall: 12 lines from the midpoint of each of the sides; 3rd wall: 12 lines from each corner; 4th wall: 24 lines from the center, 12 lines from the midpoint of each of the sides, 12 lines from each corner. 1976

Fig. 3. Sol LeWitt, Wall Drawing #289, concept.

In 1976, the Whitney Museum of American Art in New York acquired a work that looks like what Figure 3 is saying. You will agree, I claim, that the figure is made up of text. A text more or less in plain English.

What LeWitt sold to the museum was a typewritten set of rules or guidelines, instructions really, of what to do and obey when the work is to be shown to the public. The visible work itself, in some way, never existed, or existed only temporarily. And it could exist at different places at one and the same time. For LeWitt's point was that the concept was more important than the visible work itself. The work, he says, consists of a concept and its realization. More important of the two is the concept. His, the artist's, involvement ended with a certificate that the Whitney owned the concept.

In the history of art up until the mid-20th century, concept and realization of the work were more or less one and the same. At least, they were inseparable. But the artist usually did not sit down and explicitly formulate the rules according to which he would carry out the work.

He would, however, quite often sketch parts of the work. He might do several sketches, and start creating the work only when he was convinced of his sketching having reached a state where he felt a good artistic work would result. But in the act of realizing the painting, even with the final sketch in front of him, he would not necessarily slavishly copy the sketch, but feel free to deviate in each and every detail he was carrying out in following the concept.

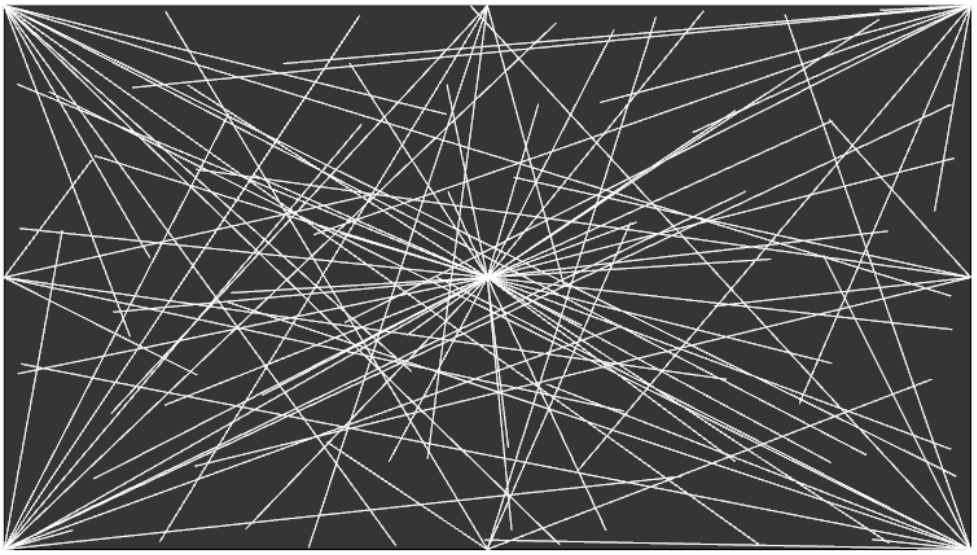

Fig. 4. Sol LeWitt, Line Drawing for Wall Drawing #289, 1976.

In 1967, Sol LeWitt summarized what he had done over the last couple of years, and what he intended to do in his minimalist future, in his famous "Paragraphs on conceptual art" (LeWitt 1967). The central paragraph is this:

> The idea becomes the machine that makes the art.

Let me repeat this in my own words. There is an idea, wherever it comes from. We only know it exists. It is there without question because otherwise we could not talk about it. This idea undergoes some sort of transformation of which, again, no detail is given. But as this transformation is happening, the idea becomes something new or other: It turns into a machine. This may already be considered a kind of miracle. But then this new machine starts doing something. It is making something. And that something that the machine is making ("generating") is called "art". Who is saying, it is art? Who is there to know? — We may depict the LeWitt automatic process as:

IDEA (becomes) MACHINE (makes) ART

A lot has, of course, been written about such a simplistic way of identifying the process of art making. But a very simple fact must not be forgotten. You may formulate

the idea for a piece of art that, in LeWitt's case, is realized as a wall drawing. That wall drawing, when the exhibition is over for which it had been done by assistants in the first place, is painted over by white or some other paint or material. So the painting disappears. The concept, if explicitly written down ahead of time, however, remains. It can be repeated elsewhere, or even at various locations at the same time. So the idea *equal to* the concept does indeed remain as the essential aspect of the work. We may tend to find LeWitt's concept a convincing thought. At least in the kind of art that allows for the clear separation of concept and work. The idea (or concept) is the human's; the work is the machine's. *Myself and the other* — this is the old theme of art, but now in modern times.

