SonicActsXI

THE ANTHOLOGY OF COMPUTER ART

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The Anthology of Computer Art

Sonic Acts XI

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Editorial

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ARIE ALTENA

Dit boek is samengesteld ter gelegenheid van Sonic Acts XI (Amsterdam, 23 - 26 februari 2006), ook getiteld The Anthology of Computer Art.

Sonic Acts XI is tot stand gekomen vanuit de observatie dat autonome computerkunst de laatste jaren een comeback beleefde. Mede door de voortschrijdende ontwikkeling van de hard- en software, is toegepaste en autonome computerkunst de laatste vijftien jaar tot bloei gekomen in zowel de beeldende kunst en elektronische muziek, net als in de film-, video- en gamewereld. Doordat hardware en software toegankelijker en gebruiksvriendelijker zijn geworden heeft een grote groep kunstenaars bezit genomen van dit domein en er is veel nieuw werk ontwikkeld. Opvallend is daarbij dat momenteel steeds meer meer kunstenaars zelf hun eigen hardware ontwerpen en hun eigen software ontwikkelen. Dit vormt opnieuw een essentieel onderdeel van de hedendaagse computerkunst.

Opnieuw, omdat de pioniers van de computerkunst, de allereerste technici en kunstenaars die de computer gebruikten bij het maken van kunst, niet anders deden. Zij waren gedwongen om zelf software te ontwikkelen, of, in sommige gevallen, hun eigen hardware te bouwen uit bijvoorbeeld afgedankte militaire apparatuur. Deze technici en kunstenaars waren de eersten die het digitale domein artistiek gebruikten, Zij ontwikkelden in de jaren zestig een eigen vorm van veelal 'abstracte', autonome computerkunst. Zij theoretiseerden over het gebruik van algoritmes en het idee van een computergegenereerde kunst -- waarbij de kunstenaars de regels schrijft en de computer deze uitvoert. Hun ideeën waren niet zelden ingebed in een debat over het samengaan van kunst, technologie en wetenschap, dat sterk was beïnvloedt door de destijds populaire cybernetica, de informationele esthetica en, wat later, de semiotiek. Er waren parallellen tussen de opvattingen van deze pioniers van de computerkunst, en tendensen binnen de conceptuele kunst, evenals parallellen met het werk van experimentele kunstenaars die hun werk opvatten als visueel onderzoek.

Aan het einde van de jaren zestig vinden er dan ook drie, inmiddels legendarische tentoonstellingen plaats, waar computerkunst temidden van allerlei andere interactieve kunst, technologische ontwikkelingen en vooral conceptuele kunst wordt getoond: het door Jasia Reichardt samengestelde *Cybernetic Serendipity* in Londen, *Tendencies 4* in Zagreb en tenslotte *Software*, door Jack Burnham gecureerd in het Jewish Museum in Ne York. Daarna lijken de wegen van conceptuele kunst en computerkunst zich te scheiden. Begin jaren zeventig verschijnen verschillende boeken over computerkunst, en lijkt ze door te breken in de kunstwereld. De focus komt gedurende de jaren zeventig en tachtig echter meer te liggen op de ontwikkeling van (industriële) computer graphics en toegepaste vormen van computerkunst; autonome computerkunst kan niet rekenen op veel aandacht, ze verdwijnt uit zicht, en het werk van de pioniers raakt grotendeels in vergetelheid.

Precies die vroege computerkunst kan sinds kort weer rekenen op een hernieuwde interesse. De Leonardo-conferentie *Refresh!* in 2005, en de tentoonstelling *The Algorithmic Revolution* in het Duitse ZKM, ook 2005, zijn daarvan slechts twee voorbeelden. Misschien ligt deze computerkunst nu lang genoeg achter ons om met een historische blik terug te kijken. Misschien is het ook zo dat de pioniers aan herontdekking toe zijn omdat, zoals boven gerefereerd, de huidige autonome computerkunst het zelf ontwikkelen van hard- en software belangrijk vindt en zo, merkwaardig genoeg, aansluiting kan vinden bij die eerste generatie.

In ieder geval blijkt er, zoals vaak, in de steegjes en op verlaten velden van de kunstgeschiedenis, van allerlei interessants en intrigerends te vinden dat ook de huidige autonome computerkunst in perspectief kan zetten.

Deze anthologie begint met een tekst van de jonge Amerikaanse computerkunstenaar Casey Reas. Hij legde een aantal jongere computerkunstenaars twee lijsten met namen voor, de ene met pioniers van de computerkunst, kunstenaars, technici en wetenschappers die hands-on met de computer werkten; de andere met bekende namen uit bijvoorbeeld de conceptuele kunst. Het zal weinig verbazing wekken dat meermaals wordt getuigd van diepe beïnvloeding door kunstenaars uit het tweede rijtje, terwijl slecht een enkeling, dan nog bijna schoorvoetend, ingaat op de namen uit het eerste rijtje. Daarmee is in feite het kader en de aanleiding voor dit boekje geschetst.

Het leek ons in eerste instantie interessant om die geschiedenis van de computerkunst eens voor het voetlicht te brengen. Immers, hier gingen software en kunst voor het eerst samen. Wie het werk uit die tijd bekijkt, de ontwikkeling volgt, de teksten van kunstenaars uit die tijd leest, en de kritische beschouwingen van toen en later, stuit op allerlei intrigerende kwesties. Bijvoorbeeld met betrekking tot de verklaringen voor het verdwijnen van de computerkunst uit het veld van de 'beeldende kunst'; was het inderdaad kunst die werd gemaakt door technici met de blik van technici? Trok ze zich inderdaad terug achter de muren van universiteiten en onderzoekslaboratoria en miste ze daarom de aansluiting met de kunst? Wat is daarbij de rol geweest van de inbedding van deze computerkunst in de theorievorming rondom cybernetica en informationele esthetica, met haar streven naar zuivere wetenschappelijkheid?

In deze uitgave zijn een aantal teksten verzameld die, bij elkaar, een tentatief en zeer incompleet overzicht geven van het werk en het denken van de eerste generatie computerkunstenaars. Daarbij focussen we vooral op de periode van 1965 tot begin jaren zeventig. De keuze die we hebben gemaakt is een noodzakelijk beperkte, een gevolg van zowel inhoudelijke overwegingen als praktische kwesties.

De teksten van Lejaren Hiller (1924 - 1994) en Iannis Xenakis (1922) illustreren hoe men in de muziek, eerder dan in de beeldende kunst, de computer ging inzetten bij het componeren. Hiller, van huis uit scheikundige, geldt als eerste die een computer gebruikte om muziek te maken: hij componeerde zo de *ILLIAC Suite* voor strijkkwartet. De compositieprincipes van Iannis Xenakis zijn vrijwel altijd gebaseerd op wiskundige regels, vandaar dat hij al zeer vroeg mainframe computers ging gebruiken bij het doorrekenen van zijn composities.

Weliswaar is de geschiedenis van de cybernetica en haar invloed op het 'digitale domein' en haar discours de afgelopen jaren diepgaand onderzocht, datzelfde kan niet in dezelfde mate worden gezegd van de informationele esthetica van Abraham Moles en Max Bense, die toch van grote invloed was op de vroege computerkunst. De filosoof, schrijver en theoreticus Max Bense (1910-1990) was in de jaren vijftig en zestig een centrale figuur voor de Duitse experimentele kunst. (In sommige opzichten valt hij te vergelijken met Umberto Eco, hun interesse in cybernetica en experimentele kunst komt overeen, en beide ontwikkelden een omvangrijke theorie van de semiotiek). Hij was een van de eersten, zo niet de eerste, die theoretiseerde over het genereren van kunst met de computer. De korte tekst *Projects of Generative Aesthetics* verscheen in 1965 in een boekje met computergrafiek van Georg Nees en geldt sindsdien als eerste manifest van de gegenereerde computerkunst. De langere tekst *Small Abstract Aesthetics* toont hoe deze ideeën ingebed waren in een theorie van de semiotiek en een verlangen naar verwetenschappelijking van de kunstbeschouwing die destijds hoogtij vierde. Van Georg Nees (1926) namen we een kort statement over computerkunst uit 1969 op.

Jasia Reichardt cureerde in 1968 *Cybernetic Serendipity* en publiceerde sindsdien meerdere artikelen en boeken, onder andere gewijd aan computerkunst. De hier gekozen tekst geeft goed weer hoe er aan het einde van de jaren zestig werd aangekeken tegen computerkunst.

Expanded Cinema van Gene Younblood is uiteraard een klassieker. Het biedt een zo mogelijk volledig overzicht van allerlei alternatieve vormen van 'cinema', verscheen in 1970 maar staat nog altijd als een huis. Het hier gekozen excerpt gaat over het werk van twee pioniers van de computerfilm. Ten eerste John Whitney Sr. (1918-1996), die in zijn zoektocht naar de visuele evenknie van gecomponeerde muziek, een fabuleus euvre aan computerfilms heeft gemaakt, alleen, samen met zijn broer en met zijn zoons. Ten tweede Stan Vanderbeek (1927 - 1984) die samen met Ken Knowlton verschillende computerfilms maakte.

Frieder Nake (1938) was, samen met Georg Nees en A. Michael Noll een van de eersten die gegenereerde computergrafiek als kunst tentoonstelde (1965) . In de twee hier gekozen teksten uit het Engelse *PAGE*, het *Bulletin of the Computer Arts Society*, legt hij uit waarom hij niet langer meer in het kunstcircuit wil tentoonstellen. In lijn met het radicale, revolutionaire gedachtengoed van begin jaren zeventig wil hij geen deel uitmaken van de bourgeois kunstwereld. Nake's positie toont een verband tussen het utopisch radicalisme van die jaren en de computerkunst. Dat is verrassend aangezien het 'verdwijnen' van de eerste generatie computerkunstenaars uit de kunstgeschiedenis meestal toeschrijft aan het feit dat zij te zeer waren ingekapseld in de technologie en de militair/wetenschappelijke instituties.

In de daaropvolgende teksten zetten respectievelijk Manfred Mohr (1938) en Vera Molnar (1928) uiteen hoe zij, -- we spreken inmiddels van midden jaren zeventig -- dachten over de verhouding tussen algoritme en kunst, en hoe zij de computer inzetten bij het maken van hun werk. Zowel Mohr als Molnar begonnen vanuit de abstracte schilderkunst, beide hebben hun eigen plek in de kunstwereld veroverd en stellen nog altijd regelmatig tentoon.

Kenneth Knowlton is een centrale figuur voor -- onder andere -- de computerkunst en de computerfilm. Hij ontwikkelde in de Bell Laboratories meerdere systemen voor computerfilms en computerkunst en werkte nauw samen met verschillende kunstenaars, waaronder Lillian Schwartz en Stan Vanderbeek. In dit boek representeert hij wellicht de figuur van de technicus die terecht komt in de kunst en daar zijn eigen, kenmerkende verhouding tot ontwikkelt, die vooral gericht is op samenwerking met kunstenaars wiens ideeën hij technologisch mogelijk maakte. Daarbij liet hij wel diepgaande sporen na op de ontwikkeling van de computerkunst. Volgend op een tekst van hem uit 1975, publiceren we hier zijn terugblik uit 2004 op de ontwikkeling van de computerkunst en zijn rol daarin.

Het boek wordt afgesloten met een drietal contemporaine visies. De musicus Kim Cascone is tevens een veelgeciteerd theoreticus wat de ontwikkeling van microsound en laptopmuziek betreft. In de hier opgenomen tekst gaat hij in op de presentatie van computermuziek, iets wat altijd een probleem is geweest en nog altijd niet goed wordt opgelost door de huidige generatie laptopmusici. Greg Kurcewicz traceert redenen voor de toegenomen interesse in de idee van visuele muziek en Wolf Lieser sluit af met een artikel over het tonen van computerkunst vanuit het perspectief van een kunsthandelaar en galeriehouder.

Uiteraard betreft het hier een keuze die op vele wijzen valt te bekritiseren. Ten eerste richt onze keuze van teksten zich bijna uitsluitend op de Duitse en deels Amerikaanse ontwikkeling van de computerkunst. Enerzijds het circuit dat sterk onder invloed stond van Max Bense, anderzijds het circuit rondom Bell Laboratories. De kritiek dat we ons daarmee feitelijk aansluiten bij het momenteel gangbare beeld van de computerkunst, is steekhoudend. We hebben inderdaad nauwelijks aandacht voor hebben voor de bijdrage van de Japanse, Braziliaanse, Mexicaanse, Zweedse, Nederlandse, Oost-Europese of Joego-Slavische computerkunst.

Ook richten we ons vrij expliciet op de periode tussen grofweg 1965 en 1975; terwijl er veel voor te zeggen is om de verder terug in de geschiedenis naar de lijnen te zoeken en zo een uitgebreidere genealogie van de computerkunst uit te zetten. Om vier voorbeelden te noemen, van heel breed tot heel specifiek: het gebruik van wiskunde in de kunst; de wens van constructivistische kunstenaars om het persoonlijke en handmatige steeds verder uit hun werk te bannen; het gebruik van Lissajous-figuren; en oscillografie.

Bovendien isoleren wij ook hier de autonome computerkunst van de ontwikkelingen in de technologische kunst, de interactieve kunst, populaire cultuur en, al gerefereerd, de conceptuele kunst. Enzovoorts. Deze mogelijke kritieken zijn evengoed aanleidingen voor aanvullingen en onderzoek.

Tenslotte zijn er de nodige teksten die we graag hadden opgenomen, maar hier moeten ontbreken wegens praktische redenen. Niet iedereen reageerde op gedane verzoeken, en niet altijd vonden we op tijd de juiste personen (ook niet in tijden van e-mail en internet). Gelukkig werd in veel gevallen wel prompt en enthousiast gereageerd. In alle gevallen hebben we van de teksten die we hier opnieuw publiceren het mogelijke gedaan om rechthebbenden op te speuren. In alle gevallen hebben de auteur of diens erfgenamen toestemming gegeven voor opname.

Helaas ontbreken bijvoorbeeld teksten van Herbert Franke, die, net als de Amerikaan Ben Laposky, al in de jaren vijftig experimenteerde met voltages en mathematische schakelingen en zo electronic graphics creeërde. Hij publiceerde in 1971 het eerste overzichtsboek over computerkunst *Computer Graphics*. Een andere belangrijke omissie is het werk van Abraham Moles (1920 - 1992), een aan Max Bense verwante -- en met hem bevriende -- Franse theoreticus. Samen met Max Bense is hij te beschouwen als grondlegger van de infromationele esthetica. Moles heeft, anders dan Bense, ook veel aandacht voor sociologische aspecten, zijn werk is van een helderheid die noch altijd aantrekkelijk is. Zijn boek *Art et Ordinateur* werd al in 1973 gepubliceerd, en intrigeert nog steeds, of opnieuw.

Dit boek is bedoeld om de geschiedenis van de computerkunst in beeld te brengen, en impliciet te verbinden met de huidige computerkunst. Misschien is het uiteindelijk een boekje geworden waarin we ons enthousiasme (dat een kritische houding niet in de weg staat) voor het werk en de esthetische postites van de pioniers te delen; enthousiasme voor en interesse in een periode waarin, voor korte tijd, de werelden van de techniek, de wetenschap (cybernetica, informationele esthetica) en de experimentele plus conceptuele kunst elkaar raakten

Het spreekt vanzelf dat deze uitgave nooit in de korte beschikbare tijd gemaakt had kunnen worden zonder de hulp van hier vertegenwoordigde auteurs en kunstenaars, en andere personen met wie we contact zochten. Het was ook niet mogelijk geweest zonder de inspanningen van al die personen en instellingen die in de afgelopen jaren talloze papers, scans, pdfs en zelfs films online hebben gezet -- als onderdeel van een onderzoeksproject naar de geschiedenis van de computerkunst, of als onderdeel van een syllabus voor een universiteitsseminar. Sommige teksten waren anders zeker ontoegankelijk gebleven.

Dit boekje is niet het eindresultaat van een onderzoek, het is de neerslag van de voorbereiding van een conferentie. En het is een aanzet tot verder onderzoek, discussie en wellicht herwaardering en inspiratie.

Who are the Progenitors of the Contemporary Synthesis of Software and Art?

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C. E. B. REAS

During the last decade there has been a proliferation of artists using software as their primary medium. Like photography and video before, the introduction of a new technology, in this case digital computers, has opened a unique space for contemporary art practice. In the author's opinion, the foundation for this contemporary work is firmly rooted in the 1960s. It's much less clear, however, if other contemporary artists agree and who they acknowledge as their progenitors. The following lists divide a selection of the innovators working in the 1960s into two groups:

List A
Steven Beck,
Harold Cohen,
Charles Csuri,
Kenneth Knowlton,
Ben Laposky,
Manfred Mohr,
Frieder Nake,
Georg Nees,
A. Michael Noll,
Manfred R. Schroeder,
Lillian Schwartz,
Stan Vanderbeek,
John Whitney Sr.

List B
Yaacov Agam,
Mel Bochner,
Hans Haacke,
On Kawara,
Les Levine,
Sol LeWitt,
George Maciunas,
Yoko Ono,
Nam June Paik,
Bridget Riley,
Dieter Roth,
Victor Vasarely,
La Monte Young.

The first group of people (List A) were among the first to use software for the production of images in the context of visual art. The second group of people (List B) presents artists working with ideas found in contemporary works created with software, but who did not utilize computers in their work. The people who comprise List B are typically associated with Minimalism, Conceptual Art, Op Art, and Fluxus and the individuals in List A have garnered such little critical attention over the years that they are not associated with a movement and are discussed only in highly specialized books on the topic of art and technology.

Within the last few years, forms of art pioneered in the 1960s have been featured prominently in exhibitions throughout Europe and the United States. Work by the practitioners in List B has been promoted recently in shows such as *Global Conceptualism* at the Queens Museum of Art, *Open Systems* at the Tate Modern in London, *A Minimal Future?* at Los Angeles MOCA, and *Force Fields* at the MACBA in Barcelona, to name a few. Work representative of the practitioners in List A has resurfaced through shows such as *Scratch Code* at the bitforms gallery in New York and the Digital Pioneers section of *Electrohype 2004* at the Malmö Konsthall and [DAM] Berlin. The unique *Die Algorithmische Revolution* exhibition at the ZKM in Karlsruhe, Germany presents the work of both groups together in a continuous narrative. Scholarly research initiatives include 2005's *Refresh! International Conference on the Histories of Media Art, Science and Technology* Conference at the Banff New Media Institute and the recent CACHe project, which researches the origins and histories of British computer arts.

New art forms emerging during the 1960s are clearly being revisited and recontextualized, but what impact has it had on contemporary artists working with software? In the spirit of exploration, I've asked a group of contemporary artists using software as their principle medium the following question:

WHAT IS THE PRECEDENT FOR YOUR WORK? DO YOU ASSOCIATE YOURSELF WITH ANY OF THE ARTISTS MENTIONED ABOVE OR ANY OTHER ARTISTS OR ARTWORKS FROM THE 1960S?

AURIEA HARVEY & MICHAEL SAMYN

In our work, we try to make something that will amuse our audience and we hope to enlighten them and enrich their lives. Expressing personal emotions or experimenting with aesthetics or technology are only means to an end. This is why we do not feel much affinity with most 20th century art.

Despite of the highly technical nature of our medium and the complexity of some of the software we create, we look further in the past, in search of masters. We probably feel most affinity with artists from the 19th century – both the romantics and the classicist Salon painters. We share their admiration for the Flemish Primitives and Renaissance and Baroque art. And, like them, we attempt to create meaningful images that communicate directly with our audience. We hope that our work can be a continuation of an artistic tradition that was violently interrupted by modern art. And we see in interactive media a technology that can advance this tradition in a similar way as oil painting did 500 years ago.

… Jacques-Louis David, William Bouguereau, Gianlorenzo Bernini, John William Waterhouse, Jean-Leon Jerome, Sandro Botticelli, Jan Van Eyck, Rogier van der Weyden, Caspar David Friedrich, and Gustave Moreau.

MOGENS JACOBSEN

When I was a young teen, I borrowed the book *Expanded Cinema* by Gene Youngblood at the local library. I renewed this loan over and over again. In the 1970s I got access to a computer (or rather to a terminal) and I guess I was supposed to program it to do simple calculations and stuff like that but I preferred to make it draw patterns on endless rows of paper. I had no knowledge of any historical roots in the world of fine art when I started writing my algorithms. But I was very inspired by what I had seen in Youngblood's book. When I had the chance, I always went to art-cinemas and film museums to see the films of Oskar Fischinger, Walter Ruttmann, Viking Eggeling, Norman McLaren and Len Lye.
It all boils down to accessibility: I never knew of "the Algorists" or their likes when I grew up. Seeing their works was something I did twenty years later. Even though I never print anything, Manfred Mohr's *Laserglyphs* are on my personal canon of algorithmic artworks. And even though some of the physical pieces by Hans Haacke continue to surprise me, I spend more time reading about Stanislaw Ulam, than about conceptual art.

GOLAN LEVIN

I used to stare at Vasarely's work for hours when I was a kid. For the past decade, though, the most direct influences on my work have come from artists whose principal medium and subject matter is interactivity itself. I'm particularly indebted to artists who have researched algorithmically-augmented interactivities in the contexts of gestural input and audiovisual output – people like Myron Krueger, Toshio Iwai, Scott Snibbe, and John Maeda. Many of the artists listed have focused on the use of the computer (or other rule-based systems) to produce mostly static visual forms. Although it's true that their work is a foundation for a great deal of today's digital art (and generative art in particular), I think it's important to recognize how the influences on digital art broadened as the computer became increasingly capable of rendering animated sequences (in the 1970s) and real-time graphics (in the 1980s). For me, the artistic potential of this time-based and responsive new medium could be best appreciated through prior achievements in absolute film (e.g. Oskar Fischinger, Norman McLaren, Stan Brakhage), kinetic art (e.g. John Calder, Len Lye), and audiovisual instrument design (e.g. Thomas Wilfred, Harry Partch). Of the artists mentioned in the above lists, I have drawn the most inspiration from Yaacov Agam, who truly was creating interactive paintings, and John Whitney, for the breadth and courage of his attempts to relate sound and image through computation.

DRIESSENS & VERSTAPPEN

We find precedent in the work of Hans Haacke, Sol LeWitt, Yves Klein, Jean Tinguely, Herman de Vries, Jan Schoonhoven, Peter Struycken (Dutch computer artist), Panamarenko, Joseph Beuys, Guiseppe Penone, James Lee Byars, Donald Judd, and Duane Hanson. Romanticism, Modernism, the works from the 1970s and 80s also have influenced our thoughts and way of working.

In our software applications we describe the laws of an artificial nature that evolves new, limitless, living worlds of phenomena. A program that shows something of the amazing power of creation, has something of the sublime about it. What Romantic painting could only portray figuratively, we can let the observer actually experience with artificial-life techniques. It is also somewhat inherent to algorithmic art and software art that you are looking at (or navigating through) abstract worlds of color. This is acceptable now, because Modernism opened up the abstract domain. Software art explores and realizes this potential further with the new possibilities that computers can offer.

The 1960s artists that we have mentioned, are important because they gave a new impulse to algorithmic art and generative art in general. In their work they used descriptions, recipes, repetitive actions, chance operations, machines, concepts, and mathematical and scientific methods. With their more or less objective and systematic approach, some of them react against the subjectivity of Expressionism while others commented on the production and perception of art in the reality of the consumption society, industrialism, and the mass-media.

TIFFANY HOLMES

My practice is inspired by conceptual artists like Hans Haacke who promoted environmental stewardship through the real-time visualization of ecological systems.

Our buildings breathe data. My recent animations dynamically visualize environmental variables hidden in building automation systems, such as kilowatts consumed per hour. The goal of my work is to raise awareness of resource usage and increase conservation behavior.

Haacke drew attention to water pollution in Krefeld, Germany by creating a system to clean wastewater. In *Rhinewater Purification Plant* (1972), the artist collected effluent from a nearby sewage plant for transformation. Haacke's installation featured a custom pump and filter that purified the tainted water for release into a goldfish tank. Surplus water was discharged to irrigate the museum's gardens. In converting wastewater to water that supported fish, Haacke highlighted the sewage plant's role in degrading the river. Haacke also introduced gray-water reclamation through art. Gray-water reclamation is used to conserve drinking water by recycling runoff from domestic showers and sinks for outdoor use. In designing my own work, I continually think of this piece as an example of the pioneering use of technology to dynamically visualize positive change in the environment.

HANS BERNHARD

Corporate Switzerland, Viennese Actionists and the dotcom boom gave us the tools of corporate identity manuals, the *Aktion*, and business plans to work on a piece of radical corporate software (*etoy*). My main technique is sampling/collage. Influenced by New York rap music from the 1980s, I learned to aggressively copy & paste and to invisibly mix conceptual elements with visuals and philosophy with code. The myth of the pop-star and the construction of a fascist global *über*-corporation was the driving force behind *etoy*. This fusion of drugs and technology was blended with results of our analysis of Andy Warhol, Archigram, Futurism, Michael Milken and contemporary boy groups such as The Backstreet Boys.

Ubermorgen.com's work is unique not because of what we do but because how, when and where we do it. The computer and the network create our art and combine every aspect of it. Ubermorgen.com is metaphysically influenced by Lawrence Weiner and practically enhanced by ever reinventing Madonna, Jean Tinguely, the Nouveaux Rēalistes and by the hardcore Viennese Actionists. The unseizable chronological and squashed spacial circuit of conceptual art, drawing, software art, painting, sculpture and digital actionism (media hacking) transformed our brand into one of the uncatchable identities – controversial and iconoclast – of the contemporary European techno-fine art-avantgarde.

Artists of relevance include On Kawara, Joseph Beuys, Mario Merz, Mark Rothko, Richard Serra, Peter Weibel, Andy Warhol, Günther Brus, Rudolf Schwarzkogler, Jean Tinguely, Lawrence Weiner, Michelangelo Pistoletto, Marcel Duchamp, La Monte Young, and Archigram.

JASON SALAVON

In the early 1990s, as an undergrad art student, I got really into hip contemporary stuff, 'ironic sculpture' particularly. I was in love with stuff from the likes of Charles Ray, early Wim Delvoye, and early Tom Friedman. There is an algorithmic quality to that work. Simultaneously, I was taking a ton of computer science, because I liked it and seeing my dad's lack of financial success at art, I was consciously hedging my bets.

It was in 1992 that I started trying to write code to generate or assist with making work. Hans Haacke, and more importantly, Sol LeWitt were obvious reaffirmations of procedural artmaking. Two other 'big boys' that I was struck by were John Cage and, less obviously, Ellsworth Kelly. Early Ellsworth Kelly drawings are heavily into chance, automatic procedures, with relatively clean finishes (as opposed to Abstract Expressionism's chance procedures). They meant a ton to me.

I've also been heavily influenced by three non-artists who investigated visual computation. Reading Douglas Hofstadter's *Gödel, Escher, Bach* was such a weird, fun ride; it opened many doors. James Gleick's *Chaos* introduced Benoit Mandelbrot and fractals, before they were goofy posters. Most importantly to me, John Conway's *Game of Life* blew my mind and validated many of my instincts toward the power of simple autonomy.

OSMAN KHAN
I find precedence for my own work with members of List B and the artist movements they represent. This has less to do with the tools used (medium) than with the approach (concept) to their respective art practices. With that said I do not intend it to mean that medium and concept are to be separated.

The artists in List A seemed foremost concerned with exploring formal possibilities of the computer – arguably many of their works can be seen as extensions of abstract art. The artists in List B concerned themselves more with conceptual repercussion (theoretical, social, and political) of new technologies. My own art practice concerns itself with the affects of the computer (and other technologies) on our social conditions, and as such works on appropriating, subverting and redeploying technologies in order to foster a new way of seeing, understanding, and interacting with a given system and not as a means to explore new aesthetic expressions. However, to conceptually explore a medium it's also necessary to have a technical understanding and I share this with members of List A.

Arguably, due to List A's lack of attention and representation their potential influence (a full understanding of their work) has been diminished and I do feel one is unable to make appropriate comparisons.

JOHN SIMON JR.
Sol LeWitt's ideas are persistent in my thinking. I first encountered his rule-based approach to drawing at age thirteen when my mathematician mother showed me *Wall Drawing #97* with its two sets of 10,000 lines. I knew how to write software when I started my art career so I was less interested in artworks that explored the artistic side of programming and was more drawn to art concepts that explored (and exploited) systems. Besides the natural affinity I feel between LeWitt's work and programmatic rules, other aspects of his work that feed my analytical approach to art making are his serial presentation of information and his fascination with combinations. Another conceptual artist who is not on the list but whose thinking influenced me is Lawrence Weiner. He writes that his artwork exists as an idea even if it is never made into a physical object. This dematerialization of art into idea led me to understand how a piece of software could itself be an artwork and remain so, even if it was stored as source code and not running.

LISA JEVBRATT
My work owes to Donald Judd and the minimalists for making things that just are, that do not iconographically or symbolically refer to this or that, and to expressionists such as Jackson Pollock, making works that are the direct expression, indexical imprints of systems rather than descriptions of systems, and maybe less obviously to Land Art. While Code Art is directly related to instruction art such as the instructional drawings by Sol LeWitt or La Monte Young's instruction-based performances, the instructions, the code, we deal with today always exists in relation to a network. The networked code and protocols form a complex entity that I call the *infome*. This entity is simultaneously an organism emerging from the rules we create, and an environment, a geology, a determining circumstance dictating the life of this organism. Coding is to generate the environment and to move, displace and map what emerges, not unlike the works of land-artists such as Robert Smithson and Michael Heizer. However the soil they displaced was generated by geological processes. Our 'soil' is made up of language, communication protocols and written agreements. Its displacement has the potential to reveal the assumptions and implications of the networks we work with(in).

LIA
As I never studied art or history at any university, most of the names you mention I have actually never heard of, just a few. When I was still in high school I liked to try to 'repaint' paintings from almost every epoch from the thirty volumes of art history books at home (skipping the cave drawings, maybe I faked some 1960s, I can't remember), because I thought this would be a way to learn how to paint better. But when I started working on the computer, one of the main issues was actually to learn how to program (after figuring out how to *use* a computer), and not already how to use the code for artworks – that only came later on and was more or less 'happening' during the attempt to get better in programming. That's probably why in this case I didn't look to what others might already have done and trying to learn from that (like I did with painting), but started completely with my own ideas, basically completely ignoring the history. So in this sense I was probably more influenced by the (back then) active 'computer scene' in Vienna than from any historic artists or art pieces.

