Computer Art. A Personal Recollection

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ABSTRACT
The story of some early computer art drawings in 1965 is told. It is a story of randomness. Computer art is viewed here as the programming of classes of aesthetic objects. In the mid 1960s, information aesthetics was a powerful and radical theory that had some influence on constructive and concrete forms of art in Europe. A connection is drawn to computer supported works by A. Michael Noll in the US, and Georg Nees in Germany. "Experiment and tendency" is identified as an important principle still valid today. The concept of the algorithmic sign appears at the horizon. Digital media are claimed to be explorations of algorithmic signs.

ACM Classification: J5 [Arts and Humanities:] Fine arts

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INTRODUCTION

History is what gets written about it. Therefore, it changes and is rewritten. There are also real processes that have not been written about at all. They have not become history, yet. It seems that after about one generation's time, if a phenomenon and process has been influential enough, its history starts to be written. Computer art is such a case. It is well accepted meanwhile. No longer does it get questioned on principal grounds. It even experiences some popularity. There are, however, in the literature a number of outright errors, inaccurate data, and smaller flaws. So it is time to research the early years of computer art and get the records straight. At a few places in the UK, the US, Germany, France and certainly even more countries, computer art has started to become part of art history. A good indicator of this is the fact that Ph.D. theses have started to appear.

In this paper, a personal story is presented as part of computer art history. It consists of facts and interpretations, i.e., the ingredients of what will establish the truth. In the end, however, only the readers can tell.

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FEBRUARY 5, 1965

The artists who had come to this gallery opening reacted in an unfriendly manner. Not with us, reports claim they said, not with us you may do that. Some left the scene generating noticeable noises. Max Bense tried to calm their moods: it was only *artificial art* what they saw on display, he declared.

What was it that you could see on that 5th of February in 1965, on the walls of the *Studiengalerie* of the University of Stuttgart, by the time still called an Institute of Technology? What caused such uneasiness? You could see some small size drawings in China ink – bundles of straight lines, series in somewhat random variations. The dozen or so of drawings could hardly have succeeded in enraging the artists from the Stuttgart Art Institute who had come downtown for the opening of the exhibit. There was, however, one single and most sensitive aspect to the situation. That aspect was almost sacred to the artists and others in the country's culture: *creativity*. It was human creativity that Bense tried to save when he coined the term of *artificial art*. This was a clever and sharp formula, typical for the master of the unusual term.

By the beginning of 1965, not so many in Germany understood what *Artificial Intelligence* could possibly be. In the US, several research groups at prestigious institutions had received large grants to develop programs that were supposed to exhibit intelligent behavior. Implicitly, Bense referred to their approach to computing when he used the term, artificial art. He called *art* what had been drawn by a machine: the machine had been controlled by a paper tape, that had before been calculated by a computer, which was, in turn, controlled by a program that Georg Nees had written. But the machine was certainly not creative.

From the 5th to the 19th of February, 1965, the first exhibition worldwide of digital art – as we would call it today – was staged at the Studiengalerie. Georg Nees had conceived of, programmed and realized the works. In issue no. 19 of the now legendary *edition rot*, six of the computer drawings were represented. The *edition rot* was designed and printed by Hans-Jörg Mayer, and published by Max Bense. He used it for publications by authors of the Stuttgart school, also called the Bense school. That name was used to identify a

loose and informal set of artists, writers, theoreticians, architects, and composers whose only common bond was their relying on some aspect of information aesthetics.

To the booklet, *rot no. 19*, Georg Nees had contributed short descriptions in everyday language of his programs. Max Bense added his short *Projekte generativer Ästhetik* (Projects of generative aesthetics). It reads like a manifesto of computer art. It was translated into several languages.

The Stuttgart artists reacted in their unfriendly manner because they had been confronted by an attack against the validity of their productions which, without hesitation, were called *art* by everyone first and for all because of their origin in the artist's studios, which he confirmed with his signature. People had on TV watched monkeys drawing and painting. It was clear beyond doubt that those scribblings were not to be called art. But now it seemed to be the same again, only that the new challenge came from the computer. Was there a difference?

The pure visual appearance of the drawings was not too exciting. One could easily ignore them, if one wanted to. The challenge really came from the principle that emerged. It was outrageous. It may have appeared as if conceptual art was left way behind but, at the same time, its idea gained a new kind of power. The schema, the structure, the class properties of entire sets of drawings were described and given to the machine for it to work out the details. The individual work became part only of a generative schema. Aesthetics was confronted by a new task, and the artist was threatened in his or her very existence. The *individual* realization on the wall no longer carried the essence of art. Art now had become the *class* of works which the picture belonged to. That class consisted most likely of endless chains of variations.

