Mapping the Beginnings of Computer-generated Art in the Netherlands

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The Beginnings of Computer-generated Art in the Netherlands

Abstract:

This paper presents a mapping of the field (participants, production, presentations, institutions and networks) within interdisciplinary research that encompasses fine arts, music, graphic design, typography and architecture as well as interdisciplinary projects and multimedia art.

Apart from a few exceptional works made prior to 1969, computer-generated art in the Netherlands started relatively late, and had its full swing in 1970 and 1971.

Several networks were active promoting computer-generated art: the working group for computers and verbal, visual and sonal research (1969 -1973), CASH - Computer Arts Society Holland (1970 - 1972, a spin-off of CAS in London); the Foundation Experiments in Art and Technology (1971 - 1976), the Werkgroep Architectuur Komputer (1970), the Institute for Sonology (since 1967), and STEIM (Studio for Electro-Instrumental Music, since 1969). Two PhD theses in art history about computer-art were defended in 1970 and 1971. Most participants in the above-mentioned networks will in the following decades become a new establishment of Dutch culture, as directors of several major museums and members of different decision-making boards. The Museum Boymans-Van Beuningen in Rotterdam had ‘art and technology’ as the topic of its annual program in 1971. Since 1966 the Dutch National Bank issued series of banknotes that used computer-generated images, designed by Ootje Oxenaar. Oxenaar also designed the world’s first post stamps with computer-generated images, that were issued by PTT in 1970.

Most of the protagonists had a leftist political orientation. The opera Reconstruction (1969), collectively written by five composers and partly composed by computer, was dedicated to Che Guevara. In the work nixmur (1969) by Remko Scha, a computer program endlessly prints out the text ‘Nixon moordenaar’. The sound installation Quadraat Stelling I (1971) by Victor Wentink, consisting of an interactive man-machine network, was inspired by the idea of socializing technology after Marx and Benjamin, and criticized the idea of computerizing the world and the power of the mainframe computers. It demonstrated a horizontal interactive participatory technology enabling all combinations of communication and feedbacks, preceding internet based social networks from beginning of 21st Century.

Apart of the art practices of Peter Struycken, Victor Wentink and Remko Scha, there is no continuation of the first generation of digital art in the fine arts today in the Netherlands. Only computer-generated music has seen a continuation of its production, institutions and education, under the umbrella of electronic music, which spans the decades and is still active today. This kind of situation is typical for the field of digital art around the world.
Introduction

Unlike other aspects of the fine arts, computer-generated art in the Netherlands has not yet received systematic treatment. This research is the first attempt to define the arrival of computer-generated art in the Netherlands in its historic context. The research was conducted in a period of half a year in 2010 - 2011 by a single researcher. As there was no single essay or other kind of document available on the subject, the research started from scratch, collecting information and linking the findings, thus creating a map of the field in a bottom-up fashion. Many protagonists and practitioners of early computer-generated art are not reachable or not alive, and many networks and institutions have closed down; therefore it was not possible to obtain, confirm or extend all relevant information within the frame of this (first draft) research. Bearing this in mind, the author is aware of possible shortcomings and structured the research documents in a dynamic manner, thereby respecting the need to fill in the gaps and double-check the information. The author will therefore welcome everyone’s collaboration in the form of comments and suggestions.

During the transition from the industrial age to the information society - since the mid-20th century - a segment of the arts has also been concerned with information, especially with digitally generated and mediated information. Computers arrived in visual art in the early 1960’s, first in Western Germany and the USA. After a short period of inauguration in mainstream art discourses and institutions in the late 1960’s and the very beginning of the 1970’s, computer-generated art disappears from the world’s art scene in the mid-1970’s, as a consequence of anti-technological sentiment and of new discourses in contemporary art. Since the 1960’s, computer-generated art has moved in waves in and out of the domain of interest of mainstream contemporary art. Several decades later, computer-generated art is viewed within the context of media art and media culture: an open area of practice and critical theory that operates on the fine line between fine arts, science, social and political activism, and technology.

This research spans only the first phase of computer-generated art, from its very beginnings up to the arrival of personal computers; it thus covers the creative use of mainframes and mini-computers and the very first use of PCs, all before 1980.

The research includes a mapping of the field: participants (artists and scientists that produced it, art historians and other supporters), institutions, networks.

Besides this text (that is still in progress), we have started creating a chronology and a bibliography. Our approach to the observed artworks takes into consideration the entire production and distribution process ranging from an initial concept to its execution (output, artwork), embracing both creative and technological aspects of the work as of equal interest. The technological process is considered of the same importance as its output, because of the specific circumstances of using new technology. The unique situation of specially created software for each artwork and the use of certain programming languages as well available hardware was therefore taken into consideration (insofar as such information was available). Considering the specific situation of computer-generated art and our limited access to the equipment of this historical period, art concepts that were not realized as well as hand-made works that were directly inspired by computers and digital aesthetics have also been included in this overview.

Our research started with a focus on the visual arts but it quickly turned out to be necessary to include other fields of creativity as well. Such a shift was motivated by the interdisciplinary approach of the arts of the 1960’s and 1970’s, and the fact that many participants created in different fields at the same time, or made collective and multimedia works; also, artworks created in one discipline were often created by people coming from different disciplines and/or from science.
**Mapping a practice of Beginnings of the computer-generated art in the Netherlands**

**Beginnings of the computer-generated art in the Netherlands**

Trijntje, reprinted in demonstrations of the TR4, RC Groningen.

Felix Hess: mathematical model for the returning motion of the boomerang, ca. 1968. Philips' very fast calculator.


Anonymous: Trijntje, reprinted in demonstrations of the TR4, RC Groningen.

Felix Hess: mathematical model for the returning motion of the boomerang, ca. 1968. Philips' very fast calculator.


**Straight and Shifted Art Disciplines, Multimedia and Interdisciplinarity**

Most of the world’s computer-generated art pioneers were scientists (as Herbert W. Franke, Frieder Nake, Georg Nees, Michael Noll) and some were trained artists (as Kurd Alsleben and Otto Beckman), while very few had both kind of education (as Charles Csuri). The new arrivals enriched or confused the protagonists of the art world at the time, as it still sometimes does today.

Such a trend we can see within the Dutch pioneers as well: trained scientists that made computer-generated art are biologist Herman de Vries and the three members of the Compos 68 group, i.e., the biology students Arthur Veen and Jeroen Clausman and the art history student Jan Baptis Edema. Computer scientists Leo Geurts and Lambert Meentens often collaborated in projects in both art and science. They both worked primarily as computer scientists but during several years devoted a lot of effort to create computer-generated graphics and music -- on their own as well as in collaboration with other composers (Louis Andriessen). Their interest in the creative use of computers leads them to establish CASH, the Computer Arts Society Holland.

Trained visual artists are Peter Struycken and Pieter Laurens Mol who stick to their original disciplines of Concrete Art and Conceptual Art respectively, and R. D. E. (Ootje) Oxenaar, who primarily worked in the field of graphic design and secondarily in the fine arts. Victor Wentink had an education in both fine arts and music, which will show in full potential in his multimedia works.

An exemplary case of the interdisciplinary approach in both education and practice is Remko Scha. In the 1960’s he studied Physical Engineering, and also participated actively in music and the fine arts, sometimes merging them in an "open aesthetics" approach that was influenced by Fluxus. Later he combined research in Logical Semantics and Computational Linguistics with a consistent practice of Generative Art.1

**Extended Science, Digital Folklore, Amateur Art and Computer-Art as a Hobby**

Early computer-generated art was mostly practiced by scientists who had hands-on access to (then) exclusive technology. Some of them dedicated their career to the creative use of technology in art; examples are the prominent computer-artists Frieder Nake and Georg Nees from Germany. On the other hand, some scientists just played with machines as a hobby, creating jokes or amateur art or solving self-imposed programming or creative problems in their free time.