MARIUS WATZ
The art and design of the 1960s are crucial precursors to the current work in computer-based art and design. I have been aware of the work of Bridget Riley, Victor Vasarely, and other artists from the 1960s since the beginning of my work with visual form. Abstract art from that period remains a main reference point for me, more strongly so than any other period in art history. Harold Cohen came to my attention early on, but I have only recently become aware of the other computer pioneers. I find the early computer works fascinating, but as an artist I feel a stronger affinity to the Op Art, Minimalist, and Pop Art movements. Their work with geometry, bold colors and form as a pure expression resonate strongly with my own work, while Conceptual Art and Fluxus provide tools for working with concepts as objects in themselves. An influence not to be ignored is the work that was going on in design and architecture at the same time, dominated by new materials, modular systems and a utopian belief in automation and mass communication. Archigram, Verner Panton, Buckminster Fuller and others explored new functional structures, as well as new ways of working with form.

ALEX MCLEAN
Until recently I have been working with sound. I've been influenced by Karlheinz Stockhausen and his process music and by more recent artists like Autechre and Speedy J. My greatest influence has been my collaborators, mainly Adrian Ward, and the other TOPLAP members. I've met Rolf Gehlhaar, a member of Stockhausen's orchestra, a few times and he told me something about what it was like to perform his work. I don't personally believe that I am channeling divine/stellar energy like Stockhausen believes, but I like the idea of giving rules to actors and giving some freedom in which to work. I find this analogous to programming. I'm inspired by the sheer effort he put into realizing extremely detailed work that we would now consider next to impossible without a computer. It's a good reminder that we should use well what we now have.

I'm currently starting to work with video more, and Harold Cohen is a major influence. It's great that he's been programming his own software and making his own machines with such interesting results. It is clear proof that you can develop and explore your style by expressing it as code and then working with that code.

JÜRG LEHNI
My self-initiated work originates from reflections about tools, the computer, and the way we work with and adapt to technology. I like the results of technology failing or not being able to keep its promises. The first generation of affordable personal computers was very promising, bringing vast possibilities for exploration and play into the living room, while remaining easy to understand and manageable. These machines seemed to have the potential of fundamentally changing our relation to tools, an expectation that has later been invalidated by the growing complexity of the newer systems. Personally, I try to keep this somewhat nerdy approach to technology alive and give it shape in my work. Some of the results have been shown in the art context, but

this is a direction I am not actively pursuing. I find it hard to see my output as a direct reaction to some events in art history, but find art in general inspiring, along with many other things the world has to offer. Somehow contemporary art seems conceptually stuck, with too many boundaries getting in the way of reasoning, the way of talking about things and presenting them.

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http://www.banffcentre.ca/bnmi/events/refresh/
http://www.zkm.de/algorithmische-revolution/

ARTIST WEBSITES

Auriea Harvey & Michael Samyn
http://entropy8zuper.org

Mogens Jacobsen
http://www.artnode.org/jacobsen

Golan Levin
http://www.flong.com

Driessens & Verstappen
http://www.xs4all.nl/~notnot

Tiffany Holmes
http://www.tiffanyholmes.com

Hans Bernhard
http://www.ubermorgen.com

Jason Salavon
http://salavon.com

Osman Khan
http://wwwosmankhan.com

John Simon Jr.
http://www.numeral.com

Lisa Jevbratt.com
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Marius Watz
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Alex McLean
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Jürg Lehni
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Interviews initiated and edited by C.E.B. Reas
http://reas.com

Computer Music

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Extracts from 'Mathematical basis of music, information theory, use of computers in composition', *Scientific American*, December, 1959, as published in Jasia Reichardt (ed.), Studio International special issue on *Cybernetic Serendipity, the Computer and the Arts*, London, August 1968. Used with kind permission of the Hiller family.

LEJAREN A. HILLER, JR.

Can a computer be used to compose a symphony? As one who has been engaged in programming a large digital computer to produce original musical compositions, I can testify that the very idea excites incredulity and indignation in many quarters. Such response in part reflects the extreme view of the nineteenth-century Romantic tradition that regards music as direct communication of emotion from composer to listener – 'from heart to heart,' as Wagner said. In deference to this view it must be conceded that we do not yet understand the subjective aspect of musical communication well enough to study it in precise terms. The appreciation of music involves not only psychological needs and responses but meanings imported into the musical experience by reference to its cultural context. On the other hand, music does have its objective side. This can be defined as existing in the score as such, quite apart from the composer and the listener. The information encoded there relates to such quantitative entities as pitch and time, and is therefore accessible to rational and ultimately mathematical analysis.

In recent years the 'physics of music' has disclosed much that is mathematical in music. It reveals how sound waves are formed and propagated, how strings, membranes and air columns vibrate and how timbre depends upon complex wave-structure; it has provided universal standards of frequency and intensity, and clarified the rationale of musical scales. In its most compact form, acoustics reduces the definition of musical sound to a plot of wave-form amplitude versus time. The groove of a phonograph record, for example, contains only this information and yet yields a believable reconstruction of an original musical sound.

Acoustics, however, deals primarily with isolated elements of music and has thus far said relatively little about how these elements may be combined in a musical composition. Musicians have devised various non-mathematical systems for analysing the structure of compositions. More recently they have begun to draw upon a new branch of applied mathematics known as information theory as a means of clarifying this aspect of musical communication.

Information theory relates the 'information content' of a sequence of symbols (be they letters of the alphabet or musical notes) to the number of possible choices among the symbols. Information content thus resembles entropy or the degree of disorder in a physical system. The most random sequence has the highest information content; the least random (or most redundant) has the lowest. The apparent paradox in this statement derives from the definition given to the term 'information' in the theory. As Warren Weaver has observed, the term "relates not so much to what you *do* say as to what you *could* say" (see 'The Mathematics of Communication,' by Warren Weaver, *Scientific American*, July, 1949). Information in this sense is not the same thing as meaning, and information theory is concerned more with the reliability of communication systems than it is with problems of meaning. Thus, it can be seen, the general enquiry into communication is confronted with the same dualistic question of form and meaning that faces the study of musical communication.

Music, sometimes defined as a compromise between chaos and monotony, appears to the information theorist as an ordered disorder lying somewhere between complete randomness and complete redundancy. This viewpoint accords well with much of traditional musical aesthetics. As early as the fourth century B.C. the Greek writer Aristoxenus noted that "the voice ... does not place the (musical) intervals at random... for it is not every collocation but only certain collocations... that distinguish the melodious from the unmelodious." The composer, employing what Stravinsky has called "the great technique of selection", introduces redundancy into his relatively random materials in order to organize them into a 'meaningful' pattern.

To be sure, meaning is as different to define music as it is in every other kind of communication. But musical sounds are not, as words are, primarily symbols of something else; the meaning of music is peculiarly dependent upon its own structures as such. The study of musical structures by information theory should open the way to a deeper understanding of the aesthetic basis of composition. We may be able to respond to Stravinsky's injunction and cease "tormenting (the composer) with the *why* instead of seeking for itself the *how* and thus establish the reasons for his failure or success".

From the analytical standpoint, the aesthetic content of music can be treated in terms of fluctuations between the two extremes of total randomness and total redundancy. The significant fluctuations manifest themselves not only between one composition and another but also among elements or sections of the same composition.

STRUCTURAL DEVICES CHARACTERISING VARIOUS HISTORICAL STYLES

The stylistic device of modulation (keyshift) shows a fairly steady decrease in redundancy over the past 200 years. Mozart employed a limited number of rather standardized modulations. In Chopin and Brahms the modulations are more extreme and occur more frequently and less predictably. Wagner and Debussy modulate so freely that the listener often loses any immediate and unequivocal sense of key. Many modern composers have abandoned the concepts of key and modulation altogether and in this dimension approach complete randomness.

By standards such as these it is possible, at least in theory, to construct tables of probabilities describing a musical style, such as Baroque, Classical or Romantic, and perhaps even the style of an individual composer. Given such tables, one could then reverse the process and compose music in a given style. The task of composition would start from the random condition with choices among musical elements all equally probable. The introduction of redundancy in accordance with a particular scheme of probabilities would extract order from chaos. It is not to be thought, however, that order is the sole criterion of beauty; as the musicologist Leonard B. Meyer has observed, 'Some of the greatest music is great precisely because the composer has not feared to let his music tremble on the brink of chaos.'

SERIES OF SHORT QUOTATIONS ABOUT TECHNIQUES USED IN THE COMPOSITION OF COMPUTER CANTATA.

The concept of mathematically programmed music easily leads to the notion of composition by computer. In 1955 Leonard M. Isaacson and I began a series of experiments in composition with ILLIAC, the high-speed digital computer at the University of Illinois. In due course we completed four groups of experiments, the results of which we have sampled, in the *Illiac suite* for stringquartet.

As our first step we set the computer to composing simple melodies. To this end we programmed the machine to generate random integers by a technique borrowed from the 'Monte Carlo' method, which physicists have devised to solve certain problems involving multiple probabilities. For our second experiment we devised additional screening instructions embodying the entire set of fourteen rules of strict first-species counterpoint. The machine was first set to turning out random 'white-note' music in four voices; randomness was then made to yield to redundancy in small increments by feeding in the screening instructions one by one. The complete set of instructions yielded counterpoint of fair quality, strongly reminiscent, if one ignores a certain monotony in rhythm, of passages from Palestrina.

In *Experiment III* we sought to find ways of producing the rhythmic and dynamic variety that the earlier compositions lacked. Since the object was to produce a type of music less imitative than strict counterpoint, the machine was first permitted to write entirely random chromatic music (including all sharps and flats). The result was music of the highest possible entropy content in terms of note selection on the chromatic scale, and thus it was strongly dissonant. With the minimal redundancy imposed by feeding in only four of the fourteen screening instructions, the character of the composition changed drastically. While the wholly random sections resembled the more extreme efforts of avant-garde modern composers, the later, more redundant portions recalled passages from, say, a Bartok string quartet. The experiment concluded with some exploratory studies in Schoenberg's twelve-tone technique and similar compositional devices.

In *Experiment IV* the objective was the synthesis of music from purely mathematical rules - a style of composition peculiarly appropriate to a computer. To this end the computer was programmed to select the intervals between successive notes according to a table of probabilities instead of at random. Moreover, the probabilities themselves were made to shift in accordance with so-called Markoff probability chains.

Free Stochastic Music by Computer

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Excerpted from 'Free Stochastic Music by Computer', in Iannis Xenakis, *Formalized Music-Thought and Mathematics in Composition* (revised edition), Harmonologia Series No. 6, Pendragon Press, Hillsdale NY, 1992. Used with kind permission. First published in *Gravesaner Blätter*, 26, 1965.

IANNIS XENAKIS

THE PARADOX: MUSIC AND COMPUTERS

A STOCHASTIC WORK EXECUTED BY THE IBM-7090
The general public has a number of different reactions when faced by the alliance of the machine with artistic creation. They fall into three categories:

"It is impossible to obtain a *work of art*, since by definition it is a handicraft and requires moment-by-moment 'creation' for each detail and for the entire structure, while a machine is an inert thing and cannot invent."

"Yes, one may play games with a machine or use it for speculative purposes, but the result will not be 'finished': it will represent only an experiment – interesting, perhaps, but no more."

The enthusiasts who at the outset accept without flinching the whole frantic brouhaha of science fiction. "The moon? Well, yes, it's within our reach. Prolonged life will also be with us tomorrow – why not a creative machine?" These people are among the credulous, who, in their idiosyncratic optimism, have replaced the myths of Icarus and the fairies, which have decayed, by the scientific civilization of the twentieth century, and science partly agrees with them. In reality, science is neither all paradox nor all animism, for it progresses in limited stages that are not foreseeable at too great a distance.

There exists in all the arts what we may call rationalism in the etymological sense: the search for proportion. The *artist* has always called upon it out of *necessity*. The rules of construction have varied widely over the centuries, but there have always been rules in every epoch because of the necessity of making oneself understood. Those who believe the first statement above are the first to refuse to apply the qualification *artistic* to a product which they do not *understand* at all.

Thus the musical scale is a convention which circumscribes the area of potentiality and permits construction within those limits in its own particular symmetry. The rules of Christian hymnography, of harmony, and of counterpoint in the various ages have allowed artists to construct and to make themselves understood by those who adopted the same constraints – through traditions, through collective taste or imitation, or through sympathetic resonance. The rules of serialism, for instance, those that banned the traditional octave doublings of tonality, imposed constraints which were partly new but none the less real.

Now everything that is rule or repeated constraint is part of the mental machine. A little 'imaginary machine', Philippot would have said – a choice, a set of decisions. A musical work can be analyzed as a multitude of mental machines. A melodic theme in a symphony is a mold, a mental machine, in the same way as its structure is. These mental machines are something very restrictive and deterministic, and sometimes very vague and indecisive. In the last few years we have seen that this idea of mechanism is really a very general one. It flows through every area of human knowledge and action, from strict logic to artistic manifestations.

Just as the wheel was once one of the greatest products of human intelligence, a mechanism which allowed one to travel farther and faster with more luggage, so is the computer, which today allows the transformation of man's ideas. Computers resolve logical problems by heuristic methods. But computers are not really responsible for the introduction of mathematics into music; rather it is mathematics that makes use of the computer in composition. Yet if people's minds are in general ready to recognize the usefulness of geometry in the plastic arts (architecture, painting, etc.), they have only one more stream to cross to be able to conceive of using more abstract, non-visual mathematics and machines as aids to musical composition, which is more abstract than the plastic arts.

TO SUMMARIZE

1 The creative thought of man gives birth to mental mechanisms, which, in the last analysis, are merely sets of constraints and choices. This process takes place in all realms of thought, including the arts.
2 Some of these mechanisms can be expressed in mathematical terms.
3 Some of them are physically realizable: the wheel, motors, bombs, digital computers, analogue computers, etc.
4 Certain mental mechanisms may correspond to certain mechanisms of nature.
5 Certain mechanizable aspects of artistic creation may be simulated by certain physical mechanisms or machines which exist or may be created.
6 It happens that computers can be useful in certain ways.

Here then is the theoretical point of departure for a utilization of electronic computers in musical composition.

We may further establish that the role of the living composer seems to have evolved, on the one hand, to one of inventing schemes (previously forms) and exploring the limits of these schemes, and on the other, to effecting the scientific synthesis of the new methods of construction and of sound emission. In a short while these methods must comprise all the ancient and modern means of musical instrument making, whether acoustic or electronic, with the help, for example, of digital-to-analogue converters; these have already been used in communication studies by N. Guttman, J. R. Pierce, and M. V. Mathews of Bell Telephone Laboratories in New Jersey. Now these explorations necessitate impressive mathematical, logical, physical, and psychological impedimenta, especially computers that accelerate the mental processes necessary for clearing the way for new fields by providing immediate experimental verifications at all stages of musical construction.

Music, by its very abstract nature, is the first of the arts to have attempted the conciliation of artistic creation with scientific thought. Its industrialization is inevitable and irreversible. Have we not already seen attempts to industrialize serial and popular music by the Parisian team of P. Barbaud, P. Blanchard, and Jeanine Charbonnier, as well as by the musicological research of Hiller and Isaacson at the University of Illinois?

In the preceding chapters we demonstrated some new areas of musical creation: Poisson, Markov processes, musical games, the thesis of the minimum of constraints, etc. They are all based on mathematics and especially on the theory of probability. They therefore lend themselves to being treated and explored by computers. The simplest and most meaningful scheme is one of minimum constraints in composition, as exemplified by *Achorripsis*.

<...>
In the next few pages of the article Xenakis describes in minute detail the 'programming' involved in the composition of his music.
<...>

CONCLUSIONS

A large number of compositions of the same kind as *ST/10-1, 080262* is possible for a large number of orchestral combinations. Other works have already been written: *ST/48-1, 240162*, for large orchestra, commissioned by RTF (France III); *Atrées* for ten soloists; and *Morisma-Amorisima*, for four soloists.

Although this program gives a satisfactory solution to the minimal structure, it is, however, necessary to jump to the stage of pure composition by coupling a digital-to-analogue converter to the computer. The numerical calculations would then be changed into sound, whose internal organization had been conceived beforehand. At this point one could bring to fruition and generalize the concepts described in the preceding chapters.

The following are several of the advantages of using electronic computers in musical composition:

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1. The long laborious calculation made by hand is reduced to nothing. The speed of a machine such as the IBM-7090 is tremendous – of the order of 500,000 elementary operations/sec.
2. Freed from tedious calculations the composer is able to devote himself to the general problems that the new musical form poses and to explore the nooks and crannies of this form while modifying the values of the input data. For example, he may test all instrumental combinations from soloists to chamber orchestras, to large orchestras. With the aid of electronic computers the composer becomes a sort of pilot: he presses the buttons, introduces coordinates, and supervises the controls of a cosmic vessel sailing in the space of sound, across sonic constellations and galaxies that he could formerly glimpse only as a distant dream. Now he can explore them at his ease, seated in an armchair.
3. The program, i.e., the list of sequential operations that constitute the new musical form, is an objective manifestation of this form. The program may consequently be dispatched to any point on the earth that possesses computers of the appropriate type, and may be exploited by any composer pilot.
4. Because of certain uncertainties introduced in the program, the composer-pilot can instill his own personality in the sonic result he obtains.

Stochastic Computer Graphics, Georg Nees, 1965. As published in *rot 19*, 1965, together with the Max Bense text *projekte generativer ästhetik*.

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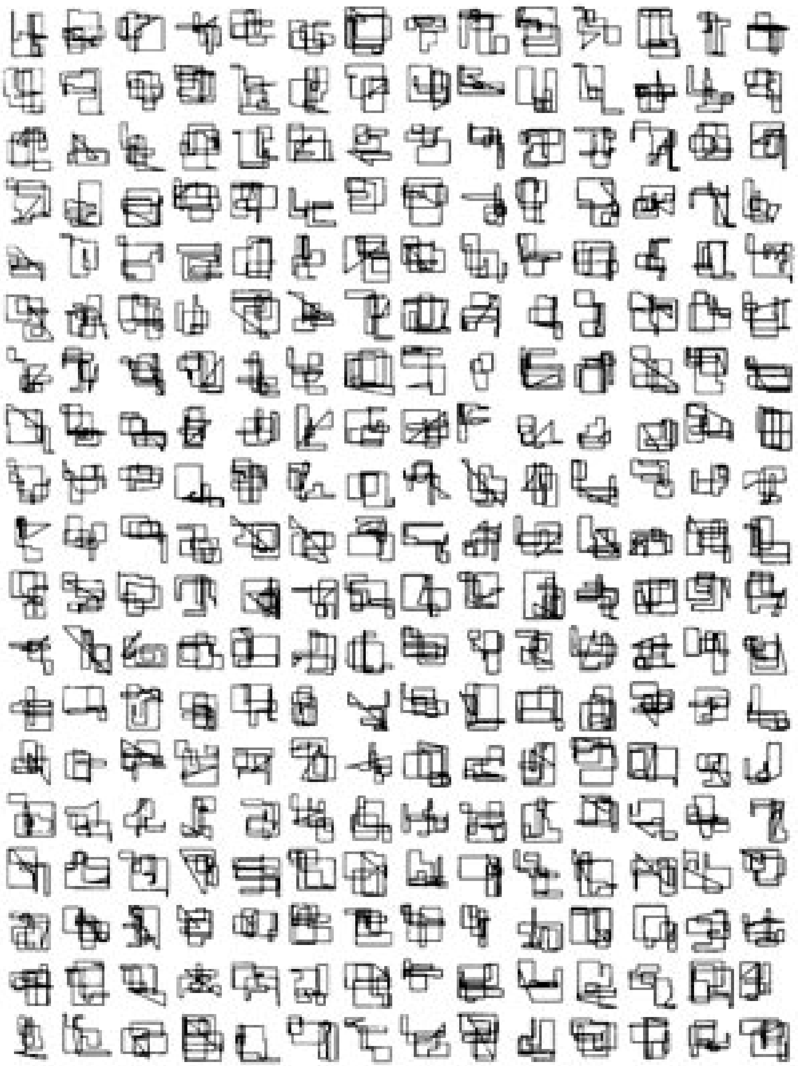
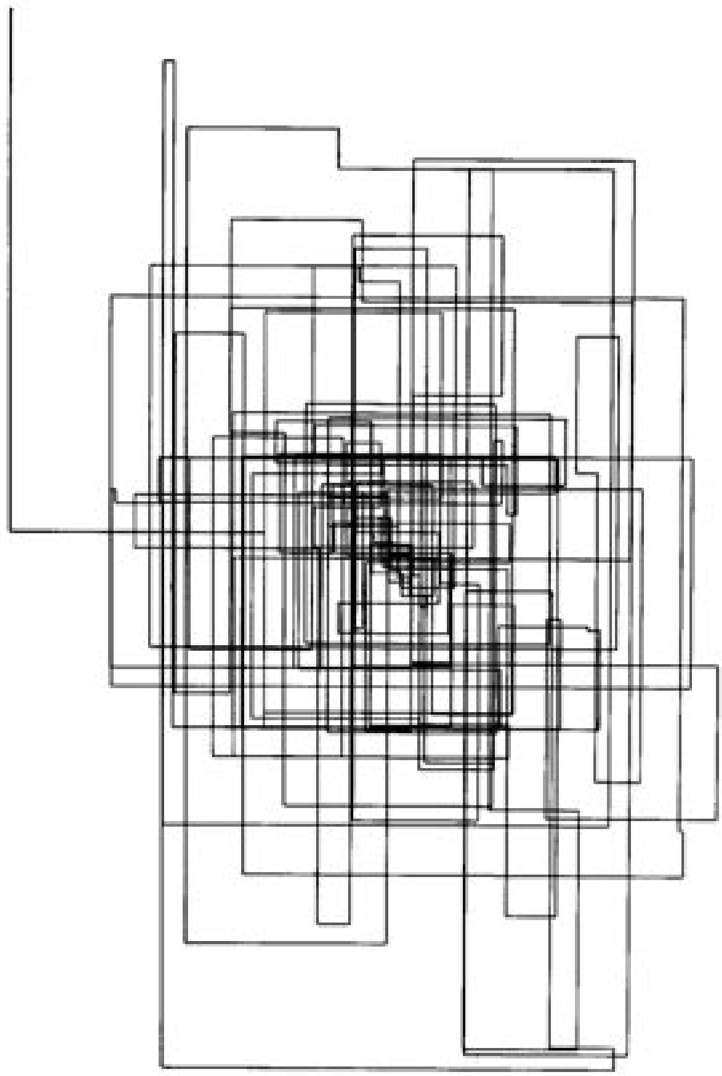


23-ecke (bild 2)



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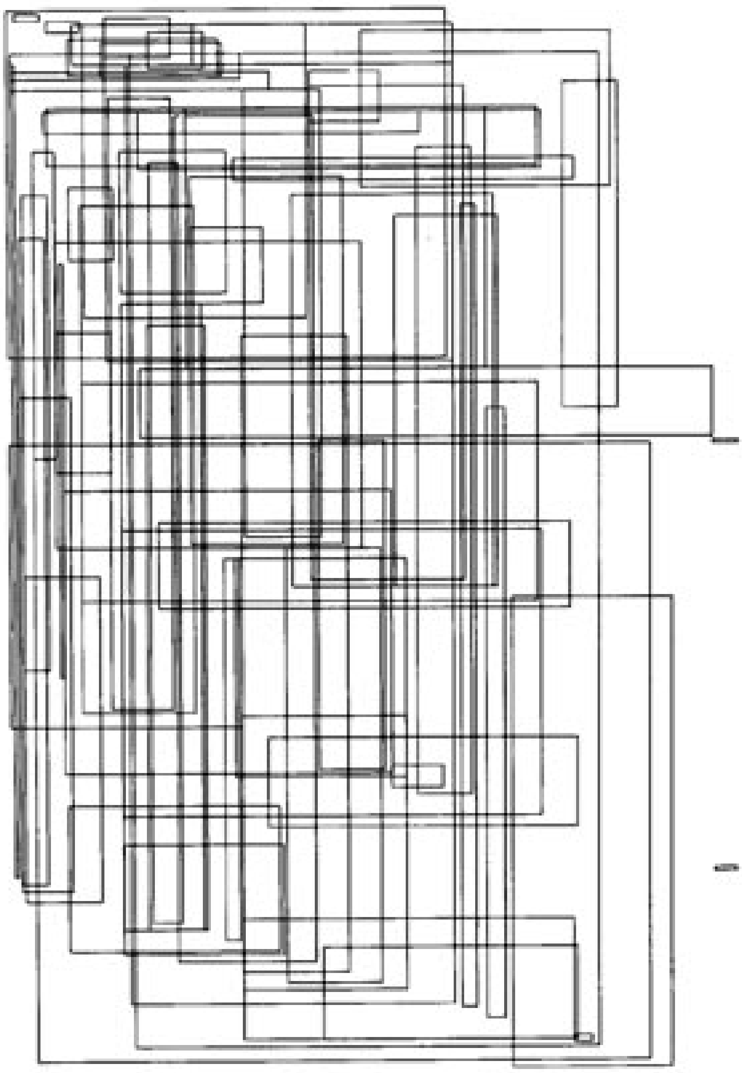

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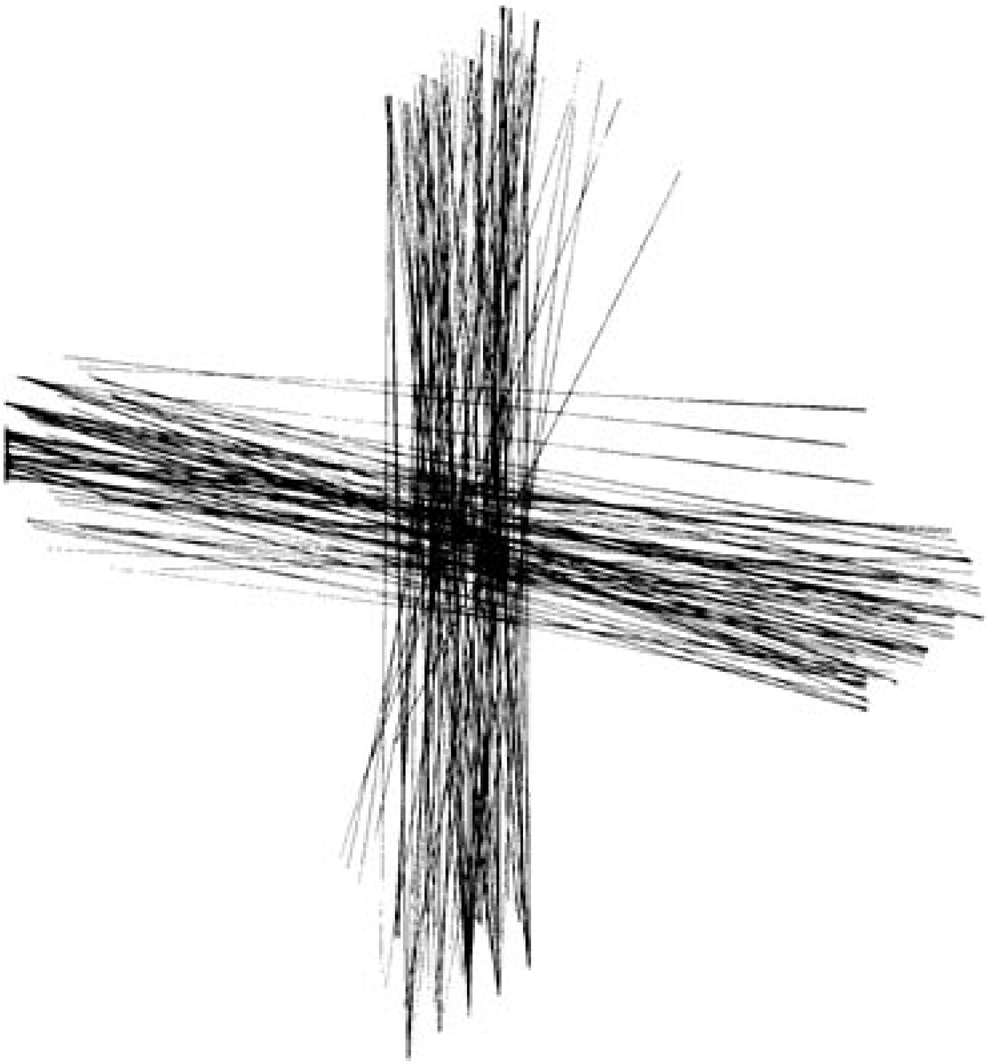

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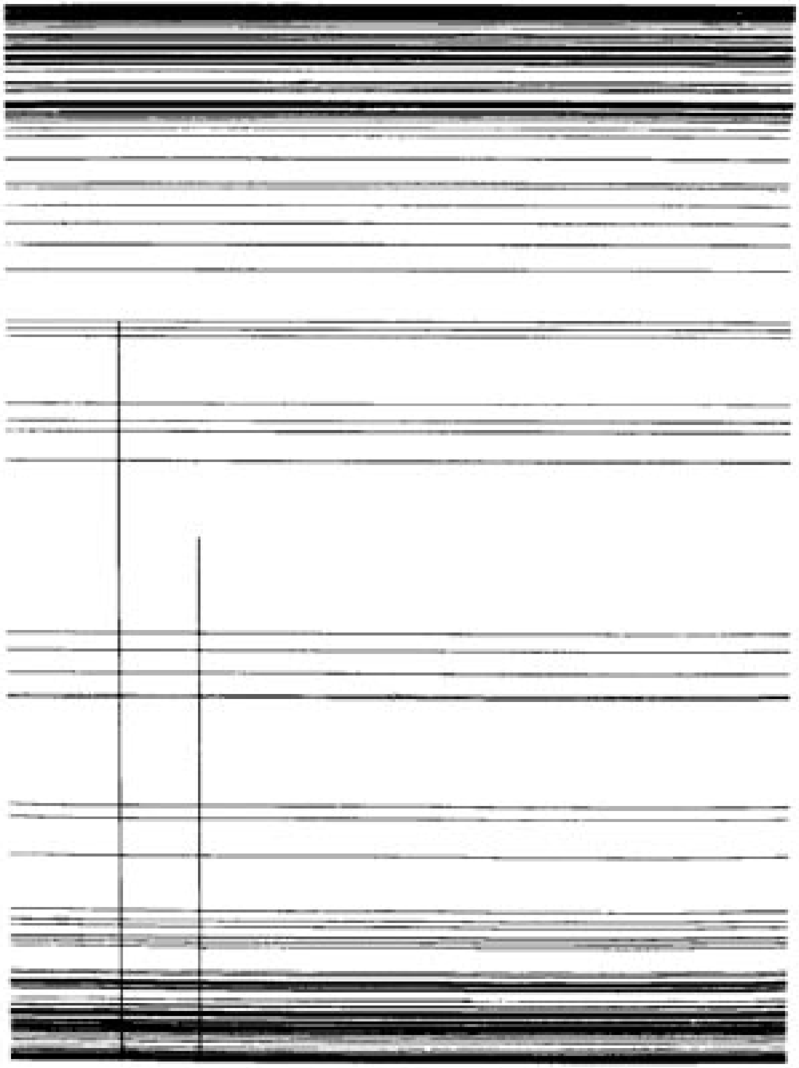

gardinen (bild 6)

GEORG NEES
Georg Nees has been producing computer graphics, sculptures and films since 1964. In 1969, he received his Ph.D. under Max Bense on Generative Computer Graphics. Together with Friedrich Nake and A. Michael Noll he organised the first seminal exhibition on computer graphics in 1965.