True, nobody by the time put the artists' uneasy feelings into such or similar terms. It was the time when the *aesthetics of unfinish* (then still to be discovered by Peter Lunenfeld) raged and stumbled through parts of the world in forms of the happening. The pale thought games of the conceptualists often appeared more like some sort of pseudo-philosophy than sensual experience and excitement. But now, the two were brought together, concept and realization, combined into an operational unit on one technological level. This operational unity was the menace.

Today, we are in a position to see more clearly and formulate what was happening as: a glimpse had become possible in those early days of a new world, the world of the *algorithmic sign*. Not so soon, yet soon enough, it would be called *virtual reality* and would be misunderstood as a negation of reality.

On February 5, 1965, an attack was launched against traditional notions of art by Georg Nees and Max Bense even though this was in no way their intention. Their act culminated in the proclamation of *generative aesthetics* and *artificial art*. They cast a rock rolling whose impulse they may not have been fully aware of. The Stuttgart artists had no desire to be hit by that rolling rock.

NOVEMBER 5, 1965

The events on the afternoon of February 5, 1965, in Stuttgart mark a historic date. But they were not absolutely unique, although participants conceivably may have shared such a feeling. At around the same time, preparations were under way at Howard Wise Gallery in New York City for a show to open on April 6, and to last until April 24. A. Michael Noll, from Bell Labs, was to display drawings that had also been programmed, run on a digital computer, and resulted in some visual output. In Noll's case, the output was on microfilm. Bela Julesz was to contribute computer generated complex patterns of dots that he used for experiments on stereo perception.

It is likely that by the time nobody in Stuttgart was aware of the parallel development at Bell Labs. According to my memory, nobody mentioned it. The name of Michael Noll has appeared to me in February 1966 when I had an exhibition in Darmstadt. Someone showed me the August 1965 issue of *Computers and Automation* with Michael Noll winning the award. Now I knew of the contest, and of Noll's work.

Likewise, the technical and ergonomic drawings were not known that the computer graphics group at Boeing in Seattle under the leadership of William A. Fetter had been working on since around 1962. All their drawings had one theme: aircrafts and their operation. There was the look out of the cockpit upon landing approach on an aircraft carrier, or design drawings for airplane wings and bodies. One of the Boeing projects became famous in artistic circles soon after 1965. In this project, wireframe drawings of a pilot appeared, reaching out in his cabin to check whether he would be able to get to all the instruments and dials.

Back in Stuttgart, not far from the location of the Nees exhibition, just a quarter of an hour walk up the hill, very similar graphics could be inspected at the Computing Centre (Recheninstitut) of the University of Stuttgart. If the philosophers, mathematicians, and artists from the February event had climbed up a distance, they would have found an opportunity to immediately double the show of computer art. The story behind the existence of those images is quite telling in different respects.

As a student of mathematics, I had been working part-time for the computing center. One day in 1963, the head, Professor Walter Knödel, told me that they were about to acquire a newly constructed automatic flatbed drawing machine, the *Zuse Graphomat Z64*. Konrad Zuse himself had constructed it. The machine was controlled by a paper tape containing in all detail the code for the entire drawing. The tape was produced by a computer under control of a basic software package for 2D drawings. That software did not exist for one of the computing center's machines, the Stan-

dard Elektrik Lorenz ER56. Knödel felt I was qualified to do the job of developing it.

Never before in my life had I known that a computer could draw. It could calculate, and was quite efficient in that. But drawing – how that? The job seemed to be a challenge, which accidentally popped up. I agreed, and that changed my life.

The computing center did not possess the machine yet. Only specifications of the drawing codes existed that would go into the tape reader of the drawing mechanism. On the extremely low level of the ER56 machine language, I developed the basic program package to do simple geometric drawings that were to be carried out automatically. The program had no clue of what it was drawing. Not a trace of geometric modeling was included. This fact certainly severely limited my first experience with the development of graphics software. On the other hand, I gained the most detailed insight of the innermost workings of an automatic drawing process that I could possibly hope for.

This wonderful opportunity and challenge had arrived out of the blue skies like a random event. Two other contingent facts additionally became important preconditions for the appearance of some of the first works of computer art. One was that I had specialized in probability theory and, as part of my computing center job, on random number generators. The second precondition was that I had sat in at Max Bense's lectures in philosophy during most of my semesters. His beloved specialty was semiotics and aesthetics. I don't think I understood much of what he told us. But it was great and obviously daring. He propagated an aesthetics of the object, which was exactly what you needed when a machine was to generate art.