Electronical engineer Willem Nijenhuis, working at the Philips Natuurkundig Laboratorium (Natlab) (Philips’ Research Laboratories) in Eindhoven, carried out a series of computer sound experiments *Calculation Sounds of PASCAL* (1962).2 PASCAL is a name of the computer he employed, and stands for *Philips Akeling Shele CALCulator* - Philips' very fast calculator. The signals emanated from the voltage of the CPU during the execution of various programs, for instance the computation of the sequence of prime numbers. The sounds were issued on a 45 rpm vinyl record enclosed with an issue of the Philips Technical Review3 which discussed the recorded algorithms from a scientific as well as from a musical point of view. The first three pieces - *Fourier Analysis, Smoothing and Calibration* - are presented as parts of a series entitled Cloverleaf Cyclotron; they are followed by individual ‘tracks’; *Cutting Losses of Corrugated Cardboard, Potential*.

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1 Het Apollohuis (1980 – 1983) was an alternative space for music and visual art in Eindhoven, the Netherlands, initiated by Remko Scha and Paul Panhuysen in 1980. As well Scha working in education within humanities at the University of Amsterdam.

2 Rekengegevens van de PASCAL.

3 Philips Technisch Tijdschrift (Philips Technical Review), 1962, no. 4/5.
fields and Electron Orbits, Jigsaw Puzzle, Prime Numbers, Mozart Minuet and Stochastic Melody. The last two compositions use conventional musical structures, but all other pieces are unintentional side-effects of scientifically useful calculations; they consist of extreme atonal electronic sounds such as beeps, cracks etc, that are reminiscent of recent experiments in underground hard-core electronic music. These experiments also preceded the translations from one code, language or medium into another, that have become popular in the conceptually oriented branch of contemporary digital art.

The Digital Plotting Newsletter issued by the leading manufacturer of graphic hardware Calcomp (California Computing) included on its last page a 'Fine Arts' section, where several Dutch computer graphics pieces were published. In the Van der Waals Laboratorium of the University of Amsterdam the physicists Cornelis Andries ten Seldam and Dick Oepts both made in 1969 autonomous computer graphics, using the CDC 1700 (Control Data computer) and the Calcomp 565 Digital Incremental drum plotter. Dick Oepts explains his motives for such an exercise: "I've always been fascinated by the pattern in the disk of composite flowers, and found it an interesting challenge to generate this with the computer. The return pattern was not so much to produce an artistic picture, but to do it with a small or elegant program." Nuclear physicist E. J. Kaptein published two graphics in the same publication: Pussycat (1972) and Hare (1973), both drawn in the Physics Laboratory at the Vrije Universiteit in Amsterdam.

From 1967 until 1975, physicist Felix Hess (b. 1941) worked on a mathematical model for the returning motion of the boomerang. A program which included a visualization component was co-written in Algol by Felix Hess and Lambrecht Cook. Graphics were made with a Telefunken TR4 computer and a Benson-Lehner plotter at the Rekencentrum of the Rijksuniversiteit Groningen. First findings accompanied by computer-graphics were published in the article The Aerodynamics of Boomerangs in the Scientific American in 1968. More calculations were carried out later with a CRAY J932 computer, that was 120 times faster. The research led to the PhD thesis Boomerangs, Aerodynamics and motion, with illustrations that could be observed with a three-dimensional stereo viewer. In 1971, during his thesis research, Hess also made a series of free works, programming a digital re-enactment of Vega 200 (1968) by Victor Vasarely. These works were digitally programmed variations of vector files, where the image was reduced to the black outlines of the geometric shape. Later on, in the 1980's, Felix Hess started to work as an artist with sound installations and semi-autonomous sound machines, shifting his profession entirely from science to art.

Also in the Rekencentrum of the Rijksuniversiteit Groningen the scientists Johan Krock and Jan Kraak made computer graphics. A series of graphics by Jan Kraak from 1970 shows horizontal lines with random deviations. The AlgOL-60 program used an interpolation routine based upon the Akima algorithm, and a subroutine called 'bibber' (jitter in Dutch), in order to form unequal - jitter line. Points lying on equal distances on a straight line were given random deviations perpendicular to that line. The shifted points were then connected by the Akima interpolation routine, to form a more or less jittering line. Around 1970, Jan Kraak made work based on A. Michael Noll's Computer Composition With Lines - Mondrian Experiment. In 1965, A. Michael Noll, one of the most well-known pioneers of computer-graphics, made two xerographic reproductions: one showing Composition With Lines (1917) by Piet Mondrian, and the other showing a picture that was generated by a digital computer using pseudorandom numbers with statistics approximating the Mondrian painting. He conducted a small-scale experiment searching for opinions as to which image is preferred by small-scale experiment searching for opinions as to which image is preferred by


Humans. After seeing this work 1970 in a journal9 Jan Kraak also tried to emulate Mondrian’s Composition with lines. His conclusion was that “Mondrian’s ‘algorithm’ was more complicated then the algorithm I (and Noll) used.”10 In 1970 Kraak wrote an ALGOL-60 program to draw a pattern for a ladies dress (claires grand patron) based upon 9 measures of the female body, as a free work. It is based on a real instruction for a tailor about how to draw a pattern based upon some measures of the human body. The pattern could have been employed for actual use, but wasn’t. The plot consists of straight and curved lines.11 Part of the drawing is a scissor (Dutch: schaar) that is used in series of prints Random scharen (1971). Figures of a pair of scissors are positioned on random positions, with a random size and with a random angle, clipped within a square boundary. This work was inspired by the computer-graphic Random War (1967) by the American artist Charles Csuri. One particular print from this series is the result of a software error (one of the two programs was probably not closed correctly): a plot of Jan Kraak (Random schaar) combined with a plot of Felix Hess (digital re-enactment of the Vega 200 by Victor Vasarely).12

During his study at the Anthem Academy of Arts, Casper C. Bosveld (b. 1941, also known on the Internet as Pointer or DutchPointer) worked for the Koninklijke Nederlandse Heldemaatschappij where he developed a perspective presentation computer drawing-program (with hidden line removal), from 1965 to 1967.13 Afterwards, Bosveld start teaching fine art at the Augustinus College in Groningen, and continues experiments on vector graphics. In Groningen he worked on computers at the University’s Mathematics Center, mostly with the Astronomy researchers, using the GIFSY-program for advanced image processing. Until 1972, Casper C. Bosveld carried out experiments with computer art graphics, and worked on public art commissions (with no computing involved). In 1972, Bosveld finished his experimental phase, and starts to conceive his computer graphics as artworks. Since 1976 Casper C. Bosveld has programmed hundreds of computer-generated graphics using a Tektronix 4051 computer and a Tektronix 4062 Interactive Digital Plotter; he made many sales to German collectors. In the early eighties, Bosveld received a subsidy of 100,000 guilders from the Raad voor de Kunst for the project Vector (the largest sum of subsidy for an experimental project until that date). He taught media art at the Academy of Fine Arts Vredeman de Vries, at Leeuwarden. After a commitment to commercial software business and a break form artistic practices over several years, he started to make computer graphics again in 1987, as two-dimensional colorful virtual reliefs.14

9 When xerographic reproductions of both pictures were shown to 100 subjects - people working in Bell Lab, New Yersey - the computer-generated picture was preferred by 59 of them. Only 28 subjects indentified the Mondrian painting. Apparently, many of the observers associated randomness with human creativity and where therefore led astray in making the picture identification.
11 Kraak wrote a program in ALGOL 40 that draw a + symbol with random size and random X and Y position. In the upper side appears a programming error. Work is made with Telefunken TR4 computer and Benson-Lehner plotter at Rekencentrum of the Rijksuniversiteit Groningen. e-mail correspondence with author, 2010.
12 To draw the curved lines, an interpolation routine based upon the Akima algorithm was used (as used in ‘bibber’, 1970).
13 printed 1st February 1971, print 117-1. Works were made with Telefunken TR4 computer and Benson-Lehner plotter at Rekencentrum of the Rijksuniversiteit Groningen.
14 programmed in Assembler and ALGOL, Univac computer and Calcomp plotter (A 0 format, a flatbed with one pen). The program was loaded in the computer by a paper-tape reader. The data came stored on punch cards. The final program was examined and approved 1967 by the Institute of Electric and Electronic Engineering (IEEE).
15 He wrote a new parser to translate mathematic formulas in images to be processed in newly developed rendering environments like PDV-Ray (that offers a programming environment in which one have to write original applications). See artist’ website: http://www.confrontaal.org/
Space of determinism and randomness / Computer-generated art as part and continuation of Concrete art

Neo-Constructivism. Concrete Art, (Lumino-) Kinetic Art and other ‘systematic’, ‘algorithmic’ and ‘rational’ styles of the 1950’s and 1960’s have natural affinity with the tendency towards merging art and science and technology. In the Netherlands, they had a strong local reference to the tradition of neoplasticism (De Stijl), Constructivism and Bauhaus, and were well-accepted and promoted within the mainstream contemporary art world.