Generative Aesthetics Projects

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Originally published as 'projekte generativer ästhetik', in *rot 19, computer-grafik*, Stuttgart, 1965; reprint in *Ästhetik als Programm, Kaleidoskopien*, Heft 5, 2004, pp. 197-199. The English translation was first published as Generative Aesthetics Projects in *The Magazine of the Institute of Contemporary Arts*, London, 6, September 1968, pp. 14-15. Reprinted with kind permission from Elisabeth Walther-Bense.

MAX BENSE

By Generative Aesthetics, we understand all the operations, rules and theorems which, if applied to an unordered set of material elements, can produce aesthetic situations. In this sense Generative Aesthetics is an analogue of Generative Grammar, the first building aesthetic structures as the other builds sentences of a schema of grammar.

Obviously to make the aesthetic synthesis possible, each system of Generative Aesthetics must be preceded by a process of analytical aesthetics, i.e. the investigations of existing aesthetic structures in a given art object. According to this aesthetic information a generative system is prepared. The above information must be describable in abstract terms. Then according to the system, it can be applied to a set of material elements and thus be realised.

At the moment there are four possibilities of abstract descriptions for aesthetic situations (either distributions or configurations) which can be used to generate an aesthetic structure: the Semiotic description, which makes use of classifications of signs and symbols, and the Metric, Statistical and Topological descriptions, which are numerically or geometrically orientated.

The **semiotic** procedure makes use of the triadic relations of signs, which was first developed by Peirce. The signs (or symbols) which constitute an object of art are determined by means of three main (and nine sub-) classes: A. in relation to object B. to the interpreter and C. to the signs themselves. The knowledge of the process of constructing an art object out of the classes of signs (symbols) is necessary for a semantic analysis, as it is necessary for the translating of a synthesis of units of meaning (semantic elements) into a set of material elements.

The **metric** procedure which, as in traditional formal schematisations (such as poetic metrics or the art-theories of proportion) uses numerical data which have the character of 'distance', of 'interval', of 'continuity, achieves above all the macro-aesthetic construction of an art object, that is, the composition of the 'Shape', of the 'Figure', or of the 'Form'.

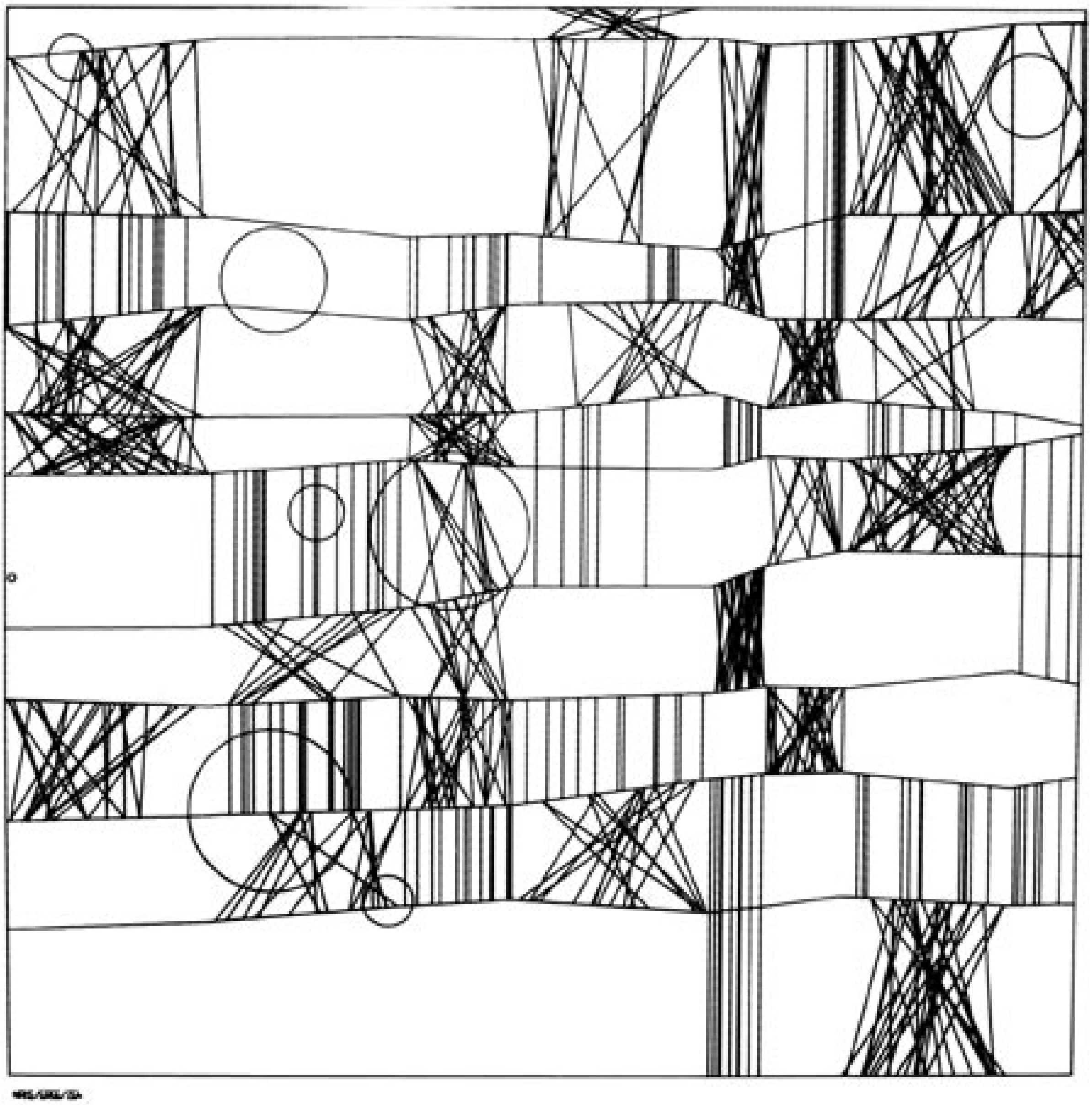
The **statistical** procedure which works on the basis of the concept of frequency i.e. of the probability of the appearance of elements or characteristics, which are capable of numerical evaluation, generates above all the micro-aesthetic structure of an object of art. It does not prepare the 'principle of configuration', but only the 'principle of distribution'.

The **topological** procedure is mainly concerned with the collection of elements which constitute the object of art, and works through such crucial concepts of 'environment', 'relationship', 'open' or 'closed' quantities and their simplicity and complexity. Thus after the principles of 'configuration' and 'distribution' comes the principle of 'collection' of elements.

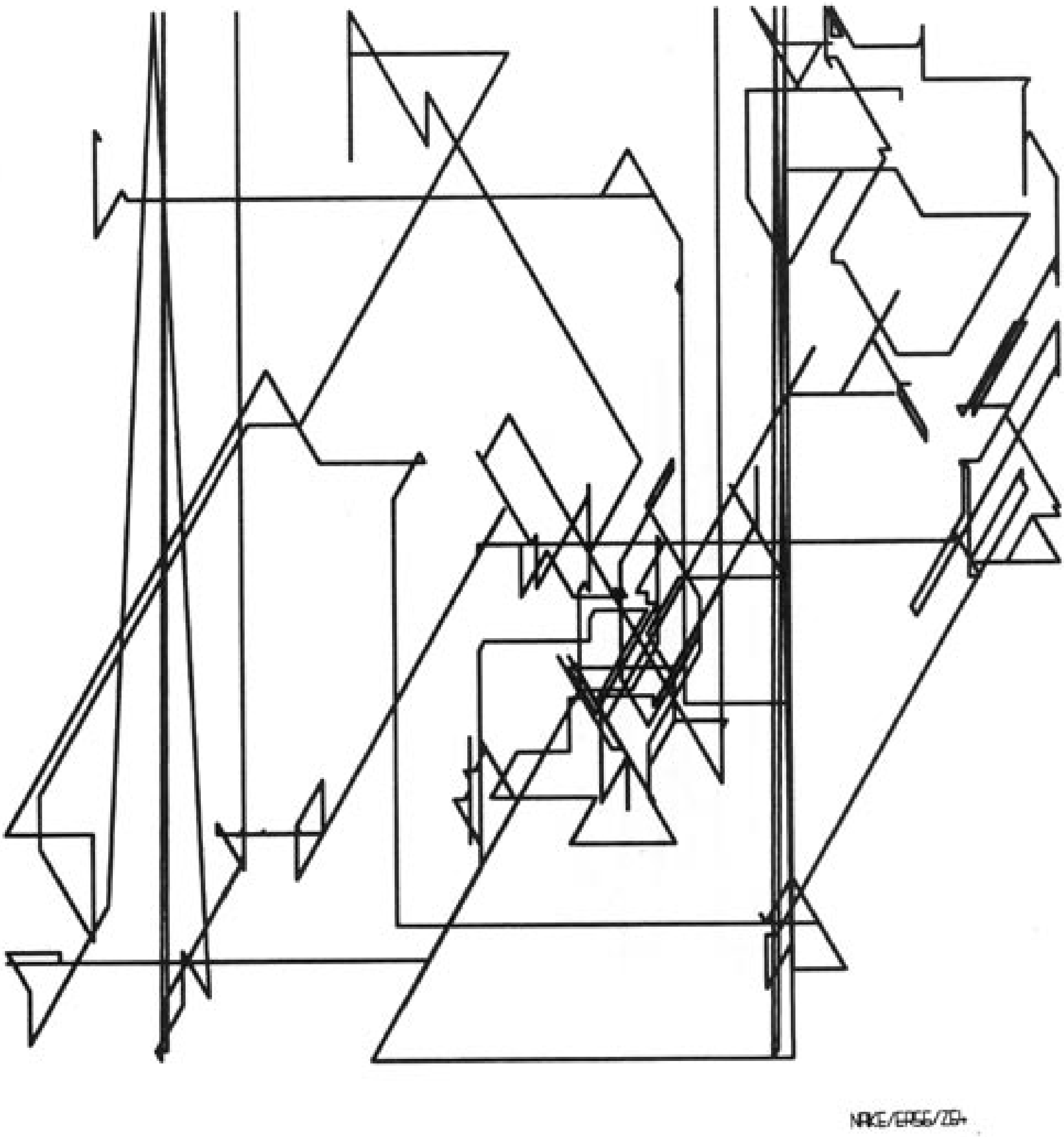
The aim of Generative Aesthetics consists in the numerical and functional description of the characteristics of aesthetic structures which are realisable in a collection of material elements. Thus they become abstract schemata of a 'principle of configuration', a 'principle of distribution', and a 'principle of collection'.

According to these principles when they are applied to an amorphous mass of elements we can find out what in the art objects relates to macro-aesthetics in two classifications: 'orders' and 'complexity', and in micro-aesthetics in 'redundance' and 'information'. This process should not be understood as the application of a formula, but as a generating principle. Even the 'programmes' in certain 'programme-languages' for the 'mechanical' realisation of 'free' (intuitive) or 'formal' (predetermined) aesthetic structures belong to the system of Generative Aesthetic experiments using the metrical (intervals, lenghts of words), statistical (word-sequence, position), and topological (connections and deformations) procedures to produce the 'aesthetic information'.

Aesthetic structures supply 'aesthetic information' only as far as they reveal innovations. Since these obviously represent only a probable (future with every new work in progress) and not definite (existing) reality, one can say that the artificial creation by means of theorems deviating from the norm of probability, is the main function of Generative Aesthetics.



13/9/65 Nr. 2, *Hommage ã Paul Klee*, Frieder Nake. China ink on paper, 50 x 50 cm.



13/9/65 Nr. 7, *Zufälliger Polygonzug*, Frieder Nake. Silkscreen print, 68,7 x 48,7 cm.

Computer Art

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This article introduced the section on computer graphics in the Studio International special issue on *Cybernetic Serendipity, the Computer and the Arts*, London, August 1968, pp. 70-71. Reprinted with kind permission of the author.

JASIA REICHARDT

"Absolute power will corrupt not only men but machines". In his article 'Inventing the future', Dennis Gabor put forward some of his expectations and fears about the function of the machine in the society of the future. The above comment was made with reference to electronic predictors, which, having built up a reputation for accuracy, become aware of their infallibility (since they are learning machines) and begin to use their newly-discovered power.

So far electronic predictors have not become a reality. However, another postulation made by Professor Gabor in the same article (*Encounter*, May 1960) appears to be very relevant indeed. Will the machine – he wondered – cut out the creative artist? "I sincerely hope", Gabor continued, "that machines *will* never replace the creative artist, but in good conscience I cannot say that they never *could*."

The computer performs various functions which in the broader sense seem to be the act of intelligence, i.e. manipulation of symbols, processing of information, obeying complex rules and even learning by experience. Nevertheless the computer is not capable of making abstractions, and is devoid of the three prime forces behind creativity – imagination, intuition and emotion. Despite this, the computer as a budding artist has been making an appearance since about 1960. In 1963, the magazine *Computers and Automation* announced a computer art contest which has been held annually ever since. The winning design usually appears on the cover of the August issue and the runners-up are given coverage inside. The designs vary considerably although they share certain characteristics, i.e. they are only in black and white, there is an emphasis on geometrical shapes, and they are basically linear. As designs, the computer products look bare and minimal and represent little else than the initial stage in what may be a far more challenging adventure in merging rather than relating creative activity with technology.

Computer graphics range from static compositions to frames of motion pictures, and could be divided into two main categories: 1. those which approximate to pure design or art; and 2. those which are not made with any aesthetic end in view but which serve to visualise complex physical phenomena.

At a conference dealing with computers and design in 1966 at the University of Waterloo, two statements were made which might at first have appeared unnecessarily boastful and heroic: 1. The computer simply elevates the level of possible creative work; 2. The computer can handle some elements of creativity now – by current definitions of creativity'. Both these statements were made by scientists, although there exists a considerable scepticism amongst scientists as well as artists about the validity of the various experiments in this area. Others claim that the computer provides the first real possibility of a collaboration between the artist and the scientist which can only be based on each other's familiarity with both media.

The first commercial computer was marketed in 1950. Ten years later the Boeing airplane company coined the term 'computer graphics'. They used graphics for purely utilitarian purposes. These were employed, for instance, to verify the landing accuracy of a plane viewed from the pilot's seat and the runway. They were used to establish the interaction of range of movements of the pilot in his environment of the cockpit. To this end they created a 50 percentile pilot and studied him in animation. All the drawings and the animation were done with a computer. Other experiments included visualising acoustic graphs in perspective and the production of very accurate isometric views of aeroplanes.

There are two main methods at present by which computer graphics are made. In first place there are the ink drawings produced by a computer-driven plotter, a moving pen, conveys the image direct to paper. Drawings can also be made with the images composed of different letters or figures and printed out on a typewriter which is automatically operated by the computer. In the second category are computer graphics made on the cathode tube with an electron beam electrically deflected across the phosphorescent screen to produce the desired picture. A camera photographs the image in various stages and an electronic console is used to control the picture and to advance the film. Static graphics can be obtained by making enlarged photographs from the film. Whether the pictures are made for analytical purposes or just for fun, the computer graphic is a visual analogue to a sequence of calculations fed into the computer.

The now 'antique' Sketchpad which has been used for numerous experiments of this type at Massachusetts Institute of Technology since 1962, was one of the first to produce drawings on a cathode ray tube, demonstrating the sort of possibilities which are inherent in the system. One could draw with a light pen on the screen simple patterns consisting of lines and curves. The operator could impose certain constrictions on the patterns he was making by demanding, for instance by pushing the appropriate button, that the lines be made parallel, vertical or straight. At that stage the operator could not demand something as complex as a solution to the following problems: "These lines represent a piece of structure of a certain thickness and size and with certain cross-section characteristics, made of a particular material and obeying specific physical laws – depict this under a stress of so many pounds per cubic foot".

Today the process whereby a design is adjusted at any stage of its development is already quite familiar. If the operator alters the design on the cathode ray tube with a light pen, the computer converts the altered design into electronic impulses using them to modify the pre-existing programme held in the computer's memory store. The altered design then appears on another cathode ray tube. This system is widely used by General Motors for car body design. The image on the cathode ray tube can be shifted, rotated, enlarged, seen in perspective, stored, recalled and transferred to paper with the intermediate stages recorded on film. Since the process suggests inhibiting difficulties to someone who is not an electronic engineer, it may be difficult for an artist to imagine how he could possibly make use of a computer. The solution to the problem lies in collaboration. There are three stages in the process of producing computer graphics, or for that matter using the computer in most cases. In the first place the communicator presents his ideas or message which is to be communicated to the computer. Secondly, the communication specialist decides, unless there are specific instructions, whether the problem should be solved graphically, verbally or as a combination of both. Thirdly, the computer specialist selects the appropriate computer equipment and interprets the problem into machine language, so that the computer can act upon it. The Korean artist Nam June Paik has gone so far as to claim that in the same way that collage technique replaced oil paint, so the cathode ray tube will replace canvas. However, so far only three artists that I know of have actually produced computer graphics, the rest to date having been made by scientists.

At the moment the range of visual possibilities may not seem very extensive, since the computer is best used for rather more schematic and geometric forms, and those patterns and designs which are logically simple although they may look very intricate. One can programme the computer to produce patterns based on the golden section or any other specific premise, defining a set of parameters and leaving the various possibilities within them to chance. In this way certain limitations are provided within which the computer can 'improvise' and in the space of twenty minutes race through the entire visual potential inherent in the particular scheme. Programmed to draw variations with straight lines it is conceivable, though perhaps unlikely, that one of the graphics produced may consist simply of one line placed exactly on top of another. If there is no formula for predicting each number or step in a given sequence, the system by which this type of computer graphic comes about can be considered random.

Interesting results can be obtained by introducing different random elements into the programme. One can, for instance, produce a series of points on a surface which can be connected in any way with straight lines, or one can instruct the computer to draw solid geometric shapes without specifying in what sequence they are to be superimposed, leaving the overlapping of the shapes to chance.

A fascinating experiment was made by Michael Noll of the Bell Telephone Laboratories whereby he analysed a 1917 black and white, plus-and-minus picture by Mondrian and produced a number of random computer graphics using the same number of horizontal and vertical bars placed within an identical overall area. He reported that 59% of the people who were shown both the Mondrian and one of the computer versions preferred the latter, 28% identified the computer picture correctly, and 72% thought that the Mondrian was done by computer. The experiment is not involved either with proof or theory, it simply provides food for thought. Noll, who has produced a considerable number of computer graphics and animated films in America, sees them as a very initial stage in the possible relationship between the artist and computer. He does not consider himself as an artist by virtue of his graphic output. He sees himself as someone who is doing preliminary explorations in order to acquaint artists with these new possibilities.

Perhaps even less credible than the idea of computer-generated pictures is the idea of computer sculpture. That too has been achieved. A programme for a three-dimensional sculpture can be fed into a computer – the three-dimensional projection of a two-dimensional design. It can be transferred via punched paper tape to a milling machine which is capable of producing the physical object in three dimensions.

The computer is only a tool which, at the moment, still seems far removed from those polemic preoccupations which concern art. However, even now seen with all the prejudices of tradition and time, one cannot deny that the computer demonstrates a radical extension in art media and techniques. The possibilities inherent in the computer as a creative tool will do little to change those idioms of art which rely primarily on the dialogue between the artist, his ideas, and the canvas. They will, however, increase the scope of art and contribute to its diversity.

Small Abstract Aesthetics

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Originally published as *kleine abstrakte ästhetik*, text 38, Edition rot, Stuttgart, January 1969. Used with kind permission of Elisabeth Walther-Bense. Translation: Joseph Ebot.

MAX BENSE

AESTHETICS
We interpret aesthetics to be an abstract aesthetics, which implies that it can be applied to any arbitrary field of special aesthetic objects regardless of whether it involves architecture, sculpture, painting, design, poetry, prose, dramaturgy, film, music, or events in general. This is no philosophical aesthetic as it is not embedded in a philosophical system. Rather, it is a scientific aesthetic in that it strives for the form of a theory. Accordingly, it is conceived of as research, not interpretation; it corresponds to the Galilean[1] type of knowledge, not the Hegelian[2] and is more strongly oriented technologically than metaphysically. Its interest is considered a relative-objective theme, not an absolute, subjective conception of the object of investigation. It is an open, expandable, revisable theory, not a closed, postulated doctrine.

AESTHETIC CONDITION
Its central concept is that of *aesthetic condition*. This is understood to include the relatively extreme and objective condition of all objects and events of greater or lesser artistic origin that are taken into consideration to the extent that it can be distinguished from the physical and semantic condition of these objects or events. The central concept of abstract aesthetics is therefore not conveyed by the term beauty and its philosophical or trivial derivatives, which for the most part can only be decided by subjective interpretation and not by objective determination. Accordingly, an aesthetic condition is also not defined as 'ideal', but as 'reality'; it is observable and describable as a real condition of the object under consideration.

AESTHETIC CARRIERS
By the term *aesthetic carriers* we mean real objects as well as events, thus *material* realities by which or with which aesthetic conditions are created, e.g., so-called works of art, but also design objects. In any case, distinctions must be made between an aesthetic condition and its carrier.

MATERIAL AESTHETICS
The actual material reality of the artistic objects in which a distinction between aesthetic carrier and aesthetic condition can be made entitles one to speak of material aesthetics. Abstract aesthetics, which is applicable, includes material aesthetics. It is therefore stated that aesthetic conditions can only be discussed by means of material conditions and are thus demonstrable only through the manipulation of given materials.

AESTHETIC REPERTORY
Materials are not necessarily material in a physical sense. Meanings, things that are imagined, words, fictional items can also be the carriers of aesthetic conditions. Distinctions can absolutely be made between material and immaterial materials or the carriers of aesthetic conditions. The phrase *material* is generally interpreted in the sense of distinguishable, discrete, manipulable elements, and the epitomy of a host of elementary, discrete, and manipulable materials is called a *repertory*. Aesthetic conditions are dependent on a repertory. An aesthetic repertory is a material repertory from which a corresponding material aesthetic condition can be created by means of manipulation.

THE FIRST DEFINITION OF AN AESTHETIC CONDITION
From this we can derive a first material and abstract definition of an aesthetic condition. In our first – material and abstract – approach to the term, we understand an aesthetic condition to be the distribution of material elements throughout their finite repertory. Here distribution means first of all nothing more than manipulated dispersion. Manipulation itself can be perceived as selection, transportation, and reordering. In a more precise sense selection, transportation, and distribution are partial *procedures* of the *process* that produces aesthetic conditions in all the material of the given repertory. This aesthetic process that is easily broken down into procedures can be specified as such in further definition attempts.

PROCESSES
We distinguish between determined and non-determined processes or procedures. This is a crude distinction. A subtler one is the distinction between fully-determined, weakly-determined, and non-determined processes. Macrophysical processes, such as a free fall, are fully determined. Certain microphysical processes, such as quantum leaps, are non-determined. Linguistic processes, being conventional, are mostly weakly determined. Aesthetic generative processes are distinguished by weakly-determined or non-determined procedures. Connected with this is the fact that their outcomes, the aesthetic condition, are almost entirely excluded from the quality that one would anticipate, namely conceivability, and are not distinguishable until they are realized and only then can they be distinguished. By aesthetic condition we therefore mean the weak or non-determinate distribution of material elements throughout their finite manipulable repertory.

AESTHETIC DISTRIBUTION
Aesthetic distributions are therefore, first, at least weakly-determined and, second, material distributions. As material distributions they are extensional dispersions and combinations in time-space patterns. Distributions of material elements in time-space schemata can be characterized as compositions. Following Lessing's terminology in *Laocoon*, we need to differentiate between 'coexisting' distributions or compositions in space patterns (painting) and 'consecutive' distributions[3] or compositions

in temporal (music, poetry, events) patterns. In a certain respect texts belong to the combined space-time system and are thus simultaneously coexisting and consecutive compositions.

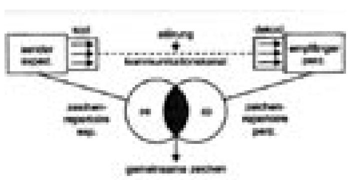
AESTHETIC INFORMATION
Since according to information theory, only undefined, therefore weakly- or non-determinative operations produce what is called *information*, the indefinite quality of aesthetic processes and aesthetic conditions is sufficient to characterize them also as *aesthetic information*. Moreover, each piece of information in information theory as well is regarded as repertory-dependent.

REALITY THEMES
We distinguish between physical and aesthetic reality themes. The former are determined by procedures and events, the latter by selective manipulations leading to singular conditions which may be comprehended as *innovations*, as novelties in the sense of a *principle of repertory-linked emergence*. A third reality theme, in a certain sense an intermediary theme, the *semantic*, can be identified between the physical and the aesthetic *reality themes*. It is governed not by procedures in natural law but also not by selective manipulation, but by *conventional* and *interpretive* contingency. Linguistic and beyond that absolutely any kind of representational communication is the true realm of semantic reality themes.

CREATIVE AND COMMUNICATION PATTERN
In order to distinguish more clearly between singular innovations and contingent conventions, let us introduce a *creative* and a *communicative pattern* as their generative principle. The contingent convention is developed in communication patterns, the singular innovation in creation patterns.

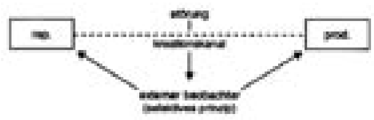
The communication system describes the model of the (linguistic) sign connection between a sender and a receiver (expedient and percipient) over a communication channel that is vulnerable to noise.[4] So that a connection in the sense of an understanding that is capable of conventionalization comes to pass, the sign repertories of the sender and the receiver must to a certain extent, therefore, correspond. Before insertion of the signs provided by the sender (expedient) into the communication channel, they must be transformed or coded appropriately, i.e., in a fitting manner transformed or coded into the transport capabilities of the channel in order to be again retranslated or decoded before being picked up by the receiver.

COMMON SIGNS



sender exped. = sender
kod = coding, codification
störung = noise
kommunicationskanal = communication channel
dekod = decoding
empfänger perz. = receiver
zeichenrepertoire exp. = sign repertory
zeichenrepertoire perz. = sign repertory percipient
gemeinsame zeichen = common signs

The creation pattern, on the other hand, describes the model of the selective connection between a given repertory of material elements and their selective distribution to a singular innovative condition. It demarcates itself from the communication pattern primarily because it introduces an *external observer* who represents the generative principle of the selective connection. The sender (expedient) explicitly acquires the character of the repertory ('source') and the receiver (percipient) the character of the product ('depression'). The creation channel can also be exposed to noises which raise or lower the degree of indeterminacy



störung = noise
kreationskanal = creation channel
rep. = repertory
prod. = product
externer beobacter (selectives prinzip) = external observer (selective principle)

The selective function of the external observer (thus of the artist) certainly refers primarily to the repertory, secondarily, however, also to the product. The selection of the product can refer back to the selection of the repertory so that the generative principle in the creation pattern can also acquire the nature of a recoupling system. In this case the product selects the repertory, or at least defines its scope. In every aesthetic generative process the selective freedom of the external observer increasingly changes into the product of the distribution of material elements; this is the reason for the consumption of selective freedom by the external observer in the process of the creative manipulation of the repertory.

SIGNAL AND SIGN
It is necessary at this stage to attempt a distinction between signal and sign, which is as relevant to the communicative as to the creative process. We speak of *signal* when the exclusively physical substratum of a connection is meant. Sound as an acoustical and color as an optical phenomenon belong, for example, to this. However, we speak of a sign when intellectual cognition declares such a substratum 1. to be a medium that 2. signifies an object and 3. for a certain interpretation thereby endows it with meaning. Accordingly, each signal as a physical substratum is definable by three place coordinates x, y, z and a time coordinate t and is consequently presented as a (material) function:

$$Sig \equiv F\ mat\ (x, y, z, t)$$

A sign on the other hand is (with Charles Sanders Peirce) [5] presented as a triadic relation between its nature as a medium, its relevance to an object, and its relevance to an interpreter. Accordingly a sign is not an object but a relationship

$$Z \equiv R\ (M, O, I)$$

As medium M the sign is manipulable, i.e., selectable, transformable, transportable, short, and communicable. In object reference O it 'objectified' the knowable or the known in that it *signified*, and in the interpretation reference it *means* the something that is objectified and signified.

CATEGORIES OF SIGNS
A sign as a triadic relationship of its reference modes of medium, object, and interpretant is, according to Peirce, is again split triadically. As medium a sign can function qualitatively (qualisign), singularly (singsign), and legitimately (legitsign); in relation to object, it can signify the object in an arbitrary symbolic manner (symbol), in an indicative indexing manner (index), and in an iconic depictive manner (icon); in an interpretive context these object relationships are introduced and acquire meaning in an argumentally complete (argument), in a dicentish closed (dicent) and in a rhematically open (rhema) connection (connex or context). Each concretely introduced sign is therefore represented in reality as a triadic relationship and at the same time as a triadic combination of the three possibilities of the triadic components. This triadic relationship covering all the possibilities of the triadic components of the sign is called a sign category. Each sign that is introduced therefore in reality represents a *sign category*.

