COMPUTER GRAPHICS AND ART



1980-1981 YEARBOOK VOLUME 5

1980-1981 YEARBOOK VOL. 5 COMPUTER GRAPHICS AND ART

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THE MAGAZINE OF INTERDISCIPLINARY COMPUTER GRAPHICS FOR PROFESSIONAL GRAPHICS PEOPLE AND COMPUTER ARTISTS

THEME FOR THIS ISSUE: MATHEMATICS AND COMPUTER ART

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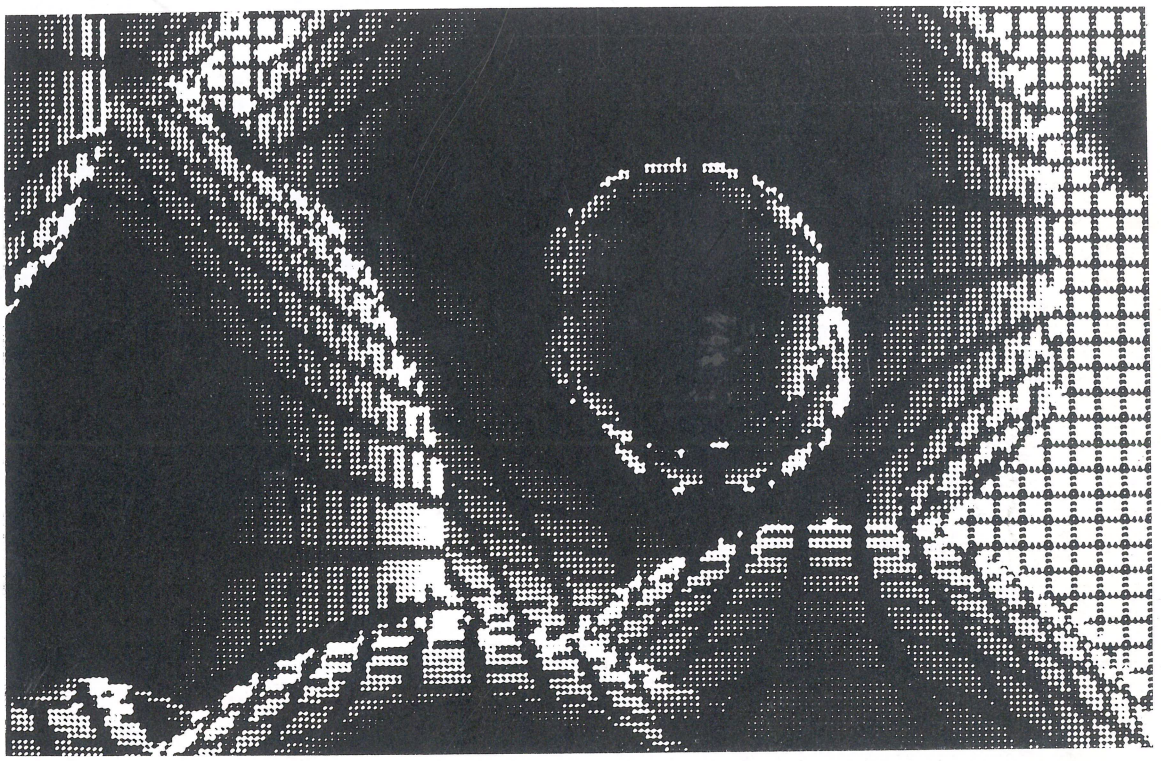
68 - BACK COVER: "Transformation, Anton Bruckner" by Herbert W. Franke, Munich, Germany. Illustration two in the series, representing some of the finest, enduring computer art created in the world today. Provocative images of the "continent of man".

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Art by Computer

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Nearly every graphic task formerly accomplished by hand now has a counterpart in computer-aided design: drafting, architecture, machine design, cartography, film animation. Along with its more practical graphic applications, the computer has proven to be a useful artistic tool. The artists and scientists who create computer art are still few in number but are gaining increasing public recognition for their innovative work.

"Art by Computer" gathers 45 representative pieces of the best current computer artwork, featuring CRT and plotter output modes. The exhibition was curated by Grace Hertlein, Department of Computer Science, California State University, Chico.

A computer and graphics tablet on loan from Apple Computer, Inc. allow the visitor to try his hand at creating computer-aided art and to learn about the special characteristics of the medium. The computer "drawing machine" was programmed for museum use by the Maryland Science Center.

Components	45 matted and aluminum-framed artworks averaging 20" x 24" each, individual captions, 1 introductory sign 21" x 25" Computer and graphics tablet prepared and mounted for visitor use
Requirements	200 linear feet Video monitor or TV screen; electrical outlet for computer
Cost	$950 member, $1,250 nonmember
Openings	Jan. 30—Mar. 14, 1982

Shipping: 5 crates, total weight 671 lbs.

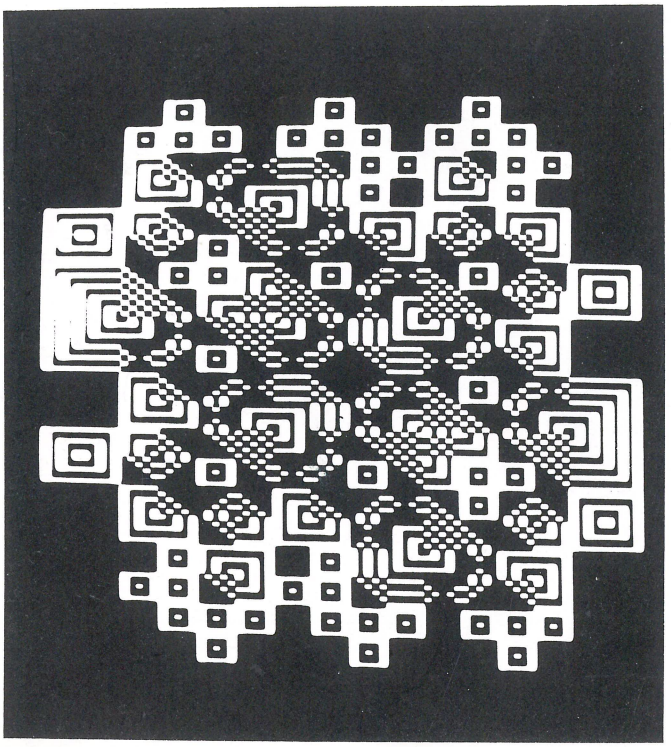
PIX-ART

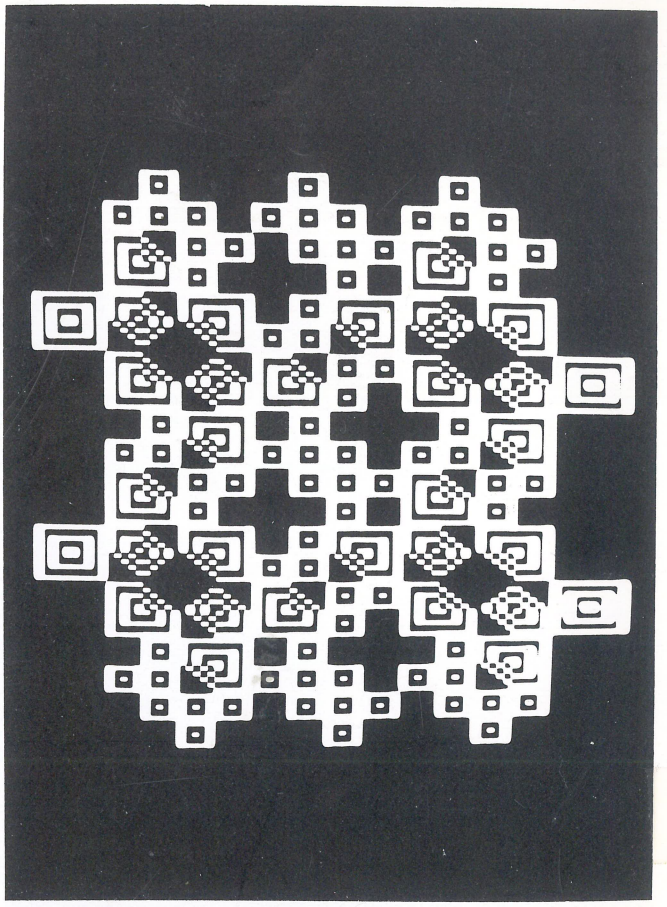
by Frank Dietrich and
Zsuzsanna Molnar
Electronic Visualization Laboratory
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Departments of Art & Information Engineering
Box 4348
Chicago, Illinois 60608

INTRODUCTION

Approaching a computer graphics system like the Bally Arcade, the user should understand the basic contradiction inherent in this system: while it offers rich options conceptually, it also produces limited or "poor graphics" compared to state of the art computer graphics. The user should not expect this small computer to generate real-life images with smooth shading, hidden surfaces, simulated highlighting and the like. Instead, the user has to accept -- or "buy the pixels", those blocky constituents of every raster system, which most people try to hide. However, once the user becomes acquainted with the needlepoint effect all the Bally images show, one can go ahead and appreciate the smart design of a personal computer system that is affordable and enjoyable at the present time. Systems like the Bally Arcade are, in our opinion, a major step towards creating a computer literate society, rather than a computer controlled one. /1/, /2/

ILLUSTRATIONS, TOP RIGHT AND BOTTOM LEFT: Untitled graphics by Frank Dietrich and Zsuzsanna Molnar, revealing some of the possibilities of the Bally Arcade System.





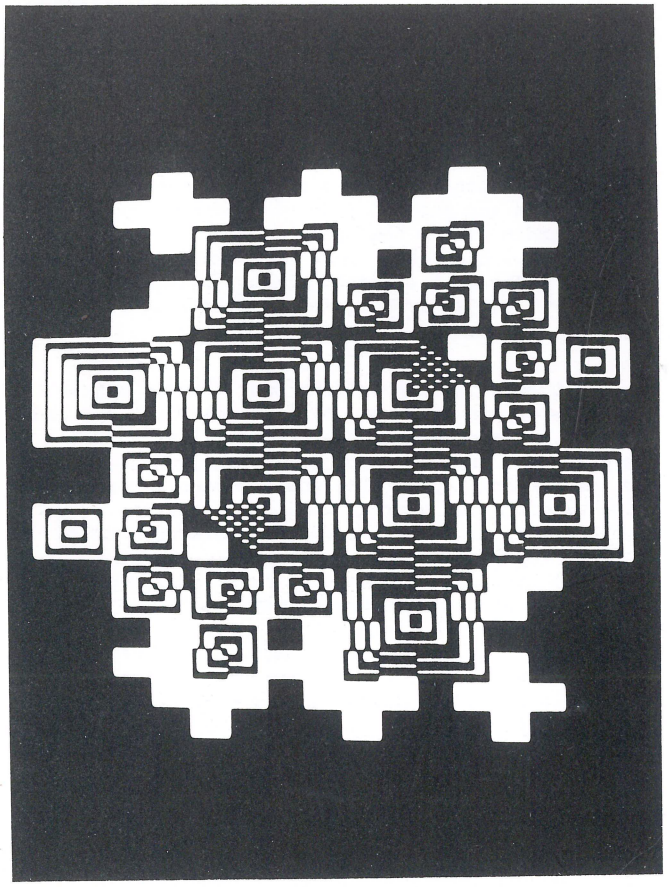
ABOVE: Variations on the Box Theme, Bally System.

THE BALLY ARCADE SYSTEM

The manufacturer of the Arcade System, Bally Corporation, gained its experience building interactive, easy-to-use slot and pinball machines that are played with by millions of people, regardless of their age or previous knowledge. Continuing their orientation towards mass entertainment, Bally started designing a microprocessor-controlled home video game in 1975. The result is the Bally Arcade. Its extremely low cost and TV orientation have placed these computers in over 100,000 homes.

The system includes the computer with a calculator keypad, four hand controls, an interface for storing programs on an audio-cassette recorder, a modulator to hook up to any TV, and a ROM with the Bally BASIC language. Its price of $400 makes it an affordable personal and educational tool. Like the portable typewriter, the Arcade offers anyone the opportunity to create their own reality, instead of simply consuming it.

At the present time, an entire community of Bally users exists in Chicago. They are mainly video artists, who could not afford (because of finances or little computing background) to work with computer graphics, except inside an institution like the Circle Graphics Habitat. /3/ Since they now can afford their own personal computer, numerous video tapes have been produced, utilizing the Bally, whether as the major source of animated graphics or just as a cheap title generator, as a device for keying effects or for producing a soundtrack.



ABOVE: Untitled graphic by S. Molnar and F. Dietrich, variations on a theme.

Computer art classes are being taught at both the University of Illinois and the Art Institute of Chicago, using the Bally Since the user immediately sees what he or she is programming, a small graphics computer like this is especially educational for beginners of all ages.

Thus the Bally serves as an introductory tool for about 100 new students per year. While some just take a short glimpse into the digital world, others go on to work with more sophisticated computer graphics systems like the Z-GRASS extension of the Bally, which has been designed by Tom DeFanti. /4/, /5/

HARDWARE

The Bally Arcade is a one board microcomputer using new large scale integrated circuit technology to produce a low cost home computer. Its electronic heart consists of a Z-80 microprocessor and three custom designed chips -- data, address, and I/O (input and output) to create both pictures and music on a standard TV. The Bally produces a recordable NTSC TV signal, a feature appreciated by video users, and one not yet provided by most home computers.

The Arcade is a raster or frame-buffer graphics system. A frame buffer is the representation in memory of one frame of the TV screen. The screen is divided into a grid of minimum sized squares, called picture elements or "pixels". Like house numbers identify each house in a city, each location in the frame buffer represents a particular pixel. Pictures are created by lighting up or turning off the pixels.

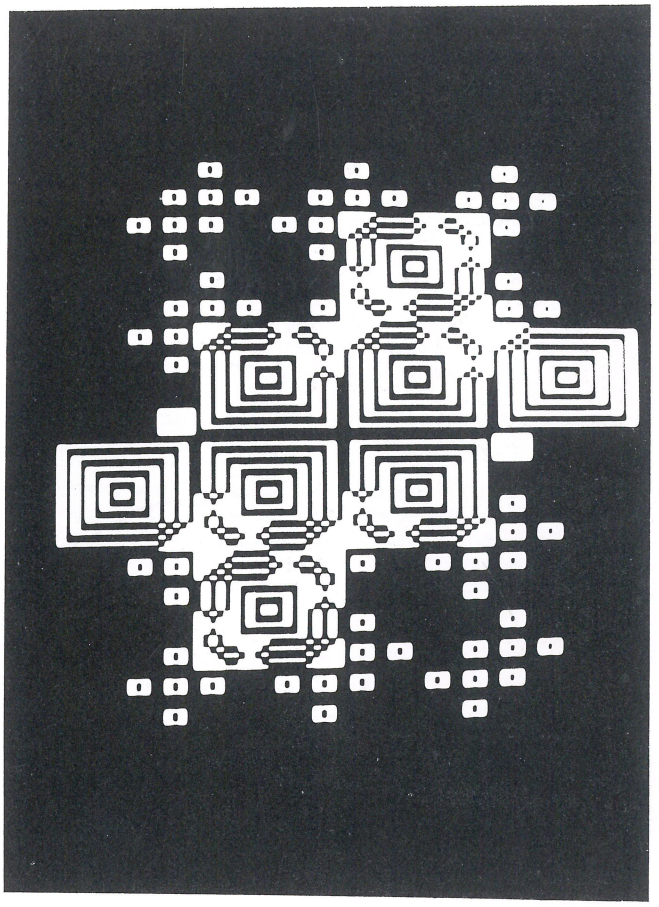
The Arcade's memory consists of 8K of ROM (Read Only Memory), set up permanently to run video games and 4K of RAM (Read/Write Memory), providing space for program and data storage. The frame buffer, containing the data for the screen coordinates, is also located in the RAM. Its size determines the resolution of the TV screen, which in the Arcade is 160 X 88 X 2 bytes. The last 2 bytes store the color of the pixel.

ELECTRONIC TOY TURNS CREATIVE COMPUTER

With the addition of a programming language, the small entertainment system is transformed from an electronic toy to a creative tool. Jay Fenton, the programmer of the Arcade, took TINY BASIC (a simple language designed to teach computing and in use on most home computers) and enhanced it with sensible graphics commands and special purpose variables to create a flexible user-oriented language, BALLY BASIC.

The change begins with the insertion of the 4K BALLY BASIC ROM. The BASIC divides the RAM formerly used entirely as a screen buffer for the game system into two sections: screen and program-data storage. BALLY BASIC now offers 1800 bytes of memory space to store programs and data.

BELOW: Another untitled variation by S. Molnar and F. Dietrich, from the Bally Arcade System.



Hand controls, formerly used as paddles in the games, now can be scanned under program control. The keypad receives a plastic overlay which lists the 16 BALLY BASIC commands, letting the user enter a command with one keystroke. As a trade-off, BALLY BASIC loses the video game's ability to use all eight colors on the screen at once. Only two colors at a time, foreground and background remain to be used from the palette of 256 colors.

All of these transformations are accomplished without hardware modification of the standard video game. With the minimal cost of a 4K ROM cassette, the user has turned the video game system into a programmable computer.

GRAPHICS COMMANDS

BALLY BASIC takes up a central problem of personal computing, that of providing a sensible yet open-minded programming language to non-experts. Two main graphics commands, LINE and BOX, as well as the four optional drawing modes, provide its visual power.

All images are plotted on the screen using integer arithmetic within the Cartesian coordinate system. The origin (0,0), lies at the screen center. The resolution of the screen is 160 X 88, so the screen coordinates range from -80 to 70 on the X axis and -44 to 43 on the Y axis.

To define a line, only three arguments are necessary: LINE X,Y,P. LINE draws a line connecting one endpoint to the next one. The location of the new endpoint is given by X and Y. P, representing "pen control", specifies which drawing mode is being used.

The BOX statement: BOX X,Y,A,B,P, functions similarly. X and Y define the center position of a solid rectangle; additionally, A and B specify its width and height. P, again, is the "pen".

For both commands four different drawing options are at hand:

1. Draw in foreground color,

2. Draw in background color,

3. Reverse -- checks what value the pixel drawn currently has and reverses that using the exclusive-or logical function,

4. Move the "pen" to the next location without drawing.

The special purpose variables of the system interface with the lower level assembly language to give the user access to options routinely used by the operating system. Jay Fenton, the programmer for BALLY BASIC, has a philosophy: "If the system uses it, let the user control it too." For example, the variable PX(X,Y) checks if a pixel is currently set on or off. Used by the video game to check for boundaries of an object, many interactive design programs depend on this feature to read the screen.

Other special purpose system variables allow control over musical notes and timing, position of text printing, and feedback from the hand controls. Each hand control has three ways to give information:

1. Trigger - a switch,

2. Analog knob - continuous number stream from 0-256 or,

3. Digital joystick - X and Y coordinate information.

INTERACTIVE PROGRAMS

One approach to using a graphics computer is to simulate pen and paper. A drawing program developed by Dan Sandin allows the user to be unconcerned about programming. Lines are drawn or erased just by triggering the hand control. Pictures can also be stored or recalled from audio cassette tape by the press of a button on the keypad.