Several artists that made algorithmic and programmed art by analogue means start to use computers, mostly as a tool for carrying out more complex algorithms. In Netherlands that was the case with the artistic practices of Herman de Vries and Peter Struycken, as well as the Czech artist Zdenek Sykora who presents both analogue and digitally generated works in the Netherlands regularly since the 1960’s.

Herman de Vries (b.1931) is an academically trained biologist, who after a short period of working in his primary profession, shifts his activities exclusively to art and becomes one of the most well-known Dutch artists. Since the 1950’s, De Vries was deeply involved in the idea of merging art and science. In 1962, he starts to work with randomly organized visual structures. His interest in the new possibilities opened by computers led him to create one of the first computer-generated visual artworks in the Netherlands. In 1965 he made two artworks from the random objectivations series on computer punch cards. The punch machines were programmed and used to make random punches in the computer punch cards, creating random visual fields. These works were made during lunch breaks, when Herman worked at the Institute for Research of Bird Migration.

The continuation of art practices achieved in Concrete art that transgressed to visual research by computers was inaugurated and contextualized by the galleries of contemporary art in Zagreb. This Gallery started the series of New Tendencies exhibitions in 1961, that by the mid-1960’s becomes a synonym for the international movement of Concrete art and other visual research-oriented art that preferred a rational and systematic approach to individual intuition and myth. Series of symposia and exhibitions under the title tendencies 4, held in Zagreb during 1968 and 1969, included programs under title computers and visual research. Herman de Vries had previously taken part in two New Tendencies exhibitions, and he replied to the call for works for the computers and visual research exhibition in 1968, submitting some works from the 1968 random objectivations series. In an accompanying letter he explained:

“These works are not designed by a computer. They could be, because all in them is strictly programmed and strictly random. [The source of randomness here is Table XXXIII ‘random numbers’ from Fisher and Yates’ handbook ‘Statistical tables for biological, agricultural and medical research’ (London, 1953).] A computer I only use for very complicated problems to solve. The others work are even so good done ‘by hand’ if the program is followed strictly, as I do. Sent works are in a simple collage - technique, and illustrate a series of possibilities of my random programmations. (the series is made for this exhibition).”

Artworks V68-67 and V68-70 were exhibited at the computers and visual research exhibition in 1968, as part of tendencies 4. Because of the strict criteria for the follow-up 1969 exhibition of the same name, where flow-charts and computer programs were requested next to artworks, De Vries’ work (as well as that of 14 other artists) was accepted.


18 In total he exhibited eleven works at both Tendencies 4 exhibitions in Zagreb 1968-1969: V67 - 93; V68 - 64; V68 - 65; V68 - 66; V68 - 67; V68 - 69; V68 - 70; V68 - 71; V69 - 72; V69 - 73.

works made by analogue computing, by computer art pioneer Kurt Alsleben, for example) were included in another part of the tendencies 4 exhibition program that presented “analogue” works: recent examples of visual research.

Finally, in 1973 Herman de Vries did actually use computer to calculate the chance-fields, in the series of works collected in the art-book chance-fields, an essay on the topology of randomness.20 Michael Herbert in Frankfurt made calculations of the chance-ranges by computer. However, he did not program the calculation of the final data needed to produce the artworks, so the last part of the calculation was done by hand.21

De Vries’ overall affinity to computers become visible in the October 1972 issue of the artist-magazine integration, that he both edited and published. It includes texts on computer-generated art by Frieder Nake (DE), Michael Noll (USA) and Zdenek Sykora (CH).

De Vries’ works made by analogue techniques were exhibited in a two-man exhibition alongside computer-graphics by Frieder Nake (DE) in Swart gallery in Amsterdam 1970,22 and presented in numerous exhibitions and publications in the Netherlands and abroad.

The group Compos 68 was founded by Jan Baptist Bedaux (1947). Jeroen Clausman (1947) and Arthur Veen (1949) in September 1968 in Utrecht, where all three members studied. Then a student of art history, Jan Baptist Bedaux brings the idea of combining the aesthetics of modernist paintings (as Mondrian and Klee) and the computer simulation of growing trees. Arthur Veen was an assistant of professor A. Lindenmayer who taught Philosophy of Biology at the Biology department of Utrecht University; Veen was programming in ALGOL in his biology research. Series 1 and Series 2 (both 1968, hand-colored computer-prints made by an Electrologica X8 plotter) were produced by the EL - X8 Philips computer at the department of mathematics of Utrecht University. The program was written in ALGOL. Bedaux, Clausman and Veen created a system that could assign numerical values to the elements ‘color’ and ‘form’ in order to obtain numbers for mathematically formulated aesthetic theories. The variable multiple Hobby Box (1969) consists of a package with four colored cardboards, a pin, a variable pattern with stylus (created by the Electrologica X8 plotter) and an instruction manual, both printed as computer sheets.23 The variable pattern is a computer print that shows an outline of a composition that is to be copied (by pin) to each color cardboard, and such cut rectangles finally assembled at the black cardboard according to a unique computer-programmed composition. This is an early example of participative computer-generated work, with new notions of ‘manual’ and ‘user’ in the context of computer-generated art (similar to do-it-yourself art multiples in Fluxus art).

In its short existence as a group (1968 - 1969), Compos 68 succeeds in exhibiting its work in several important international exhibitions of computer-generated art, such as tendencies 4 in Zagreb and Kunst und Computer in Vienna.24 They received an award for Hobby Box at the ‘tendencies 4 - computers and visual research’ exhibition in Zagreb in 1969, an exhibition that propagated the idea of visual research with computers as a continuation of the tradition of Concrete Art

21 e-mail to Darko Fritz, 10 November 2010.
22 5 - 26 april 1970 - exhibition of computer-graphics by Frieder Nake and random objectivations by Herman de Vries, Galerie Swart, Amsterdam.
23 design generated by the ELX-8 computer of Utrecht State University. Multiple consists of the package with four colored cardboards, pin, variable pattern with stylus (Electrologica X8 plotter) and instruction manual (computer sheet). Computer prints produced 10 and 11 March 1969. Program: 1 page comp. print, 10 pages output results.
24 Compos 68 presents ‘Series 1’, ‘Series 2’, ‘Hobby Box’ and ‘Example of the development of a program to generate lines’ at the ‘tendencies 4 - computers and visual research’ exhibition in Zagreb, 5th May - 3rd June 1969. ‘Hobby Box’ is exhibited as well at the Kunst und Computer exhibition, Datenzentrum der Zentralsparkasse, Vienna, 27 november - 19 december 1969 (with Farkas, Steiger, Beckmann/Grassi, Alsleben/Pasow, Adrian and Nake).
Peter Struycken (b. 1939) had established a career in Concrete Art with geometric abstract paintings in which form and color underwent systematic changes, before he started to use computers in his art. In 1968 he attended courses on electronic music (by G.J. M. Koenig) and on the programming language ALGOL at the Institut voor Sonologie - Rijksuniversiteit Utrecht, leading to his first computer-drawings in 1969. He was helped in writing the computer program for these drawings by the physicist Constant A.G.M. (Stan) Tempelaars (1958 - 2010), and by Greta Vermeulen. A series of eight paintings, Computerstrukturen (1969 - 1970), was made by hand according to computer-generated visual compositions. Black and white images used the square as basic element, with increased emphasis on the conditions that the elements had to fulfill (structural rules), and their effect on the visual outcome. Transitions were made from simple to complex, from regular to random visual structures. The series of paintings was chosen as the final selection from a much larger sequence of images, all of which are different versions of one another. The computer enabled Struycken to investigate the role of chance in the creative process, whilst also retaining some measure of control. Struycken welcomed the ability of the computer to calculate endless visual alternatives for the arrangement of a series of different colored squares across the picture plane.