SEMIOSES
Processes and procedures that are associated with signs, take place in signs, and thus are based on the manipulation of signs, are called semioses or semiotic processes. Creative and communicative processes in general are just such semioses and are therefore semiotic processes. Now while creative and communicative processes are carriers of the process characterized and artificially generated by *aesthetic conditions*, in this it is likewise a question of a sequence of semiotic procedures. Obviously signs form a medium of indeterminate or only weakly determined processes and constellations, that is fertile ground for the engendering of innovation, and therefore of *aesthetic information*, in a creative pattern. Repertories of signs are always marked by *emergence*, by the cropping up of the new, which develops in the creative pattern. *Aesthetic semiosis* thus begins with the establishment of a repertory which is always the forerunner of the innovation-creating process. Signs still function in the repertory as pure means, without an object reference, without interpreters. They have here the nature of physical substrata, and they can (in terms of the theory of knowledge) be understood as signals (of the physical substance of the world). Not until the selection of the repertory by an *external observer* is the genuine aesthetic semiosis initiated, and this takes place as a *transformation* of the *signals* in *signs*, of the objective *media* in *triadic relations*:

$$\mathrm{Sig} \rightarrow Z \equiv \mathrm{Fmat}\,(x, y, z, t) \rightarrow R\,(M, 0, I)$$

NUMERIC AND SEMIOTIC AESTHETICS
While the aesthetic generative process ends as a whole in creative and communicative procedures, it leads on the one hand to *material distributions* and on the other had to *relational semioses*. The material distributions are characteristic of creative procedures and the relational semioses are characteristic of communicative procedures. The *aesthetic condition* generated in this manner appears under the aspect of the distribution of creative materials as *selective information* and under the aspect of the communicative relational semiosis as *selective superisation*. The selective information defines the aesthetic innovation with respect to its statistical vagueness. The selective superisation denotes the coexisting or consecutive semiotic synthesis of individual (atomic) signs into complex (molecular) supersigns or hierarchies of signs. *Aesthetic theory* thereby acquires its two methodical sides: the numerical and the semiotic. The *numerical aesthetic* relates essentially to the statistical indeterminacy of the selection; the *semiotic aesthetic*, on the other hand, relates to the description of the sign categories and supersigns constituted in the relational semioses.

MICRO- AND MACROAESTHETICS
In material distribution as well as in relational sign category the aesthetic condition is repertory dependent. The degree of differentiability and refundability of the constituted elements leads to differentiation between crude and subtle descriptions of aesthetic conditions and thereby to differentiation between *crude* and *subtle aesthetics*, which also can be characterized as *macro* and *microaesthetics*. If the *smallest* aesthetic conditions, and thus the most minimal material distributions allow themselves to be differentiated as aesthetic conditions, information, innovations, or semiotic superisations, it is reasonable to speak of their *nuclear aesthetics*.

GENERAL NUMERICAL AESTHETICS
In order to make a general numerical approach to a numerical description of aesthetic conditions as a distribution of material elements throughout a repertory, one must proceed from the fact that each creative process transforms a *given condition* (of material elements) into an *artificial* one. The given condition is the condition of the material elements in the *repertory*; the artificial condition is its condition in the *product*. The given condition of the distribution of the material elements can in the extreme case be designated in the repertory as *disorder* in the sense of a disorganized crowd of elements; the relocated, artificial condition of the distribution of material elements throughout the repertory can be termed *order* in the sense of a structured crowd of elements. The degree of disorder in the condition of the repertory is a question of the *complexity* of the repertory, which can be described in the case of crude macroaesthetics by the number of constituent elements and in the case of more subtle microaesthetics by the measured value of its *mixture*, by its *entropy*. In any event the possibility thereby presents itself of expressing the material, distributive aesthetic condition as the relationship of an *ordered* condition to one that is in a state of *disorder*, as a relationship of the measured number of the order relations of the produced condition to the measured number of the complexity of the condition being produced. This general approach of numerical aesthetics to the numerical definition of aesthetic conditions can therefore be expressed by the interrelationship

$$M \equiv f\,(0, C) = 0/C$$

in which M signifies the *aesthetic measured number*, 0 die *measured number of order* and C the *measured number of the complexity*.

NUMERICAL MACROAESTHETICS
From this approach to general numerical aesthetics, which originated in a mathematical and aesthetic concept of the American mathematician George D. Birkhoff [6] in 1928, a macroaesthetic and a microaesthetic variant can be derived. Birkhoff's original approach was intended to be macroaesthetic in nature insofar as it rested on perceptible and unquestionably countable elements of the observed object. He demonstrated his calculations of aesthetically measured numbers at first in polygons, grids, and vases. Polygons, grids, or vases form to a certain extent *aesthetic families*, within whose individual objects it makes sense to develop measured numbers for comparison. Macroaesthetic measured numbers are introduced by Birkhoff as scalar unnamed masses, which only in relation to the formation of comparable objects assume comparable values. It therefore is an issue of macroaesthetic measured numbers in the sense of *form measurements*; for *form* functions macroaesthetically as a perceptible whole, as 'form quality', as stated in the concept that Christian von Ehrenfels (1890)[7] introduced. Individual polygons such as squares, rectangles, the rhombus, and the like create form classes whose 'form quality' is synthetically defined in each case by definite *order relationships* (O) covering a definite *complexity* of constitutive elements (C). Each macroaesthetic form measurement is therefore a *relative* aesthetic measurement insofar as the aesthetic condition of the artificial object to which it relates is itself relative, dependent on the order relationships O that are seen as aesthetically relevant (e.g., the number of symmetries in polygons) and the form elements C perceived as constitutive (e.g., the number of elements that are needed to make a – in a square, for instance, one side)

NUMERICAL MICROAESTHETICS
While the macroaesthetic measurement functions as a form measurement and relates to the observed artificial object as a given and perceptible unvarying whole, the *microaesthetic* measure considers the emergence of the object and its aesthetic condition from a selectable repertory of material elements and takes into account thereby the number of one-time or repeated decision steps. One can say, therefore, that macroaesthetic measurement neglects the external observer whereas it acts decisively in a microaesthetic measurement. The macroaesthetic measurement therefore yields the aesthetic object in the communication pattern, and the microaesthetic measurement produces it in the creation pattern. The macroaesthetic measurement regards the aesthetic object as a given realization, but the microaesthetic measurement sees it in connection with a collection of possibilities bestowed by the repertory. These different methods of observation explain why the macroaesthetic measurement is geometrically oriented and the microaesthetic measurement is statistically oriented and why the former means a (communications pattern) form measurement, whereas the latter means a (creation pattern) information measurement. The distribution of material elements throughout a given repertory, which is interpreted macroaesthetically as identifiable form, must therefore be evaluated macroaesthetically as innovative information. To the

extent that thereby the aesthetic condition as such is viewed as a function of the order relationship and complexity of its elements, it is necessary to represent these aspects that define the aesthetic measurement not by metrically geometric volume, but by statistically information-theoretical volume. The *microaesthetic complexity* in this aspect is conveyed by *statistical information* or *entropy* and the *microaesthetic order* is conveyed by *statistical redundancy* and is determinable. That is reasonable, since statistical information or entropy represents a measurement of the degree of mixing, of disorder, of the indeterminacy of a crowd of repertory revealing elements that can be selected and put in order. However, this is exactly what belongs to the concept of repertory complexity if it is intended to function as a source of possible innovation. The redundancy concept on the other hand means a kind of counter-concept to the concept of information in information theory in that it does not designate the innovation value of a distribution of elements but the ballast value of this innovation, which accordingly is not new but is well known, which does not provide information but identification. Order comes under the category of redundancy because its concept includes that of identifiability. It is constantly a ballast feature of the given, not an innovation feature. A completed innovation, in which just like in chaos there are only new conditions, would also not be recognizable. In the final analysis chaos is not identifiable. The identifiability of an aesthetic condition requires not only a singular innovation to be identifiable but also its identifiability in the light of its redundant ordering features. The microaesthetic measurement is therefore done by the relationship of statistical redundancy to statistical information (or entropy), i.e., by

$$Mä = R/H$$

The calculation of the (average) statistical information of the distribution of elements throughout a repertory takes place according to Claude E. Shannon [8] analogously to the calculation of the condition of the degree of mixture, of the indeterminacy by which the elements of the system are given, by means of the relationship

$$H = - \Sigma p_i \, ld \, p_i$$

i.e., as the sum of the probabilities (or relative frequencies) with which the elements of the repertory are selected or multiplied by the digital logarithm of these probabilities.

Redundancy in general is understood to be the difference between the *maximum possible* and the *actually occurring* information of an element of the repertory. The maximum possible information of an element of a repertory n elements is attained when all elements can be selected with the same probabilities, i.e., when

$$H = H_{max} = ld \, n$$

exists. The relationship to the calculation of redundancy accordingly takes the form, with reference to the maximum information, of

$$R = H_{max} - H \div H_{max}$$

If one characterizes the relationship of h to hmax als *relative information*, the result is

$$R = 1 - H_{rel}$$

SEMIOTIC MACROAESTHETICS

The macroaesthetic measurement is a *form measurement*. Seen semiotically, the form is always given in the *iconic* object reference, i.e., the sign category by which it is semiotically determined contains in each case the iconic component of the object reference. Three modifications of the sign category of the form are therefore possible: the rhematic-iconic qualisign category (when, e.g., the form is derived from the representational value of a color), the rhematic-iconic single sign category (when, e.g., the form represented by a singular form and the rhematic-iconic legisign category (when the form is represented by a rule-based applied form).

SEMIOTIC MICROAESTHETICS

The microaesthetic measurement revealed itself as a repertory-dependent distribution or information measurement.
The selection of the elements therefore required an *indexical identification*, which can be represented by the probability of its occurrence. Seen semiotically, this means that the elements are characterized by an indexical system of probability dimensions or statistical frequencies. The selectable elements of the repertory thus belong to the object-thematic, indexical-oriented sign categories: There are four modifications: the rhematic-indexical singsign category, the rhematic-indexical legisign category, the dicentic-indexical singsign category, and the dicentic-indexical legisign category. The indexical-oriented sign categories thus define elements of signs in semiotic systems which can designated as *indexical* given *configurations*. The microaesthetic measurement may therefore be regarded, unlike the macroaesthetic form measurement, as a configuration measurement. Configurations are formed that are not given in iconic but indexical form. Each element of the configuration belongs to the rhematic-indexical singsign category of the configuration, which is fixed by a singular probability. When each element is labeled by the same probability of the selection, it is a question of a legitimate use of the probability as in the case that the probabilities, for instance, are established by a regularly increasing progression; the elements or the total distribution are then defined as belonging to the rhematic-indexical legisign category. The dicentic-indexical signsign category is realized by a definite grid element (which functions dicentically as a result of its isolation), and the dicentic-indexical legisign category ultimately defines semiotically the border – or frame-limited grid system, in the area of which the elements can be located configuratively. Another important indexical system of the dicentic-indexical legisign category also creates the perspective.

NUCLEAR AESTHETICS

Nuclear aesthetics is concerned with the smallest or extremely small units of distributions in a repertory of material elements and their creative procedures, the selections. Through these selections the distributions are generated as conditions of vagueness, as innovations. We have already established in the context of microaesthetics that in principle the repertory can be regarded as an equally probable distribution of material elements, and this equally probable distribution entitles us to designate the condition of the repertory as *chaogenic*. The selection of this chaogenic repertory leads to two aesthetic borderline areas, the regular order of the *structural* condition and the irregular order of the *configurative* condition. Semiotically it would be easy to characterize these conditions object-thematically as *iconic* and as *indexical systems*, while the *chaogenic* repertory, likewise in the object-thematic aspect, would be interpreted as a *symbolic system*.

Now Aleksandr I. Khinchin [9] has developed finite patterns of the statistical vagueness of events which are explainable as elementary models of aesthetic distributions or conditions. What is observed here is a repertory of material elements that can be selected. In the selection procedure a similar material element of the finite horde of elements of the repertory are always chosen with a certain degree of probability. The chain of selections is therefore the creative process. Now if the full repertory of material elements (colors, sounds, words, and the like) is shown E_1, E2,... E_n together with the probabilities of selection $p_1, p_2 \ldots p_n$, this can be interpreted as a *finite pattern*, that is nuclear-aesthetic as an elementary model of *undefined distributions* or *aesthetic conditions*. The abstract finite pattern for classifying the elements of a repertory into the probabilities of their selection is accordingly depicted in the following figure:

$$Rep = \begin{pmatrix} E_1, E_2, \ldots E_n \\ p_1, p_2, \ldots p_n \end{pmatrix}$$

This *finite pattern*, which, as stated, according to Khinchin describes each *condition* of *indeterminacy*, conveys the creative process at the same time or the creative pattern as a distribution of probabilities, reducible to fundamental cases, to the *core* of aesthetic conditions.

NUMERICAL NUCLEAR AESTHETICS

For numerical nuclear aesthetics it is important that each finite pattern of classification among elements of a repertory and their probabilities of selection describes a condition of indeterminacy. This holds true in particular for our border conditions of aesthetic distribution, for the chaogenic, the structural, and the configurative conditions. If the repertory contains n elements and if each of them is assigned the same probability of selection 1/n, this is how the *finite pattern* describes

$$\begin{pmatrix} E_1, E_2, \dots E_n \\ 1/n, 1/n, \dots 1/n \end{pmatrix}$$

the pattern of *chaogenic distribution*, which in principle is characteristic of all possibilities of selection and innovation in the repertory.

If an element is selected from the repertory with confidence, that is to say with a probability of 1, the *finite pattern* has the form

$$\begin{pmatrix} E_1, E_2, \cdots E_n \\ 0, 1, 0, 0, 0, 0 \end{pmatrix}$$

and identifies a *structural distribution*, for example for the plan of an ornament which by setting a support element, e.g., the gap in an infinite pattern, can be constructed.

Finally, if the *finite pattern* shows a classification of the type

$$\begin{pmatrix} E_1, E_2, E_3, \dots E_n \\ 0{,}3\ 0{,}1\ 0{,}4\ 0{,}0{,}0,\ 0{,}2 \end{pmatrix}$$

it therefore reflects an irregular *configurative distribution*, a singular selective innovation.

According to Khinchin there is a function

$$H(p_1, p_2, \dots p_n) = - \sum p_k \log p_k,$$

which should be designated as *entropy* of the *finite pattern*. It is evident that with this function the *finite patterns* of the nuclear aesthetic condition experience a microaesthetic measurement determination. The function vanishes if an element e_1 with probability $p_1 = 1$ is chosen and all other p's equal zero, i.e., are not selected. In this case no lack of certainty exists for the aesthetic condition. We are therefore concerned now with a case of structural distribution whose entropy – and therefore also innovation or statistical information – is negative. In all other cases of the distribution of probability over all the elements of the repertory, the function and therefore the entropy or the innovation are positive. The maximum is attained when, as already remarked, all E's in the repertory acquire the same probability of selection. Thus in the case of chaogenic distribution, which describes the ideal repertory, the indeterminacy of this condition is greatest.