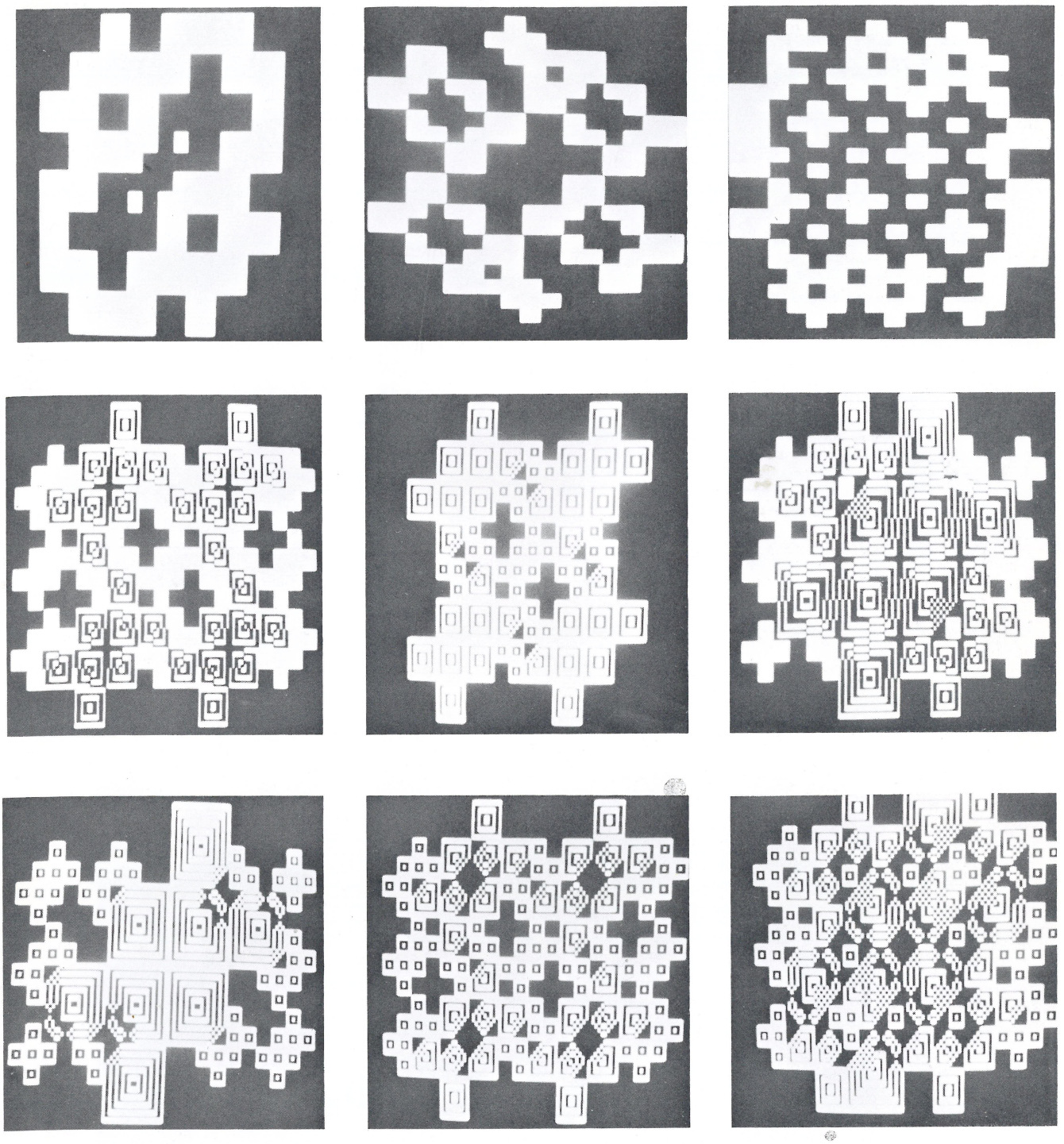
Another program providing easy graphic access to the computer was developed by Patti Harrison and Dan Sadowski. Their program uses mathematical symmetry operations to create wallpaper designs. Hand controls are the drawing input. The whole screen becomes a grid, on which the user draws a basic pattern. The special variable PX(X,Y) reads the pattern created on the screen. Once the basic cell is stored in memory, a menu asks the user to select the repetitive application of the symmetry operations.

Moving from the interplay between one person and the computer to drawing with many people, interactive programming with the Arcade has been extended to include groups of people acting together to create computer graphics and music. At an event titled "A Test of the Interactive Broadcast System", /6/ the Arcade turned into a two-way communication system resembling the QUBE cable system in Columbus, Ohio.

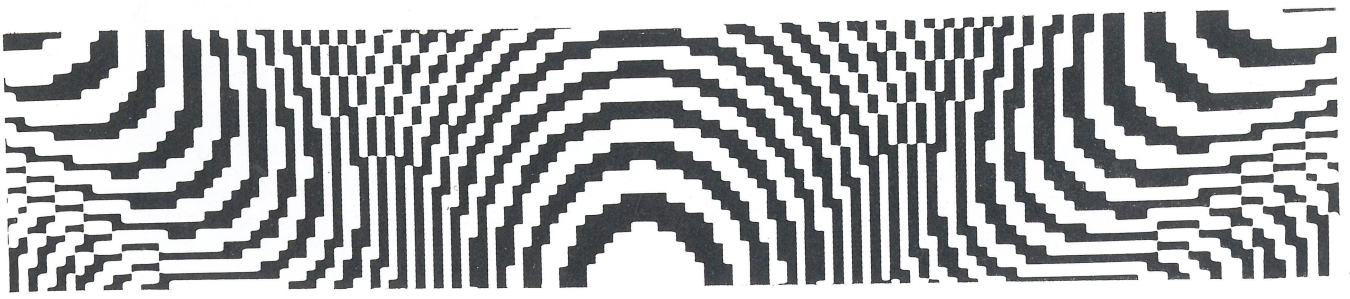
"What we're trying to prove here is that you don't need all that sophisticated technology to do two-way TV," said Dan Sandin. In this experiment, 20 homemade response boxes acting like hand controls were linked together and wired into the I/O chip of the Arcade. The low-cost computer tabulated the results in less than a second and fed them into graphics and music programs. This was accomplished by user-written assembly language programs which considerably sped up the process of evaluating the responses of the audience.

We tested two different approaches: individual and collective generation of aesthetic products. Individual control meant that each participant was assigned one single element -- for instance, one specified letter of the alphabet. That way everybody knew at each given time exactly what was going on and could relate to the game of forming words by steering their single letter into a certain position. In the individual play mode, the necessary feedback was quite good. We encountered problems with the collective control of the image generation, since it wasn't always obvious to everybody how their individual choice of a value or direction would show up in the tabulated collective results. The more complex the created patterns grew, the less transparent the overall control structure became. Thus there existed a discrepancy between a satisfying complex visual output and an easy detectable response to everybody's input.

A second programming task was to write programs that created pleasing images no matter what the input was. This graphics program by Zsuzsanna Molnar uses fourfold symmetry with boxes, adding a fifth overlaid box to produce a variety of images. The group jointly defined the vertical and horizontal growth rate of the boxes.



BALLY ARCADE VIDEO GRAPHICS - VARIATIONS ON A THEME EXPLORED IN A SERIES.



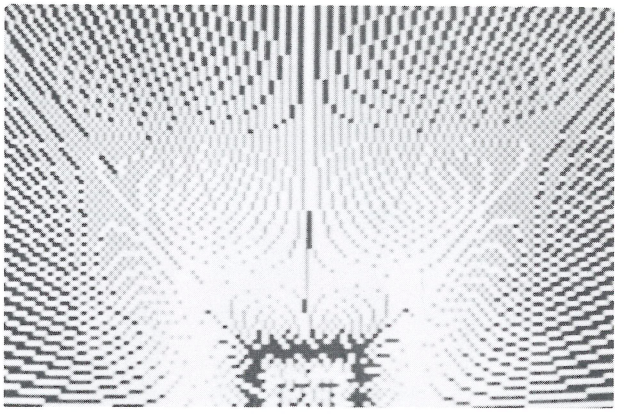


ABOVE: Wallpaper design, anonymous artist.

IMAGE GENERATION

Instead of drawing with the joysticks it is possible to generate images by describing the co-ordinates of a picture entirely with a program. A number of different approaches to picture-making are possible, whether one starts with a design and then programs a succession of coordinates, or if one develops an abstract programming concept which then produces certain images.

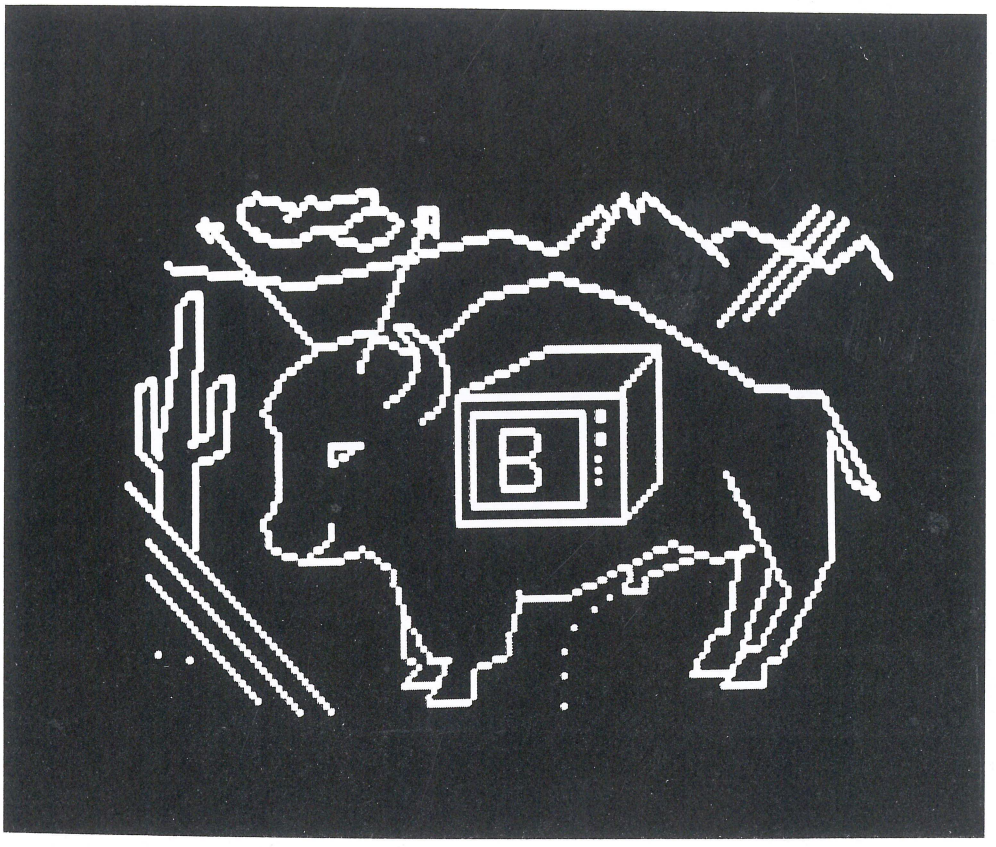
Mark McKernin used an Algerian carpet design as the basic figure for his program, GEO. (See page 11.) He measured its dimensions on graph paper and incorporated these coordinates in the drawing section of his program, carefully emphasizing the sequence of the line drawn in order to accomplish a pseudo 3-D effect. Once the image was completed, he continued overlaying it with boxes of decreasing size and thereby changing the appearance of the original pattern.

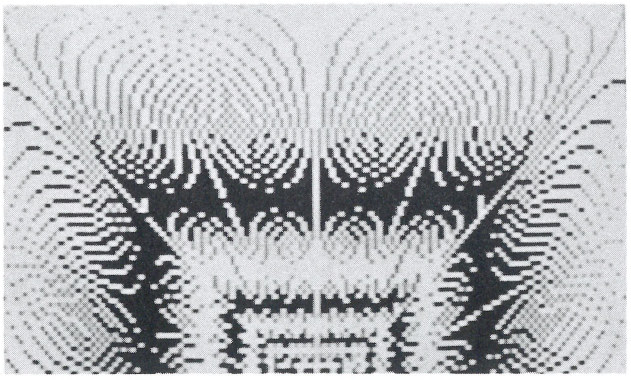


SUN

```
10 N=1
20 LINE 0,-44,0
30 X=-80
40 FOR Y=-44 TO 43 STEP N
50 GOSUB 1000
60 NEXT Y
70 FOR X=-80 TO 79
80 GOSUB 1000
90 NEXT X
100 FOR Y=43 TO -43 STEP N
110 GOSUB 1000
120 NEXT Y
130 N=N+2
140 IF N<6 GOTO 30
150 STOP
1000 LINE X,Y,3
1010 LINE 0,Y,3
1020 RETURN
```

BELOW: Untitled graphic, photo courtesy of Jane Veeder, Chicago, Illinois.





ILLUSTRATIONS, TOP LEFT AND BOTTOM LEFT: "Sun" by Julie Boren, Bally Arcade System.

While Mark's program doesn't have to calculate anything but follows explicitly given LINE statements, reading out coordinates like a piano roll reads out notes, Julen Boren sets up a much shorter program, SUN, containing three loops to compute the numerous lines composing this complex image. (See page 8.) She covers the whole screen with adjacent lines arranged like the beams of the rising sun.

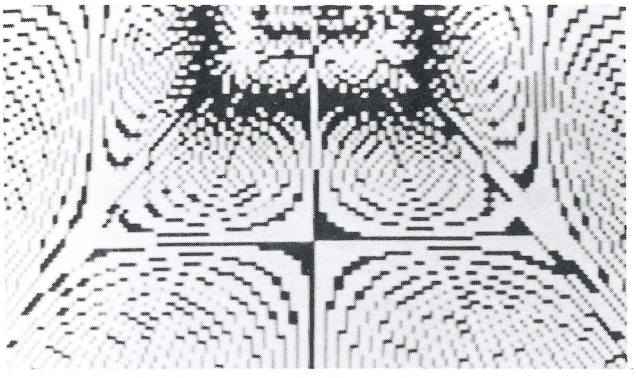
Keeping the middle of the bottom line as a fixed starting point for all of the lines, she draws with a clockwise motion to each point along the border of the screen.

Because of the conflict between the continuity of a mathematically straight line and the discreteness of the pixels in the raster grid, adjacent lines are drawn with some pixels in common. Julie enhances the results of the BALLY BASIC line drawing algorithm by using the reverse drawing mode. The reversal of the pixels that get drawn several times visualizes the underlying structure of the LINE command.

The set of patterns shown here demonstrate the use of various increments to step through the basic loops.

It takes only a couple of seconds to complete one of these pictures, while Dan Sandin needs 15 minutes to finish a single one of these MOD images, consisting of circles which seem to be mapped onto globes.

BELOW: "Sun" - Another variation by Julie Boren. (See the program and other illustration on page 8.)



MOD 2

```
10  CLEAR
20  D=5
30  FOR Y=43 TO -44 STEP -1
40    D=D+2
50    FOR X=-80 TO 79
60      M= (X*X+Y*Y)/D/2
70      IF RM=0 BOX X,Y,1,1,1
80    NEXT X
90  NEXT Y
100 STOP
```

The reason for the considerable difference in execution time between the programs lies in the following fact: Julie's program steps through the FOR-NEXT loops, immediately feeding the coordinates of the maximal 2*88+160 or 336 lines she draws. The MOD 1 program on the other hand is more elaborate in two respects: first, it not only scans the borders, but the entire screen, pixel by pixel, line by line. Second, it evaluates a circle algorithm for every point on the screen, accomplishing 160 X 88 or 14,080 calculations, checking the result each time. A pixel is drawn only in those places on the screen where X*X+Y*Y is even, thus generating circles.

Some of the important aspects of this compact 10 line program are:

1. Only two nested loops create the basic structure which scans the whole screen;

2. The computation of X and Y squared for each pixel and the RM special purpose variable turns the remainder of the last division, makes it possible to generate circles even in an integer BASIC;

3. The size of the circles depends on the value of the division factor, D. Their growth is controlled by incrementing D after one vertical line is scanned, and thus generating the 3-D effect. Without incrementing D, the result would be a regular pattern of circles of the same size.

The visual result of the program represents a projection of a sphere onto a 2-D plane by slicing through the Z axis.

CONTROLLED RANDOMNESS

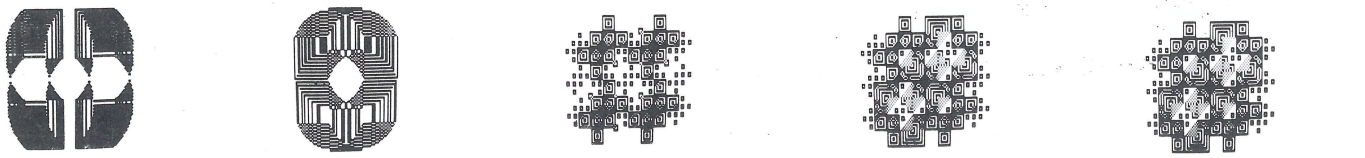
Since the early days of computer graphics, the use of random numbers has been a standard method to achieve images which are not predictable in detail, and thus defeat the usual precision of the computer and its aesthetic of overall visual regularity. The main problem when working with random numbers is to set up programs which balance between the pole of completely predictable pattern and the pole of chaos.

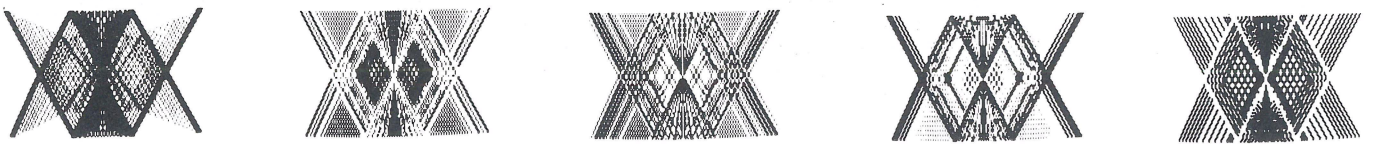
One example of our experiments in this area is the NEAR NEIGHBOR program by Dan Sandin. The program consists of three parts: first, the X, Y coordinates of a pixel on the screen are chosen by the random number generator of the Arcade. Then the program checks whether any of the surrounding pixels of the randomly picked coordinates have already been drawn. This is done by looking up the PX(X,Y) values of the neighbors. If there are no surrounding pixels which are turned on, the program executes its final task and plots a pixel-wide box at the randomly determined coordinates. Otherwise, it returns without drawing and gets another coordinate pair.