The computer program used in the Computerstrukturen was used again for an architectural art commission: the sandblasted glass partition walls on the executive floor of the KLM office in Amsterdam. Two semi-transparent sandblasted patterns overlap with a small distance, thus creating the third image. Successfully translating data to solid materials Struycken created fourteen computer-generated permanent public art works until 1980, and more since.

The use of a random program is employed in Vier toevalstekeningen voor Lien en Ad, 29.10.72 (1972, Four Random Drawings for Lien and Ad) that are Struycken's first entirely computer produced and executed works, in the form of plotted prints.

In 1972 - 1974 Struycken develops and uses the PLONS computer program to manipulate colors. The analysis of formal characteristics of color will be the inspiration for a great number of his later works. For CLUSTER (1971 - 1975), a series of 16 paintings, he developed a program with Stan Tempelaars that placed 24 different colored elements in a rectangular plane.

Since his encounter with computer, he almost exclusively shifted his working methods to computer-generated works and pioneered the use of computers in Netherlands in almost every aspect of visual arts: paintings, graphics, audio-visual light-objects, film, video and sculptures applied in public art. Struycken's continuation to work with computer-generated images form 1969 until today (2011) is unique in the field of visual arts in Netherlands.

His first film Beeldprogramma I (1970) is made as a stop-animation of drawings...
made after computer-programmed visual compositions. In 1973 - 1974 he develops the computer program ASTRON, that will find its output result in a film; in 1976 he made his first real-time computer animated images recorded on video (Waves, Disp, Hieoi, Square, Grid 3, Lijn 1) and finally in 1981 he made the 'stand alone' image generator 'SHFT'. It showed images, being calculated one by one on a display. The images never repeat in space or time and are generated by a fully deterministic program (without using randomness).

**Beeld en geluid programma 1, 1970** - (Image and Sound programme 1, 1970) is an audio-visual object, a light box showing 180 combinations of 24 basic black and white patterns, with sound synchronized in real-time.

The computer program was designed with Stan Tempelaars.

Advanced research on the relationship between structure and randomness was carried out by computer scientists Lambert Meertens and Leo Geurts in their series of works Kristalstrukturen. (Crystal Structures, 1970) that follows the logic of cellular automata in the growth of crystals. They employed a family of algorithms which all use majority voting. Some of them use larger neighborhoods than the immediately adjacent cells. The update regime is incremental: cells are updated one by one. A selection of images was printed and exhibited internationally.

Computer-generated art was presented within the frame of the Concrete Art on numerous occasions all over the Netherlands: in the Amsterdam galleries Swart (Leo Geurts / Lambert Meertens and Peter Struycken) and Multi Art Points and the Stedelijk Museum, as well as in Kunstcentrum Badhuis in Gorinchem (De Vries and Sykora), Galerie de Mangelang in Groningen and Museum Bouymans-Van Beuningen in Rotterdam. Several group exhibitions made different curatorial contributions to the subject. In 1972 the group exhibition "Programmi Sistematici: Dekkers, Hilgemann, Schoonhoven, Struycken, De Vries" took place in Galleria Milan in Milan; "Peter Struycken, Ad Dekkers, Jan Schoonhoven, Carel Visser" in Lens Fine Art in Antwerp and Struktura - een thema, een methode presented the Centrum voor Cubische Constructies, Dekkers, Van den Ende, Von Graevenitz, Hilgemann, Roskam, Van Rossum and De Vries next to computer-generated works by Geurts / Meertens and Struycken in De Lakenhal, Leiden. Varianten - an exhibition of Dutch Constructivists, organized by Nederlandse Kunststichting in De Aart in Hilversum in 1973, included work by Peter Struycken.

The topic of preprogrammed or completely determined works versus randomness or chance (Dutch: toeval) is well-known in the discourse of Concrete Art, and well applicable to computer-generated art. In 1976 the traveling exhibition of Concrete Art Toeval Kunst included computer-generated works by Struycken.

Another exhibition with a similar name, Toeval, was initially conceived as an exhibition of computer-art by Frans Haks (1938 - 2006) but later extended to the general subject of chance in art. The exhibition was prepared in the course of two years by a core group of five members (G. M. van Aspen, Frans Haks, W. Nijdam, F. C. Weiland, Stan Tempelaars) that invited more than twenty collaborators who selected the program. Finally, it took place in March 1972 in Amsterdam, 5 March - 29 March 1976, curated by Jan Martens in collaboration with Frits Weiland.

In 1970, Struycken's "Waves, Disp, Hieoi, Square, Grid 3, Lijn 1" participated in the 8th Annual Computer Art Contest, organized by the journal Computers and Automation, where they got an "honorable mention" and were published in the August 1970 issue and were exhibited at the Third Annual ACM Computers Arts Festival (Association for Computing Machinery) that took place at Rhinelander Gallery, New York, 1st - 3rd September 1970 (Honorary Mention prize). In 1972 Galerie Swart exhibited this series in Amsterdam (12 maart - 1 april), and published a portfolio of four silkscreen prints.

Peter Struycken, Beld en geluid programma 1, 1970 (Image and Sound programme 1, 1970), 1970. Audio-visual object. Light box showing 160 combinations of 24 basic black and white patterns, with sound synchronized in real-time. Computer program is designed by Peter Struycken and Stan Tempelaars.

Peter Struycken, Noise-reduction wall and garden, 1980-1984, public art, PTT dispatch hub, Utrecht. Two programs were used in design: DOTS and SHIFT, both written by artist.


Below: process of crystallization in eight steps, designed by authors with ALGOL 60 language and Electrologica X8 computer at the Mathematic Center in Amsterdam.
Utrecht and presented a new and truly interdisciplinary approach. The project included a wide range of subjects: fine arts, biology, literature, music, psychology, mathematics and physics. An exhibition, slide show, film and music program as well as participatory actions were presented. The fine arts section presented different art discourses ranging from the historical avant-garde of the 1920’s to Concrete Art and Conceptual Art. In an extensive publication that accompanied the exhibition an essay *Kunst en computer* by Hoos Blotkamp provides a context and readings of the Kristalstrukturen by Leo Geurts / Lambert Meertens and computer-generated works by Peter Struycken and Zdenek Sykora.

Computer-generated art as part of Fluxus and Conceptual Art

A different approach to structured determinism and randomness we can find in artworks by Remko Scha (b. 1945). Being active in both the music scene as well as the visual arts, his work bridges the traditions of Fluxus and Conceptual art. *Markov muziek - Opus 27* (1966) is an algorithmic music work conceived for the computer. Transition tables define Markov random processes. The piece consists of seven parts with different transition tables: 1: Deterministic scale, 2: Random White Note Music, 3: Scale with randomly broadened steps, 4: Monotone version, 5: Interpolation between Monotone and Random White Note Music, 6: Random Walk, 7: Random random.

*Untitled Algol Program* (1968, working title) is a program generating textual descriptions of ca. 600,000 assemblages, made of different objects in different configurations. The output assemblages may be built, but the program generating their descriptions may also be presented in operation, by installing a computer with a printer in the gallery. *Untitled Algol Program* follows Scha’s series of installations *Touwerbindingen* (Rope Connections, since 1966) where different groups of objects were connected by ropes, displaying their mutual relations and thus materializing a relational aesthetic. In the assemblages described by the output texts of *Untitled Algol Program*, objects, photographs, philosophy books, and/or empty spaces (holes) are positioned in a grid, on two surface layers above each other. The surfaces may be realized in different materials (formica, glass, mirror). Objects/books/spaces may or may not be numbered or connected with ropes. The total number of configurations allowed within the constraints of the program is ca. 600,000. The program that calculates and generates the texts describing these configurations was written in Algol 60 by the author.

*nixmur (automatisering)* (1969) is another Algol 60 program, conceived for an installation consisting of a computer and a printer. The program is a ‘loop’; the computer that runs the program, endlessly puts out the text ‘nixon moordenaar’ to the printer, that use long sheets of paper (as was standard at the time). As this popular anti Vietnam War slogan was officially banned in Netherlands and therefore protesters were shouting it rather than writing it on their banners, the machine here took ‘responsibility’ for the action. Despite the fact that Scha was one of few artists who actually knew computer programming at the time, he did not have an access to the hardware to execute this piece. In an artist’s statement accompanying the original manuscript of the program, he wrote: “The principle that determines all modern art, which is the identity of form and content, has been completely abandoned here. Starting point for this work was the idea of making the tension between form and content as large as possible”.