We had encountered such an hypothesized separation before, in our second example. Only then it was a separation of content and style.

In algorithmic art, the idea must be formulated in a much more precise manner than in traditional art. It must be done in such a way that the explicit concept is equivalent to a machine — it "becomes" the machine. Such a machine does now exist. It is exactly the computer. Algorithmic art thus appears as what LeWitt's minimalist and constructive art was approaching.

But, beware! When the explicitly formulated idea is being performed by people following the rules, they are still free to interpret those rules in many ways. There are still selections to be taken as, e.g., the colours and paints, the kind of brush, and more. LeWitt is aware of this fact. He takes it into account. The idea that becomes a machine must be *interpreted* in order to become that machine. The program must be fed by concrete values for all its variable parameters. The autonomy of the machine in making art is rather restricted. And, by the way, who is judging the art of the "art"?

5. FACTS FROM EARLY TIMES

Writing a program, or developing an algorithm, is often involving at least a bit of doing mathematics. Required is a kind of thinking permanently getting close to the unforgiving rigor and precision of mathematics. However, this is not the same as mathematical thinking.

Mathematics progresses, in the small and in the large and, speaking very coarsely, only in form of statements whose truth can be proved and must be proved. Mathematical thinking stops when the proof, or its contrary, cannot be given.

Algorithmic thinking, however, is thinking in terms of actions. Some process is to be described, again: with utmost precision and without any ambiguity. The process, if carried out successfully, is supposed to generate a state or result or experience of a kind that you had wanted and requested. The result may exactly be what you had expected or, depending on further contexts, it may be within a certain narrow domain around an ideal that you want to get at.

The two kinds of thinking — mathematical and algorithmic — share precision in each and every detail. But they differ in what they expect of the world. Mathematics assumes there is truth.[9] And thus celebrates a permanent festival of truth. Algorithmics is sequences of actions. Its dimension, if there were such, is time. Mathematics happens much more in structured spaces.

Designing and writing algorithmic components for aesthetic objects is a process in the domain where aesthetics, algorithmics, and a bit of mathematics meet. There are selections you must perform for the visual (and other) materials that may appear in the work. There must be selections of formal models that you are to use in your description of actions. They take you into mathematics. And there must, of course, be a concentration on the actions themselves and their efficient and effective working.

This sounds terribly abstract. I want to show results from a program from 1966 which, I believe, convincingly moved back and forth between those three aspects:

9. Mathematics happens to be the last refuge of truth. There, and only there, you can still positively relate to truth. Because in mathematics, truth is a purely formal concept, empty of contents.

mathematics, algorithmics, and aesthetics. The mathematics was quite explicit and formal, but powerful. Algorithmics was more open but became demanding in keeping track of all the possible events. And aesthetics, of course, is the ultimate criterion under whose roof everything is happening. It is done by human subjective judgment. Only within narrow limits, the mathematics and the settings of parameters may be such that their results are convincing the audience. That's the same across all forms of art, and therefore not different in the aesthetic realm.

The program in question is called "Walk-through-Raster". It requires a repertoire of signs to be selected, simple or complex (aesthetics!). It requires transition probabilities to be given that control what is going to happen next; they are allowed to differ depending on where on the image you are (mathematics!). And it requires that you specify some more parameters, the most influential of which is the mapping of a chain onto the two dimensions of the plane. Figure 5 shows examples. An edition of 40+4 pieces was generated, each one different, for the Abteiberg Museum in Mönchengladbach, Germany.