When my basic graphics package had developed to the point that it should be tested systematically, those other two areas of my education combined to generate a most fruitful energy. After first tests in drawing lines in various directions and comparing their visual quality with the specifications, I wanted to do something more exciting.

A polygon was a sequence of straight line-segments in varying directions and of varying lengths. If the number of segments, the direction and the length in each case were chosen at random, the result would be a polygon unpredictable in all its detail but known in advance in general form. The program would allow drawing *all* possible polygons of finitely many segments. It would constitute the definition of that infinite set, and the device to generate each of its members.

So I started to force the machine to draw like mad and produce small, later larger, formats of drawings consisting of random polygons. Because of my knowledge of pseudo-random number generators, I used uniform, exponential, Gaussian, Poisson, and arbitrary discrete probability distribution functions to control the myriads of random decisions needed for each of the drawings. As one further source of variability, I included in my palette of random number generators various methods for the basic uniformly distributed numbers.

My computer art programs soon developed to a point where they first had to decide which distribution function and which random number generator to use. Needless to say that the system's clock was read upon start of the generators. That random time then determined the start value for the random sequence. In consequence, hardly anybody would ever be able to repeat exactly the same drawing sequence.

INTUITION

Almost all early experimenters in visual computer art made use of random numbers. In the publications by Noll, Nees, or Nake you will find examples that look very similar. If we were talking about *natural* art (the opposite of *artificial* art), we would interpret such an event as *style*: the common manner by a group of artists to draw or paint.

In our case, however, a pattern of a variety like "random polygon" would be attributed to its simplicity. Irrespective of the details of the program, its results look much one like the other. This indicates that style and program may have some commonalities. On the other hand, Fig. 1 shows a sample of random polygons of distinctly different visual appearance. The macro-aesthetics of such drawings consist of two components: the overall geometry and the set of probability distributions. Appropriate definition of the distributions may have a great influence on the micro-aesthetics. A polygon with alternating vertical and horizontal edges differs from one with all possible edge directions only in the choice of the next direction. Otherwise, the pattern is the same.

The descriptive power gained in writing executable concepts of pictures (also known as *programs*) is enormous. It is where computer art superseded concept art.

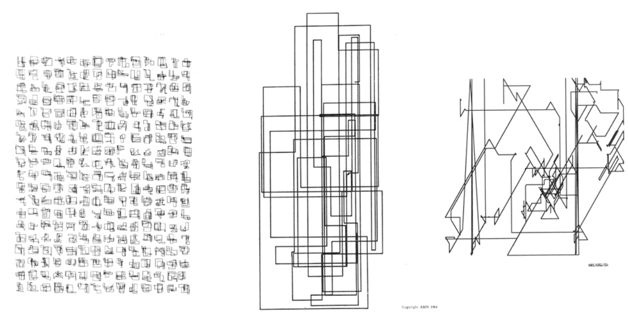

Figure 1. **Random polygons.**
G. Nees: 23 Vertices (1965), A.M. Noll: Vertical-Horizontal no. 3 (© AMN 1964), F. Nake: Random polygon (1965)

In Fig. 1, we see two large and many small random polygons. The central one is by Michael Noll. Only horizontals

and verticals were allowed. Everyone in the mid 1960s tried this pattern. The panel by Georg Nees is a matrix of repeatedly connecting 23 vertices by horizontals and verticals, and closing the polygon by an oblique line. The third example allows for a larger but finite selection of directions. This requires a discrete probability distribution.

Is it far-fetched to draw some sort of analogy between the artist's intuitive decisions and the realizations of random processes, which – as such – are governed by probability distributions? Such an analogy would definitely be far-fetched if we claimed that the artist's intuition was *equal* to a set of probability distributions. It would still be far-fetched (and thus wrong) if we claimed that the artist's decision process was *simulated* by the random process. We could, however, justify saying that the *place* of intuition in a human creative process was taken by an ordered set of probability distributions in a computer generative process.

As with any analogy, the comparison contains an element that is equal on both sides, and other elements that are different. There is just nothing equal between a human being and a computer. Only on rather abstract levels, similarities show up, or may be constructed.

If intuition is what is immediatedly clear to us, what we understand in a single moment ever so short, what does need no further reason other than being exposed to the situation, then an artist's decision process is governed by intuitive as well as discursive steps. (The same, by the way, is true for the scientist.) In the aesthetic program, the set of probability distributions exactly takes that place of immediacy – if there is anything like that.