SEMIOTIC NUCLEAR AESTHETICS

As far as the semiotic feature of the borderline case of the *nuclear* aesthetic condition and its finite patterns are now concerned, it must orient itself to the *sign categories*. Nuclear semiosis develops the distributive core as a sign category, i.e., as a complete triadic relationship covering I, O, and M. In this we must firmly realize that while the macroaesthetic description is oriented object-thematically to the icon and the microaesthetic description is object-thematically oriented to the indexical, the nuclear-aesthetic description, since it has directly become a disparate system of elements in the chaogenic repertory, can always only presume a separating *symbolic* object relationship. The constituted sign categories in nuclear semiosis are sign categories of symbolic object relationships. We are therefore concerned with the three cases in the system of sign categories, the cases known as:

```
1 the rhematic-symbolic legisign category
2 the dicentic-symbolic legisign category
3 the argumental-symbolic legisign category
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The rhematic-symbolic legisign category defines semiotically a condition of maximum indeterminacy and openness and thereby the chaogenic condition of the repertory.

The dicentic-symbolic legisign category on the other hand defines a definite condition and therewith a structure.

The argumental-symbolic legisign category ultimately comprises all configurative conditions between the condition of maximum indeterminacy and the condition of maximum definition, whereby the graduation is produced argumentally by a system of probabilities that is numerically between 0 and 1.

One can also assign the three categories of the equally probable, the regular, and the irregular order to these three sign categories. It is likewise clear that the three borderline cases of Khinchin's abstract finite pattern are semiotically represented in this manner. Finally we must also point out that the well-known sign operations of adjunction, iteration, and superisation are connected in a characteristic way within the nuclear semiosis with the aesthetic conditions that were introduced of chaogenic, structural, and configurative distribution. The adjunction of signs or categories of signs, for each sign belongs to a sign category, constitutes the chaogenic condition; for in a case like this the signs are given separately, and mere selection, which relates to the separated sign, cannot take place other than in an adjunctive manner. Corresponding to this is the structural condition, which, seen abstractly and from a principled point of view, constitutes the infinite agreement, can only be proved in the event of iteration, the reflexive repetition of the structural element. Configurative aesthetic conditions, on the other hand, are clearly set by the indexical system, but this very indexical setting of the distribution of the material elements lifts it to a totality that under certain circumstances can be identified in relation to the object as supericon. From the standpoint of distribution, for example, the points of certain pencils of lines form an indexical configuration of elements which at the same time set a perspectival system that can be iconisized object-thematically.

THE SYSTEM OF SEMIOTIC AESTHETIC

Corresponding to the growth of semiotics as such, semiotic aesthetics also is broken down into three parts: in a syntactical part, a semantic part, and a pragmatic part. The *syntactical* aesthetic produces statements about the relationships between the signs that constitute an aesthetic condition insofar as these are regarded as material elements, as mere means. The purely numerical, especially statistical or probability theoretical formulations of microaesthetics thus above all belong to syntactical aesthetics, but so do statements that relate to the well-known semiotic operations of adjunction, iteration, and superisation.

The *semantic* aesthetic, on the other hand, is concerned, as is the whole field of semantics, with the object-focused, object-related, or object thematics of the signs of an aesthetic condition. Insofar as an aesthetic condition at the same time as a distribution of the signs gives a distribution of the objects of these signs, the question arises of the aesthetic relevance not only of the signs, but also of the objects which they signify. For semantic aesthetics, the repertory of the creative selection process accordingly includes not only material elements as signs, but at the same time also the objects or object relationships of these signs. A doubled trace of selection and an ambiguity of 'representation' with respect to aesthetics corresponds here to the doubled being-themes of the repertory, insofar as the once represented 'world' and a 'representation' of world are realized and correspondingly the aesthetic distribution at one time in the particular world of semiotic means and another time in the outer world of the objects denoted by these means, is realized. For each object-thematic art, regardless of whether this is about painting, text, sculpture, or music, the redoubled problem of the given reality of things in material *aesthetic space* and in relational *semantic space* arises under the point of view of semantic aesthetics. Numerical macroaesthetics, which relates to the aesthetic measurement of objects such as polygons, vases, ornaments, models, and the like is essentially also semantic aesthetics. Hegel's metaphysical aesthetics can be thought of as 'content aesthetics' as well as an interpreting aspect of semantic aesthetics. Meanwhile their problems already refer back to pragmatic aesthetics.

Pragmatic aesthetics relates to the interpretations or references to meaning of the signs that constitute an aesthetic condition. The distinction between object reference and interpretation reference (designation function and meaning function) is defined by the fact that in the object reference the sign (by means of the external observer in the creative pattern) related to an object, whereas the signified object in the interpretation reference relates to other objects, thus (by means of the external observer in the creative scheme) is selected to go into a connex or context. Then in fact even in the interpretation reference of a sign with the rhema, the dicent, and the argument, three connexes, the open, the closed, and the complete connex, are introduced and are produced by the three patterns of meaning. As far as their connection with the three aesthetic conditions of the chaogenic, structural, and configurative distribution is concerned, it is easily demonstrated that the rhematic connex corresponds to the chaogenic as more open, the dicentic as more closed to the structural condition, and the argumental as more complete to the configurative aesthetic condition. One must just keep firmly in mind that the interpretation references are given over all of the object references. Accordingly, when it comes to connexes, we are concerned with the connexes of objects. The external observer, who acts as the interpreter of object references, selects objects as being separated in the event of an open rhematic connex, and the aesthetic condition, which is generated in this manner, is the type in which each object can replace another. As a material distribution the latter condition is chaogenic; it indicates the image of chaos; but the pattern of interpretation consistent with meaning is that of the metaphor. The principle of the metaphor is one of aesthetics, to the extent that it at the same time includes the principle of a chaogenic identification of the global connection. In the case of the closed dicentic connex, the external observer acting as interpreter has already selected certain objects as belonging together and *facts* that are open to the assertion, which linguistically may be represented as a *sentence*, visually as object-form or a form-color relationship and owing to whose stringent relevance and repetition, the signified objects of the world show up in *structures*. In the fully developed argumental connex, finally, the external observer interprets a complete global connection of symbolically signified objects in a meta-indexical system of their distribution which aesthetically possesses the abstract character of a *configuration*. It is not difficult to classify the word patterns of (lyric) poetry, (epic) prose, and (reflection-theoretical) texts within the linguistic creation process of these three aesthetic modifications of pragmatic interpretations. Obviously the function of *information* devolves upon the semantic object reference of the designation in the creative pattern of writing more strongly, and the function of *redundancy* more strongly upon the pragmatic interpretation reference of meaning. A maximum amount of (innovative) information corresponds to the rhematic, open context of (lyric) poetry that is oriented to the chaogenic global connection, and a maximum (interpretative) redundancy (of syntactic means and semantic references) to the argumental, complete context of (theoretical) reflection that is formed in the configurative global connection. The dicentic, closed context that is oriented to the structural global connection (of finite throngs of sentences) of (epic, narrative) prose, the sentences of which in each case consist of (individual) subjects and predicates which are appropriate or inappropriate for them, is on the other hand, as Rudolf Carnap has shown, determined by a special "semantic information"[10] whose measurement coincides with the "information transmitted by the statement". This 'information' interpreted as a 'statement' is the information of a dicentic and thus closed connex and thereby of a structural unity of two objects that are designated in two different categories and are linguistically interpreted as (individual) subject and (classifiable) predicate. The information transmitted by way of a statement in a dicentic connex is an innovation insofar as it, as a representation (consistent with a sentence) of a factual content, at the same time alters its original representation. The innovation which constitutes the essence of the information appears in the 'semantic information' of the connex as the difference of two representations, which means, however, as the difference of the object references selected by the interpreting external observer when he appears in the creative pattern as writer or as narrator. One must always be careful, however, that the actual aesthetic weight of a distributive material condition is in the relationship of the redundant to the innovative moment. Looked at from the standpoint of the numerical identification of the aesthetic condition, 'semantic information' can therefore only be a vehicle of the 'aesthetic'. So it is said about a semiotic identification of the aesthetic condition that it is a question of a singular relationship between the selected *designated* object references and the selected *meaningful* interpretation references.

CRUDE AND SUBTLE AESTHETICS

Aesthetics is always a description of the condition of certain distributions of material elements in their repertory. This description of a condition can be cruder or more subtle. Therefore one must speak in terms of crude and subtle aesthetics. In principle aesthetic conditions are graduated conditions. Numerical as well as semiotic categories are categories that have the capacity of fine-tuning, without which the characteristic feature of graduated indeterminacy with extreme cases of singularity and fragility cannot be comprehended. Even the *value aesthetic* of certain *emotional interpretants* of aesthetic conditions presumes that the latter are graduable even if this aesthetic does not make use of an object-related but a subject-related scale, which in fact is the theme of a value aesthetic. The conventional value aesthetic, however, can be developed into an exact value aesthetic if the conventional, subject-related and consumption-dependent values are defined throughout all of the numerical measurement rules and semiotic classifications (empirical and statistical).

GENERAL CONCLUSION

Abstract aesthetics is concerned with all possibilities of the material realization of aesthetic conditions; It does not limit the category of the carriers of aesthetic conditions. In principle it does not acknowledge any distinction between natural, artistic, and technical objects as carriers of aesthetic conditions. It can therefore be pursued as natural theory, art theory, literature theory, text theory, design theory, architecture theory, or in general as theory of technology. Since the exact applicable means of numerical measurement determination and semiotic classification relate directly to the condition of graduable indeterminacy by means of which aesthetic conditions distinguish themselves, the idea of *aesthetic programming*, which is an object of *generative aesthetics*, does not contradict the intentions of art as such.

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Statement

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From *Computer-Kunst [Computer Art], On the Eve of Tomorrow*, Hannover, catalog, 1969. Used with kind permission of the author. Translation Joseph Ebot.

GEORG NEES

Information aesthetics, as it has been developed by Max Bense and his disciples as well as by Abraham A. Moles, has made us aware of the difference between semantic and aesthetic information. Semantic information means something, whether it is a person's weight, the rough draft of a piece of work, or the content of a novel. Aesthetic information on the other hand does not mean anything; since the fact that the shape of a dolphin is simply beautiful, that it is fluidic and slips easily through water is germane to semantics, not to aesthetics. The wealth of aesthetic forms is immeasurable, but the inventory of forms meaningfully designed to serve a purpose is limited. Dophins are a synthesis of semantic and aesthetic information, just like vacuum cleaners, and they differ in that dolphins are the products of biological evolution, whereas vacuum cleaners come from sociological evolution. No dolphin is exactly like any other dolphin, and no vacuum cleaner gets exactly the same outer case as another one does from its designer. One can replicate this variability in the model. Computers give variety to a form, in that they distribute form-defining measurements in established boundaries by means of random generators (no dolphin is bigger than the maximum or smaller than the minimum). Design by computer is still in its infancy: varieating a form for a purpose by a computer, selecting ideal variants. If the computer model produces graphics, one calls it computer graphics. Design is applied computer graphics. Pure computer graphics – well, let's give some examples. We can imagine an infinite number of forms and infinite variations of these forms. The most primitive kinds of artificial plant life are suddenly there. Who knows what they are going to develop into?

from
Expanded Cinema

Reprinted from Gene Youngblood, *Expanded Cinema*, 1970. (From pp. 189 - 222 & p. 246 - 249). Used with kind permission of the author.

GENE YOUNGBLOOD

THE AESTHETIC MACHINE

As the culmination of the Constructivist tradition, the digital computer opens vast new realms of possible aesthetic investigation. The poet Wallace Stevens has spoken of "the exquisite environment of face." Conventional painting and photography have explored as much of that environment as is humanly possible. But, as with other hidden realities, is there not more to be found there? Do we not intuit something in the image of man that we never have been able to express visually? It is the belief of those who work in cybernetic art that the computer is the tool that someday will erase the division between what we feel and what we see.

Aesthetic application of technology is the only means of achieving new consciousness to match our new environment. We certainly are not going to love computers that guide SAC missiles. We surely do not feel warmth toward machines that analyze marketing trends. But perhaps we can learn to understand the beauty of a machine that produces the kind of visions we see in expanded cinema.

It is quite clear in what direction man's symbiotic relation to the computer is headed: if the first computer was the abacus, the ultimate computer will be the sublime aesthetic device: a parapsychological instrument for the direct projection of thoughts and emotions. A. M. Noll, a pioneer in three-dimensional computer films at Bell Telephone Laboratories, has some interesting thoughts on the subject: "...the artist's emotional state might conceivably be determined by computer processing of physical and electrical signals from the artist (for example, pulse rate and electrical activity of the brain). Then, by changing the artist's environment through such external stimuli as sound, color and visual patterns, the computer would seek to optimize the aesthetic effect of all these stimuli upon the artist according to some specified criterion... the emotional reaction of the artist would continually change, and the computer would react accordingly either to stabilize the artist's emotional state or to steer it through some preprogrammed course. One is strongly tempted to describe these ideas as a consciousness-expanding experience in association with a psychedelic computer... current technological and psychological investigations would seem to aim in such a direction." [21]

This chapter on computer films might be seen as an introduction to the first tentative, crude experiments with the medium. No matter how impressive, they are dwarfed by the knowledge of what computers someday will be able to do. The curious nature of the technological revolution is that, with each new step forward, so much new territory is exposed that we seem to be moving backwards. No one is more aware of current limitations than the artists themselves.

As he has done in other disciplines without a higher ordering principle, man so far has used the computer as a modified version of older, more traditional media. Thus we find it compared to the brush, chisel, or pencil and used to facilitate the efficiency of conventional methods of animating, sculpting, painting, and drawing. But the chisel, brush, and canvas are passive media whereas the computer is an active participant in the creative process. Robert Mallary, a computer scientist involved in computer sculpture, has delineated six levels of computer participation in the creative act. In the first stage the machine presents proposals and variants for the artist's consideration without any qualitative judgments, yet the man/machine symbiosis is synergetic. At the second stage, the computer becomes an indispensable component in the production of an art that would be impossible without it, such as constructing holographic interference patterns. In the third stage, the machine makes autonomous decisions on alternative possibilities that ultimately govern the outcome of the artwork. These decisions, however, are made within parameters defined in the program. At the fourth stage the computer makes decisions not anticipated by the artist because they have not been defined in the program. This ability does not yet exist for machines. At the fifth stage, in Mallary's words, the artist "is no longer needed" and "like a child, can only get in the way." He would still, however, be able to "pull out the plug," a capability he will not possess when and if the computer ever reaches the sixth stage of "pure disembodied energy." [22]

Returning to more immediate realities, A. M. Noll has explained the computer's active role in the creative process as it exists today: "Most certainly the computer is an electronic device capable of performing only those operations that it has been explicitly instructed to perform. This usually leads to the portrayal of the computer as a powerful tool but one incapable of any true creativity. However, if 'creativity' is restricted to mean the production of the unconventional or the unpredicted, then the computer should instead be portrayed as a creative medium — an active and creative collaborator with the artist... because of the computer's great speed, freedom from error, and vast abilities for assessment and subsequent modification of programs, it appears to us to act unpredictably and to produce the unexpected. In this sense the computer actively takes over some of the artist's creative search. It suggests to him syntheses that he may or may not accept. It possesses at least some of the external attributes of creativity." [23]

Traditionally, artists have looked upon science as being more important to mankind than art, whereas scientists have believed the reverse. Thus in the confluence of art and science the art world is understandably delighted to find itself suddenly in the company of science. For the first time, the artist is in a position to deal directly with fundamental scientific concepts of the twentieth century. He can now enter the world of the scientist and examine those laws that describe a physical reality. However, there is a tendency to regard any computer-generated art as highly significant — even the most simplistic line drawing, which would be meaningless if rendered by hand. Conversely, the scientific community could not be more pleased with its new artistic image, interpreting it as an occasion to relax customary scientific disciplines and accept anything random as art. A solution to the dilemma lies somewhere between the polarities and surely will evolve through closer interaction of the two disciplines.

When that occurs we will find that a new kind of art has resulted from the interface. Just as a new language is evolving from the binary elements of computers rather than the subject-predicate relation of the Indo-European system, so will a new aesthetic discipline that bears little resemblance to previous notions of art and the creative process. Already the image of the artist has changed radically. In the new conceptual art, it is the artist's idea and not his technical ability in manipulating media that is important. Though much emphasis currently is placed on collaboration between artists and technologists, the real trend is more toward one man who is both artistically and technologically conversant. The Whitney family, Stan VanDerBeek, Nam June Paik, and others discussed in this book are among the first of this new breed. A. M. Noll is one of them, and he has said: "A lot has been made of the desirability of collaborative efforts between artists and technologists. I, however, disagree with many of the assumptions upon which this desirability supposedly is founded. First of all, artists in general find it extremely difficult to verbalize the images and ideas they have in their minds. Hence the communication of the artist's ideas to the technologist is very poor indeed. What I do envision is a new breed of artist... a man who is extremely competent in both technology and the arts."

Thus Robert Mallary speaks of an evolving "science of art... because programming requires logic, precision and powers of analysis as well as a thorough knowledge of the subject matter and a clear idea of the goals of the program... technical developments in programming and hardware will proceed hand in glove with a steady increase in the theoretical knowledge of art, as distinct from the intuitive and pragmatic procedures which have characterized the creative process up to now."

<...>

COMPUTER FILMS

JOHN WHITNEY: COMPOSING AN IMAGE OF TIME

"My computer program is like a piano.
I could continue to use it creatively
all my life."

The foremost computer-filmmaker in the world today, John Whitney has for more than thirty years sought new languages through technological resources beyond human capacity. He has, however, remained resolutely 'humanist' in his approach, constantly striving to reach deep emotional awarenesses through a medium essentially austere and clinical. He has realized his goal to a remarkable degree, yet he would be the first to admit that there is a long way to go. "Computer graphic systems," he has said, "present an opportunity to realize an art of graphics in motion with potentials that are only now conceivable and have never been explored."

In his essay *Systems Esthetics*, Jack Burnham observed: "Scientists and technicians are not converted into artists, rather the artist becomes a symptom of the schism between art and technics. Progressively, the need to make ultrasensitive judgments as to the uses of technology and scientific information becomes 'art' in the most literal sense." [24] Whitney is making those judgments with a powerful extension of his brain.

Following studies at Pomona College in California, Whitney spent a year in Europe where he studied photography and musical composition. In 1940 he began specializing in concrete designs in motion, working with his brother James on animated films which won first prize at the first Experimental Film Festival in Belgium in 1949.

Early in the 1950's he experimented with the production of 16mm films for television and in 1952 wrote, produced, and directed engineering films on guided missile projects for Douglas Aircraft. He was a director of animated films at UPA in Hollywood for one year. The title sequence for Alfred Hitchcock's *Vertigo* was among the work he produced in association with Saul Bass during this period. Following that he directed several short musical films for CBS television, and in 1957 worked with Charles Eames assembling a seven-screen presentation for the Fuller Dome in Moscow. Each screen was the size of a drive-in movie screen.

In 1960 Whitney founded Motion Graphics Inc., producing motionpicture and television title sequences and commercials. Much of this work was done with his own invention, a mechanical analogue computer for specialized animation with typography and concrete design. In 1962 he was named Fellow of the Graham Foundation for Advanced Study in the Fine Arts. Finally, after approximately a decade, he found himself free once again to begin experimenting with less commercial, more aesthetic, problems of motion graphics.

The analogue computer work gained Whitney a worldwide reputation, and in the spring of 1966 International Business Machines became the first major corporation to take an 'artist in residence' to explore the aesthetic potentials of computer graphics. IBM awarded Whitney a continuing grant that has resulted in several significant developments in the area of cybernetic art. Whether working with hand-drawn animation cards or highly abstract mathematical concepts, Whitney has always displayed an artist's intuition and a technologist's discipline. He is a man of tomorrow in the world of today.

The history of cybernetics reached a milestone during World War II with the development of guidance and control mechanisms for antiaircraft artillery. Two men riding a telescope table sighted enemy aircraft and followed their penetration into the battery range. Selsyn motors in the gun-director mechanism automatically aimed an entire battery of guns while analogue computers set fuse times on explosive shells and specified true-intercept trajectories from data fed into the ballistics equation from movements of the operators.

An M-5 Antiaircraft Gun Director provided the basic machinery for Whitney's first mechanical analogue computer in the late 1950s. This complex instrument of death now became a tool for producing benevolent and beautiful graphic designs. Later Whitney augmented the M-5 with the more sophisticated M-7, hybridizing the machines into a mammoth twelve-foot-high device of formidable complexity upon which most of the business of Motion Graphics was conducted for many years.

Similar to the analogue device built by Whitney's brother James for the production of *Lapis*, but far more complex, the machine consists of primary, secondary, and tertiary rotating tables, cam systems, and other surfaces for pre-programming of image and motion sequences in a multiple-axis environment. Whitney's son John, Jr., an electronics genius who improved his father's device as a teen-ager by rewiring and implementing its circuitry, explains the basic functions of the machine:

"There's not one function that isn't variable. The whole master table rotates and so does every part in it, as well as moving laterally, horizontally, and in some cases vertically. The camera moves in the same way completely independent of the rest of the machine, or in synchronization with it. I don't know how many simultaneous motions can be happening at once. There must be at least five ways just to operate the shutter. The input shaft on the camera rotates at 180 rpm, which results in a photographing speed of about 8 fps. That cycle time is constant, not variable, but we never shoot that fast. It takes about nine seconds to shoot one frame because the secondary rotating tables require nine seconds to make one revolution. During this nine-second cycle the tables are spinning on their own axes while simultaneously revolving around another axis while moving horizontally across the range of the camera, which itself may be turning or zooming up and down. During this operation we can have the shutter open all the time, or just at the end for a second or two, or at the beginning, or for half of the time if we want to do slit-scanning."

The elder Whitney actually never produced a complete, coherent movie on the analogue computer because he was continually developing and refining the machine while using it for commercial work. It remained for his sons John and Michael to make full creative use of this device that had dominated their childhood from earliest recollection. However, Whitney did assemble a visual catalogue of the effects he had perfected over the years. This film, simply titled *Catalogue*, was completed in 1961 and proved to be of such overwhelming beauty that many persons still prefer Whitney's analogue work over his digital computer films.

The machine, like the digital computer, not only facilitated the quick and effortless rendering of complex geometrical shapes and motions, but also actually helped realize certain graphics possibilities that otherwise might not be conceivable to the artist untrained in mathematical concepts. *Catalogue* is a brilliant display of floral patterns that seem to bloom and curl as though they were actually organic growths photographed in time-lapse. Also they have a natural quality quite unlike traditional single-frame animation and are far more convincing. Elsewhere in the film, neon-like coils expand and contract, throwing out bursts of pastel color. Dish-shaped curvilinear disks wobble and strobe, stretch and contract in a variety of unexpected ways. Syncretistic dot-pattern fields collect together as in *Lapis*. Strings of green light perform seemingly impossible transformations into endless intertwined configurations of baffling optical complexity. Words assemble and disintegrate, defying logic. Floral ringlets pop like neon confetti, showering the screen with flak bursts of color.

Unlike the digital computer, which requires only a mathematical code as its input, the mechanical analogue computer as used by the Whitneys requires some form of input that directly corresponds to the desired output. That is, at least a basic element of the final image we see on the screen must first be drawn, photographed, pasted together, or otherwise assembled before it is fed into the analogue equipment for processing. This means that a great deal of handicraft still is involved, though its relation to the final output is minimal. The original input may be as simple as a moirē pattern or as complex as a syncretistic field of hand-painted dots — but some form of handmade or physically demonstrable information is required as input in the absence of conventional computer software.

GENE: You're among the few people in the world working to bring the public into a closer understanding of technology on a basis we can relate to — a movie, pretty colors, things that move. It's very important.

JOHN: Just after World War II my brother and I were constantly excited by a future world. We sort of expected it to happen before the 1940's were past. We thought nothing of taking on the formal and creative problems of a totally technological medium such as the cinema. It's taken twenty or thirty years to realize that the technology we looked upon as being the technology of the future was far from it. Instead of being the camera, the most important piece of instrumentation is the computer itself. Still ahead is considerable disciplined study to gain understanding or control of this kind of formal dynamic material so that it can be human. That's the whole problem. The light show people are doing a lot of wonderful sensory things, but I feel there must come insight into what is not seen now — an understanding of a whole new area of conceptual form. The light show people are doing something like an infant pounding on the keys of a piano. Sometimes it can be very creative and terribly exciting. But in the long run, looking at it as an adult, it's just banging away at the piano without training. We know that someone who plays a Beethoven sonata maybe has been sharpening his sensibilities and manual dexterity with that one piece for seven or eight years. That's the way I see the relationship between computer aesthetics and contemporary light shows.

GENE: Where would you place yourself today concerning what you've done and what you'd like to do?

JOHN: In one sense I'm just beginning. In another sense my work with the digital computer is a culmination of all my interests since the 1940's because I found myself forced into the techniques and mechanisms of cinema. I got to work with the digital computer thanks to the fact that I developed my analogue equipment to the point that I had. As I continued to develop the machine I realized it was really a mechanical model of the electronic computer. Anyone experimenting with the medium of cinema as opposed to working in the industry is forced into a direct confrontation with his technology. People tried all different techniques of abstract cinema, and it's strange that no one has really invented anything that another experimental filmmaker can take up and use himself. It's starting afresh every time. Jim and I were trying to make something and there wasn't a machine available for making it. So my work has come to fruition because the past thirty years of search for instrumentation has culminated in the present availability of the computer. On the other hand I'm only beginning to use it. We all are. It's the same with those who are beginning to use the computer to compose music — they're at a very primitive stage today.