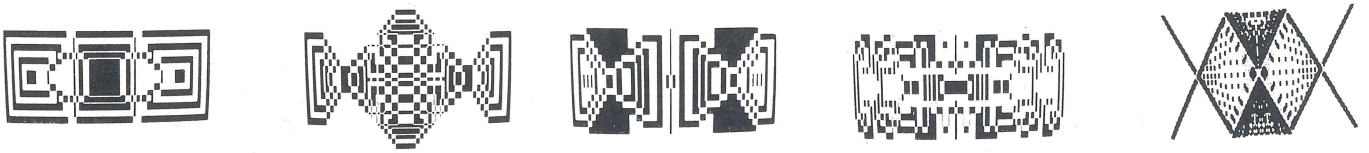
Frank Dietrich

Electronic Visualization Program
University of Illinois at Chicago Circle



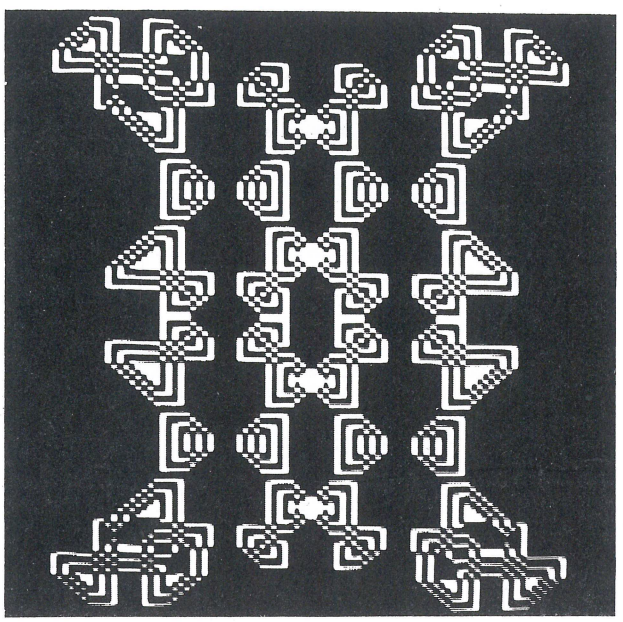


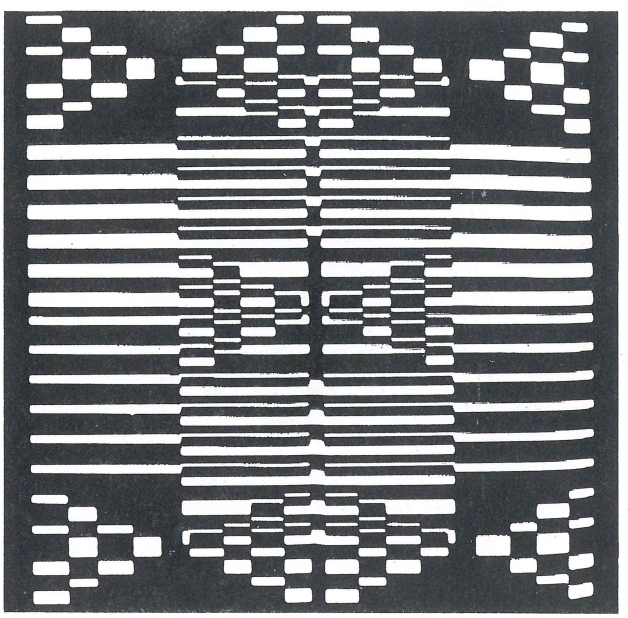


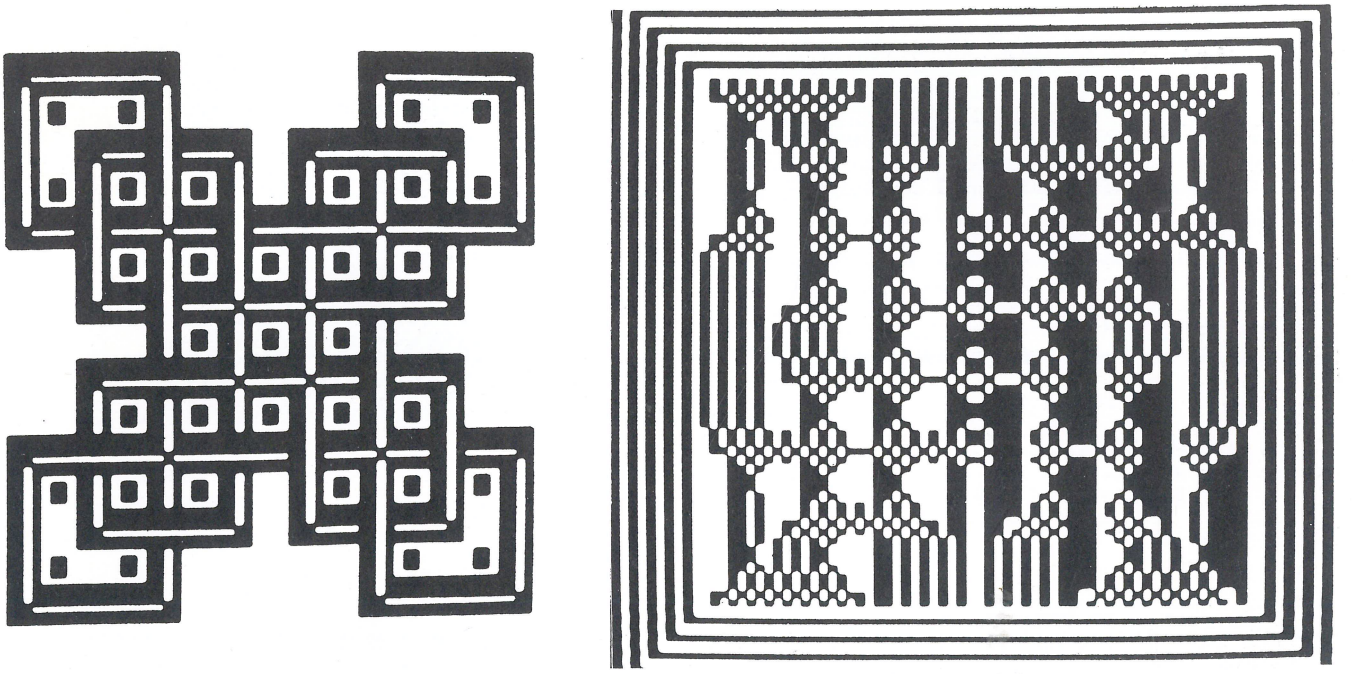


Zsuzsanna Molnar

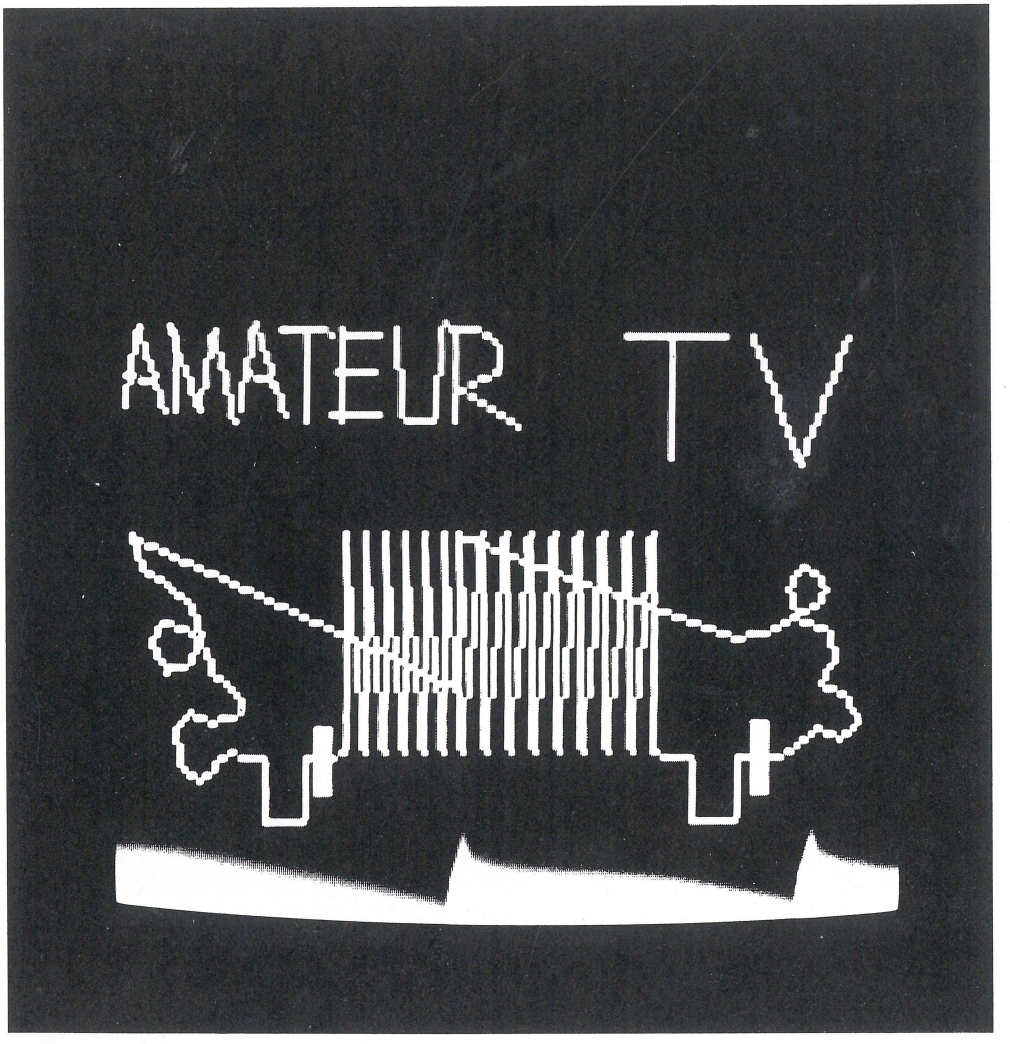
Electronic Visualization Program
University of Illinois at Chicago Circle







ABOVE: Variations of "Geo" by Mark McKernin, based on an Algerian carpet design. BELOW: Untitled graphic from the Bally System, photo by Jane Veeder, Chicago, Illinois



Two different versions of the program exist. One checks pixels which share sides; the other checks pixels which share corners. Rick Frankel elaborated on this concept by proceeding in two steps. He starts filling the screen with larger boxes and then continues printing small ones. Both versions output distinctly different visual entities.

Another interesting case of controlled randomness has been written by the computer film maker, Larry Cuba. His SCROLL programs present the structured concept of adding more loops to an existing BASIC program to create more complex images. /8/

SCROLL #1

```
10  S = 4 + RND(4)
20  C = RND (S-1)
30  FOR A = -72 to 70 STEP S
40            BOX A,-39,C,8,1
50  NEXT A
60  PRINT
```

PRINT causes the image to scroll 8 pixels up from the bottom of the screen. All boxes are now being drawn into that line with exactly the same height, since the Y coordinate and the height of the boxes are kept constant. Only the STEP S of the loop controlling the scan along the X axis varies randomly and is correlated at the same time to the width of the boxes, so there is at least a space of one pixel left between two boxes.

SCROLL #2

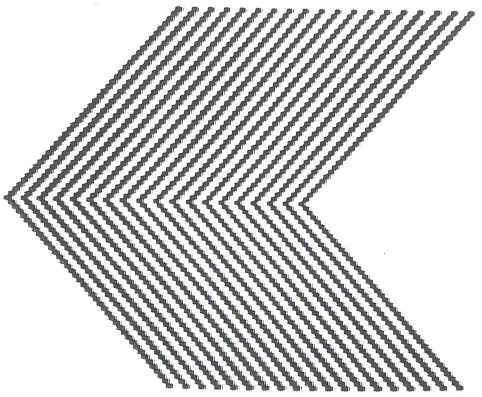
```
10  S = 4 + RND(4)
20  C + RND (S-1)
30  FOR A = -72 to 79 STEP S
40            T = RND (3) +1
50            FOR B = -43 TO -36 STEP T
60                      BOX A,B,C,1,1
70            NEXT B
80  NEXT A
90  PRINT
```

The inclusion of a nested loop using B, also being randomly determined, and slightly different arguments for the BOX command in an otherwise unchanged program are responsible for the visual difference of SCROLL #2. Each time an X coordinate has been evaluated, the program enters a second loop, where it randomly chooses Y coordinates all lying within the range of the bottom 8 pixel scroll line. With every new Y value, a box will be drawn that is only one pixel high but is as wide as the boxes of SCROLL #1.

The final version, SCROLL #3, merges both #1 and #2 into one program, executing first the loop of #1 and then the two nested loops of #2. The outcome looks like a superimposition of the images of the first two programs. Since Larry Cuba switches to the reverse drawing mode for the second scan along the X-axis, new patterns emerge from the overlay. All three programs produce highly structured, yet in part random visual output changing through time due to the upward movement of the scroll.

ANIMATION

To animate computer generated images requires millions of numeric computations per second dedicated to calculating the transformations for each object. Most computer animation films are produced



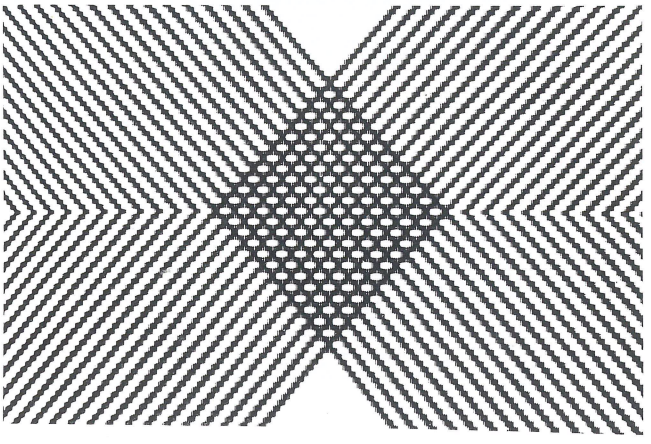
by shooting one frame at a time, and each single frame needs considerable time to be computed. Currently only expensive and specialized computer systems which feature hard-wired matrix processors for the updating of the vector lists are suited for real-time animation of 3-D objects.

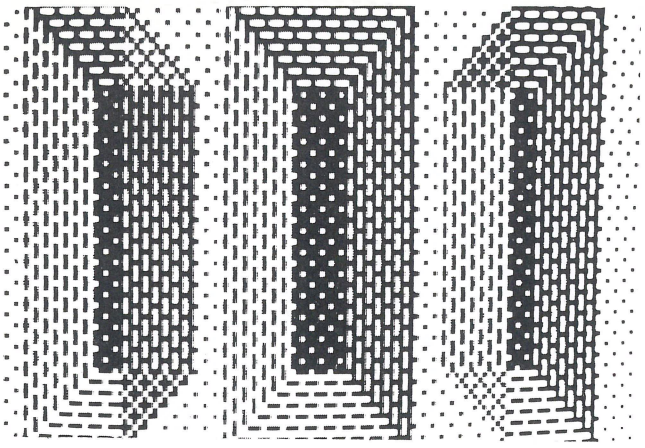
If we talk about real-time animation on the Bally Arcade, it is therefore assumed that as a low-cost system, it can only handle the gradual change of images in time. So we would consider Larry Cuba's programs, discussed above, as animation, within this frame of reference.

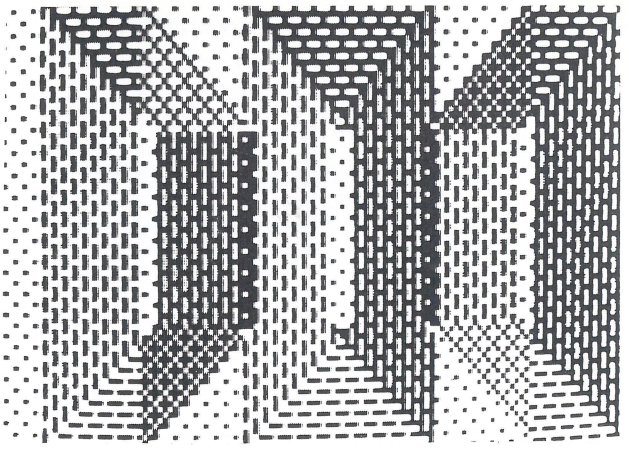
A very different approach is followed by Steve Wengerski, when he lets a bundle of arrors march across the screen. Each time he draws a new one, he erases the last one by simply drawing over it in the reverse mode. By superimposing two armies of arrows going in opposite directions, delicate patterns emerge, slowly changing in time. The great variety he achieves out of this fairly simple technique is due to the fact that the program switches between the simple draw and reverse drawing modes.

TOP RIGHT AND BOTTOM: "Arrows" by S. Wengerski.

A similar method is used by Frank Dietrich, who overwrites three different versions of one basic tessellation in the frame buffer. The program ARABESQUE consists of five parts: the drawing subroutine produces a package of eight boxes; a subroutine decrementing the size of the boxes; and three routines specifying number, size, and coordinates of the sets of the eight boxes. A counter switches the sequences in which the routines are executed, so that all possible permutations of the basic design are generated.







The most interesting animation effect, the movement of replacing one set of boxes by another set, and the gradual reduction of a superimposition of all three sets to a single one, can't be reproduced by these still photographs.

ILLUSTRATIONS ON THIS PAGE: Four variations of animated boxes, here shown in static form. The last illustration (far right) reveals the superimposition of all three sets into a single one.

SUMMARY

Our overall experience with a small computer graphics system like the Bally Arcade is that it offers the artistic user "real" power versus the "formal" power of a sophisticated large graphics system. The latter systems are rather intimidating, not easy to use, and difficult to access, which makes their virtues of speed, resolution, etc. only "formal" for non-experts. The Bally does not have comparable "formal" power, but the little it has is for "real". Its straightforward design immediately grants rewarding results, being flexible enough for users with different programming backgrounds. Since it is cheap and small, it encourages the innocent but motivated novice to enter the exciting world of computer graphics.

Perhaps one of the most exciting trends is for people to use the television as a display device for many kinds of computer systems, departing from the trend of humans passively accepting entertainment and art from the television set. The over 100,000 users of the Bally System in Chicago are proof that people may prefer to create than to passively assume the spectatorial role in life. Systems like the Arcade are making that participant role possible for most families. The microcomputer revolution may bring a new renaissance to computer art: every person may now hope to enjoy this new form of creativity.

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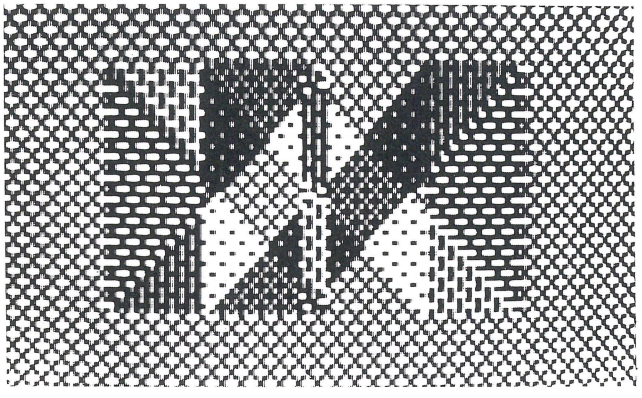
/4/ DeFanti, Tom, "Language Control Structures for Easy Electronic Visualization," Byte, Volume 5, No. 11, 1980.

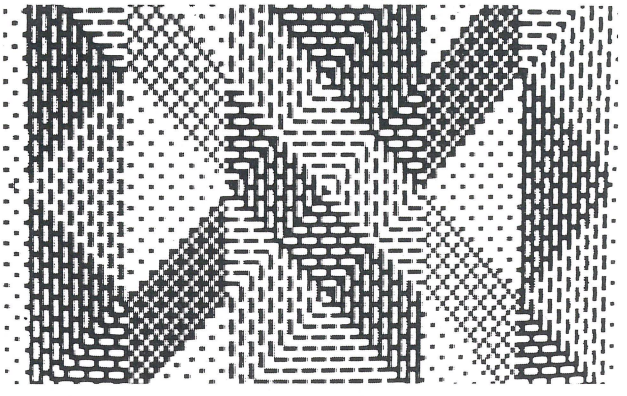
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MICROCOMPUTER GRAPHICS

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THE MICROCOMPUTER AND GRAPHICS SYSTEM USED

The computer used to create the graphics shown here is a Z-80 system with 48K RAM and one 5¼" disk drive used to store programs. (I have not sent actual program listings since I do not have access to a printer. In addition, I feel that people will want to write their own versions.)

Using Cromenco's BASIC and disk operating system, approximately 20K bytes of memory are left for programs and data. BASIC was chosen as programming language because of its availability and its interactive nature. Using this system, program routines can be altered in the middle of execution to produce particular variations in the graphic output.

My plotter is a modified Sylvanhills DFT-2 run from a parallel port. This plotter used DC servo motors and optical encoding disks to give X-Y position feedback to the computer. Since I was not using interrupts needed for accurate results with this method, pulses while the motors were coasting would be occasionally missed, since the computer was doing the plot calculations as well as controlling the plotter. Variations in the coasting rates of the DC motors would cause discrepancies in the X/Y positions to creep in, even though the motors were braked and monitored during de-acceleration.

I replaced the DC motors with stepping motors, which can then be run open loop (see BYTE, February, 1978, p. 35). The plotter now has a step size of 300 per inch in both the X and Y directions. Due to the worn gears in the X/Y drive chains, there is a small amount of backlash present in the plots.

An assembly language program was written to drive the plotter in a chained vector mode. BASIC passes the routine X and Y values, and the routine moves the pen either up or down to a new location from the previous coordinates along the closest stepped approximation to the straight line between the two X/Y positions.

I chose this flatbed plotter, since it is not limited to pen drawings on paper. For example, a scribing needle can be mounted in the pen holder and used to draw lines through an acid-resisting ground placed on a metal plate. The plate can then be etched in an acid bath and processed -- then printed as a normal etching.