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34 not performed (2011)
35 9 pages, handwritten, Remko Scha archive
36 Installation is not realized (2010). Documentation: Examples of intended output (6 pages, handwritten) and related computer program (10 pages, handwritten), 1968. Remko Scha archive.
38 that-time wellknown anti Vietnam War slogan, that was officially banned in Netherlands.
After ten years of absence from the art scene, devoted to research on computational linguistics, **Scha** made in 1980 an interactive generative art object, **Muzak for Wijnand**. The object consists of the outside of a readymade radio-receiver, whose inside hardware was substantially changed. An electronic chip was built in that was programmed by the author to generate minimal music sequences forever, interrupted at random moments by bursts of random noise and distortions. The listener could change the speed of music, by using the radio’s buttons whose function had been changed. Since the early eighties **Scha** has again become active in generative and multimedia art, employing his interests and knowledge of artificial intelligence, computing, music, social activism and ever-changing visual contemporary art.

Conceptual artist **Pieter Laurens Mol** (b. 1946) made three computer-generated works in 1968 and 1969, as he had access to IBM computers and programmers that helped him in the software company Volmac.** Machine Poem Piece** (1968) is a computer print in an edition of 8 copies. **Machine Poem Piece** makes it possible to read sentences in all directions. **Mijn Naam volgens de IBM-29 Card Punch Machine** (My Name according to the IBM-29 Card Punch Machine) (1969) is a cardboard print in oil paint on tissue paper - direct impression from punch card, made in an edition of 4. **moment 1** (working title, 1969) is a process-based conceptual artwork that made use of computer technology alongside other means of communication. The artwork took the form of personal gesture from the artist to art collectors **Martin** and **Mia Visser**. The text of the artwork read (in Dutch):

/ MENTAL VIBRATION OF PIETER LAURENS MOL / 7 JANUARY 1969 / 7.29 PM / AMSTERDAM / SOLD TO MARTIN AND MIA VISSER / MARCH 1969 / BERGEYK / OBJECT / VACUUM / TITLE / MY THOUGHTS / PRICE / THE GREATER PART OF YOUR IMAGINATION /

Additional explanatory text (in German) was displayed next to the work sent by post. The text explains three parts of the process: the idea about the work (January 1969), the production of the work (March 18th 1969, “I produce a program on the IBM card punch machine 29 ...”) and finally sending the work by post (April 2nd 1969).** This tautological piece presented the very process of making and selling as an artwork. The idea of participation and process are conceived within the discourse of conceptual art of the time; this also applies to the personal gesture viewed as an artwork.
Inauguration of Computer-generated art and design into the mainstream visual culture in the Netherlands

Unlike in the rest of the world where such processes took decades, early computer graphics were inaugurated in the main Dutch governmental institutions that deal with visual culture and its representation: the design of money and post stamps.

Artist and graphic designer Robert Deodaat Emile (Ootje) Oxenaar (b. 1929) developed a series of seven banknotes from 1966 to 1985 for the Nederlandsche Bank that were (almost all) in circulation until the currency changed to the Euro in 2003. He improved banknote design in many ways in general, but keeping our focus on the subject here, it is interesting that all designs used computer-generated basic patterns prepared at the Technological University in Eindhoven with the help of the program controlled drawing system CORAGRAPH. Looking back to the use of computers in the 1960’s, he says: “The funny thing is that this very old fashioned firm of Enschede [the printing house, DF] was the first in the world to use computer-aided machines for its banknotes in this way”.

As in the case of the banknotes, the Netherlands is the very first country that issued computer-designed post stamps in 1970, also designed by Oxenaar. The Summer postage stamps 1970, a series of five computer-designed post stamps and five related posters, are made in collaboration with the group Numerical Control of the department Business Science of the Technological University Eindhoven, and issued by PTT. The design had been developed some years before, and was realized in collaboration with the Business Department led by Prof. C. de Boer and in collaboration with Th. W. M. Lambs and J. van de Forest. The 15c+10 stamp was derived from a design by the Centrum voor Cubische Constructies, announcing their participation at the 35th Venice Biennale same summer. Max Kisman reflects on the design: “The experiment to produce computerized graphics is entirely driven by the need for visual complexity of adding security to value papers. Structures that are too complicated to be be executed by human hands. The creators have nevertheless succeeded to reduce that complexity into an accessible image (of computer application) and an attractive design.” As part of the promotion of the new post stamp series, PTT issued five computer-graphic images by Oxenaar that are related to the ones employed in the stamp designs, printed in offset in a presumably big edition. In an explanatory letter by the PTT, this abstract computer-designed graphics is called ‘wall decoration’.

On occasion of coronation of Beatrix in 1980 PTT commissioned a new permanent queen stamp that was designed by Peter Struycken. The dot pattern was based on a digitized photograph that was made at the Pattern Recognition department at Delft University of Technology. The 128 x 128 grid was ‘shaken up’ using a random program. These stamps, in many mono or two-color variations, even made the transition to the Euro, thus being the longest-circulating stamp design in the history of the Dutch Post. Struycken also made several portraits of the queen for public buildings such as the Netherlands Court of Audit in The Hague (1996 - 1997). Those works are his only figurative works. Queen Beatrix made Struycken a Knight in the Order of Orange-Nassau in 1984.

Peter Struycken, who realized fourteen high-budget computer-generated permanent public art works until 1980, and even more since, mastered the inauguration of computer-generated art in the field of public art. Struycken designed the cladding of two areas, floor, ceiling walls and sitting elements in light-reflecting metal for World’s Fair in Osaka 1970, while Wim Crouwel designed the graphic material.

42 5, 10, 25, 50, 100, 250, 1000 Guldens, and redesigns of his own design of 5 and 100 Guldens.
44 Max Kisman, Bits to Pieces, 2010

Robert Deodaat Emile (Ootje) Oxenaar, 5 Gulden banknotes, 1966 and 1973 (redesign), Nederlandsche Bank. Partly computer-generated design at Technical University in Eindhoven with the help of the program controlled drawing system CORAGRAPH.
Robert Doodd emile (Ootje) Ochenaar: Summer postage stamps 1970, series of five computer-designed post stamps. Made in collaboration with the group numerical control of the department business science of the Technical University Eindhoven, and issued by PTT Netherlands.

Below: computer printing of stamp design

Next page: poster and flyer advertising the Summer postage stamps 1970
Film director, screenwriter, inventor and entrepreneur Samuel Meyering (1944 – 2006) made a permanent public art installation with a computer-generated chaotic line at eighteen elevator lobbies of the Ministry of the Interior and Kingdom Relations \(^45\) in Hague in 1978. Meyering also worked with computer-generated sculpture, animations, interactive video games and demos, using the Apple II personal computer. In 1980 he founded the software house paralax in Amsterdam, which improved the manipulation of typography for TV and video productions.

Apart from computer-generated images in the daily use of banknotes and post stamps, the queen’s portrait and several public art installations, the imagination of the general public of all age groups was captured by the Evoluon, a permanent industrial exhibition run by the Philips electronics company. It opened in 1966 in Eindhoven, and from 1971 it was equipped with a P855 computer. The Senster by Edward Ihnatowicz (1926 - 1988, PL / UK), an interactive cybernetic-robotic sculpture controlled by a computer, was in operation at the Evoluon from 1970 until 1974, where it was developed and assembled. \(^46\) Realization of the Senster took more than two years. Engineers from Philips and Mullard (a British manufacturer of electronic components) as well the Mechanical Engineering department of University College London helped Ihnatowicz. The computer program for the Senster was written by Ihnatowicz with help from Peter Lundahl. About 4 meters long, the Senster consists of six independent electro-hydraulic servo-systems based on the articulation of a lobster’s claw, allowing six degrees of freedom. The Senster has a ‘head’ with four sensitive microphones, which enable the direction of a sound to be computed, and also a close-range radar device that detects movement. The whole is controlled by a Philips P9201 digital computer, which tells the servo-system how to move in response to various combinations of sound and movement from visitors to the Evoluon. \(^47\) Sudden movements or loud noises would make it shy away. The complicated acoustics of the hall and the completely unpredictable behavior of the public made the Senster’s movements seem a lot more sophisticated than they actually were. It soon became obvious that it was that behavior and not anything in its appearance that was responsible for the impact that the Senster undoubtedly had on the audience.