When we look at a work of computer art, and analyze its overt structure, we may in many cases fairly well describe the global geometry, which here I call macro-aesthetics. We are at odds, however, with the details that, as we know, are decided by random numbers. These details on the local scale constitute the micro-aesthetics. They remain hidden to us. The same is true for the artist's intuition.

HOMAGE À PAUL KLEE

We take a second look at the distinction of macro- and micro-aesthetics, introduced in the previous section. Consider Fig. 2. It depicts one of the better-known examples of early computer art, the graphics "13/9/65 Nr. 2". In an attempt to avoid any connotations and allow the name of a picture only to identify it, my naming schema gave the date of production and the running number during that day. The successful artist, Manfred Mohr, has been using a similarly simple, clear, and context-poor naming device for decades.

But the picture of Fig. 2 is also called *Homage à Paul Klee*. It has been described as incorporating some stylistic rules gained from analyzing drawings by Paul Klee and putting them into computable form such that they could become part of an automatic process. I myself didn't do enough against this misinterpretation, although it is clear from reading [Nake 1974:214ff] that we see something totally different from anything an artist like Paul Klee would probably have done. In actual fact, Fig. 2 is related to some of Klee's art in so far as it clearly distinguishes micro- from macro-structures.

The first impression many observers have of Fig. 2 is its horizontal orientation. The broken lines running from the left to the right boundary have a definite tendency of "going there". Their bends add to this impression. They are main roads. As you proceede along one of them, several events may occur. You may get along freely and fast because nothing is preventing you. But you may also get to some place with a lot going on in criss-crossing short paths, which at this place determine everything. Or you may have to cross roads of a secondary kind running perpendicular to your direction.

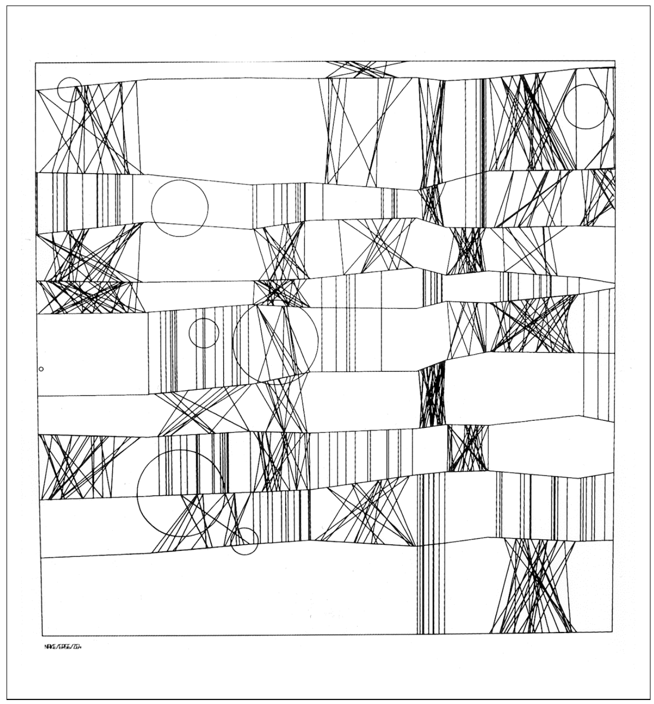

Figure 2. **Frieder Nake: 13/9/65 Nr. 2.**
Also called "Homage à Paul Klee". 1965

Although the bulk of the graphic line material is of the second, local kind, those local parts align with the global structure. These are the micro- and macro-aesthetics.

There are two components that combine the two. One are the vertical local roads that may run across not only one, but two of the horizontal stretches. They thereby create connections between micro and macro levels.

The other combining component is the set of circles. Their visual appearance distinguishes them sharply from all the straight lines. Therefore, they counterbalance the drawing's general impression. They introduce, on the macro-level, a

contradiction between straight and circular, or between open and closed forms.

The lesson learned from this exercise was that it could be an easy task to generate graphics in a layered design – a lesson well known to anyone in the field of design and art.

THE FIRST COMPUTER ART CONTEST

"To encourage explorations in this new artistic domain, *Computers and Automation* will hold an informal contest for similar examples of visual creativity in which a computer plays a dominant role. We invite any reader to submit to us examples – which we shall consider for publication in *Computers and Automation*." Such read a short announcement on page 21 of the February 1963 issue of the magazine, Computers and Automation.

The editors, mainly Edmund C. Berkeley himself, had been motivated to take such a step by the front cover of their January 1963 issue. It had shown the output of a mathematical transform of some optical data.