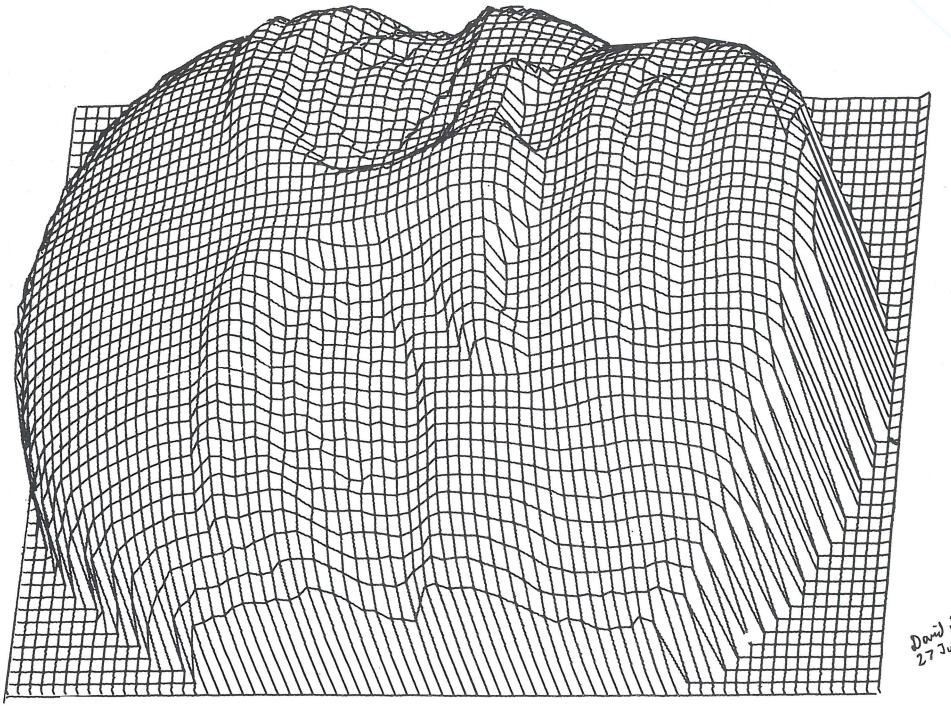
MY PRESENT GRAPHICS TRENDS AND INTERESTS

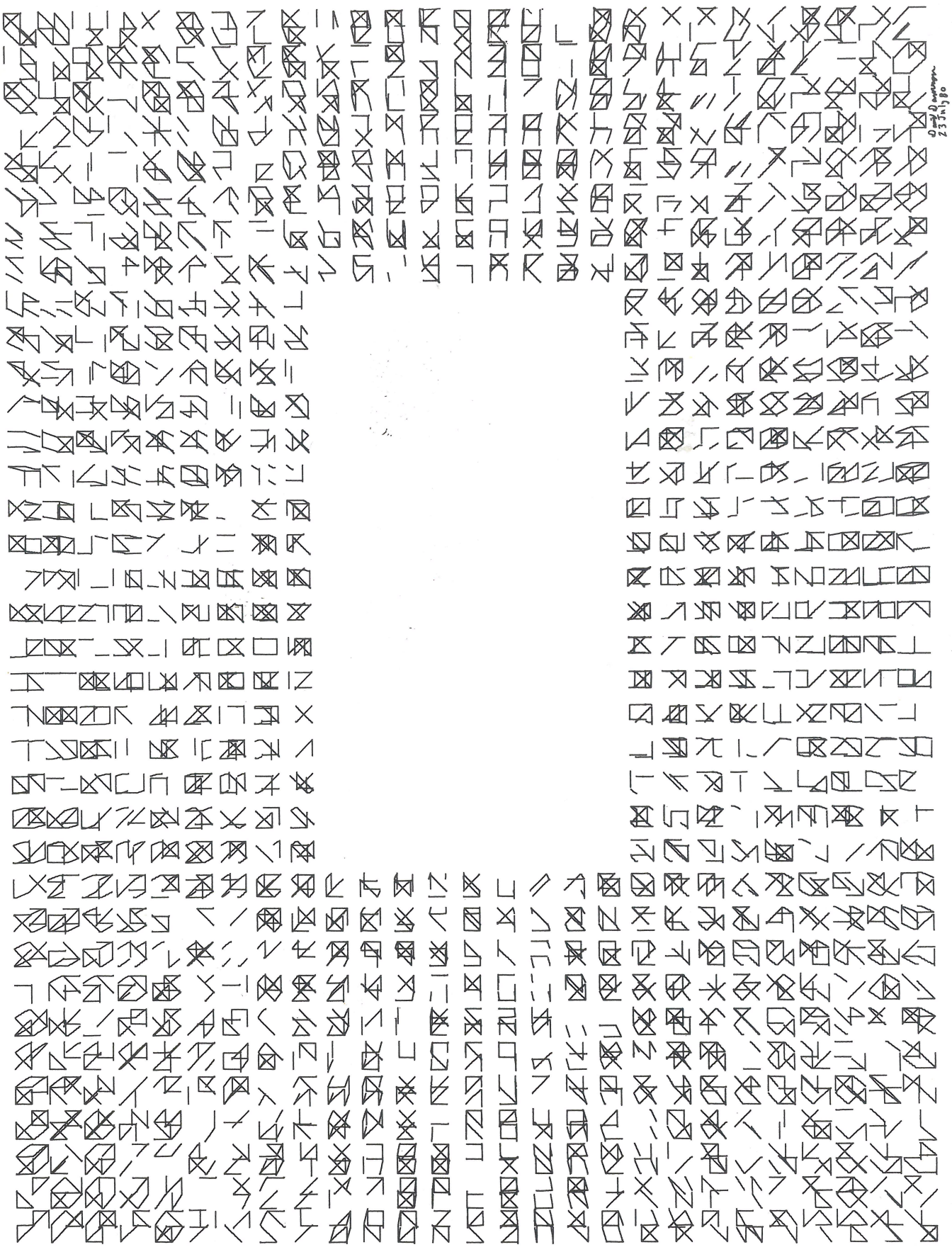
My computer graphics work is now evolving toward more three-dimensional types of work. I am also interested in more interactive types of programs, where the artist and computer work together, vs. many programs (interesting in themselves), where only certain parameters are entered to run the program. In these programs, the program itself is the major human input.

An example of this increased type of interaction is the plot of the head (Figure 1) -- both human and computer were needed together to produce it, in comparison to a spiralgraph or polygon-type program, which runs solely from a geometric/mathematical algorithm.

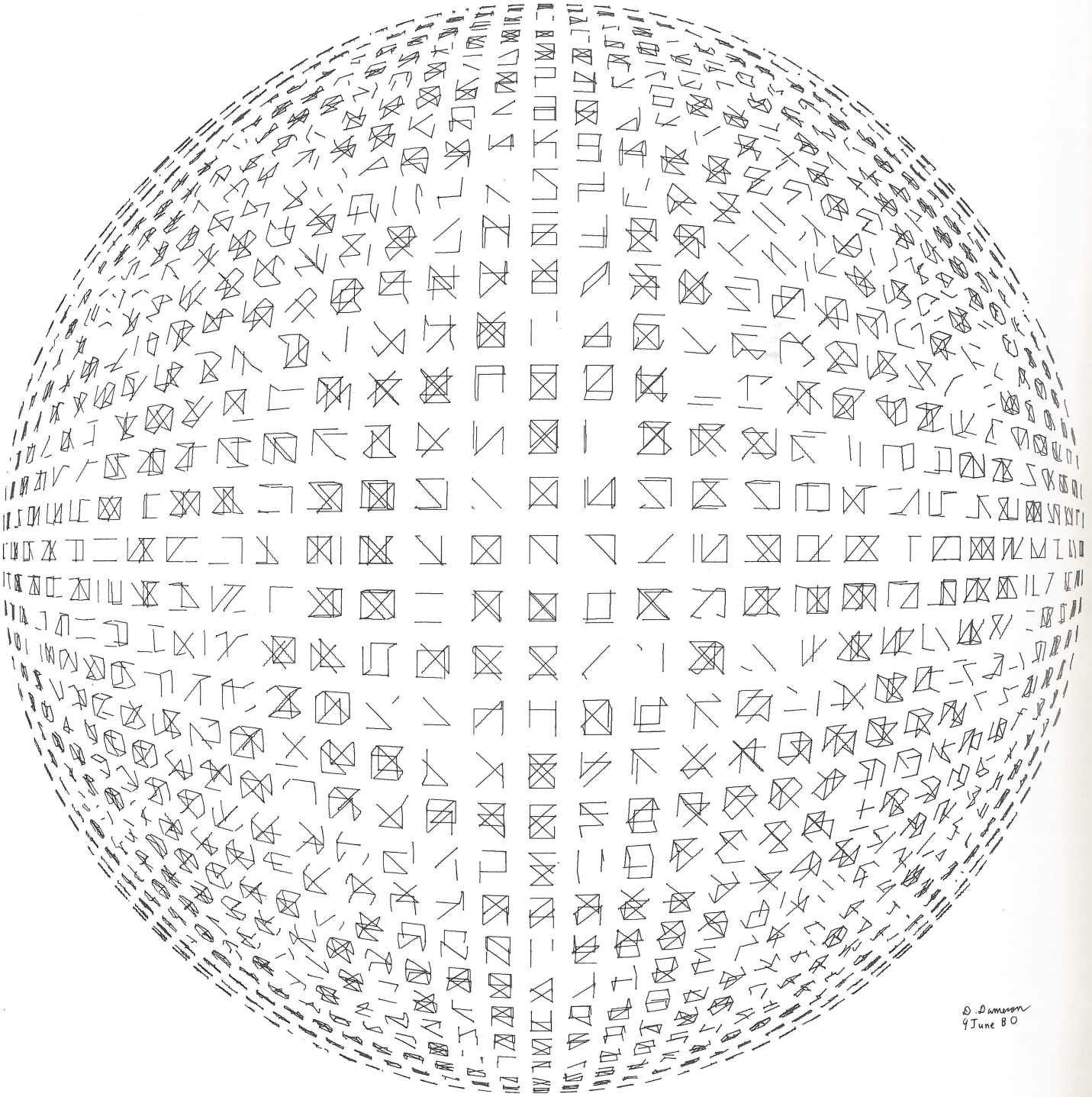
My main project now is actual 3-dimensional input and output of data to the computer. I have built a computer-controlled sculpture machine which can carve objects out of wax. I have made both copies of objects like the head and other computer-generated objects. For input I am working on parallax input via TV camera, digitized or traced input, as well as generation by algorithms.

BELOW: "Head #6" by D. Dameron. The original function Z=F(X,Y) was obtained by measurement from a clay sculpture of a face.



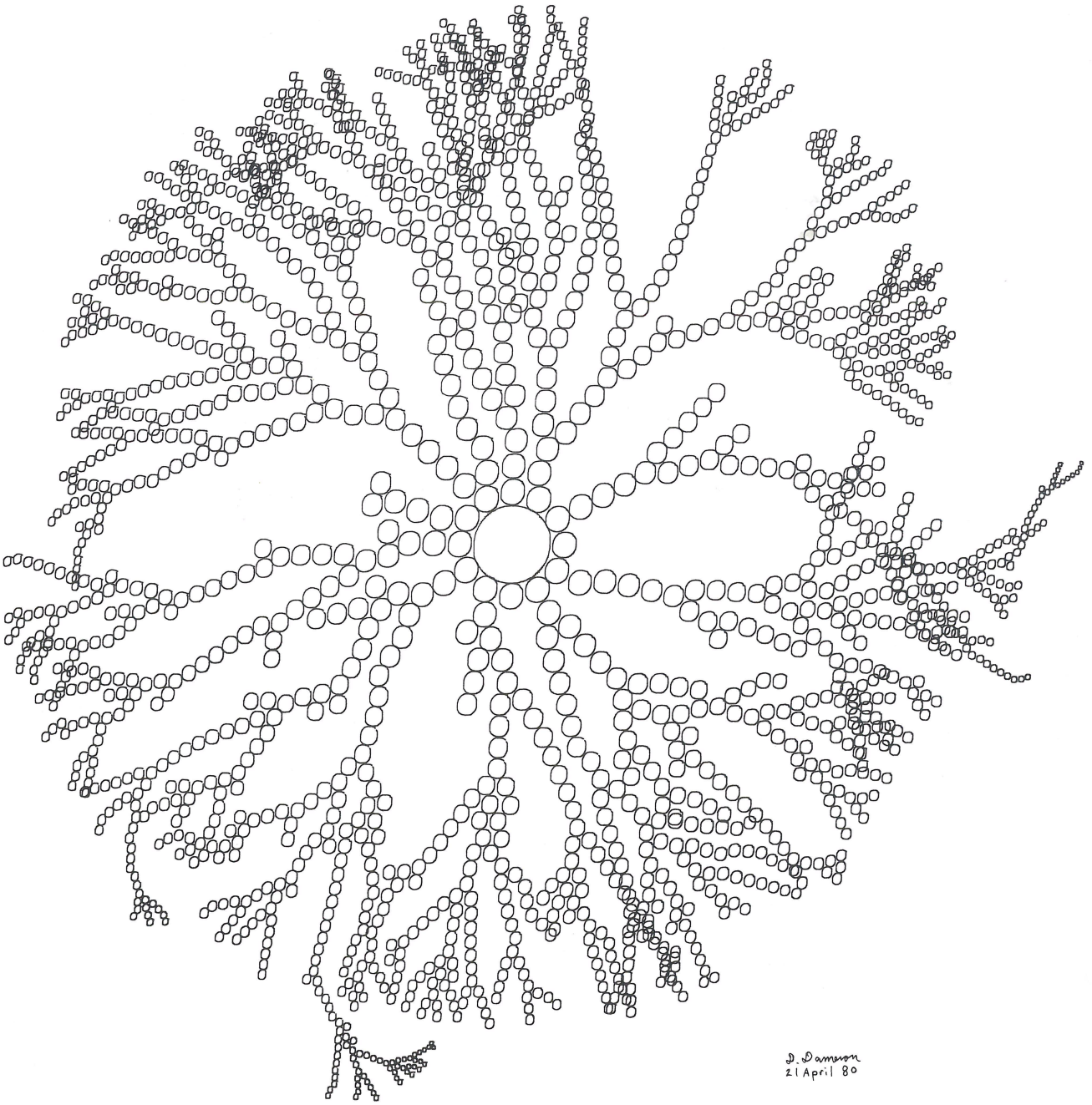


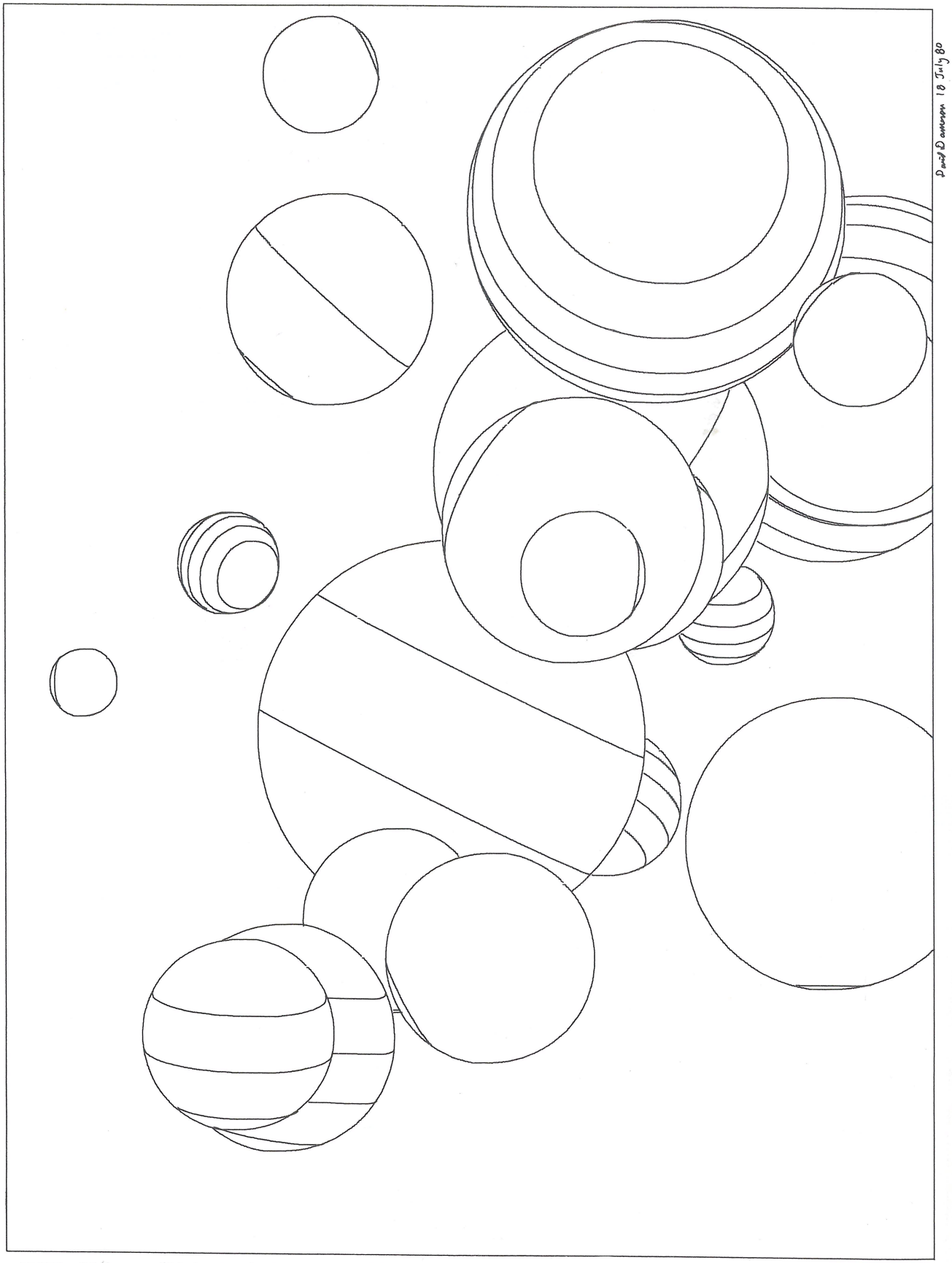
ABOVE: "Variation #2 after Manfred Mohr's Sphere" by David Dameron. Random variations of a cube are revealed serially, with exclusion of patterns within a a pre-designated inner frame.



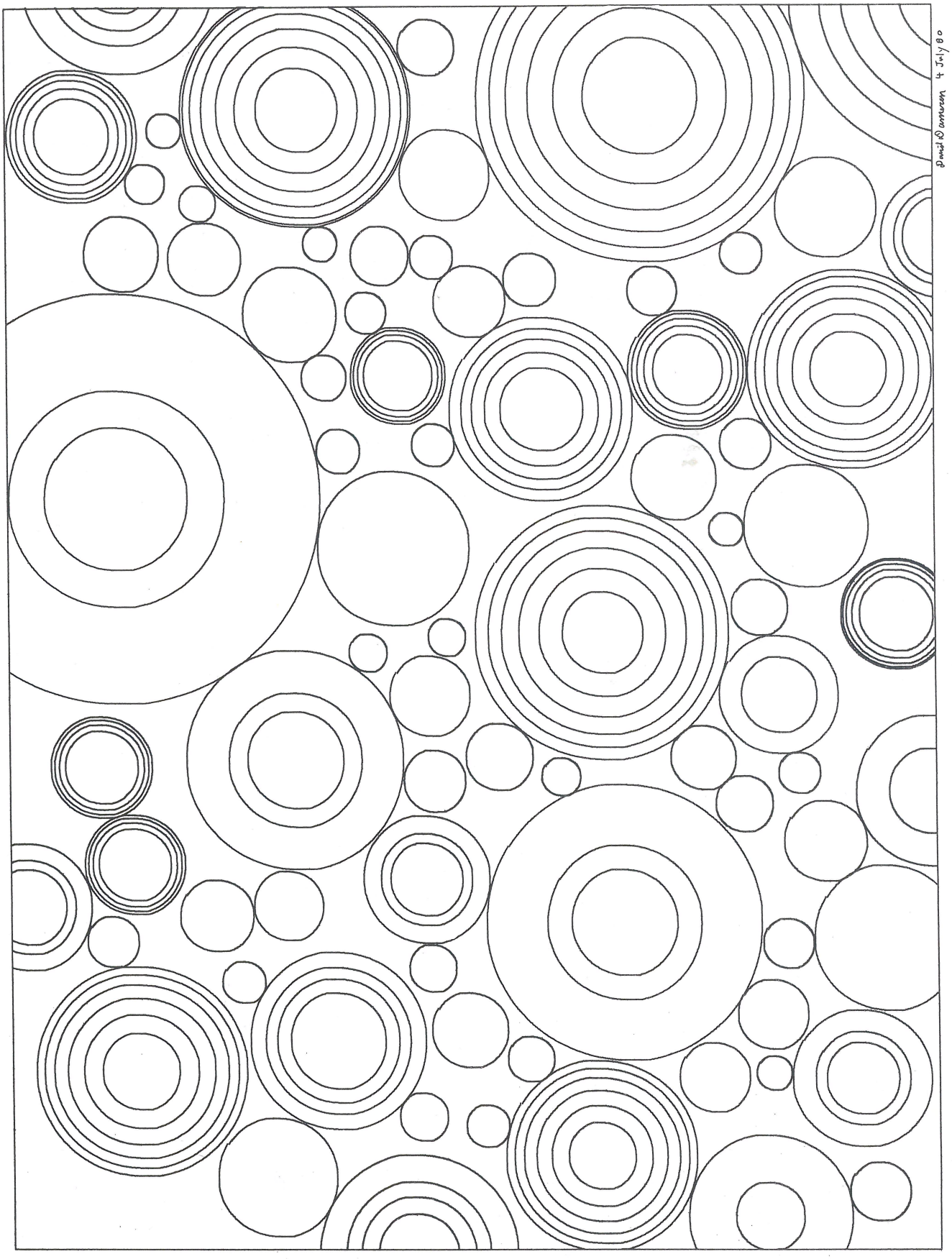
ABOVE: "Sphereless after Manfred Mohr's Earlier Work" by David Dameron. This graphic takes for input a 3-dimensional wire-frame object. Then random variations of the image are projected onto a 3-D sphere.

BELOW: "Tree Trunk #3" by David Dameron. In this program, concentric circles are drawn with a random perturbation of the radius as a function of the polar angle. The radius of a circle at a particular angle is determined by adding a constant plus random increment to the radius of the previous inner circle at the same angle. In this manner, "circles" are drawn progressively increasing standard deviations of their radii. The random factor can be exponentially reduced at the edges or outside of a superimposed rectangle, if desired.





ABOVE: "Spheres #1" by David Dameron. This program draws a collection of spheres in an X/Y frame. Each sphere has circles at constant Z drawn on it, and is then rotated about the X and Y axes before it is drawn. Before each sphere is drawn, it is checked with all previous spheres to determine any segments which are hidden and thus eliminated.



ABOVE: "Circles #4" by David Dameron. In this drawing, circles are drawn within a fixed window. The circles do not overlap, but tangentially touch. They are added until no more with a minimum diameter can fit. Concentric circles are then drawn within these first level circles within smaller diameters corresponding to fixed angular displacements on projected spheres.