R. A. Leeuw wrote as part of his doctoral studies in art history a thesis on computer art. \(^48\) The thesis was completed in 1970 and tries to provide an introduction to computer art for art historians. The technical aspects are therefore discussed only if they are important for understanding why a particular artwork is created. Chapter 1 covers the history of computation and its operation, only elaborating on the key visual output media: line printer, plotter and cathode ray tube. Chapter 2 examines how the interest in machinery and technology arose, that drove artists to no longer produce works by themselves, but rather through machines. The era of the Industrial Revolution and Futurism are discussed in depth. After a treatment of some aspects of art and cybernetics finally follows a critical discussion of computer art and a discussion of the work of some artists, such as Struycken, Barbadillo, Nake, Nees, Lecci, Oxenaar, Sumner, Computer Technique Group Japan, Cordeiro, Moscati, Whitney and Metzger.

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\(^{45}\) Ministerie van Binnenlandse Zaken
\(^{48}\) R. A. Leeuw, Instituut voor kunstgeschiedenis, Groningen, September 1970
Edward Ihnatowicz, The Senser, interactive cybernetic - robotic sculpture controlled by a computer, 1970 (in operation until 1974). Computer program (far left) written by Ihnatowicz with help from Peter Lundahl. Senser consists of six independent electro-hydraulic servo-systems based on the articulation of a lobster's claw, allowing six degrees of freedom: 'head' with four sensitive microphones, which enable the direction of a sound to be computed, and also a close-range radar device that detects movement. Controlled by a digital computer Philips P9201, which tells the servo-system how to move in response to various combinations of sound and movement from visitors to the Evoluon.
Computer-generated art from activist and leftist positions

After the mid-1960’s Concrete Art and related systematic visual research start to lose the edge of their political (new) left positions that were dominant in the late 1950’s and early 1960’s. The notion of participation art that was inaugurated within such art discourses by Arte Programata (Umberto Eco, 1962) and the related demystification and democratization of art with the progressive positions of the New Tendencies (since 1961) and similar phenomena were lost in the commercialization of mainstream contemporary art and the related cultural industry. Their ideas entered the mainstream and were reshaped using simplifications, while their leftist social engagement, once at the forefront, was being neglected. The ‘Responsive Eye’ exhibition was held in the Museum of Modern art in New York in 1965 and numerous politically engaged artists participated as well. However, their work was immersed in the commercial context focused more on retinal effects than on the social dimension of artistic work; visuals lost the seriousness of ‘systematic research’ and started to be used in pop culture and fashion (after this exhibition, the term ‘op art’ appeared). Many artists, as they gained international recognition, bent their style in commercial directions and blended into the commercial system of the culture industry, which they had often severely criticized earlier.

A positive output of such an appreciation of the mainstream we can see in the inauguration of visual research, gestalt theories and modernistic aesthetics within the sphere of graphic design, the trend that continues until today and has a strong presence in the Netherlands as well.

In general, the Dutch art scene of the 1960s and 1970s was impregnated with rebellion, anarchistic and other leftist positions and activism. A famous pre-1968 hybrid of art and activism was conducted by Provo (1965 - 1967) in the public spaces of Amsterdam.

In 1967 Remko Scha and his improvisational multi-media band The New Electric Chamber Music Ensemble played in the Sigma Centrum (Kloveniersburgwal, Amsterdam)49, a center for anarchist culture that at the time served as the home base of Provo, as well at the conference “Culture and Society”, organized in Maastricht by the left wing of the PvdA. (“Tien over Rood”) and the local branch of Provo (“Ontbijt op Bed”)50. Remko Scha also presented the installation ‘Touwverbindingen’ (“Rope Connections”) at the opening night of the new headquarters of Provo in the Apollo Bioscoop in Amsterdam.51 Those works were not computer-generated, but they did lead to other similar artworks conceived for computer, described above, and show us the political context of Scha’s art activities and their presentation in both official and non-official venues.

Lambert Meertens worked at the Mathematical Centre in Amsterdam but he was also chairman of the Pacifist Socialist Party (PSP)52 from 1975 to 1981. He and his colleague Leo Geurts were deeply involved with the creative use of computers since 1967, which led them to make computer-generated music as well as the computer graphics mentioned before. They wrote the programs to generate parts of compositions53 by Louis Andriessen and Peter Schat that were part of a collaborative work, the opera Reconstructie. Een moraliteit. (1968 - 1969)54. Other participating composers were Reinbert de Leeuw, Misha Mengelberg, Peter Schat and Jan van Vlijmen. Hugo Claus and Harry Mulisch wrote the libretto. The opera was dedicated to Che Guevara, openly showing the political orientation of the authors. Meertens and Geurts collaborated with Andriessen on

Reconstructie. Een moraliteit, 1968 - 1969, opera by Louis Andriessen, Peter Schat, Reinbert de Leeuw, Misha Mengelberg and Jan van Vlijmen. Hugo Claus en Harry Mulisch wrote a libretto. Program and LP. The opera was dedicated to Che Guevara. Parts of score by Andriessen and Harry are computer-generated, in collaboration by Lambert Meertens and Leo Geurts, by Electrologica EL X8 and score printed by EL X1 in the Mathematisch Centrum, Amsterdam.

49 February 3, 1967
51 early April 1967, Provo-Bioscoop, Haarlemmerdijk, Amsterdam
52 Pacifistisch Socialistische Partij (PSP), http://www.parlement.com/9353000/1f/j9vvhy5i95k8zxl/vh8lnhrp8wsk
53 Computing was done by Electrologica EL X8 and score printed by EL X1 in the Mathematisch Centrum, Amsterdam
54 premiere was 29th Jun 1969 at the Holland Festival, Theater Carré, Amsterdam.
Interactive man-machine networks by Victor Wentink

Composer and visual artist Victor Wentink (1948) made a step further in interactivity and participative art with his original notions of horizontal and vertical computing. He developed such ideas considering political notions of an author in relation to power structures and technologies.

Quadraat Stelling I (De Windmachine I) (1971) is a sound installation with an interactive hardware-programmed man-machine network. The set-up is based on a display of horizontal entities, both human and technological, creating an interactive network, or “new ground of existence”. Four people sitting in the room, interacting via a matrix board and pins (consisting of 0’s and 1’s) with the sound-producing electronic equipment that was set-up on the floor in the same space. The four nodes of the established network are made of two pairs (that can be extended without limits), following the logic of multiplied communication in pairs. Wentink views the traditional orchestra as a mainframe machine controlled by the conductor and the score. Further, considering the idea of computerizing the world and the power of mainframe computers, this installation was designed as an opposition - democratising technology. Wentink’s idea was to decentralize and deconstruct the machine relationship represented in the mainframe computers, and create a personalized and intelligent technology network, that will empower the interaction of the human body and technology in the creation of the “slow human computer”. It follows the idea of socializing technology after Marx and Benjamin. The installation was intended to be used in the private environment of a group of musicians; four such sessions were held in May 1971 by members of the student’s electronic instrumental group Het Leven in the Koninklijk Conservatorium in Den Haag. The group consisted of eight musicians, involving Dick Raaymakers, who did technical preparations and made the drawing of the technological set-up. All electronic circuits and the matrix board were designed and built by Wentink. It also included commercial sound equipment: two stereo amplifiers, a Moog analogue music synthesizer, two product modulators (that multiply two sound inputs into a complex output signal), three tape-recorders (for storing and playing sounds) and a reverb device. In 1979 the installation was also presented in a museum space.