The August issue singled out two plotter drawings that were visualizations of certain physical processes. Their titles were "Splatter Pattern" and "Stained Glass Window". We are told that they both were automatically graphed by a dataplotter of Electronic Associates. The names of the authors are not given.

The August issue in 1964 again has, on its cover, a drawing of some mathematical function. The 1965 award went to A. Michael Noll for his "Computer Composition with Lines". It had been included in the April show at Howard Wise, and was Noll's famous simulation of a Mondrian painting. Four more graphics were reprinted inside the magazine, two more of them by Noll, the other two simple mathematical patterns.

Twelve examples were displayed as award winning or honorary mention of the 1966 contest. My "Distributions of Elementary Signs" appeared on the cover page only partially. Its blue part had vanished, most likely due to reproduction problems. Otherwise, some speculation about color in early computer graphics could have been settled already then. Other contributors were Maughan S. Mason, Petar Milojedic, C.K. Messinger, L.W. Barnum, and D.K. Robbins.

Far more entries from far more people caused Ed Berkeley in 1967 to announce "Computer art: the turning point". The award went to Charles Csuri for his famous *Sine Curve Man* (Fig. 3). Six more of his works, mostly with his programmer, James Shaffer, were reprinted in the August issue. Other authors represented were Leslie Mezie, Petar Milojedic, Darel Eschbach Jr., Stan Vanderbeek and Ken Knowlton, Donald K. Robbins, Lloyd Sumner, Frieder Nake, D.J. DiLeonardo, Maughan S. Mason, and Craig Sullivan.

"Art in the future will be as profoundly influenced by the computer as by any other medium of expression." is the thrust of Berkeley's more elaborate comment on the contest's results. He goes on to praise to artists the technical advantages of using a computer. He raises the question whether the human being will be superseded. He answers with a clear "No".

At that turning point, the figurative element had clearly entered the scene, through Csuri and Mezei. The genre of immediate visualization of mathematical things and relations was still prevailing. But Csuri had a background in the arts, so had Mezei, and in Europe several galleries had put up shows of large constructivist repertoires of art that involved computers.

Once more, in 1968, the number of entries increased, the breadth of visual expression increased, and the background of people contributing became more diverse. Color was no great deal any more. The work by Evan Harris Walker, constructivist in character, depended much on color. Leslie Mezei contributed his Tower of Babel series. The Japanese Computer Technique Group appeared. The award went to two representatives of Calcomp Plotters.

A total of 165 entries reached the editor for the 1969 contest, a year after Cybernetic Serendipity (see below). Petar Milojedic was still contributing. He had now turned to L-systems. Besides dozens of mathematical curves, and portraits of famous people, two works of art received honorable mention: one by Auro Lecci from Italy, the other by Hiroshi Kawano from Japan. Soon later, a selection of computer art would be represented at the 35th Biennale at Venice, Italy, together with constructivist art (1970). In Europe, the question of *art* had been settled. The Prix Ars Electronica was still a decade away. A calm and innocent contest by a small computer magazine had provided some fundamental work.

EXPERIMENT AND TENDENCY

In retrospect, the earliest time of digital computer art may appear as if, for a very short time or for a moment only, the US and Europe were on a par. Such a statement is justified, when we look at the history of exhibitions. They started, almost in parallel, in 1965.

Noll began working with computers in 1962, Nake and Nees in 1963/64. So on this count, there is a US priority. Nees is most likely the first in the world to finish a Ph.D. on computer art [Nees 1969].

But such comparisons and claims of priorities are rather pointless. A more exciting issue is the difference in attitude on both sides of the Atlantic. As one would expect, we meet American pragmatism, and we also see a definite orientation towards theory in Europe, particularly in Germany.

It is no accidence that Max Bense became host of Georg Nees' first exhibition in 1965. We will take a brief look at Bense's Information Aesthetics in the next section. Besides his work on the theory of aesthetics, Bense himself wrote

concrete poetry, and he was head and center of the Stuttgart group, sometimes also called the Bense School.

Nobody really belonged to it, or at least there was no manifesto, no declaration, no great event uniting in action all those considered, or considering themselves, as members of that artists group. The best accounts may be the various *Festschrifts* celebrating Max Bense, and later Elisabeth Walther-Bense.

More fruitful is to take as a fact that Bense was capable of attracting to his rational theory, and uniting in their creative work, large numbers of writers, poets, visual artists, theoreticians, and musical composers. Constructivism, concrete art, communication, semiotics were threads mentally holding together a wild group of individualists who were externally linked to the names of Bense and Stuttgart. Their internal bond was a negation of subjectivism and of all sorts of romanticism in the arts. From here it is a short distance to the machine, which in the case of mental work means: the computer.