MATHEMATICS, MICROCOMPUTERS, AND ART

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COMPUTERS, MATHEMATICS AND ART

I have been interested in mathematics and graphics since high school. My computer art is a direct result of this interest in mathematically derived art. I am, however, interested in the union of mathematics and art and seek in each new series of works, to create mathematical art that holds the viewer's eye for more than a few minutes. I want my mathematical art to be art that may appeal to more than just computer people -- yet at the same time be art that makes good use of the computer as an artistic tool.

I have found the computer to be a valuable assistant in producing graphic works of art. In programming a graphic, I describe the image to the computer with a programming language (in this case, BASIC). This "description" is an algorithm -- a precise set of procedures or operations to be carried out by the computer and the graphics system to produce the desired image.

Some of these operations involve mathematics. However, the mathematics may be quite simple, calling for: scaling, rotation, shifting, computing intercepts of lines and the basic mathematical primitives of multiplication and division. However, for sophisticated graphic arts, the mathematics may be quite complex. But advanced mathematics is not necessary for a great many designs and patterns. A wide variety of interesting designs may be drawn using simple mathematics and varying algorithms.

PROGRAM DESIGN

When this particular program was designed, a coordinate system had to be determined. In this system, the plotter was arbitrarily defined to have a Cartesian coordinate system with the mathematical origin of (0.,0.) at the lower left corner. It extends one "unit" to the right and up. Using this method, I am not forced to work with physical units of measure, such as inches or rasters. All objects are fitted into this

BELOW: "Random Variations of Circles and Squares" by Kerry Jones. FACING PAGE, TOP LEFT: Further variations of circles and squares.

The choice of data structure is crucial in any graphics program design. The basic elements are defined as polygons (not necessarily closed) or line segments. For each polygon or line, a corresponding "bead" consisting of X/Y coordinates is inserted into an array. The number of beads stored is limited only by the memory available in the computer used by the artist.

THE ALGORITHM USED IN THIS SERIES

The algorithm may be stated as follows:

1. Advance the pen from left to right by small increments.

2. Attempt to draw a line from bottom to top of the plotter.

3. Examine all beads (polygons).

4. If any fall on the line:
   - Compute the point(s) of intersection,
   - Store these points in an "intercept" array.

5. If any intercepts were found:
   - Sort the points in the intercept array into ascending order,
   - Move to the first point,
   - Alternate moves and draws until all points of the intersection have been exhausted.

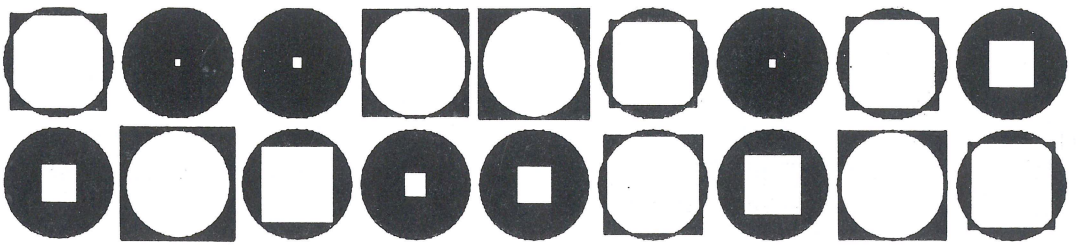
6. Continue advancing the pen to the right until the rightmost edge of the plotter surface is found.

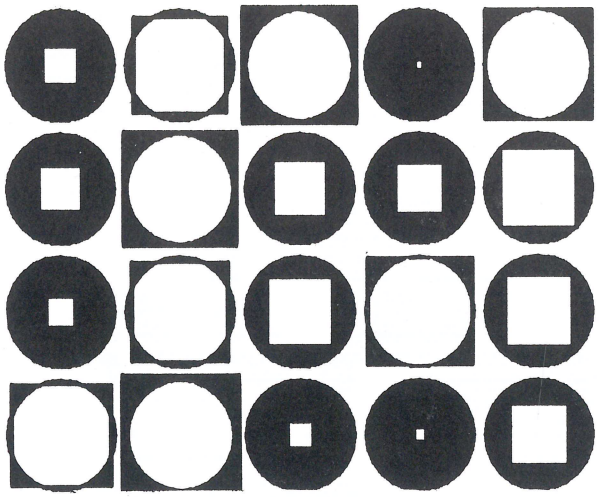
AN INTERACTIVE SYSTEM

Having a highly interactive system is a great help to the artist and designer. By "highly interactive" I mean a system that's easy to get along with -- allowing the user to terminate a program at any time, to inspect the program's variables and code.

Such a system allows the user to make changes changes where needed, and to restart where the program stopped -- or at any point in the program.

Mini- or micro-computer based systems with simple interpretive languages, such as BASIC are often highly interactive. However, even FORTRAN programs may be written readily to allow interactive use of a graphics system. The trend towards user-oriented, interactive systems is obvious at the present time, and we may expect this more "enjoyable" mode of computer use to become more common in the future.





In the past, I have used a batch-oriented mainframe, where the program was compiled, linked with the run-time library and executed to produce a plot tape. The tape was then carried over to the plotting system and played to the plotter. This can be tedious, and downright annoying. The long turnaround time makes it difficult to experiment and explore variations and new ideas. Direct terminal input, minus tapes, minus cards, with the user having control and direct communication with the computer has now become a common reality in many installations.

BACKGROUND ON THE ALGORITHM

The procedure to draw the design is simple in concept. The pen is moved between the bottom and top of the plotter, advanced to the right a small amount and moved from bottom to top again. This is repeated until the pen has swept out the entire plotter surface. However, with that alone, nothing would be drawn. As the pen is moved from bottom to top, a test is made to see if it is crossing a boundary of any bead. When (or if) such a boundary is encountered, the plotter's pen is lifted from the paper if down at the time or lowered if it was up.

I generally start the pen "up" so it fills in the simple polygons. If the polygons intersect, the pattern becomes more complex. By starting with the pen "down" as it moves up and down the plotter surface, a negative is drawn -- and the resultant black and white areas are reversed.

SHAKEDOWN

With the first few graphics, the computer kept well ahead of the relatively slow plotter. As the graphics became more complex, the computer spent a great deal of time searching through the beads for intercepts. As an example, one complex graphic ran over 16 hours. To alleviate this bottleneck, an index into the beads was built so that the program could do a simple boundary check against each bead to determine if its X/Y coordinates should be searched for a possible intercept. After this revision, the time-consuming graphic then took only two hours to draw. With this new modification, most graphics were drawn at full speed on the plotter.

VARIATIONS ON A THEME

Once the program was deemed correct, it was easy to produce many variations on a theme, merely by changing the data upon which the program operates. There is one module in the program responsible for storing the beads describing the collection of lines and polygons. This module is unique for each graphic. The rest of the program remains unchanged. Some designs are easily described algorithmically -- very few instructions are needed to describe circles or other simple geometrical patterns. Other designs in this series were digitized from graph paper. However with suitable programming, this may be automated, using a graphics tablet.

The computer is a natural tool for the graphic artist in this type of process. While it may take considerable time to get the first finished graphic, other variations are readily possible by slightly modifying the program. Furthermore, the resultant graphics are exactly reproducible quickly and precisely.

GRAPHICS SYSTEMS

The graphics system and its supporting software govern, to some extent, what may be accomplished by the artist. There are a wide range of graphics systems available, ranging from graphics terminals and plotters that access a time-sharing system with high speed communication lines, sophisticated software, large memory, high performance CPUs -- to mini- or micro-computer based stand alone systems.

The system used to produce the graphics shown in this article is a microcomputer based system with a high resolution CRT display and plotter (plus other peripherals such as diskettes, tapes, tablet, joystick, printer and communications interface). All graphics were drawn with the assistance of a Tektronix 4051 or 4052 computer and 4662 digital plotter.

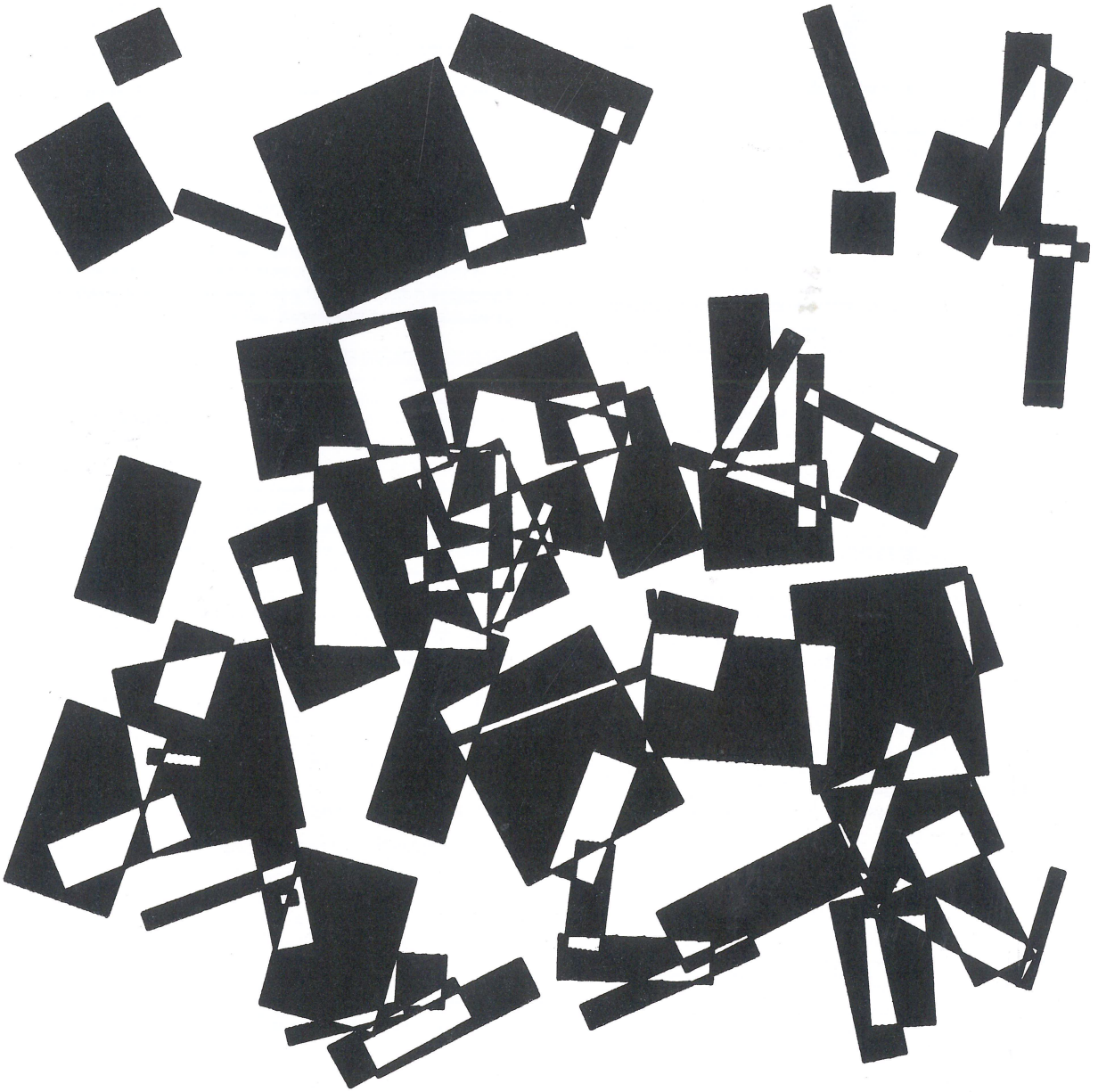
NOT WITHOUT A COMPUTER

These graphics would never have been attempted without a computer. I do not possess the patience and manual dexterity to design such graphics and fill in the many polygons used. Using a computer, the artist can experiment with designs until the precisely desired graphics are found. The data may then be saved to later redraw the original or exact reproductions of the original.

In addition to the precision afforded by the computer, new forms and families of design may be achieved. Thus the computer is more than a drawing implement -- it is an aid in the discovery of new forms, a literal treasury of forms, as Herbert Franke advocates.

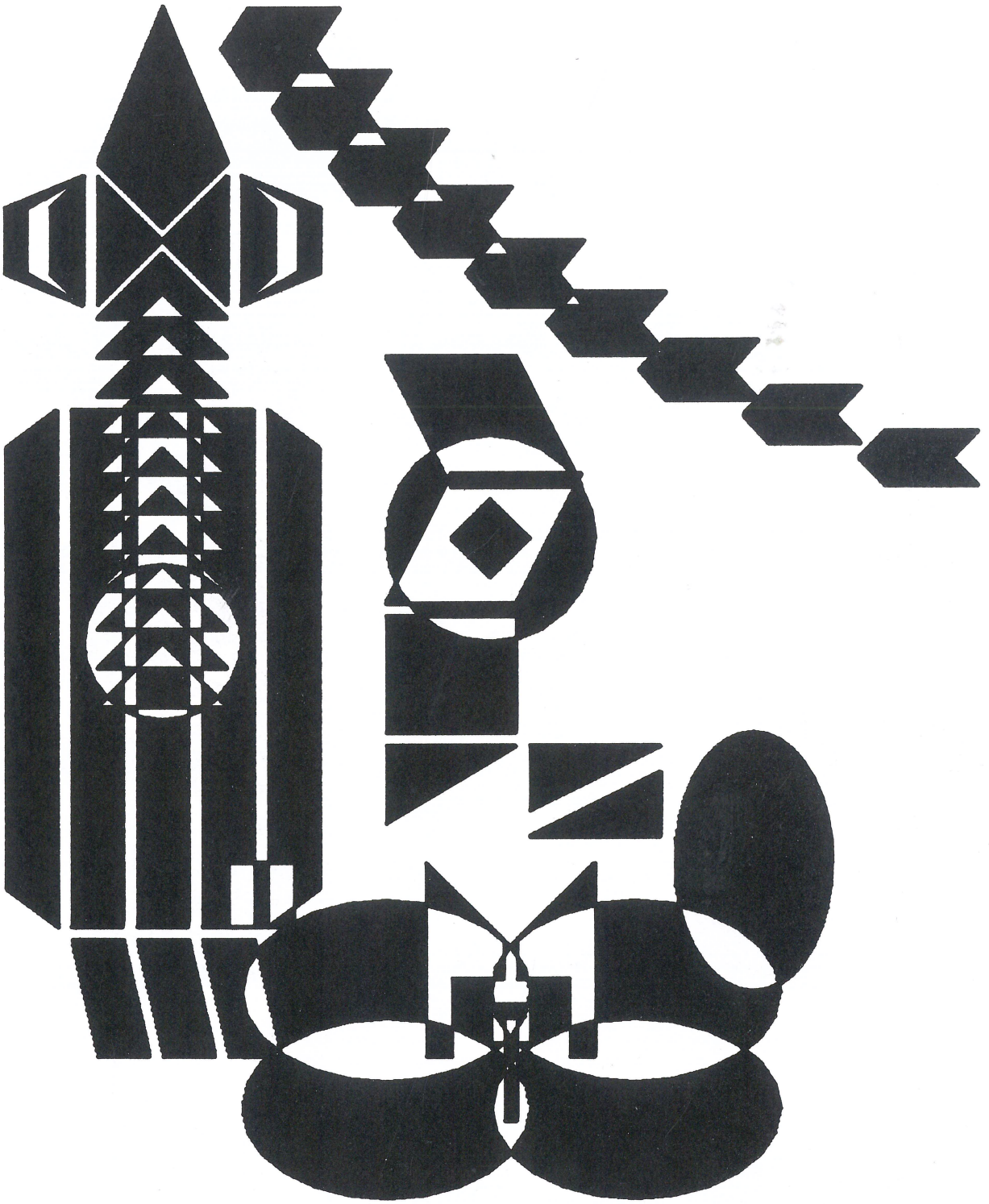
Some twenty designs have been programmed so far using this system, and many more will be explored.

The majority of the works in this article are from the "Scanline" series, inspired by the series drawn by the op-artist, Victor Vasarely, from his Black and White" period.

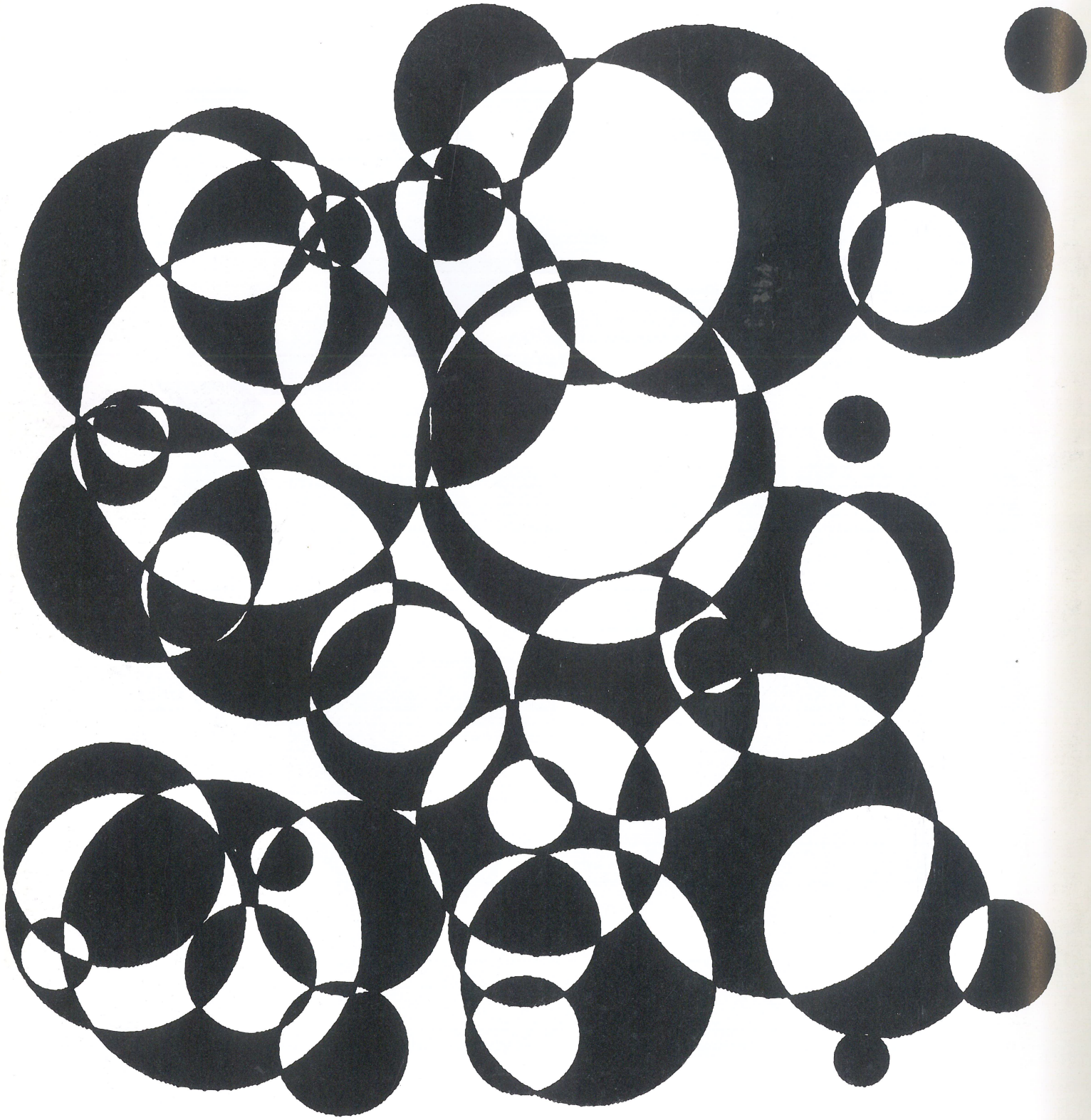


ABOVE: "Rectilinear Random Composition after Vasarely" by Kerry Jones. Random sizes, both X and Y, random angles of rotation, with random interjections of white polygon areas. Note that often the black and white illustrations (in this and other computer art) would make for superior translation into the varied visual arts, including computer-designed paintings.