Permutations, the first cohesive film to come out of Whitney's work with the digital computer, is a dazzling display of serial imagery that seems to express specific ideas or chains of ideas through hypersensitive manipulation of kinetic empathy. The patterns, colors, and motions dancing before us seem to be addressing the inarticulate conscious with a new kind of language. In fact, Whitney thinks of his work precisely as the development of a new communicative mode. Speaking of *Permutations*, he explains:

"The film contains various types of dot patterns which might be compared to the alphabet. The patterns are constructed into 'words', each having basically a twohundred-frame or eight-second time duration. These words in turn can be fitted contextually into 'sentence' structures. My use of the parallel to language is only partially descriptive; I am moved to draw parallels with music. The very next term I wish to use is 'counterpoint'. These patterns are graphically superimposed over themselves forward and backward in many ways, and the parallel now is more with counterpoint, or at least polyphonic musical phenomena. Should it be called 'polygraphic phenomena'?"

Whatever they're called, Whitney's films are impossible to describe with the archaic language of the phonetic alphabet. Circles, crescents, quadrants, and multiplex forms of infinite variety and endless motion interact serially, and cosmically, until one is transported into a realm of expanded consciousness that intuitively understands this new language. It's as though the very essence of the idea of permutation is expressed in this film, as though the 'word' no longer were separate from the fact. And that's exactly what Whitney has done: he's merged language with what it is intended to express. 'Beautiful' seems such an inadequate term in this respect.

<...>

GENE: You seem hesitant or apologetic using the parallel with musical forms.

JOHN: I'm wary of it. I've been making that analogy all along, but I'm aware of the pitfalls of a lot of people in history. Da Vinci talked about an art of color which would be dealt with as musical tones. Wilfred and Remmington in England at the turn of the century were building color organs. They were so hung up with parallels with music that they missed the essence of their medium. People talk about abstraction in graphics as being cold or inhuman. I just don't see that at all. What is a musical note? It's totally abstract. That's the essential point and that's why I use the musical analogy. The essential problem with my kind of graphics must resemble the creative problem of melody writing. It is perhaps the most highly sensitive task of art, involving as it does balance, contrast, tension, and resolution all brought into play with minimum expenditure. Music really is the art that moves in time. The many statements about architecture being frozen music notwithstanding, here we are truly looking at another art that moves in time. Someone once said about musical compositions: 'Time and tone completely fill each other... what the hearer perceives in the tones and rests of a musical work is not simply time but shaped and organized time... so the conventional formula receives its final interpretation: music is a temporal art because, shaping the stuff of time, it creates an image of time.' I like that idea very much, so I ask myself, what can be essentially the image of time for the eye to perceive?

<...>

GENE: Which comes first, sound or image?

JOHN: Image. In *Permutations* the sequences and colors were all done before I selected a piece of music, yet there are all these astonishing relations with the music. That's where accident is working in my favor. In many areas of art and music it has been commonplace for the artist to tell you there's nothing in his work that doesn't have some sort of valid relationship or meaningful reason for being there. They've constantly sought to avoid arbitrariness — not accident: you can often make an accident turn into a very wonderful twist to new meaning. But the worst kind of arbitrariness is when a person thinks his own casual decisions are great simply because he's done it, because he decided to be arbitrary. I expect to make a lot more progress in the direction of having more and more levels of formal organization—therefore it should be more and more human and multistructured.

GENE: In one sense you're in the forefront of avant-garde art today, concerned as it is with systems aesthetics, scientific discipline, and so on. In another respect, however, you do seem to be running against the grain of a trend toward the stochastic element, especially in music, films, and theatre.

JOHN: It's a universal misunderstanding. At the Aspen Design Conference in 1967, a scientist was describing a problem scientifically, saying it could be done this way and that, and then he said if it couldn't be done in such a rigorous way let's do it anyway and that'll be art. Scientists very frequently get excited about becoming involved in art. And the very first thing that comes to their minds is just to chuck out the whole discipline that their entire career is based on. They think if it's art, it's free. Anything that goes with random numbers is art; and anything that has to be worked out carefully so that this goes here and this has got to go there, that's not art, that's science. But for my money it's more important and difficult to get this here and that there in the area of art, because it involves much more than just counting numbers and making it mathematically sound: it's got to be intensely and intuitively sound. That's what I'm searching for. That's what I mean by structure.

<...>

STAN VANDERBEEK: MOSAICS OF THE MIND

"We're just fooling around on the outer edges of our own sensibilities. The new technologies will open higher levels of psychic communication and neurological referencing."

For the last five years Stan VanDerBeek has been working simultaneously with live-action and animated films, single and multiple-projection formats, intermedia events, video experiments, and computer graphics. Clearly a Renaissance Man, VanDerBeek has been a vital force in the convergence of art and technology, displaying a visionary's insight into the cultural and psychological implications of the Paleocybernetic Age.

VanDerBeek has produced approximately ten computer films in collaboration with Kenneth Knowlton of Bell Telephone Laboratories in New Jersey. They are descriptively titled *Poem Fields*, *One* through *Eight*, plus *Collisdeoscope* and a tenth film unfinished as of this writing. The term *Poem Field* indicates the visual effect of the mosaic picture system called Beflix (derived from 'Bell Flicks') written by Knowlton. A high-level set of macro-instructions was first written in Fortran. The particular translation or definition of this language for each film is then determined by the subroutine system of mosaic composition called Beflix. A new set of Beflix punch cards is fed into the Fortran-primed computer (an IBM 7094 interfaced with an SC-4020 microfilm plotter) for each new movie desired.

Whereas most other digital computer films are characterized by linear trajectile figures moving dynamically in simulated threedimensional space, the VanDerBeek-Knowlton *Poem Fields* are complex, syncretistic two-dimensional tapestries of geometrical configurations in mosaic patterns. "The mind is a computer," says VanDerBeek, "not railroad tracks. Human intelligence functions on the order of a hundred-thousand decisions per second." It appears this brain capacity was a prime motive in the production of the *Poem Fields*, whose micro-patterns seem to permutate in a constant process of metamorphosis which could very likely include a hundredthousand minuscule changes each second.

"The present state of design of graphics display systems," VanDerBeek explains, "is to integrate small points of light turned on or off at high speeds. A picture is 'resolved' from the mosaic points of light." The artist seems to feel that this process bears some physiognomic similarities to human perception. "The eye," he notes, "is a mosaic of rods and cones."

The early *Poem Fields* were investigations of calligraphic relationships between dots and alphabetic characters integrated into fields of geometrical patterns constantly evolving into new forms. The most famous of these is *Man and His World* (1967), a title piece for an exhibit at Expo '67.

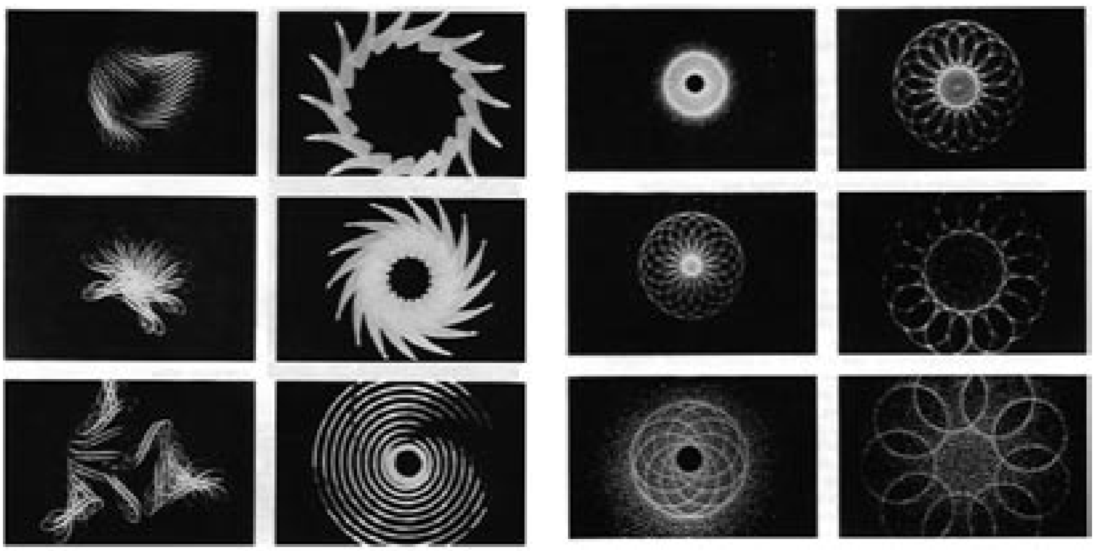
Variations on the mosaic field became more complex with successive experiments, until simulated three-dimensional depth was achieved in the form of infinitely-repeated modular units in perspective. It is immediately obvious that these films would be prohibitively tedious and time-consuming to do through conventional animation techniques. "Because of their high speeds of calculation and display," writes Knowlton, "the computer and automatic film recorder make feasible the production of some kinds of films that previously would have been far too expensive or difficult. In addition, the speed, ease, and economy of computer animation permit the moviemaker to take several tries at a scene — producing a whole family of film clips — from which he chooses the most appealing result, a luxury never before possible." [27]

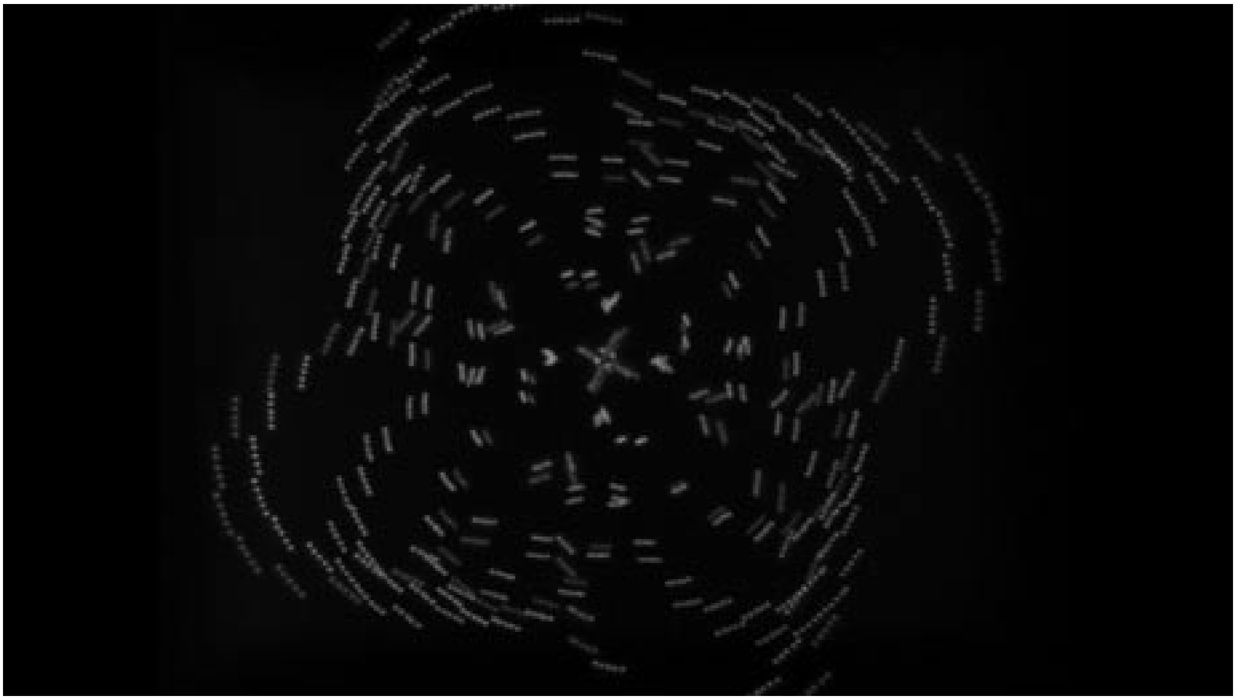
The more recent Beflix films have abandoned the original calligraphic patterns for highly complex Rorschach constellations of stunning beauty. They actually began with a film produced by two other scientists at Bell Telephone, B. Julesz and C. Bosche, for use in experiments with human vision and perception. This involved semirandom generation of graphic 'noise', whose patterns were reflected several times to produce intricate mandala grids resembling Persian carpets and snowflake crystals.

"We're now working with variations on the Beflix system that involves secondary systems," VanDerBeek explained. "It goes through two levels: first Beflix, then computerizing and quantizing that level. It's something similar to what Ken Knowlton and Leon Harmon did with pictures-within-pictures. We're trying to do that cinematically." *The Poem Fields* are filmed in black-and-white, with color added later through a special optical process that permits color gradations and increments almost as complex as the forms themselves.

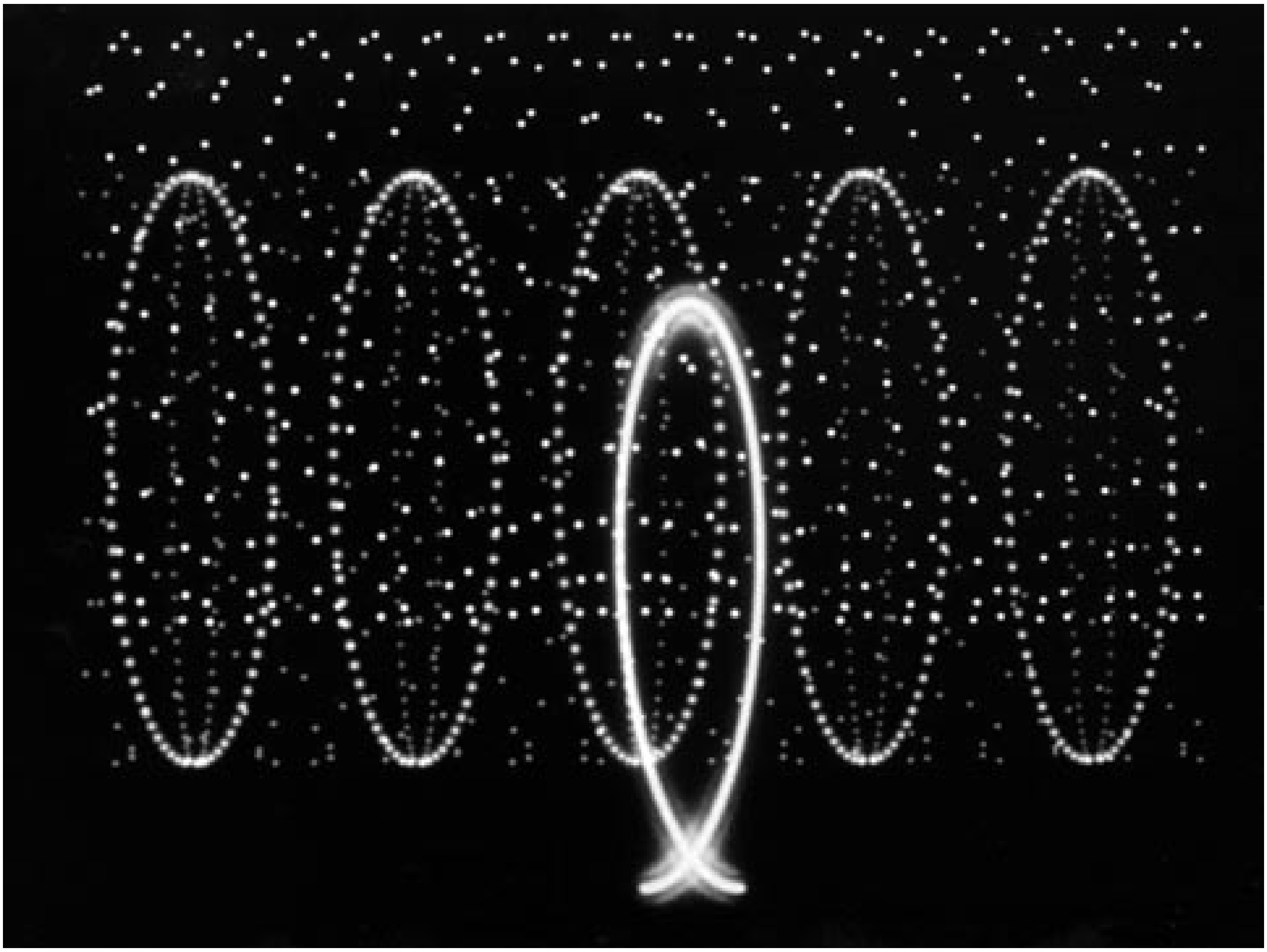
Notes

21 A. M. Noll, 'The Digital Computer as a Creative Medium', *IEEE Spectrum* October, 1967, p. 94.
22 Robert Mallary, 'Computer Sculpture: Six Levels of Cybernetics', *Artforum*, May, 1969, pp. 34, 35.
23 Noll, 'The Digital Computer as a Creative Medium', p. 91.
24 Jack Burnham, 'Systems Esthetics', *Artforum*, September, 1968, pp. 30-35.
25 John Coplans, 'Serial Imagery', *Artforum*, October, 1968, pp. 34-43.
27 Kenneth C. Knowlton, 'Computer Animated Movies', *Cybernetic Serendipity*, a special issue of Studio International, ed. Jasia Reichardt, London, September, 1968, pp. 67-68.





Permutations, John Whitney, 1968. 8 minutes, 16mm color, sound.



Arabesque, John Whitney, 1975, 7 minutes, 16mm color, sound.

There Should Be No Computer Art

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FRIEDER NAKE

Soon after the advent of computers it became clear that there was a great potential application for them in the areas of artistic creation. Before 1960, digital computers helped to produce poetic texts and music; analog computers (or only oscilloscopes) generated drawings of sets of mathematical curves and representations of oscillations. But it was not before the first exhibitions of computer produced pictures were held (1965) that a greater public took notice of this threat, as some said, – progress, as others thought. The threat and progress being the use of an extremely complicated, sophisticated, expensive and rational machine in the arts. i.e. in one of the last refuges of the irrational; as some believe. And it took another three years before there was a tremendous breakthrough caused by two big international exhibitions of 'computer art' '*(Cybernetic Serendipity*, London 1968, *Computers and Visual Research*, Zagreb 1969).

Since then, a serious discussion has been going on in the art world about the consequences and implications of the use of computers. Art magazines are full of articles, exhibitions are held everywhere; seminars are offered by art schools, books are published, portfolios are sold. Computer conferences have their computer art sections, computer journals publish technical papers. Computer scientists are flattered by the little public success they make and amused by the interest artists develop. Artists surrender to the pressures of the new technique or laugh at the results, and get humiliated by the attitudes that scientists assume when they try to communicate with each other.

The discussion centers around the question "is it or is it not art?", and is heated, often extremely ignorant and prejudiced, showing virtually no progress, highly repetitive, although the few interesting new methods and the little knowledge of computers that one needs have been published several years ago.

I was involved in this development from its beginning onward (1964). I found the way the art scene reacted to the new creations interesting, pleasing and stupid. I stated in 1970 that I was no longer going to take part in exhibitions.

I find it easy to admit that computer art did not contribute to the advancement of art if we judge 'advancement by comparing the computer products to all existing works of art. In other words, the repertoire of results of aesthetic behaviour has not been changed by the use of computers. (This point of view, namely that of art history, is shared and held against "computer art" by many art critics.)

There is no doubt on my mind on the other hand, that interesting new methods have been found, which can be of some significance for the creative artist. And beyond methodology, but certainly influenced by it, we find that a thorough understanding of 'computer art' includes an entirely new relationship between the creator(s) and the creation: Walter Bense uses the term 'art as a model for art' in this context.

The dominating and most important person in the art world today is the art dealer. He determines what is to be sold and what is not. It is the art dealer who actually created a new style, not the artist. Progress in the world of pictures today is the same as that in the world of fashionable clothes and cars: each fall, the public is presented with a new fashion, artificially (sic!) created almost a year before in the centers (Paris, London for clothes, Detroit for cars. New York for pictures). Differences from one year to the next are rarely ever substantial, in the majority of cases they are superficial and geared according to the salesmen's requests and analysis of the market.

It seems to me that 'computer art' is nothing but one of the latest of these fashions, emerging from some accidental, blossoming for a while, subject matter for shallow 'philosophical' reasoning based on prejudice and misunderstandings as well euphoric over-estimation, vanishing into nowhere giving room to the next fashion. The big machinery, still surrounded by mystic clouds, is used to frighten artists and convince the public that its products are good and beautiful. Quite frankly, I find this use of the computer ridiculous.

In many publications on 'computer art' we read complaints that 'real' artists do not have access to computers because of the forbidding expense of the machine , and because the artists' lack of knowledge in programming. We also read that we could obtain really interesting and new results if artists had the opportunity (money) to realize their ideas using a computer, perhaps being helped by programmers and mathematicians.

At the same time, artists become aware of the role they play in providing an aesthetic justification of and for bourgeois society. Some reject the system of prizes and awards, disrupt big international exhibitions, organize themselves in cooperatives in order to be independent of the galleries, contribute to the building of an environment that people can live in.

I find it very strange that, in this situation, outsiders from technology should begin to move into the world of art and try to save it with new methods of creation, old results, and by surrendering to the given 'laws of the market' in a naive and ignorant manner. The fact that they use new methods makes them blind to notice that they actually perpetuate a situation which has become unbearable for many artists.

COMPUTERS OUGHT NOT TO BE USED FOR THE CREATION OF ANOTHER ART FASHION.

Questions like 'is the computer creative' or 'is a computer an artist' or the like should not be considered serious questions, period. In the light of the problems we are facing at the of the 20th century, those are irrelevant questions.

COMPUTERS CAN AND SHOULD BE USED IN ART IN ORDER TO DRAW ATTENTIONS TO NEW CIRCUMSTANCES AND TO FORGET ‘ART’.

There is no need for the production of more works of art, particularly no need for ‘computer art’. Art (better: the aesthetic object) comes afterward (but it does come). Aesthetic information as such is interesting only for the rich and the ruling, For the others (and they are in the majority) it comes ‘with’. Namely with other information.

Thus the interest in computers and art should be the investigation of aesthetic information as part of the investigation of communication. This investigation should be directed by the needs of the people.

We should now be interested in producing some more nice and beautiful objects by computers. We should be interested in producing a film on, say, the distribution of wealth. Such a film is interesting because of its content; the interest in the content is enhanced by an aesthetically satisfying presentation. That is, the role of the computer in the production and presentation of semantic information is meaningful; the role of the computer in the production of aesthetic information per se and for the making of profit is dangerous and senseless. (It is interesting to notice in this context that Helmar Franke after a successful beginning in information aesthetics, gave it up and concentrated more and more on problems of education and psychology.)

REITERATING THE ARGUMENT: I DON’T SEE A TASK FOR THE COMPUTER AS SOURCE FOR PICTURES FOR THE GALLERIES. I DO SEE A TASK FOR THE COMPUTER AS A CONVENIENT AND IMPORTANT TOOL IN THE INVESTIGATION OF VISUAL (AND OTHER) AESTHETIC PHENOMENA AS PART OF OUR DAILY EXPERIENCE.

As concrete projects to be investigated I propose:

1 The study of the alienation of the artist from his product which is caused by technology in general and by computers in particular (the distance between the artist and his work increases). What are the good, what are the bad effects of the division of labor taking place in art?

2 Investigation of the repertoires of signs used by individual artists and styles in the past and present. Such repertoires have been described occasionally, but not rigorously enough. The emphasis of such a project should be to describe those repertoires (and their various levels) in a way suitable for an application of information aesthetics.

3 Design and performance of experiments to test the significance of aesthetic measures defined so far; perhaps new definitions of such measures.

4 Investigation of the importance of aesthetic information in various areas (education, propaganda, environments of work and living). This work would have to be based on a rigorous numerical definition of ‘aesthetic information’.

Technocratic Dadaists

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FRIEDER NAKE

In *PAGE* 18, a rather polemic statement was published about the question: should we have, or should we talk about 'computer art'? In the December 1971 issue, John Lansdown wrote a brief reply. If his reply and partial refutation of my short article marks the start of a discussion of the goals, the necessity and the merits of computer art – then I would be very pleased indeed. *PAGE*, it seems to me, is the natural communication channel for such a discussion.

In the present note I want to answer John Lansdown and make an attempt to further clarify my own position.

First of all, I readily admit that I view computer graphics as a central part of computer art and that I do so to a point where computer graphics is almost equated with computer art. John Lansdown is right in pointing out that this may lead to false conclusions. I hope to be more careful about this in the future. Although graphics (visual information) has attracted perhaps the largest attention by computer art appreciators over the last eight years, it is only one of the many fields of art to which computers have been applied. I maintain, on the other hand, that with the exception of music, no other field has shown so much progress. The achievements in music are superior to those in graphics; to which extent they constitute an enrichment of the repertoire of results – I do not know because of my lack of knowledge in music. But I would believe that a programming system like MUSIC V is an advancement of the methods as well as the results.

So I concede that the repertoire of results of aesthetic behaviour has changed. (John Lansdown lists three specific examples; H. W. Franke draws my attention to certain new moire patterns produced in Stuttgart; I am sure many a worker in the field would want to have his work attached to the list).

I thus correct my statement to: the repertoire of results of aesthetic behaviour has not changed significantly by the use of computers. (Already in 'There Should Be No Computer Art' I said that methods are a different story). This argument could be (and is usually) countered by pointing to the short history of computer art. How can we possibly expect a significant change to take place within a decade or so? Isn't that imaginary list of new and original works of computer art an indication that, given just a little more time, money, output equipment, assistance from experienced programmers, and co-operation of artists and programmers, we will be able to drastically change the places at which aesthetic objects are found and aesthetic events happen (museums, theaters, music halls etc.)?

Yes, maybe, given all that. But why should it be given? Why should we ask for it, in the first place? Who is 'we'? Who would benefit from all that?

This is getting closer to my intentions. The title of that first note. 'There Should Be No Computer Art', was not meant to be interpreted as: 'you should not use the *computer* for the production of art'. It should rather be read as: 'you should not use the computer for the production of *art*'.

'So what?' some might answer: 'I am using the computer, but not in order to output art or to control art – art doesn't exist anymore. And if it does, somewhere, I'm not interested in it. I don't care how you call my products – but they are not art'. Obviously, this is evading the point.

My point is:
'There is no need for the production of more works of art, particularly no need for 'computer art'. This is meant literally. By 'work of art' I mean aesthetic object (picture etc.) as well as aesthetic event (film, dance etc.) But notice, that I first mention art in general, only then computer art in particular. Since my influence is limited, if I want to change something, I have to focus on that area which I know most about. Therefore my attack is on computer art as that part of art that I am familiar with.

But, obviously, I do not want to say that art should be banned, that the word 'art' should be wiped out, that artists should lose their jobs, or anything of this kind. The investigation of the realm of aesthetics is important – I listed some concrete problems at the end of 'There Should Be No Computer Art'.

Why don't we need art (in its traditional sense) anymore? Because, in its 'traditional' sense, it is tied up with the bourgeois class. Art, the way most of us understand it nowadays, seems to be a fairly recent invention. The artist did not exist detached from society, doing his own thing, inventing new styles, pampering his ego. I would like to see him give up his role as a servant to the bourgeoisie and begin working on meaningful projects again. It is *meaningful* for an artist to help a computer scientist producing a book or lecture or a film such that these media do not transmit semantic information alone but aesthetic information as as well. It is *meaningful* for an artist to work in a team of architects, engineers, sociologists, urban planners on the design of a hospital or city district. It is *not meaningful* for an artist to produce a picture as such. It is *not meaningful* for an artist to produce a ballet or whatever intricate combination of however many art forms he is able to come up with. Such objects and events are of no significance whatsoever for the vast majority of people.

To make use of computers for the production of pictures 'Gesamtkunstwerke' is even less meaningful for an artist than the production of such things alone. To make use of computers for problem-solving and presentation in education and urban planning is even more meaningful for an artist than such problem-solving alone.

To summarize, my remark about the result of computer art should be re-interpreted. I do not wish that aesthetic use of computers contributes to art history by enlarging its repertoire. Such use should contribute to art history by bringing art back into the working world. If artists request that machinery should be built to suit their needs, they are on right track. For they realise that their means of production are long outdated. This is one reason why artists don't amount to an important part of society anymore; they can be neglected.

But, unfortunately, it seems that our artists who demand access to computers get caught in the old trap of the bourgeoisie: negating one aspect of social life is regarded as a revolutionary act that will cure the evil. Whereas the important step to do is to negate the negation.

Applied to our case:

demanding access to computers is progressive in so far as it is an attempt to bring the means of artistic production up to date. As a consequence, even the relations of production might change. At any rate the old notion of art would have to undergo considerable changes. But on the other hand, this negation of the old way of production seems to mark the end of thought, i.e. as soon the artist has access to the computer he continues to work as he did before. Whether he is more interested in the object or in the procedure (process) of his production, does not make much of a difference.

For, what is required is the negation of that first negation: to negate the present methods of artistic production and critique in order to preserve their positive elements and put them on a higher level. This level would no longer know the individual artist working for his personal fame and for an aesthetic justification of the present social system (the computer artist is doing just this).

Many computer artists we can call technocratic dadaists. They deny and replace the traditional ways of artistic production and see this as a revolutionary step; but, in effect, they only create a new artistic style – nothing more. The dadaists were bourgeois; they honestly believed in their revolution; they ended up with just another style whose products can be sold and assigned a place in bourgeois art history.

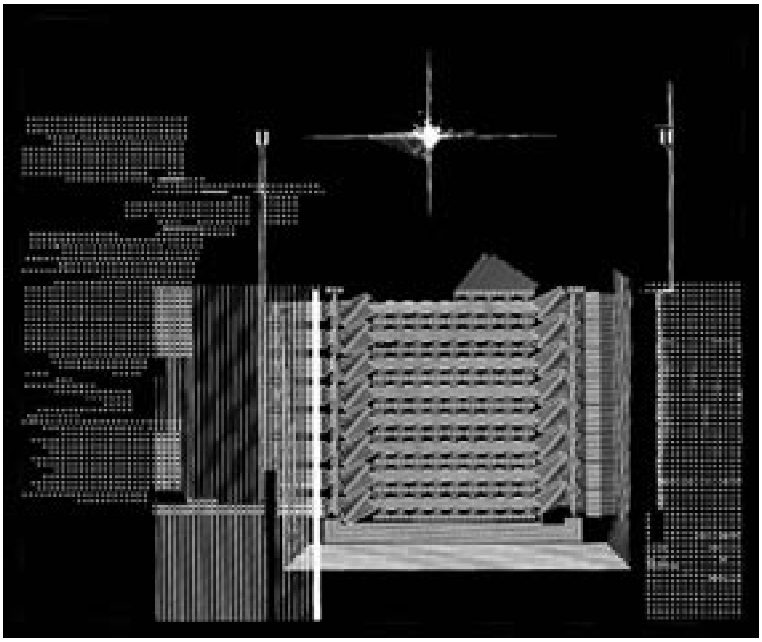
We often hear and use the argument that the computer will at last, set free all that hidden creative power in the artists. Almost everybody writing about computer art is quick in pointing out that only with the advent of the computer will the artist be able to concentrate on the really important problems of creativity, for all the tedious elaboration of patterns and compositions will be done by the machine.

"One of the major effects of artist-computer co-operation will be to personalize art work"; "The artistic computer will" even play "the roles assumed in medieval society by the court jester and minstrel". (G. Mallen: Where next? in *Computers in the Creative Arts* 1970, p. 50). Apart from the personification of the computer, what I find appalling in such statements is the naive way in which computer artists surrender to the principle of productivity. Sure, we are able to try out so many more possibilities and alternatives for the solution of an aesthetic problem. And sure, we can produce all these thousands of original works. And yes, we can have all those screens in everybody's home that puts him or her right into a network of aesthetic events (although this latter road, for some time to come, would be open to a few privileged ones only). But – what for? To me, such aesthetic progress does not introduce any new quality, only quantity. Productivity and consumerism in even a new field.

There is no alternative: the negation has to be negated, or else we all end up as sad technocratic dadaists.

Let me finish with a remark on the creativity issue. If, for the proceduralists, it is a fundamental issue "to discuss whether or not procedures within closed systems can be creative" (John Lansdown: 'Computer Graphics, Computer Art' *PAGE* 19, 1970) then, I am afraid, they will gain nothing but their small paragraph in a bourgeois art history. And who is interested in this? We can solve this fundamental issue right away. Since we assume a closed system, we have to start out with an operational definition of 'creativity'. We are free to choose this definition; but once chosen, it is fixed. Now, even if we try hard to come close to our intuitive understanding of creativity, I cannot see any problem in giving two such operational definitions. One will be such that the closed system is creative. The other such that it is not. All that I can see springing up from that fundamental issue is an investigation of *our* creativity, an attempt to better understand it. How a set of procedures can be creative – I must confess, I cannot see.

In closing I want to point out that some of our problems here are analogous to problems of and in artificial intelligence.



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Night Scene, Lillian F. Schwartz. Copyright © 1972 Lillian F. Schwartz.

LILLIAN SCHWARTZ [US]

Together with the computer programmer Ken Knowlton, Lillian Schwartz developed a series of impressive computer-generated films in the early 1970's, which won many prizes at international festivals. Perhaps the most striking of these films is *Olympiad* (1971), in which computer-designed athletes run across the screen against a naturalistic full-colour background.

Lillian Schwartz has, throughout her career, been at the cutting-edge of computer technology. She may be described as someone who, over the years, has been able change people's perceptions about the computer and its capabilities.

Untitled Statement

Manfred Mohr, 'Untitled Statement', from Ruth Leavitt (ed.), *Artist and Computer*, Creative Computing Press, Morristown, Harmony Books, New York, 1976. Reprinted with kind permission of the author.

MANFRED MOHR

The fundamental view that machines should not be considered as a challenge to humanity but, like McLuhan predicted, as an extension of ourselves is the basic philosophy when becoming involved with technology.

A technology which 'functions' has to be integrated in our lives like a physical extension – a necessity of our body and our mind. We are living now in an era of enormous technological transitions, where so many misunderstandings in human machine relationships are created by lack of knowledge and the categorical refusal to learn by most individuals. A quasi mystical fear of an incomprehensible technology is still omnipresent.

Breakthroughs in human development are always accompanied by radical changes of attitude towards the so-called human values. It is, for example, from a practical (and philosophical) point of view evident that one should simply be ready to leave the most possible part of a work to a machine when it becomes clear that in this way the desired solution may be better and more reliably achieved. It is also true that human thought can be 'amplified' by machines, raising our consciousness to a higher level of comprehension.

To apply methods of this kind in science is obvious, and generally considered as basic. To use similar methods in aesthetical research is, in my opinion, a possible and nevertheless historical consequence. Aesthetical research runs, for this point at least, parallel to scientific research and together they make our human developments more comprehensible.

In this context I consider the computer as a legitimate amplifier for our intellectual and visual experiences.

Through detailed programming analysis, one is able to visualize logical and abstract models of human thinking, which lead deep into the understanding of creative processing. Creative processes are mental processes having a priori an associative character, where associations are defined as interactions and/or transversal connections (*Querverbindungen*) of thoughts in a Time-Space neighbourhood relationship. Unifying those divergent or intersecting data from memory in order to form new meanings is called imagination or the facility of creating free associations. Most adults have been taught to think in a way which does not allow them to play with free associations. This 'cliche' thinking of so many people is radically opposed to imaginative thinking. To create new and perhaps important aesthetical information, it is necessary to operate with free associations. This does not necessarily involve a talent, but a training which has to be practiced. A computer, however, is (at least until today) not able to process in an associative way, even though it is a self-supervising machine. The computer is not conscious of what it is doing and can only execute orders from outside: from us! That means: a computer itself cannot create or invent anything.