Reinhard Döhl, a concrete poet, literary researcher, and early Internet author, has summarized the great times of the Stuttgart school in the 1960s under the roof of "Experiment and Tendency". These two concepts apply beautifully to early computer art. They apply to computer art both sides of the Atlantic but with different emphasis in detail. I take a brief look at this. It can be argued, that two events are paradigmatic for the difference. They began only one day apart, in August of 1968.

Event one was started on August 2, 1968, at the Institute for Contemporary Arts (ICA) in London: an exhibition of the surprising title "Cybernetic Serendipity". It refers to the exact, formal, rational calculations of cybernetics in general, of computer science in particular. In "cybernetics", the theory of control is referenced. The "serendipity" part of the title could be interpreted as "the happy art of finding without searching".

Elsewhere in these proceedings, Christoph Klütsch writes more about the extremely successful show at the ICA. It was a joyful event, for the whole family to go and have fun. It took place in a new mood: you don't go to the art museum for quiet contemplation, but rather to run and jump around, play and try out things. A feast for the body as well as for the mind. IBM was given a large section at the show.

This show, someone has remarked, could at this time not have taken place in Paris. The revolutionary students would have swept it away.

We may interpret the ICA show as the announcement of digital media, and the whole new world of entertainment. The fact that it took place in the tempest of time may be part of its inherent contradiction.

The time – summer 1968 – was still determined by the student and youth revolt in France and West Germany, and by the defeat of a socialism with a humane face, the Prague Spring. The great longing for justice, democracy, and peace that had brought the masses to the streets in continental Europe, had not much affected the British island. In the so-called Socialist countries under Soviet dictatorship, parts of the intelligentsia felt that they had something to win, too.

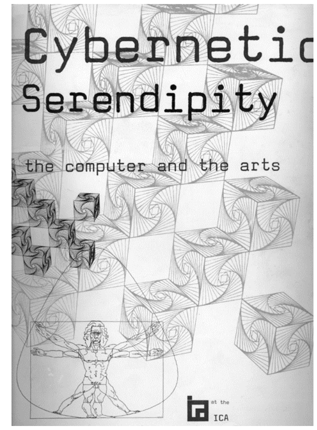

Figure 3. **Cover pages of the journal, bit international, no. 3, and of special issue of studio international**

Yugoslavia under Tito had become a country where East and West could meet. In Zagreb, the New Tendencies movement in the arts had brought together artists of the Bauhaus and constructivist tradition, op artists and kinetics artists, in a series of events since 1961 (NT 1, 2, and 3 in 1961, 63, and 65). The local organizers had constituted a crisis of the movement that was to bring together experimental avant-garde art with the tendency for democracy. They decided, after considerable discussion, that the modernist tendency of the machine was now located in the computer, and that its impact on the artists and arts should become the focus of a series of events. They therefore started a sequence of colloquies, exhibitions, a competition, and an international journal (*bit international*). The general title of all this became "tendencies 4". The official topic of the work and effort was "computers and visual research".

So, event no. 2 started as an international colloquy at Zagreb on August 3 and 4, 1968. Many of the talks, discussions, and also exhibition are documented in the issues of *bit*. Recently, a remarkable attempt has been published to reconsider and evaluate the endeavor from a distance of 35 years [Denegri 2004]. Other research is under way to grasp and put into perspective those events that had in the West and East be forgotten almost totally (Darko Fritz, Barbara Büscher). The contribution to this volume by Christoph Klütsch gives some more data.

One of the many remarkable events of the Zagreb year called tendencije 4 was a competition of "computers and visual research". It was judged by a most remarkable jury: Umberto Eco (who was still largely unknown by the time),

Karl Gerstner (who had already gained a good name), Vera Horvat-Pintaric, Boris Kelemen (both for the Zagreb group), and Martin Krampen (who had organized the *Design and Planning 2* symposium at Waterloo, Canada, and was now with the Ulm Design School).

The jury issued a statement of scepsis as far as computer-aided visual research was concerned. They nevertheless mentioned five groups as "interesting": the Boeing computer graphics group, the researchers at Bell Labs (Harmon, Knowlton, Noll, Schröder), Vladimir Bonacic from Zagreb (who later went to Bonn, Germany), Marc Adrian from Vienna, and the group compos68 from Utrecht, the Netherlands.