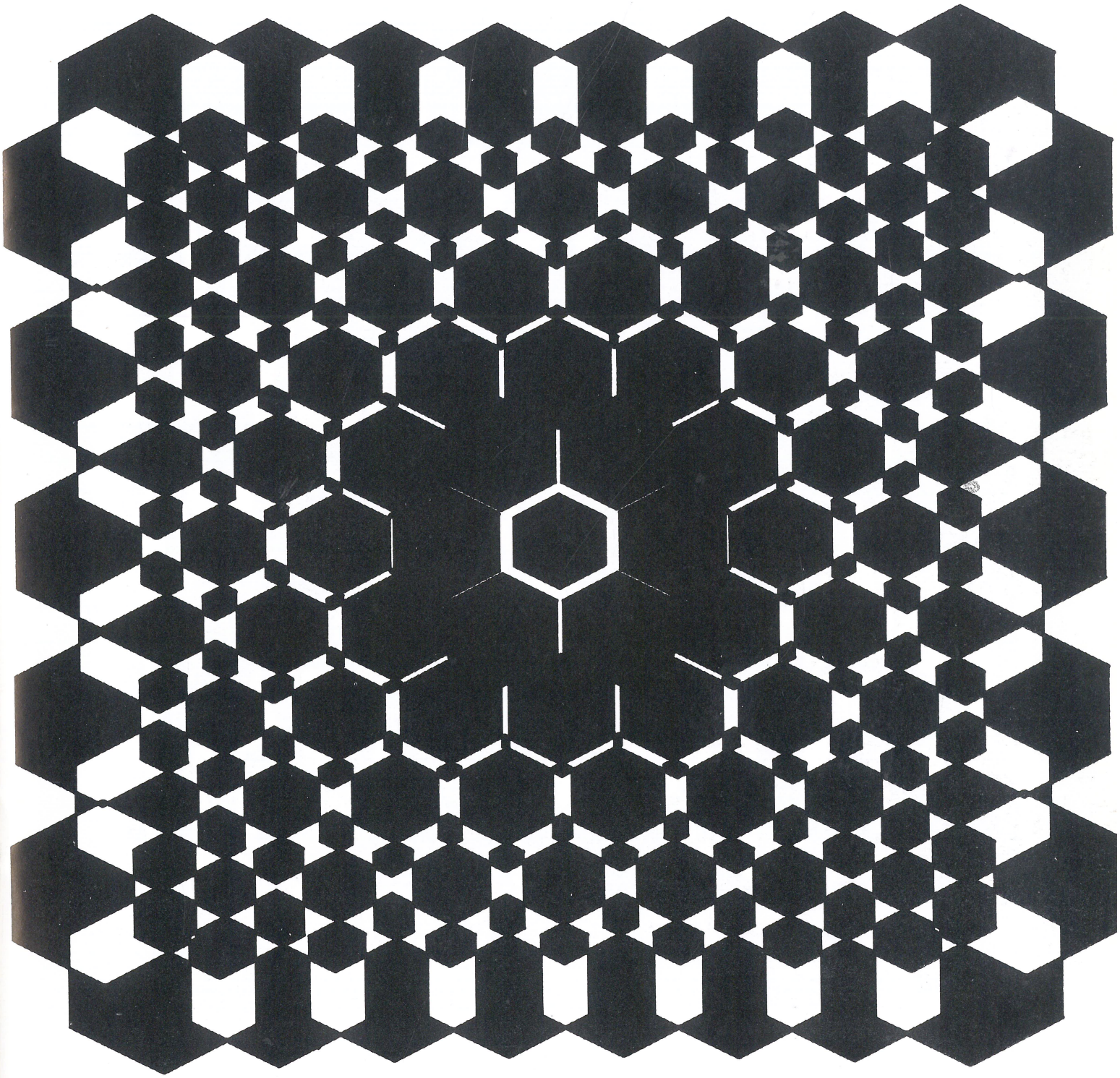
BELOW: "In Flight" by Kerry Jones, combining rectilinear and curvilinear patterns. Although the artist has designated this view of the graphic, such an abstract work would be equally provocative from any angle.



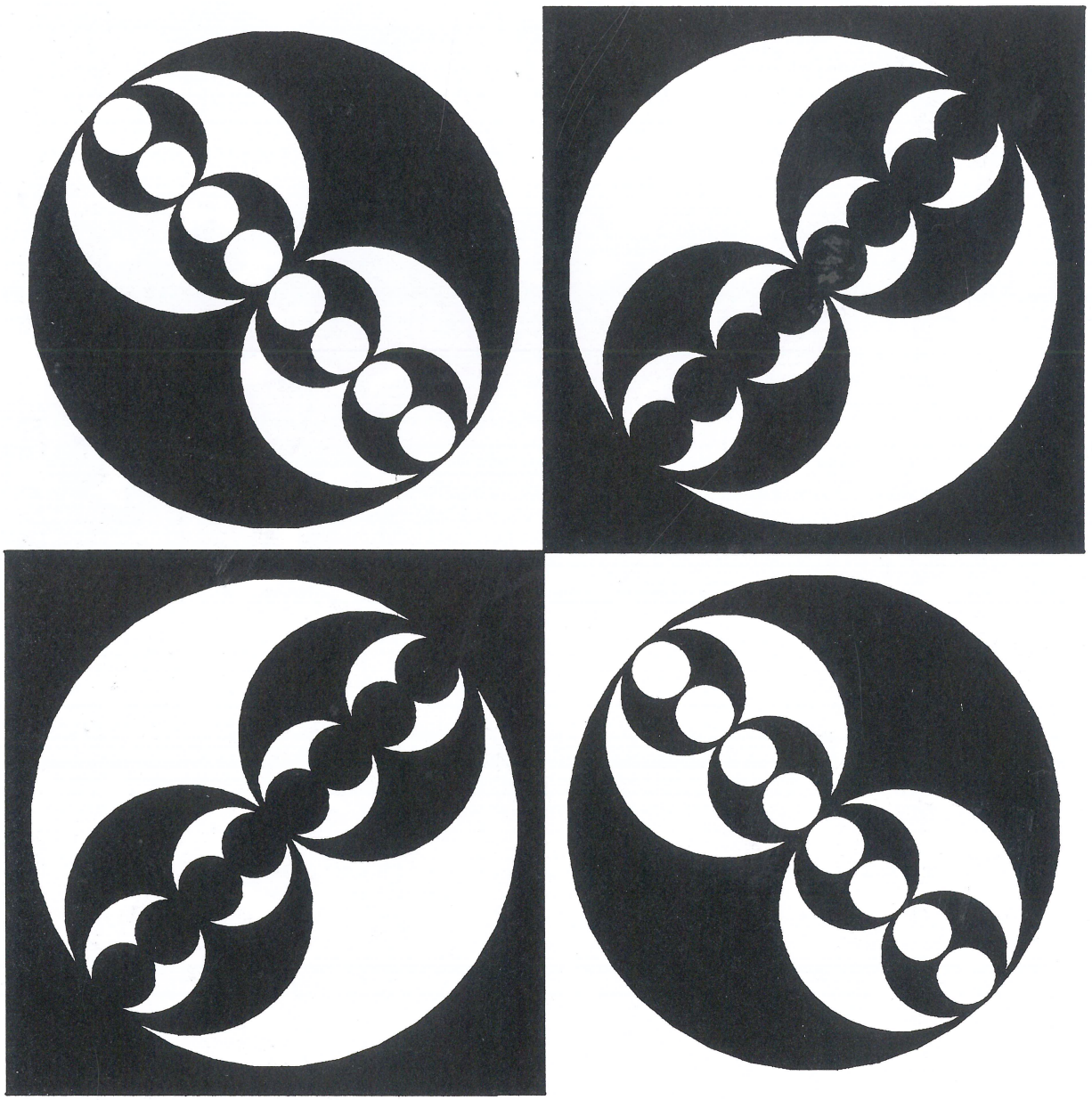
BELOW: "Not Holes" by Kerry Jones, an excellent study for implantment in the varied visual arts.



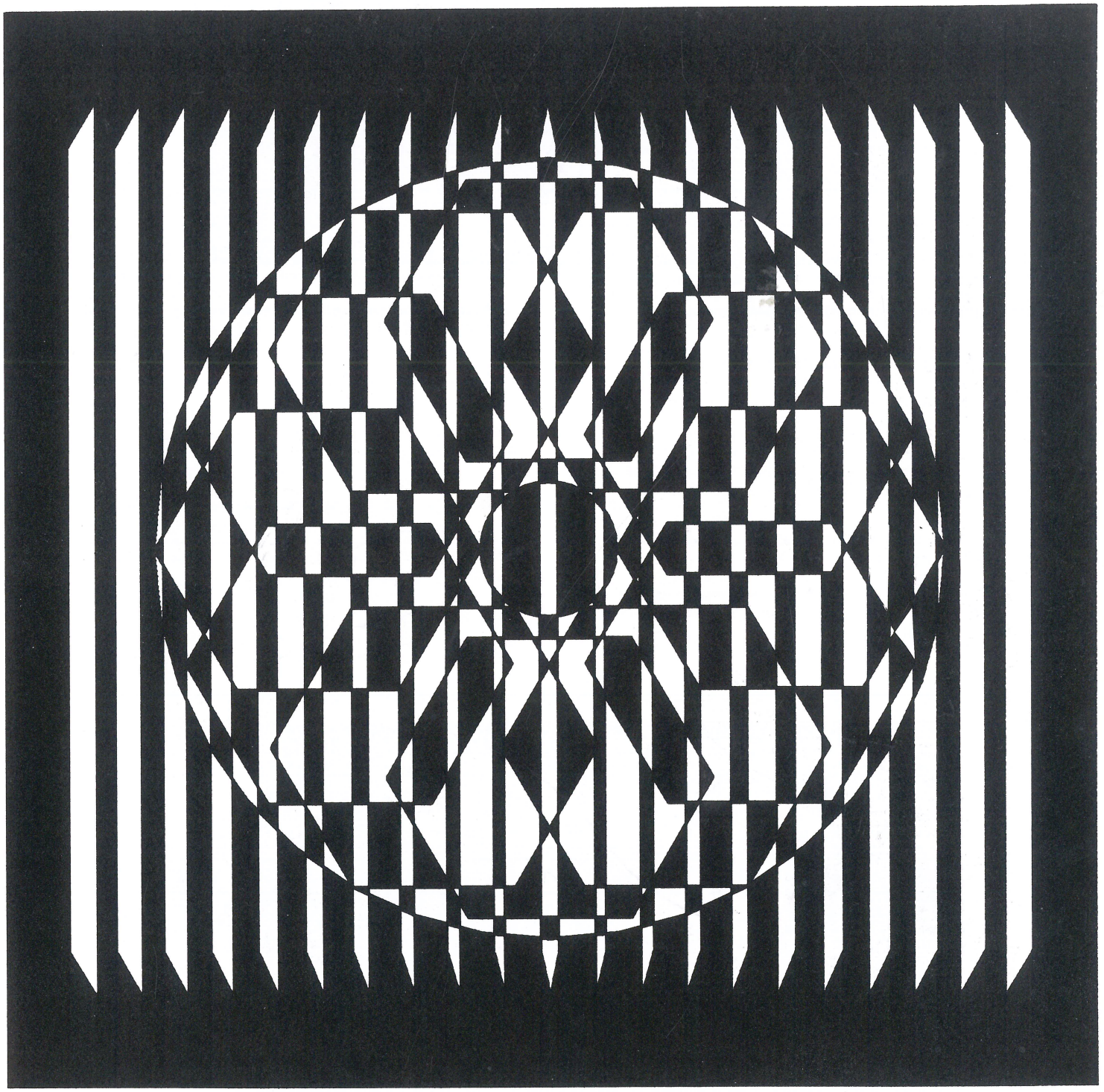
BELOW: "Study after Vasarely, Serial Form" by Kerry Jones. In this work and the others in the Vasarely Series, black and white areas are a counterfoil for each other, with positive and negative spaces of equal significance in the compositions.



BELOW: "Balance" by Kerry Jones, with circles and squares mirroring and balancing the composition, with a slight hint of motion, as the more dominant square and circle patterns appear thrust forward in the composition.



BELOW: "Summation, Vasarely Sketches" by Kerry Jones. This particular work is a superior example of graphics that are impossible to do by hand, yet readily programmable with the aid of a computer. Here is a composition worth studying and enjoying for some time -- going beyond the "interesting" and temporary appeal of much computer art. Kerry Jones has continuously explored a genuine unity of art and mathematics.



THE CITY AS AN ELECTRONIC GAMEBOARD

by Thomas E. Linehan, Ph.D.
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NOTE: The following is a summary of the above article, scheduled to appear soon in Computing Teacher. A video tape presentation of the research will be given by Dr. Linehan at the National Art Education Association meeting in Chicago on April 10-15. The tape shows children playing the computer-generated, microcomputer-controlled video learning games. Future games will focus on aesthetic aspects of city planning, architecture, and landscape.

SUMMARY: THE CITY AS AN ELECTRONIC GAMEBOARD

The article describes current research by the author in computer-generated and microcomputer-controlled video learning games. The simulations and games are designed with 3-D, color, computer animation, with eventual presentation on videodisc, under microcomputer control.

The present games are directed toward 4-5 grade elementary students. Each game contains a step-progression feature with increasing levels of task difficulty. This form of design extends the games' audience into high school and adult levels.

SUPPORT AND POTENTIAL

The current research is funded by the Ohio State University College of Education.

The rapid development of the videodisc technology presents considerable opportunities for professional educators. The low production cost of mass-marketed videodisc presents an opportunity for cost-effective marketing of entertainment and educational materials.

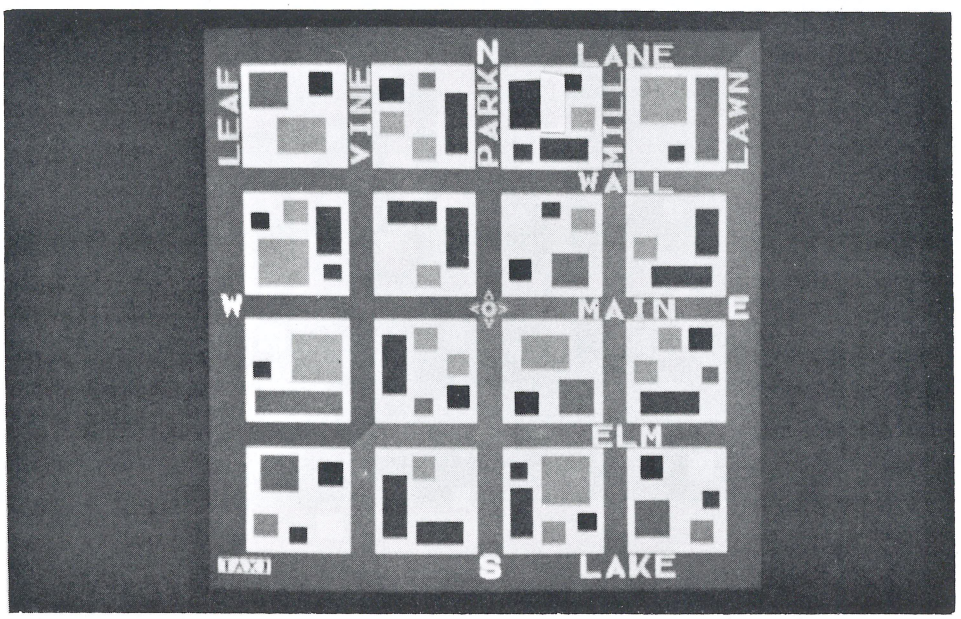
GAME DESIGN CRITERIA

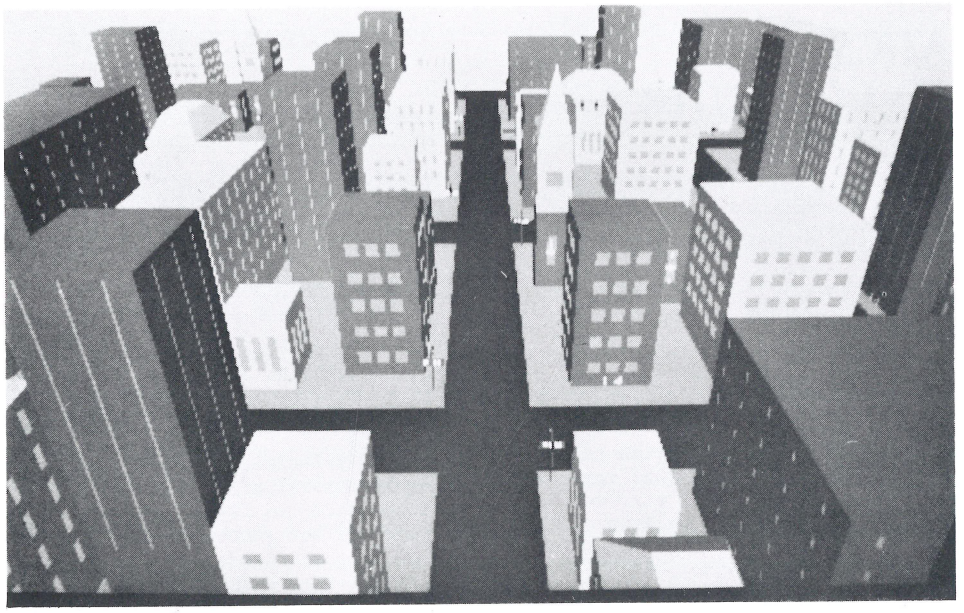
The following criteria were selected for the video, learning games. Learning games are to be:

1. Attractive in graphic presentation, using 3-D, computer-generated animated sequences.

2. Motivating and challenging to play, making use of current interests in home video and arcade games.

BELOW: The game of "Taxi" allows students to acquire map reading skills, as they familiarize themselves with address structures of a given city.





ABOVE: Another game, "Rescue Squad". BELOW: "Helicopter Rescue" uses an aerial view of a city.

3. Stimulating, to promote significant learning relative to a wide variety of fields, to promote and require both conceptual and perceptual skill development.

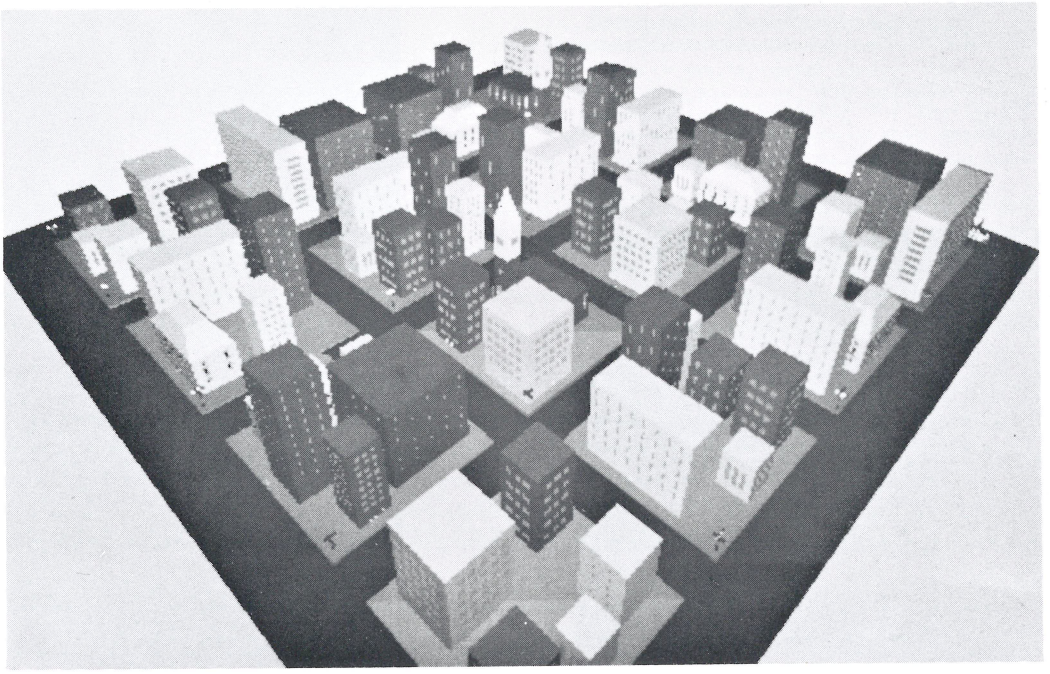
4. Designed and structured to include an evaluative strategy to provide a competency "score" if desired by the player.

5. Constructed in a manner to afford increasing levels of difficulty, to encourage repeated playing of the games, with advanced skill and knowledge acquisition.

SUMMARY

At the present time, other games are in various stages of design. Motivation of participating students to play the learning games is very high. The new technology represents a renewed challenge to the educational designer to present substantive content for students to learn in such a context. The new videodisc technology and microcomputer interface invite development of educational materials that can prove to be far more stimulating for learners than previous learning systems technology experiments.

Descriptions of new experiments using the new technology will be presented in future issues of Computer Graphics and Art.