From 1973 - 1976 the Quadraat Stelling II (De Windmachine II) was made and performed as an audio-visual live performance / installation with an interactive hardware-programmed man-machine network. Four people performed a preprogrammed audiovisual score, composed for four audio and of three visual channels. Six paintings (oil on canvas) by Wentink were displayed in the space, one showing the figure of Karl Marx in a bourgeois interior taken from a Vermeer painting. Participants via switches control and perform a preprogrammed 6-part audiovisual score of 90 minutes, that is based on Das Manifest by Bertold Brecht. The third part of the score is a recording of the Eemnes Machine. Visuals consists of approximately one thousand slides, ranging form reproductions of historic photos of industrial areas and technology, to details from the displayed oil paintings and contemporary photos by the autor (of personal situations). The score was the software. The installation consists of a 4-track tape recorder (TEAC 3340 S), a rotator (to control direction of four loudspeakers, custom-built in Stein by technician Johan den Biggelaar), and 4 control switches (commercial matrix boxes, unlike the custom-made ones in Quadraat Stelling I and 3.

The Volkslied (1971) - For an unlimited number and kinds of instruments (in all octaves) by Louis Andriessen was programmed by Leo Geurts on the Electrologica X8 computer of the Mathematical Centre, Amsterdam. The score starts with the Dutch national anthem Wilhelmus van Nassouwe and then gradually, with small steps, morphs into the socialist hymn ‘The International’.

• For an unlimited number and kinds of instruments (in all octaves) by Louis Andriessen was programmed by Leo Geurts on the Electrologica X8 computer of the Mathematical Centre, Amsterdam. The score starts with the Dutch national anthem Wilhelmus van Nassouwe and then gradually, with small steps, morphs into the socialist hymn ‘The International’.

55 three of them were co-authors of Sonate opus 2 No. 1 voor piano en blazers, premiered 21st September 1969 in Stedelijk museum, Amsterdam
56 as stated by Wentink to author
57 2nd may 1971. Archivs Victor Wentink
Victor Wentink continues to develop Quadraat Stelling series and horizontal computing until today (from 1997 it is entirely internet-based). Horizontal interactive participatory technology realized in these works enabling all combinations of audiovisual communication and feedbacks in different directions simultaneously and in real-time (one-to-one, one-to-many, many-to-many etc), preceding the internet based social networks in the beginning of the 21st century.

Another long-term project with several developing phases is an interactive hardware-programmed self-composing sound machine titled Eemnes Machine (1975 – 1979). It was designed by Victor Wentink and implemented by the author in collaboration with Johan den Biggelaar at STEIM in Amsterdam. All electronic circuits were built from scratch. Inputs were sound and light (and in concept wind and human movement), and real-time data processed by the machine resulted in unpredictable electronic sound output. The piece was intended as a permanent installation powered by solar energy in a desert-like environment, a new polder in Flevoland. Variable analog and digital voltage generators were employed in the design. In STEIM in 1975 the first print of a personal computer’s motherboard was available. The idea to make machine with digital equipment was put into consideration, but it was deemed to be not flexible enough and therefore rejected. The work was inspired by the social circuitry of Hewitt Crane. The ‘Eemnes Machine’ was built in 1978 - 1979, (250 x 43 x 43 cm, and first presented at Tektonik solo-exhibition in het Haags Gemeentemuseum, March 1979. It was used in several music performances by the music group Het Nieuwe Leven (1980 - 1985) and exhibited in Zeeland by STEIM in 1985 for the last time. A completely digital version of the machine under the name Waterloo-Machine was designed in concept in 1983 but never built (the Apple II, owned by STEIM, was not suitable). Some ideas of this work were later developed into the Waterpaviljoen in Zeeland, 1997 (in collaboration with Edwin van der Heide). The theoretical and technical background of Schakelkunst (Circuitry Art) employed in this work are elaborated in Wentink’s book De Vrolijke Techniek (Happy Technology) (1975, not published). Wentink’s first completely digital audio-visual composition is KAND digitale beeld/geluid-compositie voor Apple II computer (1979 - 1980), coproduced by Studio Stein and Studio Amsterdams Conservatorium. Floris van Maanen did programming and handle data transfer from mainframe to personal computer. The Apple II computer performed audio-visual composition: sound from the computer was played through the concert’s hall sound system and monitor output was transmitted from color TV monitor via an attachable lens system to the projection on the (curved) screen. The reproduction of the painting from Kandinsky was scanned manually with the help of transparent grid paper (1 mm resolution) - where 20 colors from the painting were transmitted into Arabic numbers and later on translated into a binary system and fed into the mainframe computer at the Amsterdam Conservatory. Stored data was then fed into the Apple II computer because of the color output. The color cubes appeared on the computer screen in vertical lines until the picture was completed, in approximately 10 minutes. The speed was adjustable. Each color was translated into mono sound, using the Apple II sound generator. Each vertical line performed at the monitor, was in real-time translated to a sound chord according to its color value.

Transmedial artist Andreas Maria Jacobs (b. 1956) developed a game for three humans and one mainframe from 1979 to 1980, during his study of physics and musicology at the University of Amsterdam, using the mainframe computer of SARA. An interactive program was written in FORTRAN to feed to the computer with punch cards. Jacobs later made a fusion in his artwork of visual art and music.
Institutions and networks

Several networks and institutions have been active promoting computer-generated arts at the closure of the 1960s and beginning of 1970s.

The first meeting of the Working group for computers and verbal, visual and sonic research was held at the Institute of Art History of Utrecht University at 19th December 1969. The invitation was signed by M. L. Alinei, Peter Struycken, F. de Tollenaere, H. van de Waal, F. C. Weiland and Johannes van der Wolk. The program of the first meeting comprised both an agenda and a list of those who had announced their interest to participate. It was primarily a platform for the exchange of information between those who were pioneering in the use of computers in various fields concerned at both national and international level. Art historian Johannes van der Wolk, who edited, self-published and distributed eleven newsletters, exclusively handled the organization of working group.60 The Werkgroep had no formal organization and Wolk’s private address was used for its contact. The newsletters published 155 articles in total. Subscribers to the newsletter were considered members and by 1972 the mailing lists consist of 126 subscribers; 92 from Netherlands and 34 from abroad. The members participated with information providing for publishing, and influenced the Newsletter’s content via replies to published questionnaires. The questionnaire about expression of interest was published, and the following issues presented 38 responses of which ten were related to arts and creativity.64 Van der Wolk initiated both Symposia of the Dutch Working group for computers and verbal, visual and sonic research that were held in 1970 in Deft and Amsterdam.64 In the latter participated the following artists and researchers from Netherlands and abroad: M. L. Alinei (IT), J. Daan (NL), Leo Geurts / Lambert Meertens (NL), Frans Haks (NL), John H. Holloway (UK), Joseph Raben (USA), C. E. C. de Reus (NL), Alan Sutcliffe (UK), K. Schröder (DE), Peter Struycken (NL), H. Swart (NL), F. de Tollenaere (NL), H. van de Waal (NL) / S. Sandström (SE) and Johannes van der Wolk (NL).

Johannes van der Wolk defended in 1971 a doctoral thesis in art history that included topics like “The first experiments in computer use by the art historian and the possibilities for the future”; “Packing the same knowledge in various media as a contribution to smooth the process of scientific communication” and “Computers and visual creativity.”66 He started to work in the Boymans van Beuningen Museum in Rotterdam in 1971 and published numerous articles on computer art in various periodicals since 1986. When he started to work, the Boymans van Beuningen Museum already ran an annual program for 1971 with the subject ‘art and technology’. The description of the 53 images of works from the collection begins with a brief reflection on ‘technology’. A quote: ‘Even bewust worden welke technische verworvenheid wij over het hoofd zien, als te gewoon en te vertrouwd; even ons er opnieuw over verwonderen; even het lachwekkende zien van een overtrokken bewondering; even de betrekkelijkheid voelen van zekerheid en onzekerheid. Even maar. Wat een belevenis.”