No computing expert was on the jury, and *visual art* was its direction. That may be the reason for the group to allow for an extra amount of critical scrutiny. To my knowledge, this statement has not been taken up after the summer of 1969.

The London show in some of its exhibits had the fascination of an Alice in Wonderland location. The Zagreb events were sober in comparison: enlightened mind trying to understand most recent technological developments as liberating acts for humanity. In London, the question frequently recurred, "can computers create?" A question that, for the critical mind has the simple and unshakingly certain answer, "no". In Zagreb, the type of twisted thinking behind the creative-computer question was never felt. Here the matter was, how to advance basic democracy in times of the giant machine. An inkling of this discourse would occasionally appear in London, too. But the general fun media atmosphere easily regained control.

The European past had led into the greatest horrors, which continued in the world at the middle of the 20th century. The 1968 movement was the uproar against the father generation. As far as its ties to modernist art were touched, Zagreb was its event. Instrumental reason and democracy against power defined its orientation. Tendency and experiment was a clear message, steps back from ideological barriers.

European inventiveness had also led to allow for juvenile fun and excitement in all affairs. Many movements and events in the arts of the 20th century were proof of this. In London, the technologically oriented caucus of these celebrated their feast. Media ubiquity and joyful fun against power defined the orientation. Experiment and tendency were clearly present here, too, first steps into a future still totally unknown.

Experiment and tendency – that is not beauty and influence. The two terms stand for the sceptical avant-garde spirit that decides to do something, presents it to the world, perhaps even claims to have achieved partial goals, but is ready to revise and alter. Definite results have more or less gone. They disappear in an *aesthetics of unfinish*. That was the message of the 1968/69 events in London and Zagreb.

The extra show that Dietrich Mahlow and others curated for the Biennale in Venice, 1970, came under the title "Proposal for an experimental exhibition". Coincidence?

INFORMATION AESTHETICS

I have indicated before that information aesthetics had an astonishing influence on early computer art in continental Europe during the first phase of five, perhaps a few more years. Max Bense and Abraham A. Moles were its heroes [Bense 1969, Moles 1968]. Herbert W. Franke is presenting his particular optimization theory of aesthetic information derived from observations of human perception.

Since Shannon and Weaver, it was believed that any message (a sequence or field of perceivable signals) contained information. The information content of a message could be measured. A painting could clearly be considered the carrier of signs. It could, indeed, be viewed as a complex sign composed of subsigns which were in turn composed of subsigns and so on. On each level of such a hierarchy the statistical information content (according to Shannon's axiomatic definition) could be determined.

Various other measures were defined in information aesthetics, notably the aesthetic measure (Gunzenhäuser) as an adaptation of Birkhoff's macro-aesthetic measure, and the measures of surprise and of conspicuousy. The latter were defined for each individual sign in a picture (Helmar Frank).

The approach of information aesthetics rested upon the assumption that the work of art was realized in a stepwise process of selection of signs. Each sign was chosen from a given finite repertoire of signs. The repertoire of signs, together with probabilities of their appearance, constituted the properties of the source of messages (which stood for the creative artist). The art appreciator was in the role of an information sink. He consumed the information in a process of building redundancies.

Information aesthetics attracted considerable attention because of its scientific attitude. All romanticism was banned from it. No subjectivism was left. An aesthetics of the object was intended that should come close to the way physicists were studying their subject.

In 1968, I developed a program that claimed to become proof of Bense's and others' theory. It started from the formal definition of an analytical aesthetics as a set of statistic measures. It took the inverse of the analytic aesthetics, and called it generative aesthetics. A set of numerical constraints was specified that a picture construction was to satisfy. The generative aesthetics tried to solve the set of constraints. If that turned out to be possible, a picture was determined as a probability distribution over the set of permitted elemental signs. A quadtree construction process then dispersed the signs onto the picture.

Generative Aesthetics I, as the program was called, was a great experience [Nake 1974]. It produced, as printed out-

put, a large quantity of pictures with prescribed numerical features. Two of the printed patterns were actually realized by hand. One of them still exists (Fig. 4).