We do not have to ask: what can the computer do?, but reverse the question by asking ourselves: what do we want to do? and then consider whether the help of a machine could be useful for our purpose. If the answer is positive, we have to find ways of asking the machine the right questions in order to get reasonable results, amplifying our thoughts and intentions. Proceeding in this way is an important step towards a systematic approach of aesthetical problems. Abraham Moles once said: "La machine ne pense pas, elle nous fait penser."

There are several ways of approaching the computer for this purpose:

1. A visual-concrete procedure. An existing

visual image is dissected into its basic elements. Each element can represent an algorithm. One can operate in various ways with these elements. The experience is:
visual image -> process -> visual image.

2. A statistical–flexible procedure. An existing or invented abstract logic is the basic algorithm and no visual image, or only a vague one, can be predicted. The importance of this approach lies in the applied rules, which are, at least in their conception, a new way of approaching a visual experience. The experience is:
abstract logic -> visual image.

Statistical–flexible procedures deviate into two distinct directions:

1. The visualisation of mathematical formulas. Without doubt very interesting results can appear which have never been seen before. For long-term artistic interest however, the resulting aesthetical information of a mathematical formula is in itself limited and therefore a closed system.

2. The research to find or invent individual rules as a means of artistic expression.

The individual impact of human behaviour, filtered and reformed through the inherent peculiarities of a computer, will lead directly to an interesting and overall coherent open system. Of course mathematics are used, but in this case only as a technical help, and not as the sole purpose.

The logical construction of a programming language forces us, on the one hand, to concentrate with an almost maniacal precision of formulation (the instructions), but opens, on the other hand, new dimensions for a wider and statistical thinking.

New operation models appear:

* — Precision as part of aesthetical expression.
* — High speed of execution and therefore multiplicity and comparativity of the works.
* — The fact that hundreds of imposed orders and statistical considerations can be easily carried out by a computer instead of by the human mind, which is incapable of retaining them over a period of time, for example during plotting time (calculation time).
* — The continuous feedback during a man-machine dialogue involves a learning process on the side of the human being, resulting in a clearer image of the creator's thinking and intentions.

Properties of this kind form a conceptual basis that shows a rigorous attitude in dealing with aesthetical problems.

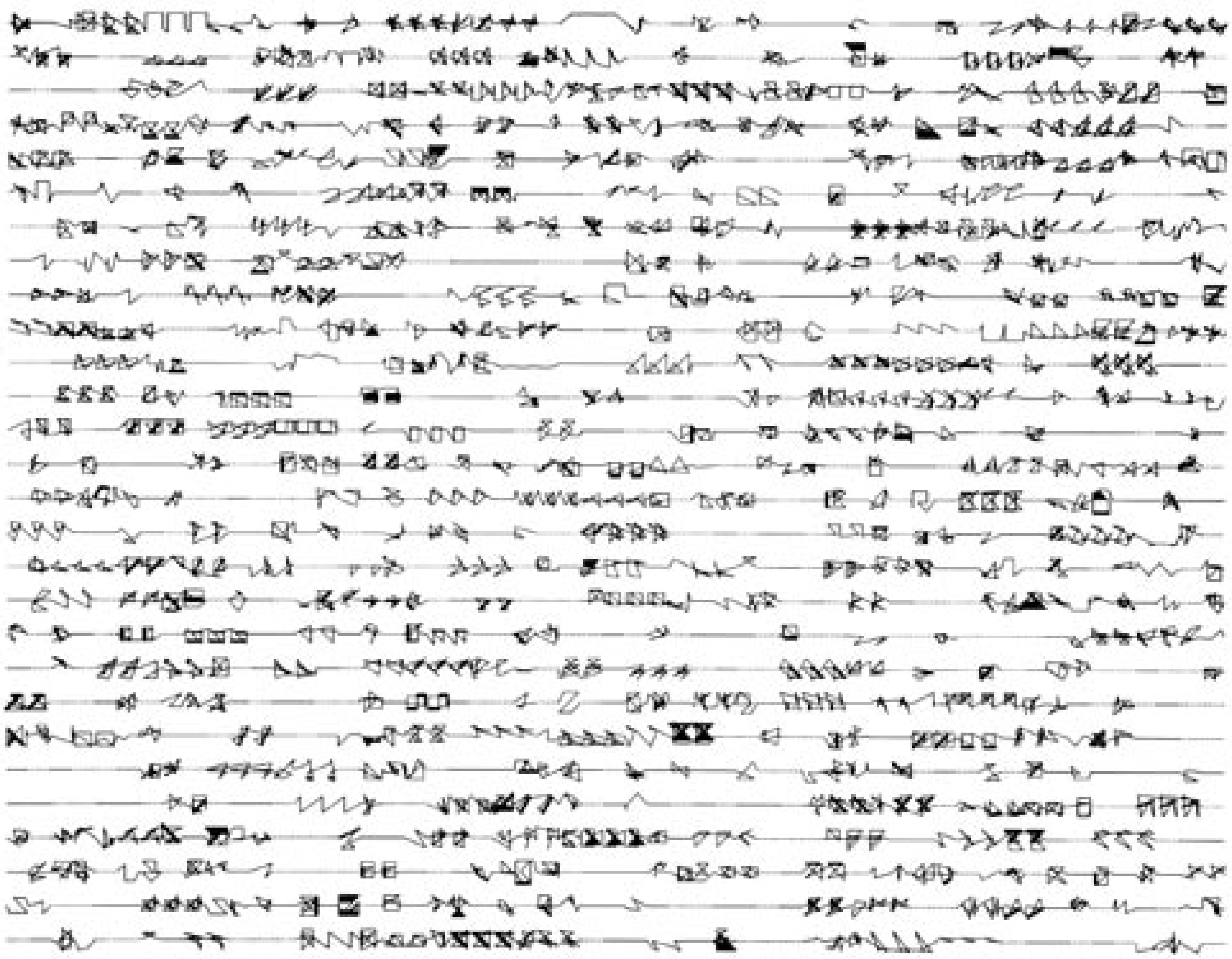
The dialogue with the computer implies also that results (graphics, etc.) and their visual expression have to be judged under completely new aspects. It is evident that one should not create single forms and judge them by a traditional and subjective aesthetic, but build sets of form where the basic parameters are relationships between forms with no aesthetical value associated to any particular form in the set. It is possible within this context to ignore the former ‘good’ and ‘bad’, now allowing aesthetical decisions to be based on statistical and value-free procedures, where the totality represents a quality of a quantity.

This procedure may lead to different and perhaps more interesting answers, lying of course outside one’s normal behaviour but not outside the imposed logic. The above postulated conception becomes part of a conditioned aesthetical information.

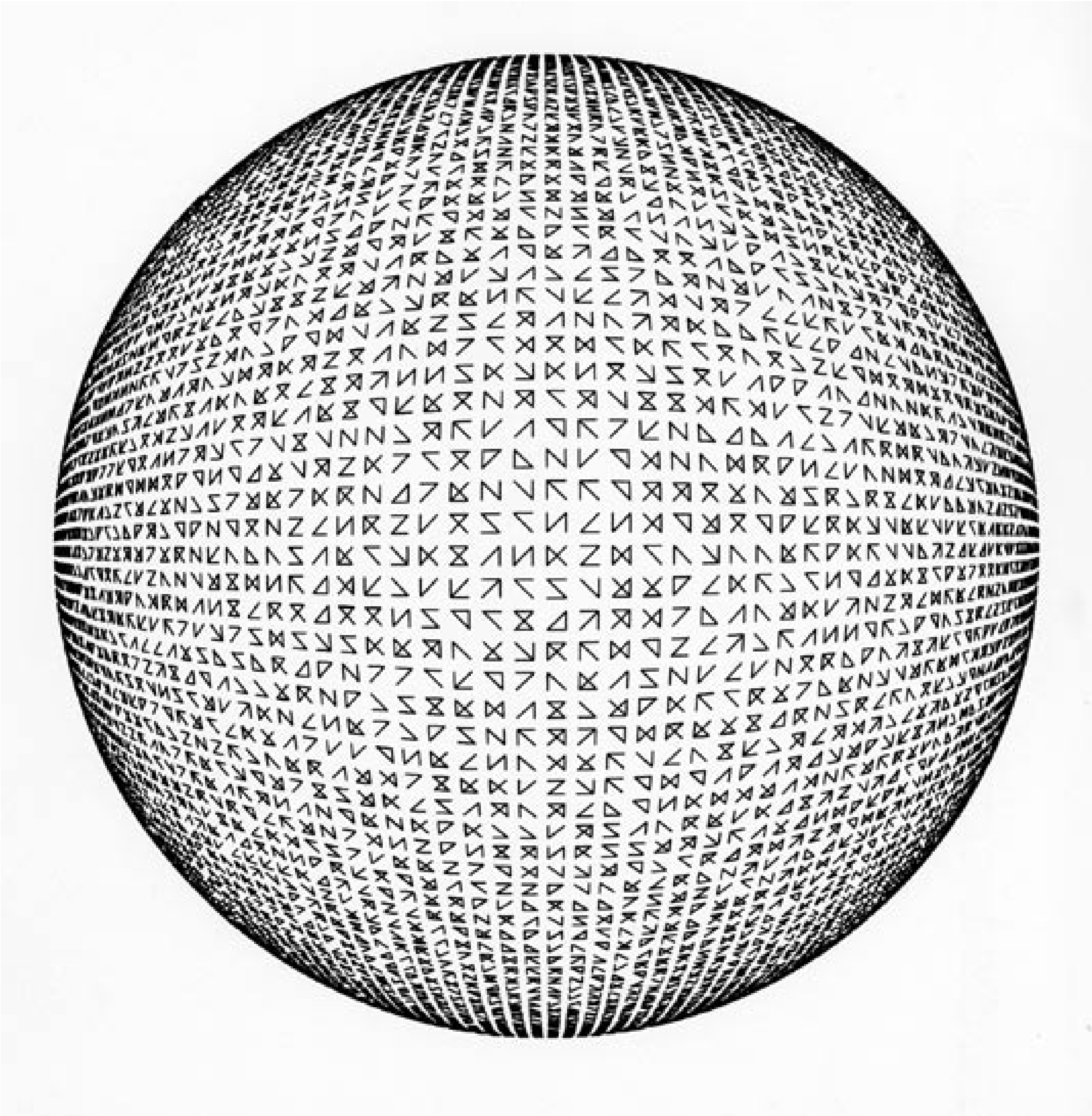
Computer–aided art is too young a phenomenon for one to foresee all its influence on the arts. It is most probable that the importance of an art thus created might lie essentially in its subtle and rational way of proceeding, which means that not only the ‘what’ but also the ‘how’ of the change will have fundamental consequences for the future.

The world will not be changed from the outside but from the inside and aesthetical decisions will be more and more based on knowledge rather than on irrelevance. The shift from uncontrollable metaphysics to a systematic and logical constructivism may well be the sign of tomorrow.

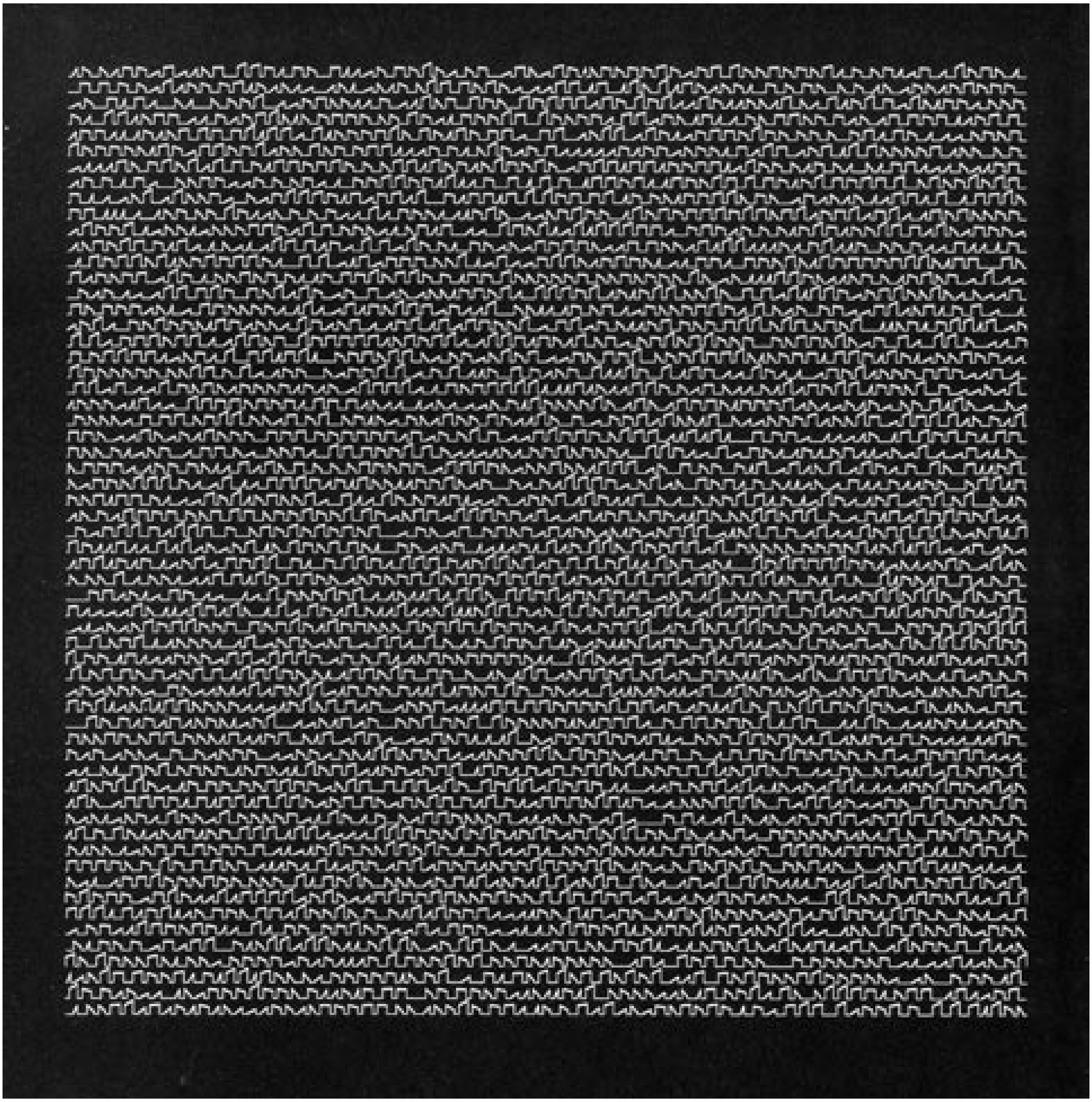
Paris, France
February 1975



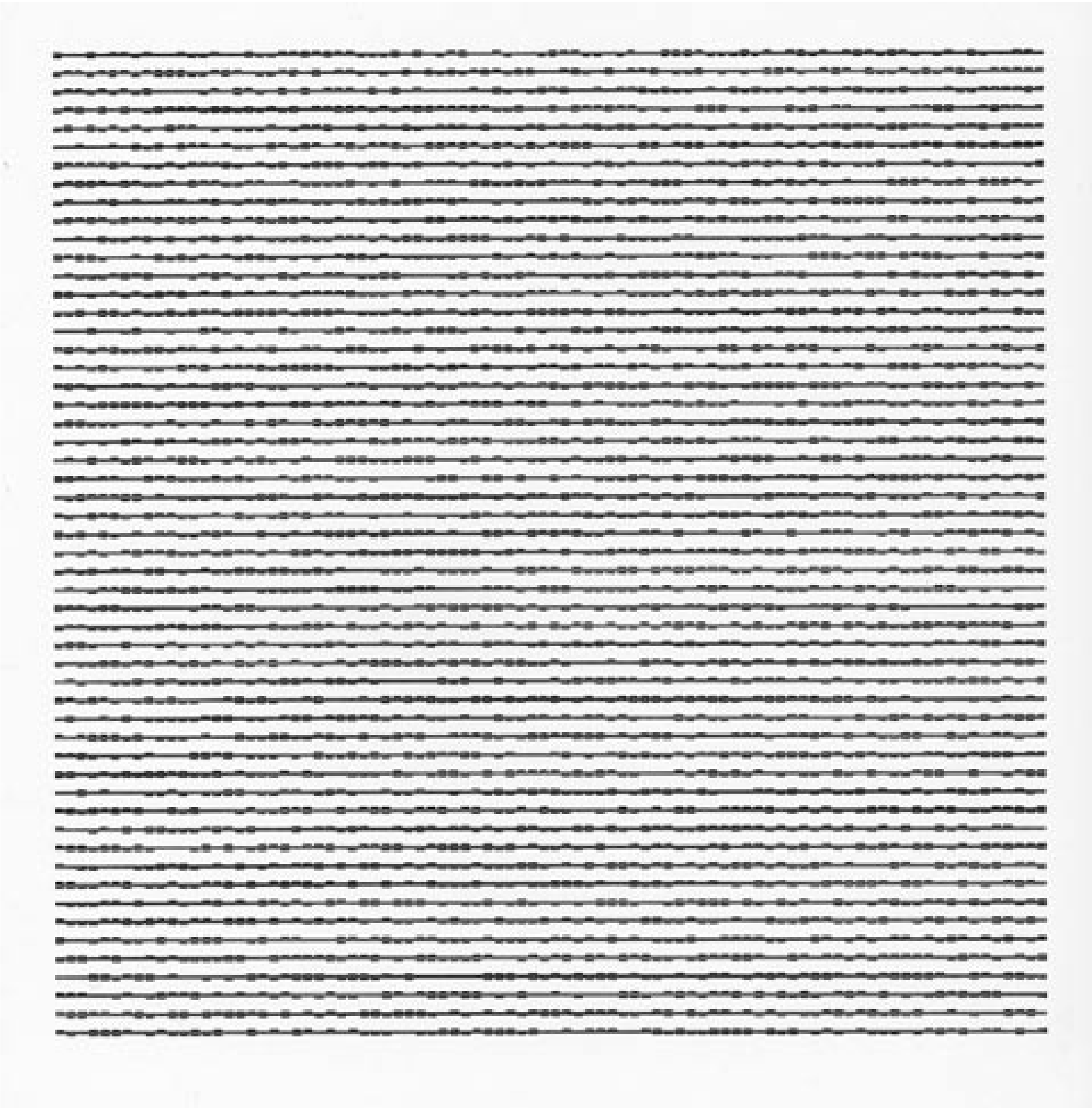
White Noise, Manfred Mohr. Ink, paper, wood, 100 x 132cm.



Sphereless, Manfred Mohr. Plotter drawing, ink on paper, 50 x 50cm.



Scratch code, Manfred Mohr. Plotter drawing, ink on paper, 50 x 50cm.



Inschrift, Manfred Mohr. Plotter drawing, ink on paper, 50 x 50cm.

MANFRED MOHR [US]

Since 1968, Manfred Mohr exclusively works with a computer, that is with the logic of a programming language, to create his art. Through this approach he is considered an important contributor to concrete and systematic art. His process centers on the logical content of an idea and the search for general rules which describe that idea. He writes procedures which generate results that are the logical consequences of complex and multi-layered rules.

Untitled Statement

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Vera Molnar, 'Untitled Statement', from Ruth Leavitt (ed.), *Artist and Computer*, Creative Computing Press, Morristown, Harmony Books, New York, 1976. Reprinted with kind permission of the author.

VERA MOLNAR

After an academic art school training (Beaux Arts) I began to make non-figurative images. The images I 'create' consist of a combination of simple geometric elements. I develop a picture by means of a series of small probing steps, altering the dimensions, the proportions and number of elements, their density and their form, one by one in a systematic way in order to guess what kind of formal modification challenges the change in the perception of my picture: perception being the basis of aesthetic reaction. My final aim, in common with so many painters of history, is to be able to create valuable works of art in a conscious way. Conscious way does not mean in my opinion the suppression of intuition, but its reinforcement by a cognitive process; it does not mean that painting becomes a matter of logic. Art at its inception is essentially intuitive, it is in its elaboration that intuition needs control and aid by cognition.

Since simple geometrical shapes are used, stepwise modifications are relatively easy to make. By comparing the successive pictures resulting from a series of modifications, I try to decide whether the trend is toward the result that I desire. What is so thrilling to experience is the transformation of an indifferent version into one that I find aesthetically appealing.

This stepwise procedure has however two important disadvantages if carried out by hand. Above all it is tedious and slow. In order to make the necessary comparisons in developing series of pictures, I must make many similar ones of the same size and with the same technique and precision. Another disadvantage is that I can make only an arbitrary choice of the modifications inside a picture that I wish to make. Since time is limited, I can consider only a few of many possible modifications. Furthermore, these choices are influenced by disparate factors such as personal whim, cultural and educational background, as well as ease of execution.

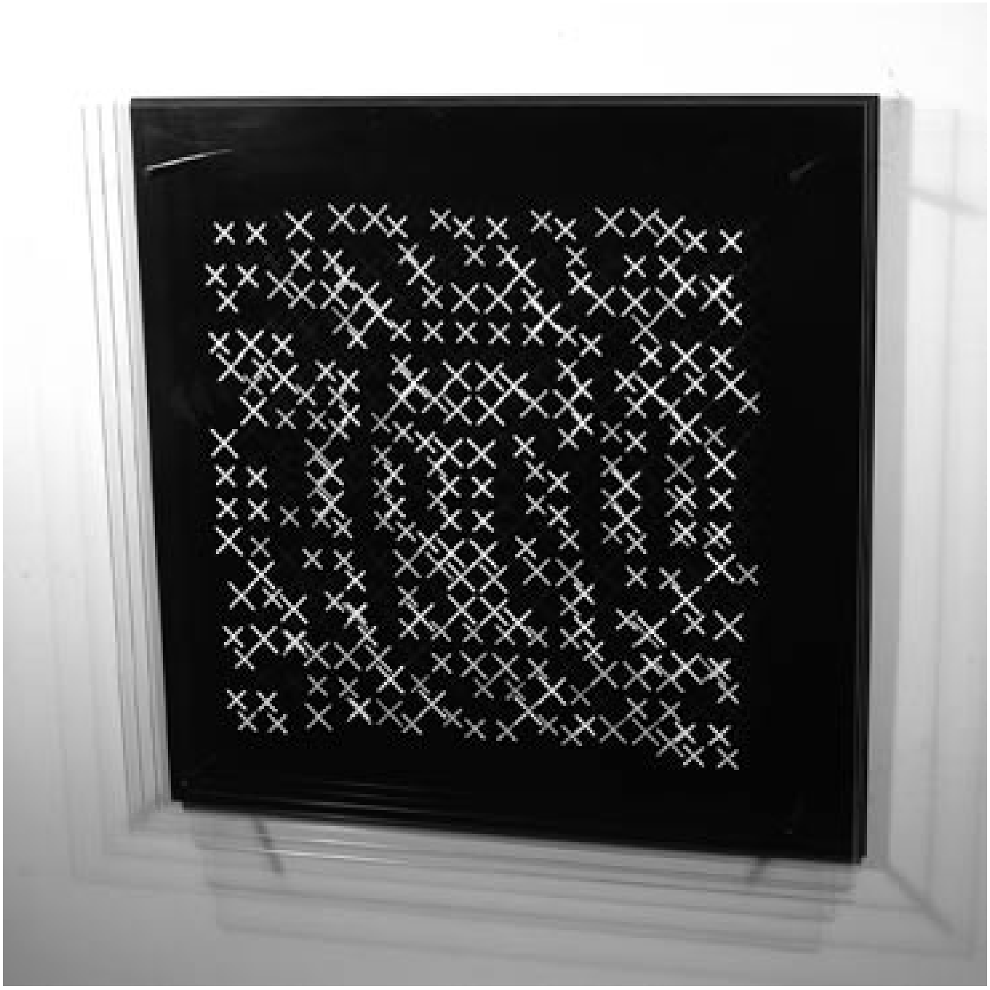
All these considerations are to explain why the use of the computer is imperative for my purpose. Using a computer with terminals like a plotter or/and a CRT screen, I have been able to minimize the effort required for this stepwise method of generating pictures. Some of my works were made interactively on a CRT screen with a program I call RESEAU-TO. This program permits the production of drawings starting from an initial square array of like sets of concentric squares. The available variables are: the number of sets, the number of concentric squares within a set, the displacement of individual squares, the deformation of squares by changing angles and length of sides, the elimination of lines or entire figures, and the replacement of straight lines by segments of circles, parabolas, hyperbolas and sine curves. Thus, from the initial grid an enormous variety of different images can be obtained.

I am working just now on a program whose aim is to explore systematically the possibilities of the program RESEAU-TO and to visualize in a exhaustive way all the types of images I can obtain. After my first approximate calculations I had 27,600 types of pictures. This number corresponds only to the types of pictures: inside of each of those types an infinite number of different images can be generated by changing the values of parameters one by one, several of them, or all at the same time.

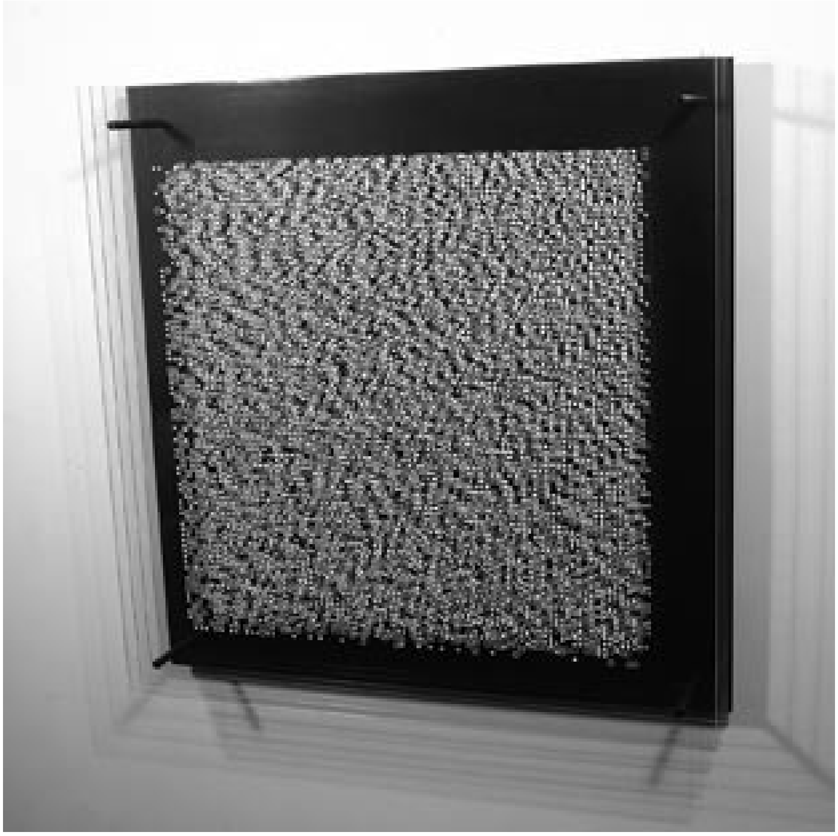
It is obvious that this kind of work can not be done without the aid of a computer, and it is obvious also – as far as I am concerned – that my computer aided work is closely related to my former work carried out without the assistance of a computer.

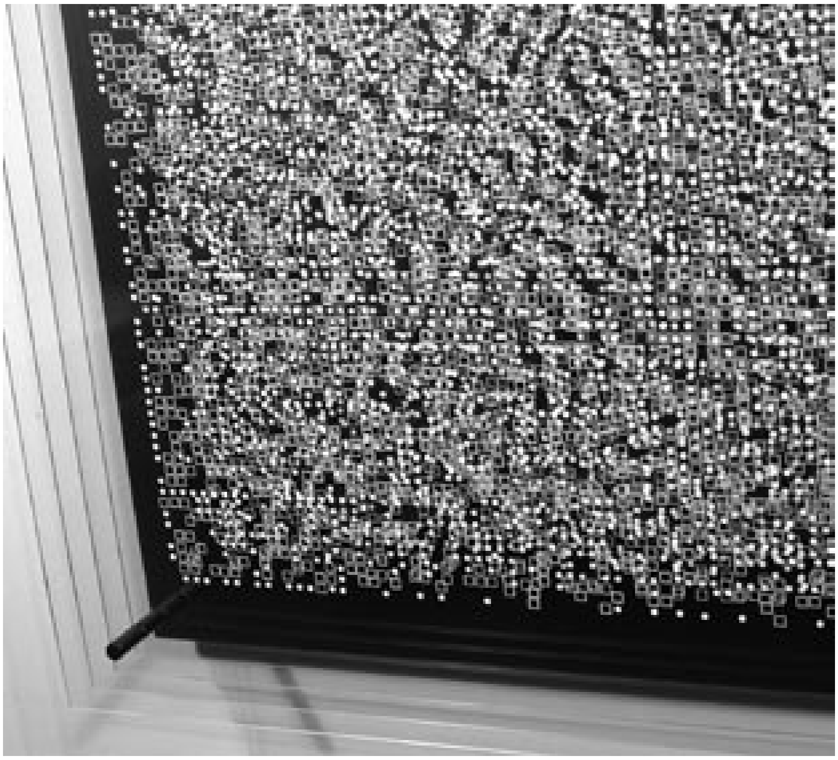
This approach to the generating of pictures is not new; it had been applied long before computers were constructed. Making a series of pictures that were alike except for the variation of one parameter is not uncommon in the history of art (Haystacks and the Rouen Cathedral by Monet, for example). Just as erasing, scraping, retouching, covering parts of a picture or coming back to a preceding version were always familiar techniques used by painters. My computer-aided procedure is only a systematization of the traditional-classic approach. I believe that the use of the computer in art is an important tool for the working out of a 'science of painting', more generally spoken of a 'science of art'. With regard to the impact the computer can have, I am in favor of the introduction of computer science in the Art School curriculum.

Tihany, France
August 1975



CRS, Tony Longson. Milled plexiglass and enamel paint, 24 inches x 24 x 6, 1975.





Square Tonal Drawing, Tony Longson. Screenprint on plexiglass, 24 inches x 24 x 6, 1978 - 1986.

TONY LONGSON [US]

Procedurally, Longson likes to use (or abuse) the characteristics of the materials and methods available to him. In his work he explores the interplay between 2-D and 3-D visual space and exploits the compelling desire to make order out of chaos.

Untitled Statement

Originally published in Ruth Leavitt (ed.), *Artist and Computer*, Harmony Press (1976). Reprinted with permission.
Kenneth Knowlton: http://www.knowltonmosaics.com/

KENNETH KNOWLTON

The computer does not make it possible to define or execute complex processes — this possibility exists independently — but the computer does make execution fast enough to be done interactively with further human decisions, accurate enough to avoid mistakes, and cheap enough to afford a great deal of experimentation. Whether the computer is defining a new branch of art is an open and difficult question, particularly in the area of works defined entirely by logic (i.e., those resulting from processes with no natural input or human interaction once the computer program has been written). This latter category, the most severe form of 'computer' art, I would like to discuss, beginning with a definition of art.

What is art?
The process of doing or making art is a particular kind of giving or offering. If I give you something that is not obviously related to your physical or psychological well-being — not food or protection or direct affirmation or sex — and if it is a concoction of my own design and construction, then it is some sort of symbolic gift. If furthermore it is a new symbol, without a previously agreed upon referent or meaning, I am probably trying to present something that verges on being unpresentable by communication protocols established to date. This symbolic presentation, where the symbols themselves have no clearly defined meanings or usage, I shall take to be the usual (at least my) definition of 'art'.

A work of art furthermore has a purpose and a function. The artist usually intends it to be an augmentation of the viewer's experience: it may either be a new and interesting or useful experience in itself and/or it is a clue or suggestion for reorganization of past and present experience, or a guide to organization of future experience. This sort of communication requires not agreement on meanings (the usual prerequisite of communication) but only an understanding that the artist is offering something to at least one receptive person. The recipient's inferred meanings and use of the work may be more, or less, or deviant from, the giver's intent or hope; the recipient may or may not in addition be able to experience vicariously in hindsight the experience of the artist.

As with other gifts, the psychological function is clearly different for giver and receiver. For the artist, the function is that of producing, being vital and effective, of creating, generating, and by this sort of catharsis, washing out the products of this effort by actually constructing, dispersing, and dispensing. 'It is more blessed to give than receive' in this context means that the experience of having been a channel of flow and processing of ideas and things, that come from somewhere and go to somewhere, is usually the more soothing reward. (It is also nice if people acknowledge, appreciate, or even acclaim, but for people whose mommies loved them this is of secondary importance.)
The function of art for the recipient is more diffuse, more difficult to discern or deduce: art is an agitation which causes his/her experience to be enlarged in one or more of many possible ways.

The Role of Tools
Works of art are produced by the use of tools and materials: brushes and paint, hammers and chisels and stone, torches and slabs of metal. Some sets of tools are more complicated in function and use, and in some cases the end product exhibits a corresponding or resultant complexity.

By watching a painter, but not the painting in progress, I can get some idea — but not too much — of the sort of work being produced; conversely, by looking at the finished work I can infer something at least about the overt activity involved in its construction. By watching an author at a typewriter, but not the paper typed on, I need a sharp eye, a quick mind, and a good memory to discern something about what sort of novel is being written. With program-defined computer art, the situation is hopeless: by watching the programmer work, I can scarcely begin to anticipate the nature of the result — I may not even be able to guess whether sounds or pictures are the goal.

It is the degree of remoteness between the inspiration and the product which I think characterizes computer art more than other kinds: the long and devious way that thoughts and feelings and purposes map into human actions, the way that these actions rigorously define mechanical procedures, and the complicated way in which these in turn produce the result. (Even in an interactive system where an artist uses a 'new sort of paintbrush' in an apparently direct and obvious way, the nature of the resulting art is determined largely by the programs which essentially define a new medium — these programs consist of a complex set of processes that have been selected, carefully or not, from a vast reservoir of potential processes and combinations, and sequences of them.)

The remoteness of thought-to-result is also felt in reverse: it may be extraordinarily difficult to look at a result and recreate anything like either the artist's experience or the machine's process. Sometimes it helps to see a number of results: from them, the viewer can begin to define by induction the parameters of the space of possibilities.

The Nature of the Gift

What sort of enterprise or endeavor is it, then, for the person who programs and produces 'computer art'? Very much the same as with other artists, he/she conceives a process and/or an ultimate product and then proceeds to construct the process which in turn constructs the work. With the computer as the tool, it is usually the intrigue of new combinations, sequences, probabilities, relationships, geometries, and logic which fire the imagination in the definition of new processes; it is the complexities and austerities, made easily possible by the machine, and the sharpness, smoothness or coarseness of the imagined result which stir a sense of anticipation.

But to the viewer, what sort of a gift or offering can a computer-generated work be taken to be? Not only are the symbols new and ambiguous as with other art; they seem, still at this stage, to be new kinds of symbols. They may in themselves be a new experience—sometimes very delightful in ways difficult to achieve 'by hand.' But they don't readily relate to other experiences. There is an uneasy suggestion that a new kind of symbolism is trying to emerge, but what the symbolic meanings might be taken to be remains incredibly nebulous. One can scarcely begin to infer the syntax, much less the semantics.

We seem to have here something like a bridge to be gapped or a gap to be bridged — I'm not surprised that different people have different answers to that. I prefer to think of it as a drawbridge: sometimes down so that we can apply our complete set of contemporary abilities to our total set of current needs — sometimes up to protect ourselves from the precisions and rigidities which the machines, and to some extent their users, must necessarily follow.

Plainfield, New Jersey
January 1976

Portrait of the Artist as a Young Scientist

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http://www.knowltonmosaics.com

KENNETH KNOWLTON

KNOWLTON'S METAMORPHOSIS: BELL LABS IN 60S & 70S, AND BEYOND

> If you don't know where you're going, you will surely end up somewhere else. (Yogi Berra)
>
> To be sure of hitting the target, shoot first, and call whatever you hit the target. (Ashleigh Brilliant)
>
> Basic research is what I'm doing when I don't know what I am doing. (Werner von Braun)
>
> One never goes so far as when one doesn't know where one is going. (Goethe)

Through today's lens – near-future and pragmatic – it was a place of misty legend: that brick and mortar fortress on a hill in the Northeast Kingdom of New Jersey. Quiet and apparently innocuous. But stealthy, to those who read its press releases as warnings of upheaval down the road. To most folks, its announcements – about atoms, plasmas, phonons, and such figments of science – were of little relevance to their composures or bottom lines.

Bell Telephone Laboratories, as my colleagues and I experienced it during the 1960s and 1970s, was a beehive of scientific and technological scurrying. Practitioners within, tethered on long leashes if at all, were earnestly seeking enigmatic solutions to arcane puzzles. What happened there would have baffled millions of telephone subscribers who, knowingly or not, agreeably or not, supported the quiet circus.

For people who believe in science, and who still believe in technology, it was the epitome of free exploration into how the world did, or could, work. For those concerned with tangible results, the verdict, albeit delayed, is indisputable: fiber optics, the transistor, Echo and Telstar, radio astronomy including confirmation of the Big Bang. Advances in metallurgy, computational methods, and all manner of information storage, transmission and processing. Bell Labs truly was a national resource, and for anyone who was there or who cared, its decline is one of the great tragedies of the past half century.

You may be familiar with the names of people I knew there: Claude Shannon, John Pierce, William Baker, and a dozen Nobel laureates, McCarthur Fellowship 'geniuses' and other notables. Like Richard Hamming who, soon after I arrived from MIT in 1962, advised me to "slow down – if everyone here made more than one contribution to the Bell System in his lifetime, the System would be in chaos." At first startled, I did accepted this as an excuse not to obsess over telephones.

My main interest was computers, particularly their use in picture-making. The Labs had a new microfilm printer that exposed letters and vectors on 35mm film. Some of my friends – Mike Noll, Ed Zajec and Frank Sinden – were soon making simple movies (with terrible vertical jitter because the camera lacked filmgate registration pins). My own shtick became a sort of greyscale picture made by filling the screen with thousands of different letters chosen for their brightness. I soon wrote a memo to department head Tom Crowley, suggesting the possibility of a computer language for making animated movies; his two-part response launched my career in raster graphics: "It sounds rather ambitious, but why don't you see what you can do?"

Within a year, I had a set of subroutines someone dubbed BEFLIX, acronym for 'Bell Flicks', arguably the first computer language specifically for movie making. (I have also been called the inventor of the pixel, which is a bit of a reach, though I might claim independent discovery.)

I used BEFLIX, of course, to make a movie about the process by which it was made. It had no sound track, was unbearably dreary and highly schematic. But this, in 1964, was a first of sorts, and Bell Labs arranged a press conference for fellow movie makers and me to crow about our accomplishments. I remember in particular one reporter who badgered me about the possibility of someday resurrecting Rock Hudson and Doris Day, by computer, to star in posthumous movies. I argued that nothing like that would ever happen: it was too complicated, and certainly not worth the effort; computers were for serious scientific movies, for example about atoms, whose cavorting could be scripted by vectors and equations. Unswayed, his newspaper story about computer animation featured Rock Hudson and Doris Day. (As we all now know, the obstreperous reporter's imagination was right on target.)

The BEFLIX language did serve, non-reflexively, a couple years later for a set of films that I made about my list-processing language L-6 (the Laboratories' Low-Level Linked List Language); it contained an early case of articulated animation in which insect-like base pointers crawled about in the computer, pointing to blocks of memory.

The nonscientific, some say artistic, aspects of computer graphics arose for me via a sophomoric prank. Ed David, two levels up, was away for while and the mice, one might say, played ever more freely. Leon Harmon stopped by to ask me for help with a brilliant idea: when Ed returns, one entire wall of his office will be covered with a huge picture made of small electronic symbols for transistors, resistors and such. But overall, they will form a somewhat-hard-to-see picture of, guess what, a nude! And so the renowned Harmon-Knowlton nude was conceived, coaxed into being, and duly hung on Ed's wall.

Ed was delighted but worried. More viewers than we had expected were apparently familiar with the subject matter, and could 'see' the 12-foot-wide picture from as many feet away. It was therefore judged an unseemly decoration for the Labs, especially midway up the hierarchy. After just one day of glory there, she was retired to Ed's basement rec-room. Smaller versions of the big picture mysteriously did propagate (we had not the slightest idea how); the PR department scowled and warned that "you may circulate this thing, but be sure that you do NOT associate the name of Bell Labs with it."

But the big version burst forth a while later at a press conference on Art and Technology in Robert Rauschenberg's loft, and on the watershed date of October 11, 1967, it appeared atop the first page of the second section of *The New York Times*, which made not the slightest effort to conceal its birthplace. Billy Kluver claims that this was the first time ever that *The Times* printed a nude! The PR department huddled and decided, so it seems, that since she had appeared in the venerable *Times*, our nude was not frivolous in-your-face pornography after all, but in-your-face art. Their revised statement was: You may indeed distribute and display it, but be sure that you let people know that it was produced at Bell Telephone Laboratories, Inc.

We did make similar pictures – of a gargoyle, of seagulls, of people sitting at computers – which have appeared here and there. But it was our *Nude* who would dolphin again and again into public view in dozens of books and magazines. Sometimes it is excused by a more dignified title, like *Studies in Perception I*; once the two of us were photographed in front of it, providing a scant two-piece cloak of modesty. Just recently I encountered it in Lewis Mumford's *The Myth of the Machine* (1970) where, as last in a three-panel display, it demonstrates progress (or regress) in mechanization of the portrayal of woman.

That was the beginning for me of a fascination with large pictures made of small things that has occupied my eyes, hands and mind ever since. It was also my first conscious buffeting by chaos: a mischievous butterfly had flapped, and a huge chunk of my career and persona veered onto a new course.

On the other hand, and again by chance, my debut as artist was postponed for several years. How so? Because Art-and-Technology was the rage, and The Museum of Modern Art had a 'Machine Show', and the Brooklyn Museum and other places had similar parties, and in each case Leon and I submitted the *Nude* to demonstrate a collaboration between artist and techno-geek (or whatever). One of us had to be an artist. So by the whim of a spin-launched coin, Leon became the artist and I remained a technologist (pretense aside, so did he). I did not understand until ten years later that I had lost the toss, since artists, I was learning, were the perceptive predictors, the daring, flamboyant and revered analysts of past, present and future, the grand but sly commentators on human joy and sorrow. (After another ten years, and exposure to a hundred artists, I learned that that notion was ninety percent humbug.)

Other breeds than scientists crept into the Laboratories, especially at night and on weekends. Encouraged especially by Max Mathews and Billy Kluver, they were musicians and artists seeking access to big machines and to people who knew how to use them. I was one of the native knew-hows, and thus became the engineer/scientist/programmer/technologist of a series of art-technology collaborations.

We were all trying, exploring and enjoying things made possible by new hardware and software. Few of us were aware that we were making history – a misfortune for historians because both stories and artifacts, who knows how many, have slid into oblivion. I think, for example, of my worst seashell portrait, so washed-out in appearance that it served only as my entry in a 'Vague Art' show in Phoenix, Arizona; I later flung it, face-down, two-arm Frisbee style, into a New Hampshire landfill (where it may possibly survive intact longest of all).

I slowly lost my sense of awe at artists. Art, ten or a hundred years after the fact, can be inspiring, admirable and mysterious. But few artists are more stunningly awe-inspiring than, say, gardeners or woodworkers or masons. Or than children. With the perceived barrier lowered, I decided that although I was still a communications scientist, I was also an artist – mostly at home, puttering away, taking pictures apart and putting them back together in idiosyncratic ways, and keeping a low profile. I had already had my fifteen minutes on stage.

Most of my work concerns people's faces – an unendingly rich subject area, as is well demonstrated, for example, by Terry Landau's entertaining book *About Faces*. An in-your-face face is hard to ignore. It is also a good proving ground if the visage well-known.

You may, quite rightly, have serious skepticism about the use of computers for art – how much humanity can be expressed by the use of such an unwieldy machine? Perhaps, paraphrasing Abraham Kaplan, you may say that, because I have a hammer, everywhere I look I see things that need pounding. Well, ah, yes.

I do look here and there and see existing or potential images that do need my kind of pounding. And I think that some of the results might be worth keeping. That's how I see the results of my artistic endeavors so far – a thrust into several new possibilities for picture-making, including serious first tries at artwork of intrigue and substance.

Perhaps these are examples of esoteric art about art. But quietly so – they are non-assaultive; you have to invite, and process, them. The main questions here, old as art itself, are: Can these images help you to experience in a new way the things and people pursuits alluded to? Why do you see what you think you see, and more than is in fact really there? How is it that crude or oddly structured pictures can be more evocative than scrupulously detailed, explicit ones?

KCK Parsippany, New Jersey, October 2004

Laptop Music – Counterfeiting Aura in the Age of Infinite Reproduction

51

KIM CASCONE

> "This function of music gradually dissolves when the locus of music changes, when people begin to listen to it in silence and exchange it for money. There then emerges a battle for the purchase and sale of power, a political economy."[1]

It was only a couple of hundred years before the advent of sound recording that musicians became free to perform concerts for the public (that is other than opera and jongleurs which are beyond the scope of this essay). Until the appearance of the concert hall in the 1700s, music was primarily performed in the socialized settings of churches, European courts and in the parlors of the aristocracy, where the musician's work and body were fully owned by their employers. Once freed, the act of performing music shifted from indentured servitude to entrepreneur, and thus became based on exchange, i.e., the transformation of value into money. Musical performance, now distanced from prior rituals of socialization, created a polarized axis of performer and audience. This polarity created a distance or aura which empowered the performer with an authenticity, that helped create value in their craft. Although a performance takes place in the moment, the original creation of the music, the score, occurs in a displaced time and space. The audience came to understand that music being performed (as interpretation, not improvisation) was not created on the spot, at that moment – but that the work of creation i.e. the score, occurred separately from the work of performance.

Music as experienced in the concert hall became a performing art, borrowing presentation codes from the theatre arts of seventeenth century France "in which costume, dance and clever scenery and scene changes were more emphasized than acting and plot."[2] This influx of theatrical codes ushered in the element of spectacle. "Music announces that the political economy of the nineteenth century could only be theater, a spectacle trapped by history."[3]

REPETITION AND DISPLACEMENT

> "Stated very simply, representation in the system of commerce is that which arises from a singular act; repetition is that which is mass-produced."[4]

It took some years before phonograph records containing musical performances were mass-produced and marketed to the public. At first, the experience of hearing disembodied voices emanating from a machine seemed supernatural – some claimed the phonograph was a hoax, a parlor trick, or an act of ventriloquism. The phonograph was a 'ghost box', a device that captured and regurgitated the voices and music of people who did not exist. Eventually the recording became a generally accepted derivative form of live performance spurred on by the dance crazes of the early 1900s. The record "transcribed, reproduced, copied, represented, derived from and sounded like performances."[5] The record presented a potent new aura created by the magic of technology – one of displacement, the magic of hearing music emanating from a different place and time by people not physically present.

After advances in sound technology gave birth to the recording studio, the record shifted from document to that of a highly crafted object of "ideal, not real, events."[6] The final product was created by an invisible assembly line of composers, musicians, producers and engineers, who created an aura that operated at a meta-level to the star performer. The recording studio became a laboratory in which cultural artifacts were concocted; audio technology could now enhance, repair, or even create a musical performance through the fusion of science and art.

Technological wizardry afforded the artist a larger-than-life aura/presence through the studio-produced record. The expectation for performers to maintain and reinforce this presence in concert resulted again in the appropriation of theatrical codes. Set design, props, costumes, pyrotechnics and lighting all served to create a heightened sense of spectacle that the recorded object could not. The use of spectacle increased the feeling of distance, distance from the mundane, distance from the recorded object, the ethereal distance of fabricated reality. Borrowing codes from opera perhaps more than theater, this brand of spectacle – the amplification and fabrication of personal aura through technology – resulted in a new type of aura: the rock concert.

COUNTERFEITING AURA

> "Pop music hangs on to the folk-era image of the individual artist communicating directly to her or his listeners. Milli Vanilli became martyrs to this myth of authenticity. They were the recording industry's sacrifice meant to prove the integrity of the rest of their product – as if the music marketed under the names U2 or Janet Jackson weren't every bit as constructed and mediated, just because the voices on the records matched the faces in the videos."[7]