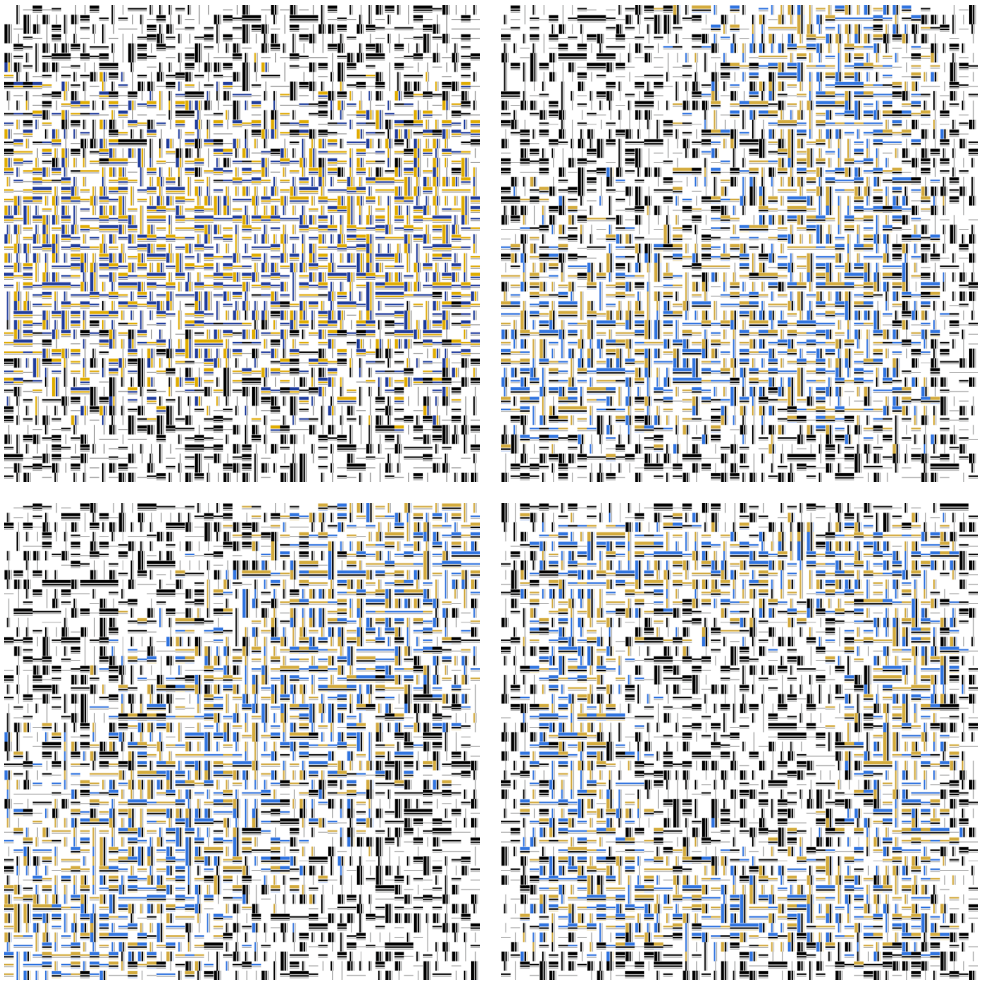

Fig. 5. Frieder Nake, Walk-through-Raster, new version of 2005.

Without giving more space to a discussion of these four drawings, what you see is how a selection of a *repertoire* of mild complexity helps dealing with a sort of richer aesthetics. Further, how the mathematical power of the *Markov chain* (borrowed from probability theory) allows for some first global patterns emerging from local control, in particular if, as here, the transition probabilities are not stationary. And finally, how various mappings of linear chains onto the plane create similarities of an abstract kind.

Comparing the geometric straight-line aesthetics of these four drawings with the flashy deep structured style exercises of section 2 may draw all attention to the landscape images. In them, the Sunday painter re-appears after having been squeezed

10. In generative art, you develop algorithmic descriptions of images to appear without seeing images but only formulae and algorithmic structures.

through a neural network torture. Big data easily win over mathematics of probabilities and pseudo-randomness. Image processing in its results appeals more to an immediate judgment than "painting with eyes wide shut".[10] I offer the examples and statements of this essay as stuff to further think about.

6. BEAUTY AND PROGRAM

Kurt Kranz and Max Bense knew each other. They may have been friends. They occasionally met in Hamburg. In the 1960s, Bense wrote prefaces to Kranz's catalogues. Did they influence each other? There were commonalities: the rational approach to making art by selection, variation, series, experiments. The processual character of aesthetic objects in the 20th century. The denial of the great piece that shakes the world of art.

In 1965, Bense coined the term "generative aesthetics" in the context of computer programs being used to generate first drawings of an aesthetic claim (I have mentioned this before). In retrospect, Kurt Kranz in his experiments was working like a programmer. But he himself was, of course, carrying out the program that he had thought up in his mind where he still kept it. He had *not* formulated that "program" in a proper programming language. But as we see, ideas are floating around, shared by different persons who are not even aware of the other person sharing the same idea.

Neither did Sol LeWitt write computer code to automatically run the conceptual schemata he had thought up for the generation of a work. Again, such schemata either remained in a state of only rough formulation without realization of a concept; or LeWitt had to go through the trouble of performing the operations himself if he and others should actually see the new piece (he did not usually realize those works as material forms. The gallery hired people to do that.) In this way, Sol LeWitt's machine was a human machine.

The question of "beauty" or, better, of aesthetic evaluation — "can aesthetically interesting results be generated by an algorithm?" — must, of course, be answered by: "Yes, this may be the case." But the answer also is: "Whether or not it actually happens, is not an issue of the algorithm." Artists generate works. Of course, they want their work to become art, great art. But this is not theirs to decide. Society only, in extremely opaque ways, is perhaps turning an artist's work into a work of art. In the old days, such work was then called "beautiful". Now it suffices if some person finds it interesting.

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