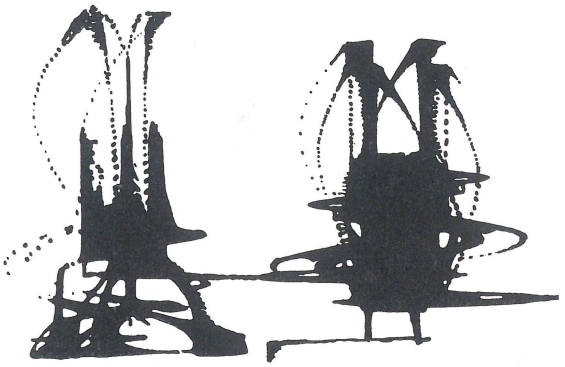


MATHEMATICS AND COMPUTER ART

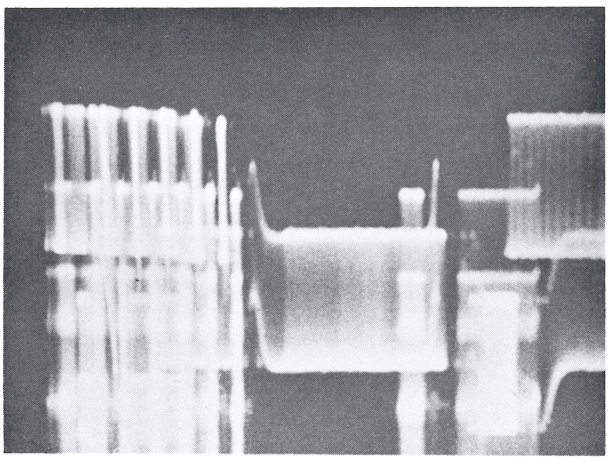
by Dr. Herbert W. Franke
Haus 40
8195 Puppling, West Germany

(Translated by Dr. James Loren Brown, California State University, Chico)

Computer art is not bound to any one style. With appropriate systems and programs, it is possible in principle, to come to grips with any of the usual types of representation in art. Moreover, the misconception of many critics has been finally laid to rest, which held that computer graphic methods were confined to non-representational statements: With the technic of "picture processing", pictures may be estranged and quite new effects won for the abstraction. And the constantly developing picture synthesis, too, allows the representation of real objects and scenery. Here too the capacity for artistic creation extends beyond what has existed up to now -- e.g., with the visions of a utopian architecture (compare the results of the group, Ars Intermedia, Vienna) which cannot, by means of present-day building techniques, be realized.



Hybrid computer art by the Ars Intermedia Group. (See other illustrations of utopian architecture by Otto Beckmann and his colleagues from Vienna.)



COMPUTER ART AND CONSTRUCTIVISM

Nonetheless, there exists a close affinity between artistic computer graphics and constructivism. It lies in the special characteristic of this style of art, which operates with simple geometric elements and high precision -- foundations for which the computer is no less than predestined. The basic elements of esthetic programs are the mathematical formulae, and this computer art establishes a new link between mathematics and art.

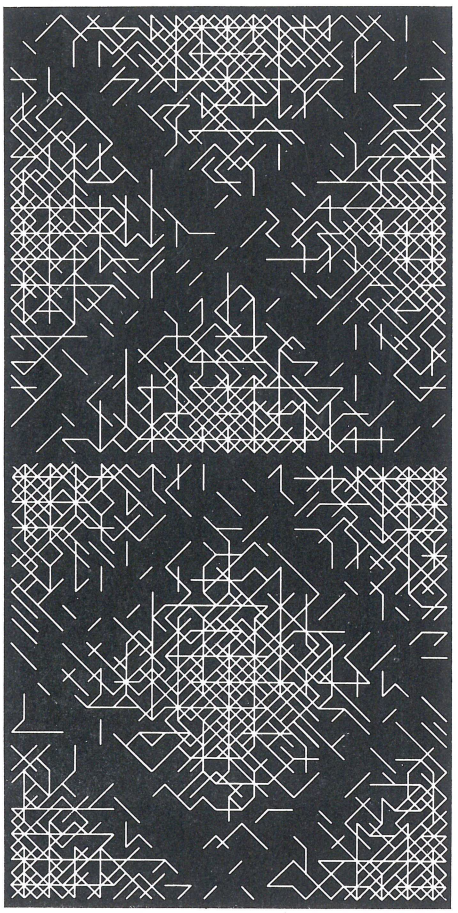
(See the next pages for generous examples of constructivist art by international artists.)

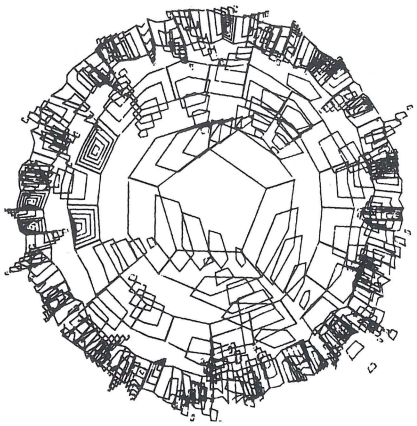
MATHEMATICS AND ARTISTIC PERFORMANCE

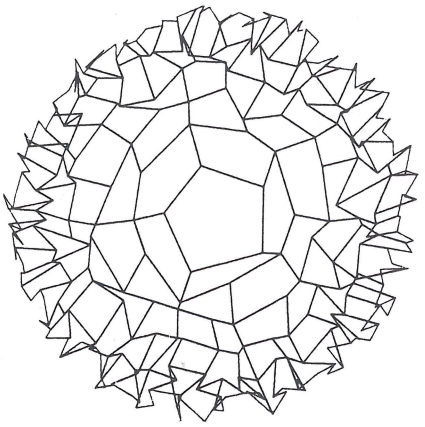
In principle it would be possible to realize an individual picture without the utilization of mathematics -- for example, by assigning the contours of the represented object point by point. But then of course, one would bypass the special capabilities which the computer offers for artistic performance. For it turns out that there is a whole mass or group of esthetically effective arrangements which are easily achieved by mathematics, e.g. symmetries, constants, statistical distributions, etc.

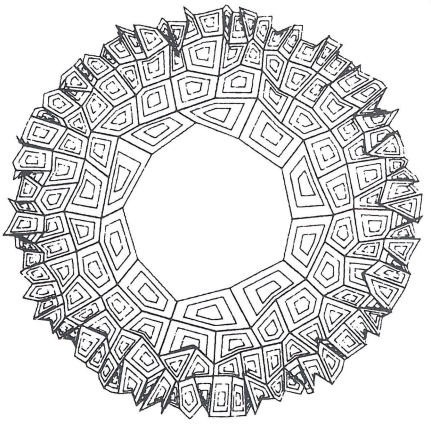
If the artist makes use of mathematical formulae, he or she at once attains, as to effort involved, a notable advantage over the point-by-point representation. There are, however, yet other grounds which make mathematics indispensable for computer art.

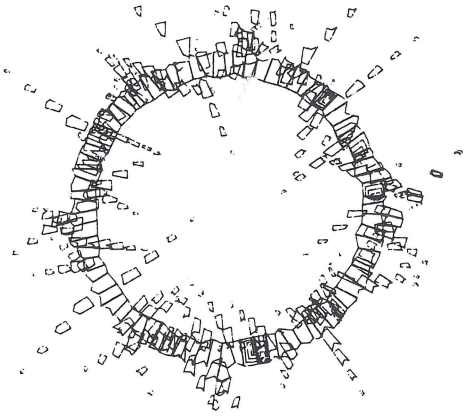
Examples of the Grid Series by Coqart.

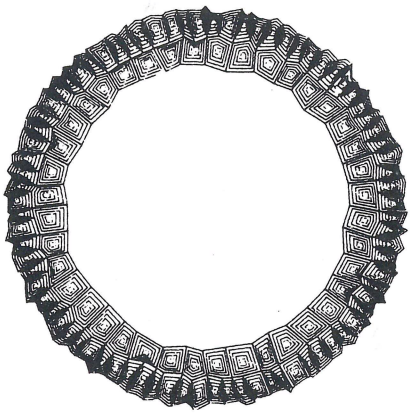


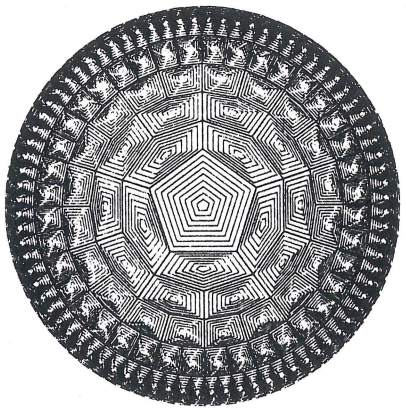












COMPUTER ART AND SERIES CAPABILITY

It is hardly sensible to involve the expense of programming if one wishes to prepare only a single picture. One of the most important characteristics of non-representational computer graphics is its series capability. And with that, the conception changes: the single picture will no longer be evaluated as the best solution to an esthetic problem, but rather as an example of a multiplicity in which still other possible solutions may inhere. The variants arise from the formula when changes are made in the parameters.

The advantage of a mathematical point of view becomes especially clear just at the point when one proceeds from the single picture to the series. The question then comes up of itself: which characteristics of the picture will remain unchanged through the entire series, and which ones will be changed? The mentioned invariants, through which the higher order gets defined, prove to be the stylistic elements. The remaining parameters merely characterize the locus of action of the style concerned. Upon going into series they may be changed a step at a time, or else be determined through random generators. And incidentally, one recognizes by this example that the basic mathematical principles of the computer give a strong impetus to the rational understanding of the phenomenon: art.

It is worth noting that most programmers, coming fresh into the guild of computer graphic artists, find, to begin with as forms: horizontally and vertically superimposed lines in a distribution of squares, stars and algebraic curves. This stems naturally from the fact that the instrument of mathematics is especially easy to apply in representing those particular forms. The exertions of the beginner are often laughed at -- wrongfully, I should say. One need only remember that the "horizontal-vertical principle" (discovered through Constructivism), which is inherent in this simplest form of programming, must be completely exhausted.

ON THIS PAGE: Examples of a mathematical series by Reiner H. Schneeberger. Related polygons decrement randomly in a related yet variant group of works.

A BROADENED CONSTRUCTIVISM

But just as the camera (at least for a long while) created a crisis in the objective-realistic representation, so now the computer renders illusory a further application of the horizontal-verticle principle. Whereas earlier, it may have been still necessary to put each individual picture manually and time-consumingly to paper, now a single program comprehends collective possibilities for the superimposition of squares, rectangles, chevrons and the like -- especially if these are confined to positions with parallel axes.

As it appears, however, computer art by no means places a terminus upon Constructivism -- but gives a decided impetus to its further development. If one subscribes to the thesis that Constructivism, looked at formalistically, means the discovery of geometrical precision for art, then by that alone, a decisive frontier is placed upon preparation by hand. Even when one leaves aside tools, such as ruler and compasses, the library of forms is itself limited to the combination of very few geometric principles. Thus it would mean for example an unusual increase in the multiplicity of forms if one used as picture elements not just the straight line and the algebraic curves of the first order, but turned to curves of a higher order -- irregular curves.

Already the strict rendering of single curves carries with it a scarcely admissible expense, or effort, and if it comes to the superimposition of several curves, then it is soon evident that even the highest precision attainable by technical draftsmen does not suffice.

This becomes especially clear through a mathematical phenomenon, that known as Moiré formation. If one superimposes two densely packed masses of curves, then patterns of a higher order arise -- specifically Moirés -- where even extremely small imprecisions stand out as distortions. Classical Constructivism is accordingly confined to straight lines and circles. It is the computer which makes possible for the inclusion of an incalculable wealth of further elements, among them, the curves of a higher order.

A whole body of works exist which may be viewed in the framework of such a broadened Constructivism. It is noteworthy that most of these will be rejected by the critics -- mostly for their precision and symmetry. Obviously, there is perceptible here a quite limited esthetic view, one which tries to measure the new by the standards of the old. There are no objective grounds to refuse or reject curve-compositions on principle; indeed they will be very positively received by unbiased observers.

VISUALIZATION OF A MATHEMATICAL CONTEXT

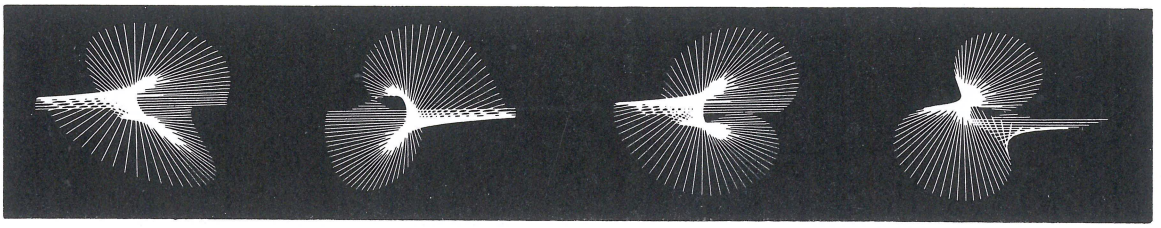
The ease of producing in series facilitates as well the step towards films, or more generally stated, to representation in movement. Motion attainable through the computer goes of course much beyond the linear projection of a film. If, for example, one allows the open parameters of a graphic program to be selected by a random generator, then there occur ever-renewed, unforseeable projections of the film -- as it were, strolls through the field of possibilities marked out by the program. As an example of the extension of the old Constructivist principle of horizontal-vertical in the program, "Mondrian", which begets series of pictures in any desired length, whereby anterior elements are over-written by the new.

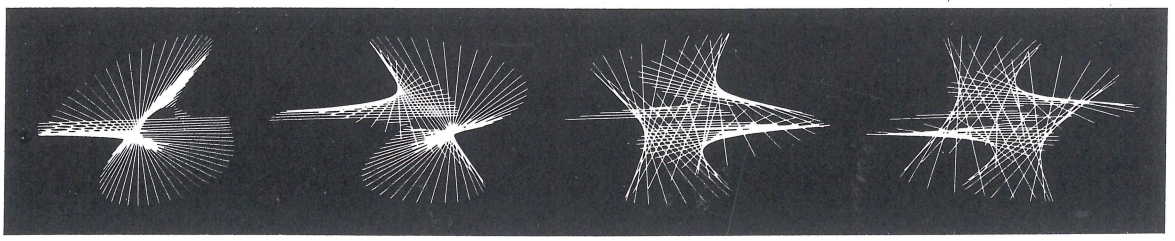
The possibility of bringing preconceived forms into reality by computer with the appropriate programs is still only one way of applying the new methods. It can be far more attractive to allow oneself to take inspiration in hitherto esthetically unused mathematical contexts. Exactly as one can see each use of computer graphics as the visualization of a mathematical context, so each mathematical context may conversely be visualized -- and moreover, in as many ways as one desires. This is noteworthy to the extent that with it a new library of forms is introduced into the artistic field -- forms and contexts which relevantly enlarge the repertory of our visual experience and consequently fulfill a genuine educational task. As is proved by the results of many computer artists who proceed from mathematical bases, one may consider this kind of procedure in fact as an heuristic principle for the discovery of ideas.

In the picture section, I shall bring evidences thereof where one arrives at unexpected but all the more interesting results if one does no other than to visualize mathematical orders which have not hitherto been converted into the visible. Worthy of mention perhaps are the works of the mathematician, Benoit B. Mandlebrot, who has been occupied with the "discovery" of new kinds of irregular curves. To illustrate them for the readers of his book, "Fractals, Form, Chance, and Dimension" he had recourse to computer graphics -- and from the esthetic point of view, also the results were a delightful surprise. (See pages 40 and 45.)

It is remarkable what diverse pictures are evoked through the individual principles of mathematical order. Through the application of symmetry, for example -- a modus of organization which is also closely connected with classical art, one arrives at ornamental forms.

BELOW: Variations of a mathematical series by Jean Brette, Paris, France.



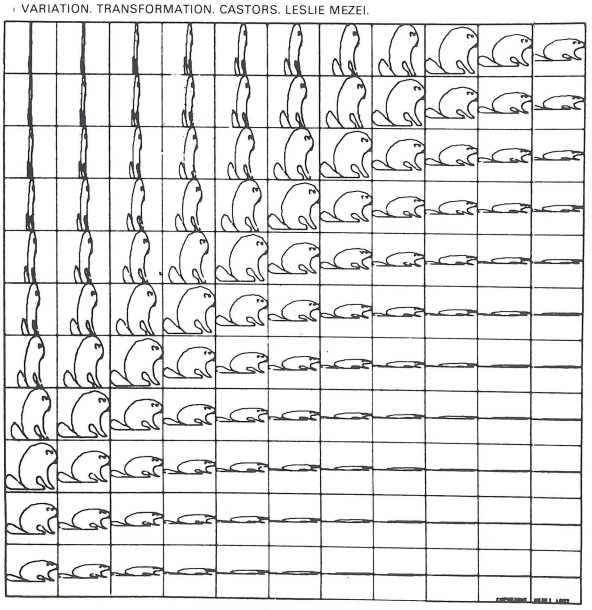


ON THIS PAGE: Black and white reversals of mathematical variations by Jean Brette, Paris.

Here too is seen the impetus to the extension of a long-existing visual fact: on the foundation of mathematics, one opens the way to the achievement of far more complicated symmetries than those thus far achieved. And through the effortless precision which the computer brings with it, it is also possible to render complicated elements in diverse symmetrical arrangements. Moreover, the critics' skepticism directed against ornamental representation is misplaced: ornament as an esthetic accessory, as a tacked-on embellishment is considered (not without some justification) as proscribed. But it should be noted that it appears here as a quite intrinsic form of design and thereby joins even the oldest and most thoroughly appreciated traditions. Worth mentioning also is the possibility for generating "three-dimensional ornaments" -- through the application of spatial symmetries -- images which indeed are representable perspective-wise, but not realizable under physical conditions.

Another esthetically valuable principle of form is constancy. Simply put, it is a matter of curvatures of the highest symmetry, without flawed spots or immediately juxtaposed portions having different curve-radii. This quality of conforming to laws also plays a role in the domain of design -- for example as the (even technologically based) principle of stream-lining. Without saying that an individual style would grow out of it, the constant curve is nevertheless found in the most varied areas of artistic style as an element of form. For the computer it is, through the usual intrapolation routines, easily accessible.

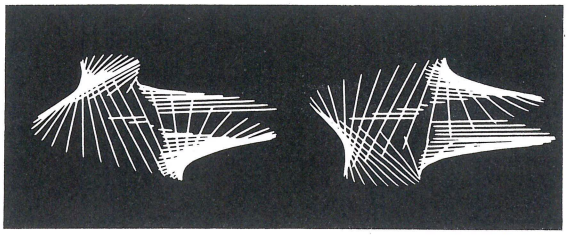
VARIATION. TRANSFORMATION. CASTORS. LESLIE MEZEI.



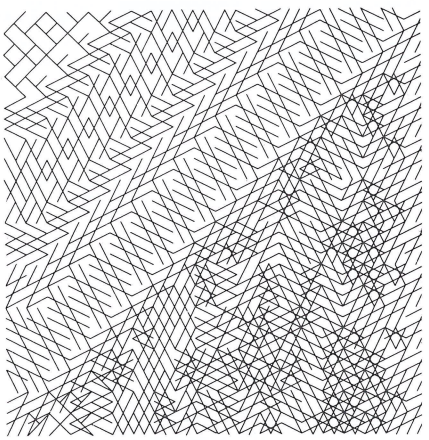
Further attractive forms result from plane and spatial fields, generally the coordination of definite numerical values for surface or space coordinates. Here various possibilities are offered for representation. Familiar perhaps is visualization with contour lines or else through lines of maximum slope, known from topological maps. New kinds of patterns are approached through the gray-or color-coordination module-n, where n assigns the number of the value of gray or of the color. This means that the numbers coordinated with the field will be marked by the same grayness or color when they have the same positive difference in relation to a multiple of n.

The already mentioned Moirés are a means of design of a special sort. One obtains them through the superposition of masses of curves. In this an effect of interference is produced such as is known from optics: according to the position of the points of intersection, bright or dark spots arise. These form a pattern which is to be understood in the sense of information theory as a "supersign"; by which is meant a superimposed form which is built up out of the elementary class of signs. With the Moirés there enters at the same time a mathematically confirmable effect of enlargement; if the individual lines (the just mentioned basic elements) crowd together so closely that they cannot by the naked eye be perceived as separate, the Moiré pattern can still be recognized.

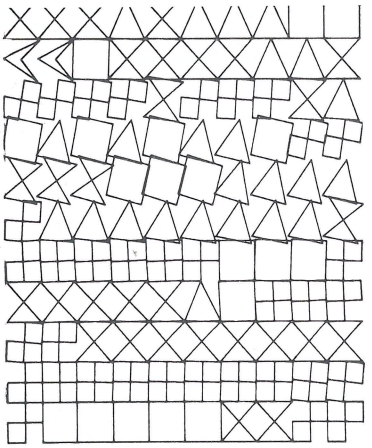
A class of mathematical processes which deserves the attention of computer art is that of transformations. Here it is a matter of geometric alterations, expressible by formula, which extend to complete deformation and the construction of new forms. An example thereof, already nearly a classic, is the graphic work "Beavers" by Leslie Mezei. In this, the drawing of a beaver is stretched out or inverted by steps in horizontal and vertical directions. There are, however, far more complicated (and in effect more surprising) examples: perhaps among these belong mirror-images in circles and other irregular curves. Particularly productive are also the Fourier-transformations, for which demonstrations exist in optics. To my knowledge these have not yet been evaluated esthetically for computer graphics.