With the introduction of the phonograph, the aura of the musical performer had shifted to the record, but through the development of media technology, it now resides in multiple locations simultaneously. Within the pop culture apparatus, these locations are designed to exchange and share energy: a network of aura. For example, when Madonna releases a new CD, a song from the album (the single) is played on the radio, the music video is broadcast on cable television, articles and advertisements appear in print media, music retailers prominently display and sell her CD's and Madonna performs concerts for stadium-capacity crowds. Through the deft interconnection of cross-promotional tie-ins, give-aways, sneak previews, advance copies, email lists, web sites, and downloadable mp3 files, this promotional engine is tuned to produce demand.

The media's use of spectacle, which has little to do with the value of music, conspires to capture and maintain a constant focus on the artist, to establish a singular omnipotent presence. This omni-presence produces a demand for records containing the artist's aura. This system forms the basic apparatus by which the political economy of pop media operates: the production of demand by counterfeiting aura. The pop aura is artificial; a synthetic system of caricatures, each one designed to be most prevalent in a particular media. Aura can no longer reside in any one location – a pop star can only exist through their vast network of presence; which is powered by cross coupling its various instances, i.e. the flow of money. While not all art forms operate within this type of system, the constant din of pop media makes it difficult for the public to learn about alternative music operating in sub-cultural markets.

GHOST BOX REDUX

The recent adoption of the laptop computer in concerts and festivals by post-digital (I use this as an umbrella term for glitch, microsound, click-house, clicks & cuts, etc.) musicians and DJ's has caused much controversy amongst concert promoters and audiences. Witness the strange report from a concert promoter in Australia: "I was nearly punched one night in Melbourne over the 'laptop/performance' issue - I do not want to be tagged with the 'laptop' stereotype."[8] The stereotype the promoter is referring to is that of laptop performances being considered counterfeit, fake. The antagonism arises when a performer generates music by a process unknown to the audience; using technology more at home in an office cubicle than a musical performance. The laptop's signifier as a business tool is so ingrained in the public consciousness that its use as a musical instrument is considered a violation of the codes of musical performance. The audience feels cheated, because the laptop musician appears to be simply playing back soundfiles stored on their hard drive. The following tongue-in-cheek poke at the laptop stereotype clearly reveals a nagging suspicion. On a CD by the laptop musician Pimmon, a MC back-announces the artist after a performance and interjects: "...and while he was doing that he'd logged his tax return electronically!"[9]

Usually, music performed on laptop is presented in a traditional proscenium setting, framed in the traditional performer-audience polarity. This context frustrates the audience because they are unable to resolve the setting with a lack of spectacularized gestures (i.e. the lack of theatrical codes) which signify performance. Gesture and spectacle disappear into the micro-movements of the laptop performer's wrists and fingers. From the audience's view the performer sits motionless, staring into the luminous glow of the laptop screen while sound fills the space by an unseen process. The laptop ghost box plays sounds created not in a displaced space-time, but in one that is totally absent. The laptop musician is perceived as a medium conducting a sēance, whose tricks of table knocks, wall rapping and spectral voices broadcast from nowhere are orchestrated to feign the effect of authenticity where none really exists. Thus, the cultural artifact produced by the laptop musician is deemed a counterfeit, leaving the audience unable to determine a use-value.

In a traditional musical performance, the aura of the score and the performer combine, yet both are able to be located separately. This is commonly experienced while listening to a cover band perform popular songs. The score has an obvious origin that is communicated through the simple act of interpreting it. In laptop performance, the score has no obvious origin; the performer does not serve as an animated conduit for it, and does nothing to reassure the audience that a score exists. Even the most perfect representation of laptop music is lacking in one element: its unique existence at the place where it happened to be created. This combination of the score's lack of origin and the polarized artist-audience axis gives the laptop performance the quality of being broadcast. In the 21st century, music will not be performed, it will be broadcast. However, in actuality an aura does exist, and resides in "the distance that separates a sound from its origins."[10]

POP-ACOUSMATIC

> "Hrvatski and Greg Davis use Apple Powerbook computers in performance and are deeply sorry for the lack of visual stimuli this creates. Please let them make it up to you..."[11]
>
> "What the absence of visual identification makes anonymous, unifies and prompts a more attentive listening."[12]

Thankfully, the history of electro-acoustic music provides a pretext for this seemingly counterfeit manner of performing music. Typically, in acousmatic music, a composer, seated by a tape recorder, mixing board or computer, pushes a button and the music is 'performed' for the audience. The academic music community has engaged in acousmatic music for many years without the need for "the social rituals prompted by the interaction of stage performer(s) and audience."[13] There is no suspicion of counterfeit because this particular audience holds little of the expectations that pop music encourages; the aura this type of music presents is located in the musical content, not stage sets and costumes. The location of aura in an acousmatic work is achieved via a different set of codes – ones that seem unnatural to audiences imprinted by pop music culture.

Although the sub-culture of electronica unabashedly appropriates symbology from electro-acoustic music, this surface skimming of cultural signifiers leaves much of its cultural and theoretical underpinnings unexamined. Falling into neither the spectacularized presentation of pop music nor the academic world of acousmatic music, laptop musicians inhabit a netherworld constructed from performance codes borrowed from both. The political economy of electronica/post-digital music places it squarely within a pop media context even if it operates at a sub-cultural level to the mainstream media. Therefore, this context raises many issues concerning use-value, exchange-value. The most difficult issue being how the expectations they bring into play mediates and impedes the development of new performance codes. The political economy of pop media produces demand through the promise of value disguised as the expectation of spectacle.

THE GRAVITATIONAL PULL OF SUPER-CULTURE

> "Performance contexts and their evaluation are tightly defined, particularly for micromusics that need defining or, at least, public explanation, for their appearance, most commonly at officially sanctioned events celebrating 'diversity'."[14]

A problem which sub-cultures experience when in proximity to super-culture (pop media) is that one will gravitate towards the other to co-exist in parasitic orbit. I will briefly examine both viewpoints.

TREND SURFING

Pop stars that look for ways to look 'cool by proxy' have recently begun to incorporate signifiers from DJ and electronica culture into their stage shows and compositional process. One example is Björk's *Vespertine* tour that employed a duo of musicians hovering over laptops, datamining gigabytes of glitchy beats and abstract loops. However, the token addition of the laptop in pop concerts helps little in achieving stability for the signifier of laptop. Drowning in a sea of pop spectacle, the signifier floats unanchored and remains unstable, unable to transmit aura, convey origin or demonstrate its musical contribution through gesture.

RECYCLING SIGNIFIERS

On the other side of the problem, the laptop musician often falls into the trap of adopting the codes used in pop music – locating the aura in spectacle. Since many of the current musicians have come to electronic music through their involvement in the spectacle-oriented sub-cultures of DJ and dance music, the codes are transferred to serve as a safe and familiar framework in which to operate. The use of spectacle as a solution to the lack of visual stimuli only works to reinforce the confusion of authenticity and aura and hence the stereotype of the laptop.

In order for the signifier of laptop to stabilize, there needs to be a recuperation of codes that move away from the use of spectacle, that establish aura, and show the audience how to differentiate 'representation by the machine' from 'repetition of the machine.'

"Creating new circuits in art means creating them in the brain too."[15]

Notes

1 Jacques Atali, *Noise: the Political Economy of Music*, Minneapolis, University of Minnesota Press, 1985.
2 *The History of Theater*, http://www.ebicom.net/~tct/oftheatre.htm, as of February 2002.
3 Jacques Atali, *Noise: the Political Economy of Music*, Minneapolis, University of Minnesota Press, 1985.
4 ibid.
5 Sarah Thornton, *Club Cultures, Music, Media, and Subcultural Capital*, Hannover, New Hampshire, Wesleyan University Press, 1996.
6 Simon Frith, 'The Making of the British Record Industry, 1920 – 1964', in: *Impacts and Influences: Essays on Media Power in the Twentieth Century*, edited by J. Curran et al., Methuen, London, 1987.
7 Ted Friedman, 'Milli Vanilli and the Scapegoating of the Inauthentic', *Bad Subjects*, Issue # 9, November 1993, http://eserver.org/bs/09/Friedman.html, as of February 2002.
8 email from a concert promoter in Melbourne Australia, June 2001.
9 'Electronic Tax Return', Pimmon, Tigerbeat, Meow016 CD
10 Jĕrôme Peignot, as quoted in Francis Dhomont, 'Acousmatic, what is it?', http://www.electrocd.com/notice.e/9607-0002.html, as of February 2002.
11 Hrvatski, Greg Davis, Keith Fullerton Whitman spring tour, email announcement, February 27, 2002.
12 Francis Dhomont, 'Acousmatic, what is it?', http://www.electrocd.com/notice.e/9607-0002.html, as of February 2002.
13 Darren Copeland, 'Cruising For A Fixing - in this "Art of Fixed Sounds"', http://www.interlog.com/~darcope/cruising.html, as of February 2002.
14 Mark Slobin, *Subcultural Sounds – Micromusics of the West*, Hannover, New Hampshire, Wesleyan University Press, 1993.
15 Gilles Deleuze, *Negotiations*, New York, Columbia University Press, 1995.

On the Resurgence of Interest in Visual Music

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GREG KURCEWICZ

Visual music means different things to different people: for example, to coordinate sound and moving image together, or to watch the silent, abstract movement of an image. I suppose that we usually understand the term as being about elements of synaesthesia, and, on another front about perception and neurology. What follows is a set of thoughts about the current state of visual music and how it can relate to historical issues. There has been a readdressing in recent years of the significance of visual music. From my (subjective) point of view this can be explained through theory and technology.

In cinema there is a long tradition of artists creating abstract pieces that can be regarded as equivalent works of light or 'visual music'. Oskar Fischinger, Hans Richter and Viking Eggeling worked between the wars. Various designers of colour organs (Thomas Wilfred one of them) took their machines to music halls and cinemas in the 1920s and 1930s. Visual music also stretches back centuries to pre-cinema too; it was theorised and sometimes actualised in the days before celluloid and video. From the 1940s to the late 1960s the development of this kind of thinking, this experiment into fundamentals in vision, perception and its analogous reactions as music, were addressed by a succession of artists, all striving towards an equivalent idea: the idea of light, or visual music, a form of cinema that aims at a meditative state and that believes in fundamentals, almost Jungian in its approach. You will see it in Hy Hirsh's work, Len Lye's films of rhythm, colour and motion, and in Mary Ellen Bute's films. The link with music was direct. Bute set animations to Grieg, Wagner and Milhaud. Bute, with Leon Theremin, the electronic music innovator, wrote a thesis on 'The perimeters of light and sound and their possible synchronisation'.

> Light is the artist's sole medium of expression. He must mould it by optical means, almost as a sculptor models clay. He must add colour, and finally motion to his creation. Motion, the time dimension, demands that he must be a choreographer in space. (Thomas Wilfred)

I recently saw an installation of a *Lumia* work by the Danish-American artist Thomas Wilfred. The exhibit seemed very magnetic, it drew me into a subtle area of perception I don't often reach in a gallery, something I only usually find in the cinema. I know how the *Lumia* pieces were created, I have seen Wilfred's plans and what appear to be quite crudely painted glass discs that generate the patterns. After at least half an hour of blissful contemplation I left and couldn't stop thinking about the experience. The *Lumia* was an organic thing, light refracting and spilling: a simple system of a cycle of patterns slowly going in and out of phase, creating unforeseen minute fluctuations and variations through light's 'organic' nature. I reflected on the differences between this type of work and modern digitally produced equivalents. It would take a software writer a long time to model, it would be virtually impossible to reproduce, and, even if you could, you would face the problem of the final presentation of the work. Most digital projection I have witnessed would not do it justice.

If you read about the work of Wilfred, you will find that he was very eager to put his portable *Lumia* into production (and did in a modest way). His ideals were utopian, he wanted people to benefit from having such a thing in their homes. I certainly would want one: it would be far better than the television. Somehow, the sound visualisation programme on my computer doesn't do the same thing, even though it has so much more technology behind it.

To place John Whitney within the canonical view that focusses on the development of technology and ideas in this field, would be a folly. Works like *Arabesque* and *Permutations* are really the product of art: form, motion, dynamic and technique together. I recently screened the work of John Stehura and John Whitney alongside work made in the UK at the same time during the late 1960s and the early 1970s. You couldn't have had a starker contrast: pure technical work against art. If you read books about the development of computer art, the focus is usually on Whitney's technical setup, because it was sophisticated. However, the technical aspect is only one element and does not recognise his understanding of how the eye and brain work when viewing such pieces. From the 1950s onwards, the development of computer graphics has taken the main push of research. To render something in three dimensions realistically has been as of much commercial importance as the technology of sound-synched film in the 1920s and 1930s. We see the latest marvels of 3D modelled characters, the hyperrealistic computer games of the new season expanding in complexity exponentially month by month. It seems like we have arrived somewhere. But where is perception in all of this?

To think as some do, that there has been a linear development of visual music can be too simplistic and misleading. There have been artists working in the same field who have influenced other artists decades later. For instance, consider the Thomas Wilfred and Olafur Eliasson connection, the Jordan Belson and Joost Rekveld, the Bruce McClure and Paul Sharits dimension. These affinities seem all the more satisfying as they transcend 'progressive' models of development.

Perhaps we are long past the scientific analogies of light and sound. We accept the world of the digital: we can sense its limits and see that perception is more complicated – it is elsewhere. Every investigation and model is interesting to us, like Newton's theory of colour against Goethe's; Goethe's against Wittgenstein's. All exist as plausible models, each an attempt, a rationalisation, each a world in their own right. The fact that these elements of visual music stay unfixed and subjective and defy science continues to fascinate us and hold our attention.

In terms of our current climate of thinking about visual music the importance of the work of Stan Brakhage cannot be underestimated. His films and writings have been reassessed by a new generation, a generation that was not bored with their tutors extolling their virtues. Brakhage's idea of 'hypnogogic vision' and the films that grew from this idea seem very essential now. In the early 1970s artists' film and video was a relatively small field. There was a certain canon of thought that could be represented via mainly European and American works: Surrealism, Structuralism, etc. The technology of video gradually superseded that of film from the 1970s onwards. The general interest in film waned with the new frontiers of video and digital opening up. These mediums do not deal directly with projected light, which is, in essence, the raw material of visual music. Postmodernism directed people's thoughts to the new semiotic frontiers of these mediums: appropriation, gender and cultural issues. For a time, talking about any kind of 'formal', 'Jungian' or 'utopian' ideas in art was thought to be at the least 'hippy' thinking or at worst 'fascist' in its associations with high modernism. How could that be interesting? To revert to formal play or exploration seemed retrograde, simplistic and unsophisticated in light of the conjecture of the paradigm-shifts of postmodern writing and opinion.

There is also the neurological aspect of the apparatus of visual music. We can't ignore the fundamentals of our viewing apparatus; we can't ignore the fact that the medium of a moving image can affect us with its frame rate or flicker, that light can have different forms. The resurgence of interest in visual music has also been accompanied with a reassessment of 'expanded cinema' too. Expanded cinema's engagement with an audience transcends some of the investigations into multimedia or interactivity that we have seen explored in computer art over the last 25 years or so. Tony Conrad's filmic neurological excursions, Ken Jacob's nervous system works and *Crystal Palace* are pieces which, in many ways, cannot be reproduced outside of a cinema. These works bypass the digital world but still deal with space, light, the brain in a very direct way. Bruce McClure's intricate multiple overlaid projections offer a deep space which is beyond the digital. These are examples of the physical, real tangible aspects of visual music – through film and light in essence. We should all stop, and begin to examine why these older technologies worked or were, and continue to be, so successful.

A John Whitney film can take a lot of explanation to a student who has only ever seen post-modern aesthetics displayed in artists' film and video. For someone to get their head around the kind of decisions and programming that might have been used to generate such work is also fascinating. We now have tools that can help us make such works but people really have to go back to the source of such ideas to deal with visual perception. Artists have to delve deep past the macro operations of moving image software to find basic tools to manipulate images in meaningful ways. To find the basic units of digital moving images seems more confounding than finding them in film with its visible single frame-bit.

So perhaps we are back to the older questions about perception, its borders and limits. One place where this was investigated extensively in the 1960s and 1970s was Bell laboratories in New Jersey. Bell laboratories was always interested in perception – it was the main area of investigation. The work of Bela Julesz, Kenneth Knowlton and Leon Harmon into spatial cognition with still and moving images were by-products of commercial research into telecommunications. This early work into ways that images could be encoded by a computer and then decoded by the eye and brain with limited means was of interest commercially. The development of these techniques meant that compression could be achieved and images could be sent down phone lines.

I personally was interested in looking again at this work, and when I got to speak to these people I was very surprised that no-one else had. Some people said "well that's very easy work to do now, you could make that using the computing capacity of a mobile phone – perhaps they are interesting in the same way as Norman architecture is interesting". Well, no. These are very interesting works and due to the limited computing capacity of the time come from a very specific aesthetic of exploring the basics of perception and visual music.

In a contemporary sense, we have a hybrid set of tools now. Artists can use computers, can use light and film if they wish, they can use a combination to suit their investigations. Digital projection will get better in time. We are in a privileged position to be able to view the explorations of previous generations and should not ignore the opportunities that this can create. We know what the virtual computer world looks like, we know what computers are capable of: we can now look back and reassess other systems of tackling visual music and absorb them into a synergy to form exciting new works. We must use this rich history to inform a creative future.

Digital Art: From the Viewpoint of a Dealer

WOLF LIESER

Art must take new paths, and the most fascinating artists have given proof of this again and again. When computers were first set up to create drawings in the 1960s, this was primarily experimental in nature. Nobody thought about art at this time; the focus was on the technically doable. The first pioneers were often scientists. The first programs that could produce a drawing had to be developed. These computers had neither a monitor screen nor a keyboard nor a mouse. Memory was handled by punch cards or punched tape.

My first contact with computer art occurred twenty years later on the beach of a small town in Florida. Not necessarily the place where I would have expected 'cutting edge' art. I was spending my vacation in the sun and visiting a girlfriend who told me about an artist who was getting artistic work out of a computer. Naturally I was skeptical, since I had no inkling what was in store for me. The artist from New York, whom she then introduced to me at her beach house, was Laurence Gartel, who had just created a new series of pictures on the Amiga Commodore. He had just come back from Florida State University, where he had printed his files. He presented me with loud, brightly colored printouts in DIN A4 format on a roll of paper. I was quickly enthused by it and bought my first handsigned work for 200 dollars. Gartel surfed on the wave of advancing software developments. He was constantly experimenting with everything new that the market came up with. His roots can be traced to photography. But in the mid-1970s, while he was studying at the School of Visual Arts in New York, inspired by Nam June Paik, fascination with the electronic screen took hold of him. He made his first video-based stills at the Media Study Department of Buffalo State University and among other things made use of the Paik-Abe Colorizer, an electronic device that allowed you to manipulate video information in color. In 1981 the first collages by an *Artron Studio Computer* came along and then in 1985 the first Macintosh with the graphics software McPaint in black and white. At that time these efforts had a file size of 48 kb. Gartel was not interested in programming or conceptual context; he was and is a digital storyteller, and the the conquest of new aesthetic territory excited him.

Genuine purists like Manfred Mohr, Frieder Nake, or Vera Molnar disapprove of this kind of position. For them it was not imaginable and not even possible to make use of a prefabricated software, because at that time, when Frieder Nake in 1965, Vera Molnar in 1968, and Manfred Mohr in 1969 were creating their first items of work at the computer, there wasn't any. They were able to control their program, and they worked conceptually. What interested the artists Mohr and Molnar was playing through a large number of possibilities in the context of an established aesthetic and conceptual system. The computer made this possible in broad scope for the first time, more than the unaided hand of the artist could achieve. A work of art consisted of a series of works of similar character. Both artists have persistently developed their output further over the course of thirty years. Molnar remained tied to painting to a greater degree, whereas Mohr tenaciously pursued his projects based on multidimensional dice. The work of both artists was aimed primarily at the intellect and only secondarily at emotional perception.

I met Manfred Mohr for the first time in the mid-1990s at Siggraph in Los Angeles, where he, like many other important computer art pioneers, had an exhibition at the Art Gallery. The annually scheduled exhibition of digital media, including animations and digital films, within the scope of this computer graphics fair in the USA was a meeting place for the digital art scene and the most important artists, which was also true of Ars Electronica in Linz, Austria. The latter scene, however, was largely isolated and did not have much relation to contemporary art, let alone to the art market. The big interactive systems that were presented at both locations at great technical expense were often very much in love with technology and even more they lacked the ability to come to terms with the digital medium in matters of substance.

With the emergence of the Internet and the resulting acceleration of communication, in most branches the procedures and the corporate culture have completely changed. One assumes, for example, that an e-mail will be answered within twenty-four hours, naturally anywhere in the world. One of the consequences of this for an artist is that new digital creations, the moment they are available online, can come to the attention of any important curator, art dealer, or museum staff member within a single day. Artists like Gerhard Mantz or Manfred Mohr have extensive websites at their disposal that can accomplish more than a traditional catalog can. Naturally this also has negative effects since a work of art published here can also be copied very rapidly somewhere else on the planet and from there can be further distributed. This means among other things that some artists, like Yves Netzhammer, do not allow their digital work to be accessible on the Internet at all. In this context intellectual copywrite laws are difficult to enforce. Fascinated by the possibilities and repercussions of the computer as an artistic medium and goaded by the great repudiation or reservations on the part of artists, I am becoming more and more engaged in this field. It caused me to wonder what prejudices digital art would encounter in the art world. The well-known German art periodical *Art* published the following headline in 1986: 'Now Computers Are Painting, Electronic Art Breakthrough'. It was too soon, however, to talk about a breakthrough in the art market. In the 1990s computer art was not yet accepted. In my regular visits to fairs in Basel, Cologne, and London, I stumbled upon computer generated work only in exceptional cases. This was to change slowly only after 2000, when the American art magazine *ARTnews* proclaimed in an April 2001 headline: 'Digital Art Is Coming of Age' and three large exhibitions in US museums such as the Whitney Museum in New York/San Francisco, the MOMA and the Brooklyn Museum in New York made this a reality right away.

The art market is comparatively easy to understand, for here we are not talking about a mass market, since single, unique items are normally put on the market and traded. Curators, critics, and museum people are accordingly important. If they are not open to a genre, it is hard to establish anything new on the market. So I looked for another way. It was clear to me that it would not be enough to direct a gallery for digital art. At this time we were already putting on regular exhibitions of digital art at our gallery in Wiesbaden. A more comprehensive approach appeared necessary in order also to convey art historical associations, technological development, and theoretical backgrounds. But it was a matter of integrating still broader goals: many artists who already had devoted large segments of their lives to this medium failed to sell their work because their computer art was insufficiently accepted. How important this is for an artists's development is something I had often experienced as an art dealer. Of course I by myself did not dispose of the right financial means that would have been necessary to make the most important artists known to the public. It seemed to be a difficult undertaking, but from it the idea of the Digital Art Museum [DAM] was born.

In the beginning there was the realization that digital art needed an online museum, where digital art could be presented better than on a computer screen. With this approach an interested public could be reached around the clock. In 1998 vrml was the latest trend and accordingly the online museum needed to be implemented with the latest technology. The idea of navigating through virtual space and in this way meeting up with digital art seemed tempting. Rupert Kiefl at the Institut für Neue Medien *[Institute for New Media]* in Frankfurt developed an adaptation of his plug-in plaza (an example of virtual architecture) for the [DAM]. After much discussion we abandoned this idea, however, since the processor speeds of the time did not enable us to make any kind of user-friendly implementation. Besides, 3-D architecture was so dominant that it pushed real art into the background. In the meantime I had expanded my gallery activities to London and had become partner at the Colville Place Gallery, the only gallery for digital art. From this there evolved a link to the London Metropolitan University LMU. Jointly with Keith Watson, partner at the Colvile Place Gallery, Kerry John Andrews, artist and designer, Dr. Mike King, artist and lecturer at LMU, and Alan Hicks, webmaster, we brought the [DAM's] contemporary web design into being, and it has been online since 2000.

The [DAM] project combines different aspects of the art scene and fills it in part with new content. It consists of the following fields:

- The Digital Art Museum [DAM] is the online museum. The plan is to make available online a complete collection of documents pertaining to all the important male and female artists in the field of digital media over the past 35 years: To accomplish this, an advisory panel of seven experts decides in consultation with me which artists should be admitted. The artistic development of the artists who are selected is documented by their visual production, films, and interviews. In addition, a chronological history line and an essay field are available. In the future a field for media documentation and a chatroom will be added along with important links and international exhibition notices. The online museum is freely accessible for everyone.
- The [DAM] location operates as a substitute gallery for the artists; it takes part in art fairs and fosters contacts with institutions and collectors. The first location, [DAM] Berlin, was opened in Berlin in 2003. Others will follow.
- Curated group exhibitions on the theme of digital media are organized.
- The [DAM] has also instituted the d.velop digital art award. This is a lifetime award for an important contribution to the field of digital art. Jointly with the benefactor of the German d.velop AG from Gescher, the [DAM] has allocated the [ddaa] annually since 2005. The prize is endowed with 20,000 euros, an exhibition at the Bremen Hall of the Arts, and a catalog. A second prize is planned for young artists in the digital media.

In the meantime, when the location in Berlin has been well established, we shall devote ourselves with renewed energy in 2006 to expanding our web presence. To get this done we must apply ourselves to solving the problem of funding. The entire project relies exclusively on private funds of the sponsors and sales made by the [DAM] in Berlin. The combination of commercial and charitable activities complement each other in the best possible way and have contributed to the positive development of the [DAM] and a higher degree of celebrity status for digital art.

In closing I would like to take another look at the special market situation of digital art and the consequences that flow from it. Digital artwork implies the possibility of infinite replication. In contrast to photography, where you still had to make prints, digital artwork can be made accessible online, for example, and/or also downloaded. The first art form that regularly brought this about was net-art. As an independent art form, net-art experienced its first boom in the mid-1990s, but it soon lost ground again in terms of prominence. Why? It didn't earn any money. Although this is a problem for every digital artwork, the artistic shortage – in other words, limitation – that is possible in prints or CDs and even in software programs is a market concession that facilitates price revision and higher prices. This strategy had the result that big collectors have opened up to this field and now are regular buyers of digital art in order to be present right from the start. Therefore, quite different approaches could be conceived of here. Digital work could be made available in a database and could be rented for a certain period of time. We are standing here at the very beginning of an exciting development which certainly means just one thing for the buyer: with the purchase of one howsoever finished work, he supports the artist and enables him to create more art in the future. Isn't this what ultimately should happen in art dealership?

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