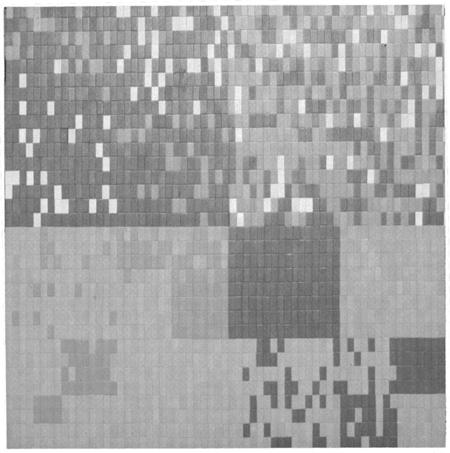

Figure 4. **Frieder Nake: Generative AestheticsI, Experiment 6.22. Colored tiles on board, 120 x 120 cm. 1969**

The program's greatest contribution was the invention of the quadtree structure (others independently found it at the same time). The project also showed that the hope for an absolutely objective aesthetics was in vain.

Although Moles' book (originally written in French) was translated into English and published in the US, information aesthetics did not gain any influence or attention there. I gave a seminar in Toronto (1969), and Mihai Nadin tried a few things at Ohio State University at Columbus. But compared with the importance, the Zagreb meetings attributed to Bense's and Moles' theory, it is fair to say that a huge gap existed between the two continents. Computer art in Europe, from the very beginning on, was a practical as well as theoretical innovation even if the particular first theory failed.

THE ALGORITHMIC SIGN

On a descriptive level semiotics is a powerful theory. As long as we do not expect a predictive potential from semiotics, we can use it nicely to describe certain differences between communicative processes.

This paper can only very briefly hint at the concept of an algorithmic sign. More on it will soon appear in print.

Software objects in general, and digital images in particular, exist in two ways. They appear on the surface of the digital medium, and they are hidden away deep in its internal storage structures. The surface appearance is for our senses to perceive. The internal existence is for the computer processor to manipulate. The software object is a pair and unity of a perceivable and a manipulable aspect. The two are inseparably interlinked. One does not exist without the other. With a few exceptions, if one of the two sides disappears, the other disappears, too.

Another consideration (which must here be suppressed) shows that software is intrinsically of semiotic nature (the computer is at times called the *semiotic machine*). I was therefore looking for the special features that would distinguish software as sign from other signs. It turns out that software should be understood as an *algorithmic* sign.

Signs get interpreted. Otherwise, they do not exist. The interpreters of signs are humans. Humans cannot exist other than by constantly interpreting signs, and through the very act of interpretation, they are creating signs.

Algorithmic signs get interpreted twice: by a human and by a computer. This is a dangerous statement because computers *cannot* interpret in the same way as humans do. Only in a formal way can we put computers into the role of interpreters of signs. Formally, computers are indeed forced, as humans are, to constantly interpret a stream of signals that is appearing when a program is executed. The only difference is that the computer's act of interpretation lacks the defining power of human interpretation: whereas we are, in principle, free to interpret this way or the opposite way, or any other way we choose, the computer's interpretation is reduced to an act of precisely determining what the processor must carry out next. There is no freedom of choice.

We expect nothing but strict obedience from the computer even if, as a machine processing signals, it should have the potential of interpreting those signals. It obeys what it is told by the signals, and it does a good job in that. We therefore have no reason to talk of interpretation on behalf of the computer. Formally, however, the determination appears at exactly that place in the semiotic process where the human would be interpreting. Ontologically, the computer is not interpreting. Logically it is. Therefore it is justified, in a formal theory, to define the algorithmic sign in the way indicated above. It is a sign between us and our computers.

In the context of computer art and digital pictures, algorithmic signs appear as a challenge for a new attention in design work. To design algorithmic signs is to design such that a machine functions correctly, but for the only purpose to affect humans as perceivers.

An aesthetics of digital art must take that into account. It will become a theory of a similar kind as any other aesthetics; it must also, to some extent, pay attention to the digital medium in its technical existence.

CONCLUSION

To give away, in writing, personal memories of events that may meanwhile have gained some historic relevance can be a very touchy act. Too great is the danger of putting more importance than is justified on personal involvement. I am afraid I was not absolutely able to avoid this tar pit of image cultivation. My intention was, however, not to be objective. How could, and why should I try since objectivism is an

ideology of oppression. My intention was to call to attention some aspects of the early history of computer art that may turn out to be more important than is commonly known or assumed.

Now is the time when serious work has started to uncover that history, to collect as much of the remnants as possible, and perhaps even to preserve some of the works (which in this technology-prone area seems virtually impossible). I hope that the wonderful as well as the ridiculous of those first five or ten years will come to the surface.

Computer art is usually no longer called by that name. Digital art, virtual art, and a plenty of more words are now being used. That is alright. "There should be no computer art", was the heading of a statement I published in *page*, the Bulletin of the Computer Arts Society (no. 18, 1970, 1-2). It has survived, and it is lively as ever.

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