Lambert Meertens met Alan Sutcliffe before the above-mentioned 1970 symposia in Delft, at the IFIP (International Federation for Information Processing) Congress in August 1968 in Edinburgh, where his computer-generated Quartet No. 1 in C Major for 2 Violins, Viola and Violoncello was performed and won a special

63 11th newsletter was made in november 1973, but not distributed
64 Newsletter no. 8 - 18 February 1970; no 9 - 30 Jun 1970.
67 “Just be aware that technical achievement we overlook as too common and familiar, here again we marvel, as the ridiculous seeing an exaggerated admiration, as the relativity of feeling of certainty and uncertainty. A moment. What an experience.”
price of the jury. At the IFIP Congress Sutcliffe initiated the initiative of Computer Arts Society (CAS) that was founded in London soon after. The spin-off organization CASH - Computer Arts Society Holland was initiated by Leo Geurts and Lambert Meertens and held its first meeting in May 1970. Out of thirty-four attendants ten were creatively involved in art (visual arts, music, design, literature) and nine attendees dealt with art (art history, art criticism, musicology, museum). Sixteen of the participants had experience working with computers.

Leo Geurts and Lambert Meertens edited two issues of the Page bulletin of the Computer Arts Society (London), presenting new developments in the Dutch scene in 1970 and 1971. Recognizing the essential problem of computer literacy for participants coming from the arts and humanities, CASH organized programming courses that were given at Honeywell Bull venues in Amersfoort and The Hague, with time-sharing using teletype consoles for input and output.

G. H. Bührmann paper wholesalers from Amsterdam hosted an exhibition Computer Grafiek from London’s Computer Arts Society (CAS), extended with works by Oxenaar and Strychken and presentation of computer films. In the exhibition space a Calcomp plotter was placed that produced computer graphics. Part of the exhibition was later on shown in Galerie de Mangelgang in Groningen, including works by the Centrum voor Cubische Construkties (Jan Slothouber and William Graatsma).

Composer Roland Kaye (DE, living in NL since 1970) was program adviser at the Goethe Institute Amsterdam that hosted the travelling group exhibition IMPULSE: Computer-Kunst set up by IBM Company. The exhibition that started in 1970 in Munich was presented in Amsterdam in 1971, and also traveled to other nine European cities. In collaboration with the Aesthetics Institute of Amsterdam University an extensive program was executed, consisting of an exhibition, computer-music and computer-film program, computer time-sharing, a lecture by Max Bense (DE) and a forum chaired by Matthieu Marie Aler.

Amsterdam based underground film venue Electric Cinema (1970-1974), led by filmmaker Barbara Meter showed several programs of computer-generated films. Typically for early computer-generated art, universities took an important part in creating environments and platforms for its production, sharing the know-how and networking.

The secretary of the symposium was L. H. Meuldijk and presentations by A. van Dam, B. Peters, P. Purcell and Nicholas Negroponte were delivered.

Under the auspices of the Dutch Architects Association and the Building Centre in Rotterdam (div. Prototypes) the international CAAD seminar Rotterdam took place in 1971. The IFIP working conference on principles of computer-aided design was held in Eindhoven in 1972, organized by IFIP Technical Committee 5, Computer Applications in Technology.

There were several initiatives involving collaboration between the Eindhoven University of Technology and Philips' Research Laboratories. Both institutions jointly established the Instituut voor Perceptie-onderzoek (IPO) in Eindhoven in 1957.

In 1956, The Centre for Electronic Music - CEM studio was opened within the acoustics department of Philips' Research Laboratories. Henk Badings, Tom Dissevelt, Dick Raaijmakers and Edgar Varèse took full advantage of these facilities. The artistic highlight of the electronic music activities at Philips was the Poème électronique, an automated performance with image, color, and electronic music in a building specially designed by Iannis Xenakis for the Brussels World Fair in 1958, with electronic music composed by Edgard Varèse. The Eindhoven studio moved to Utrecht University in 1960 and was called Studio for Electronic Music (STEM), where German composer Gottfried Michael Koenig became artistic director in 1964. STEM became the Institute of Sonology in 1967 at the Koninklijk Conservatorium in Utrecht. International attention for the institute increased with the arrival of a PDP-15 computer which was used to develop programs for algorithmic composition and digital sound synthesis. Computer programs such as Project 1, Project 2, and MIDIM/VOSIM (Werner Kaegi), and POD (Barry Truax) are landmarks in the history of computer music. For many renowned composers such as Cort Lippe, Robert Rowe, Dirk Reith, Amnon Wolman, Jean Piché, and Takayuki Rai, their experiences at the Institute of Sonology formed the basis for their later work.

In the area of voltage-control technique in the analog studios, the Institute of Sonology continued to design and build new equipment. This tradition continues today. The institute moved to the Royal Conservatory in The Hague in 1986. Interface - Journal of New Music Research started in 1972 as the continuation and merger of Jaarboek (seminar for Musicology, ghent, Be) and Electronic Music Reports of the Institute of Sonology in Utrecht. JNMR seeks to establish an interdisciplinary foundation for the creation and study of music by means of the most advanced technologies, by publishing material which is both scientifically rigorous and musically relevant. JNMR draws on disciplines ranging from musicology (music theory, aesthetics, sociology), psychology (from psychoacoustics to cognitive psychology - with emphasis on modelling), acoustics (including sound engineering), computer science (from signal processing to artificial intelligence), philosophy (epistemology and methodology) to brain sciences. The journal is still being published today.

STEIM (STudio for Electro Instrumental Music) was founded in Amsterdam in 1969 by a group of up-coming composers: Louis Andriessen, Konrad Boehmer, Reinbert de Leeuw, Misha Mengelberg, Dick Raaijmakers, Peter Schat and Jan van Vlijmen. They were offered a budget for their collective multimedia opera Reconstruction (where Geurts and Meertens took care of the computer-generated parts of the score) which was premiered in 1969. The technology used in this opera was then taken to the Prinseneiland which was STEIM’s first location. STEIM is a center for research and development of new musical instruments in the electronic performing arts, still active today. Artistic and Managing Director 1971-1981 was Peter Schat (1935-2003).
The Foundation Experiments in Art and Technology\textsuperscript{75} was active from 1971 to 1976, with art historian Cor Blok was coordinating the exhibition program. They published \textit{Orientation materials on science and art} edited by Cor Blok, P. H. van de Poel and Stan Tempelaars, in 1975.\textsuperscript{76}

Most participants of the early 1970’s networks and institutions became in the following decades a new establishment of Dutch culture, as curators and directors of several major museums and members of different decision-making boards. They inaugurate art, science and technology and related computer-generated art into the fabric of the cultural life of the Netherlands. Despite the fact that many early protagonists lost their interest in media art,\textsuperscript{77} the foundations they established indirectly led a new generation of artists and related institutions and networks to solid ground.

Conclusion

Apart of few exceptional experiments and works made prior to 1969, computer-generated art in the Netherlands started relatively late but quickly reached a critical mass and had its full swing in 1970 and 1971. The production gradually faded out by the middle to late 1970’s. In general, the trends in the Netherlands have followed global streams with about a half decade delay, which created a unique regional situation that will show some advantages in follow-up developments. The new wave of computer-generated art was propelled by the use of personal computers in the 1980’s, and therefore did not have such a dramatic discontinuity as in the rest of the (Western) world. Only computer-generated music has a continuous history of production, institutions and education under the umbrella of electronic music, which continues without breaks over the decades and is still active today. Such a situation is typical for the field of digital art globally.

Except for the art practices of Peter Struycken, Victor Wentink and Remko Scha there is no continuation of the first generation of digital art in the fine arts today in the Netherlands. From the mid-1970’s onward Peter Struycken was perceived as the exclusive computer artist with almost no competition in the mainstream visual art world; in this situation he created numerous high-budget public art works using systematic research and the formal language of Concrete Art.

Unlike in the rest of the world, computer-generated art in the Netherlands got quickly inaugurated in the cultural mainstream that would support its activities and its gradual development from the 1980’s onward. This trend continued until today, positioning the Netherlands as one of most developed country of media art networks and support, particularly with little or no distinction from the mainstream contemporary art world, unlike cultural policies in most of the world.


\textsuperscript{76} Blok, Cor. P. H. van de Poel and C. Tempelaars (eds.), Ortisite materiaal over wetenschap en kunst. Stichting Experimenten in Kunst en Techniek (E.K.T.), Amsterdam, 1975.

\textsuperscript{77} as for example Rudi Fuchs, director of Stedelijk museum, Amsterdam 1993–2003