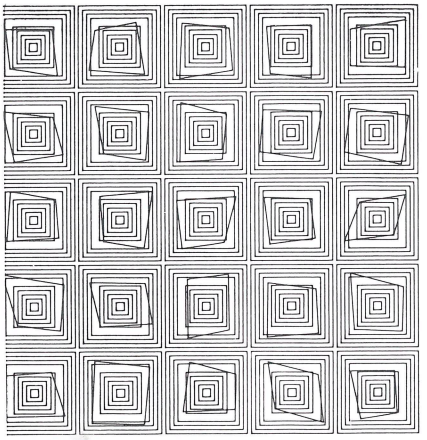
ILLUSTRATIONS OF CONSTRUCTIVIST ART, BASED ON THE SQUARE



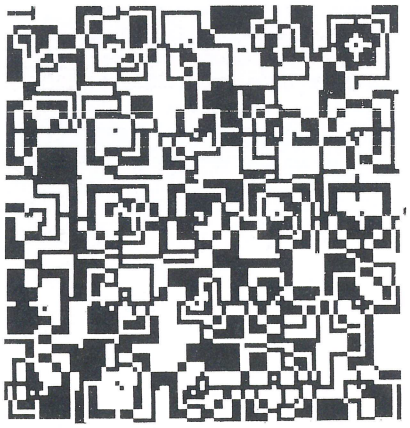
Jacques Palumbo



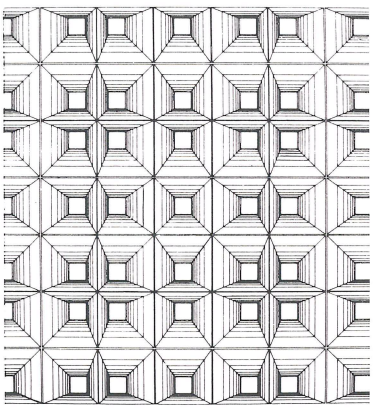
Christian Cavadia



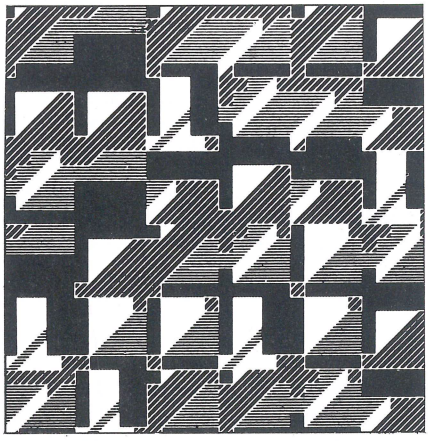
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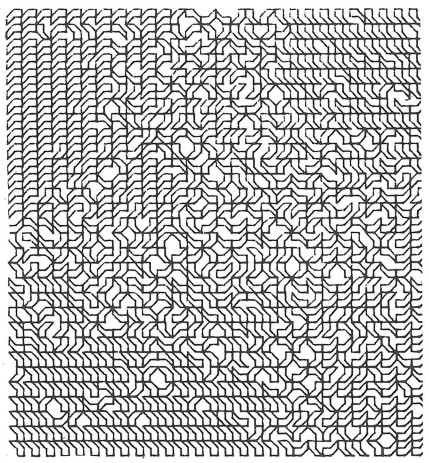
Chihaya Shimomura



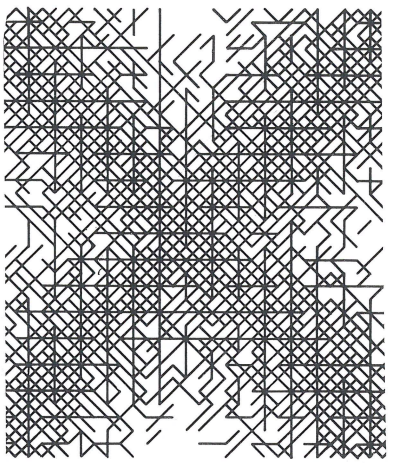
Paul Shao & Ken Dunker



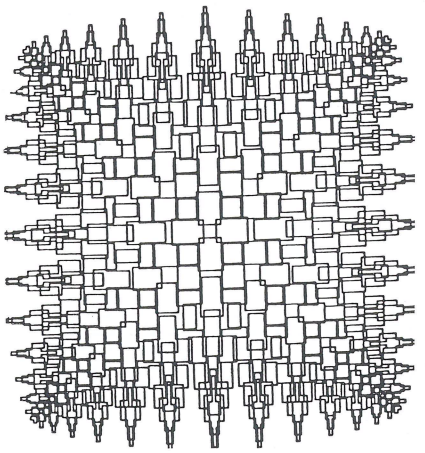
Edvard Zajec



Peter Beyls

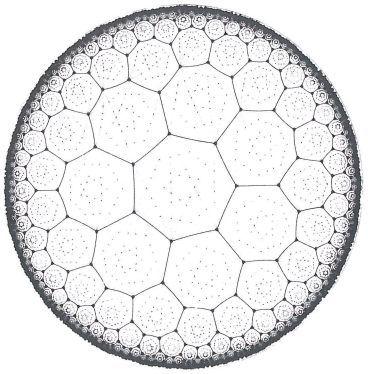


Roger Coqart

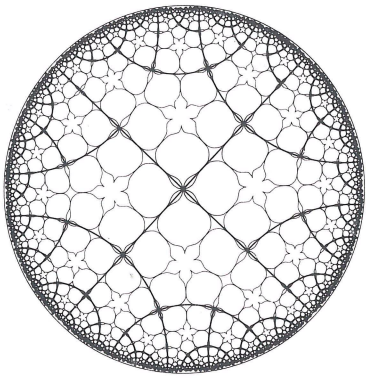


Francois Colonna

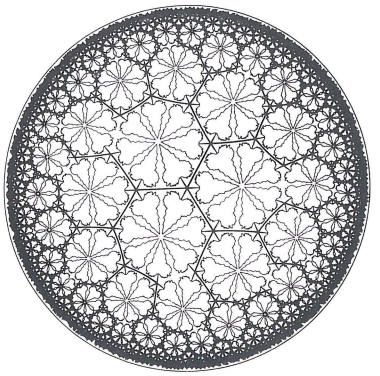
CHRISTOPH POPPE, GERMANY: NINE SKETCHES



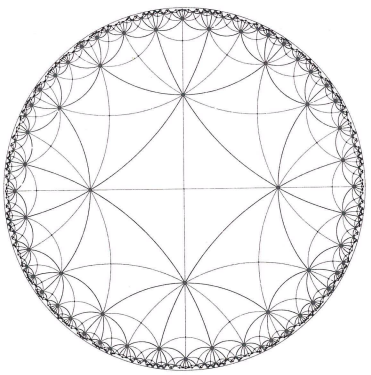
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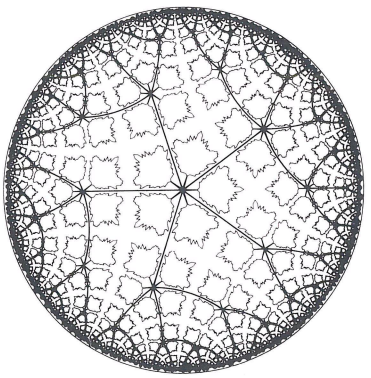
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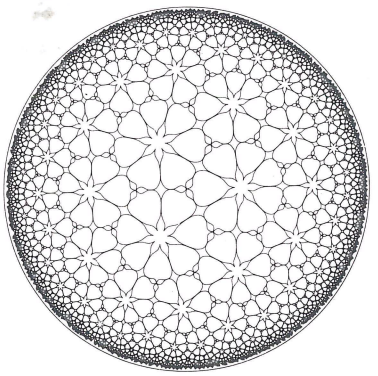
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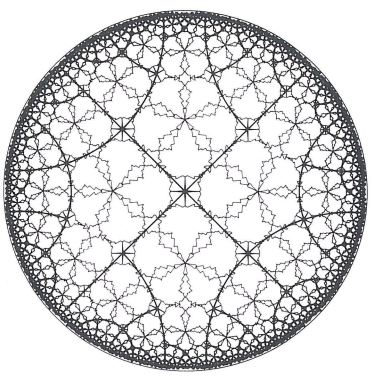
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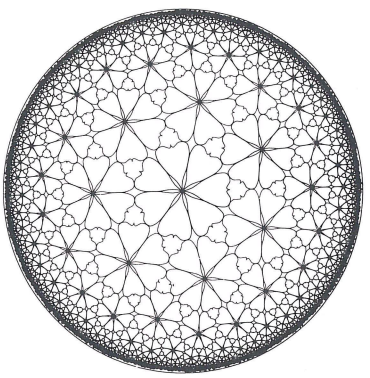
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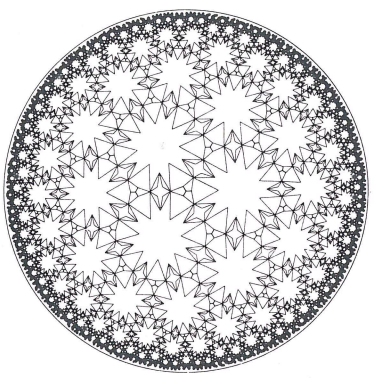
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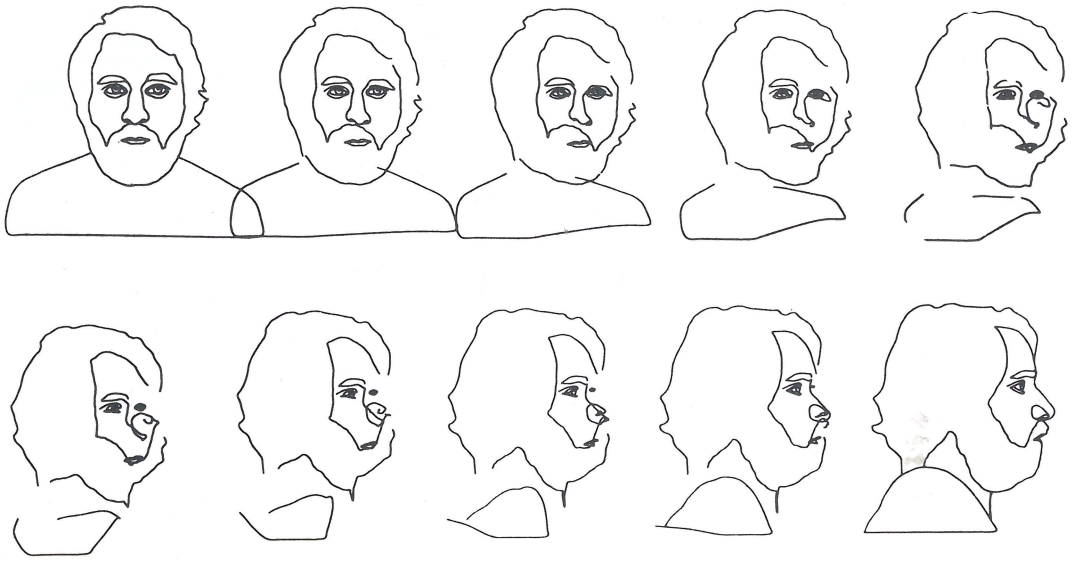


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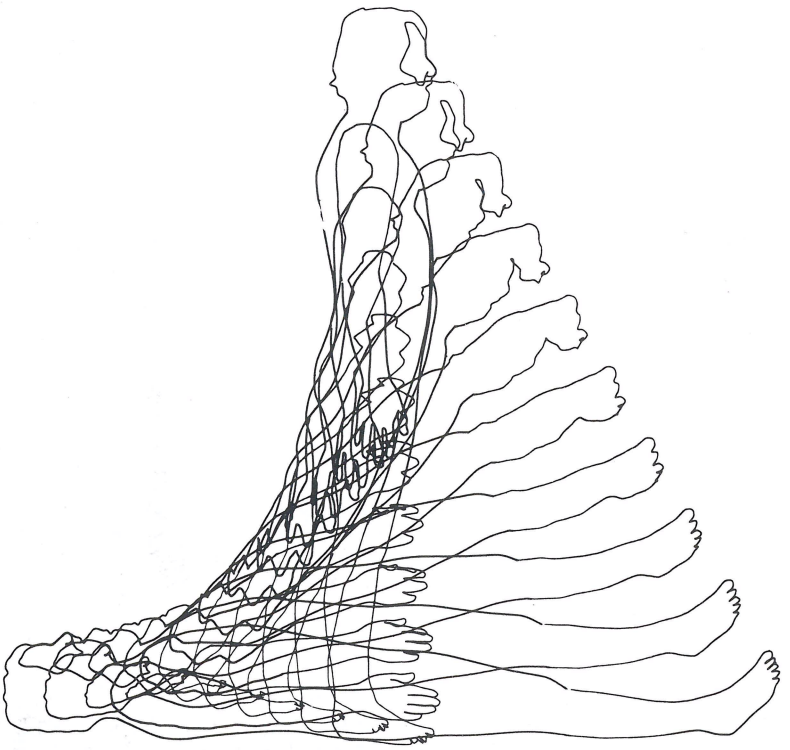


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ROGER PFUND, SWITZERLAND: SELF PORTRAITS

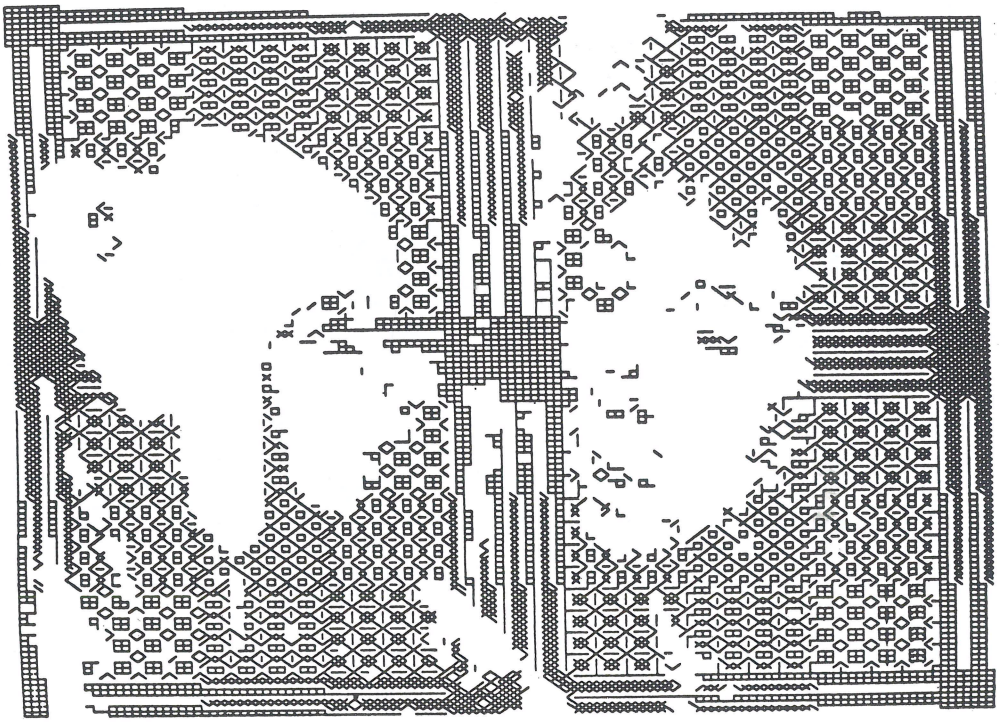


"Self Portrait - Interpolation of the Frontal to the Lateral"

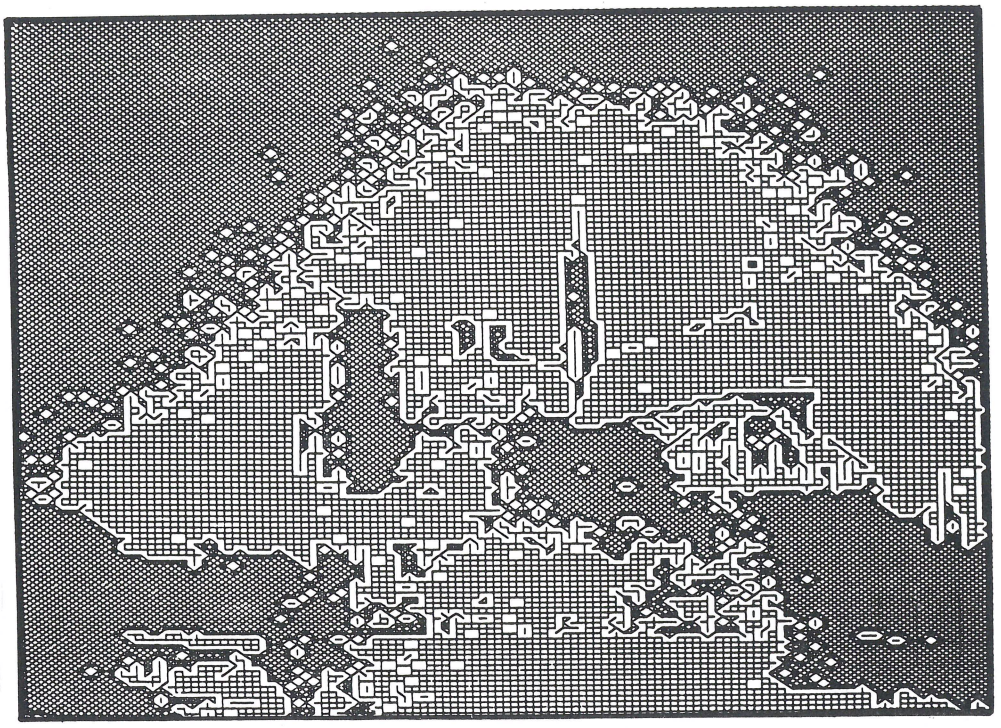


"Dimension Absurd - Reclining to Standing View"

JEAN-FRANCOIS COLONNA, FRANCE: TRANSFORMATIONS



"Transformation from a Study of Bruegel"



"Untitled Transformation"

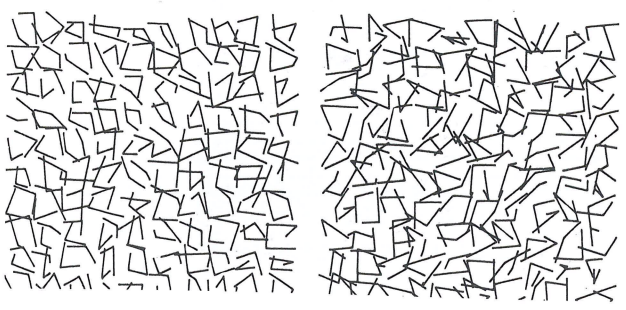
MATRIX CALCULATIONS

Standing in connection with transformations is the matrix calculation. By matrix of course is understood a digital numbers-field. With such, the operations of addition, multiplication, etc. may be carried out, matching each one with natural numbers. If one coordinates the numbers with the grays or the colors in a module-n representation, then the operations yield various sorts of transpositions, some of which are scarcely forseeable. If one uses matrices with a sufficient number of lines and columns, then with their help real objects too may be delineated in a corresponding degree of fineness. In this way one may mathematically transpose single pictures and may also merge several with each other (e.g. an apple with a fir tree). Here too again a sort of mathematical graphic experimentation is possible, which leads to unforseeable results.

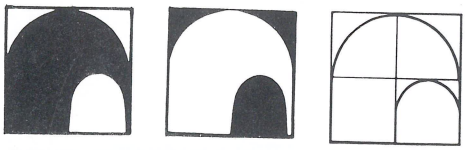
Several artists have applied mathematically the combinatorial, where it is a matter of the kinds of distribution possible with a definite number of elements. If one selects elements from the point of view of possible "connections" (as Manuel Barbadillo has done somewhat) then one obtains again a kind of supersign, which one would scarcely have expected as a result of a simple distribution operation.

The combinatorial is a foundation of the probability calculation, which in computer art finds a special multiple application. One may use it for example as Vera Molnar did, successively to destroy transparent organizations, but one may also by its laws create distributions, e.g. probability fields with pre-given centers of gravity, which additionally let themselves be combined and superimposed in various ways. But from theoretical grounds also, statistical methods in art are worthy of attention. For they rest on processes which in contradistinction to all others here mentioned lead not to the heightening of the degree of organization but to its decrease, to the production of chaos. In this way one attains to genuine innovation -- configurations which are not by any imaginable method predeterminable.

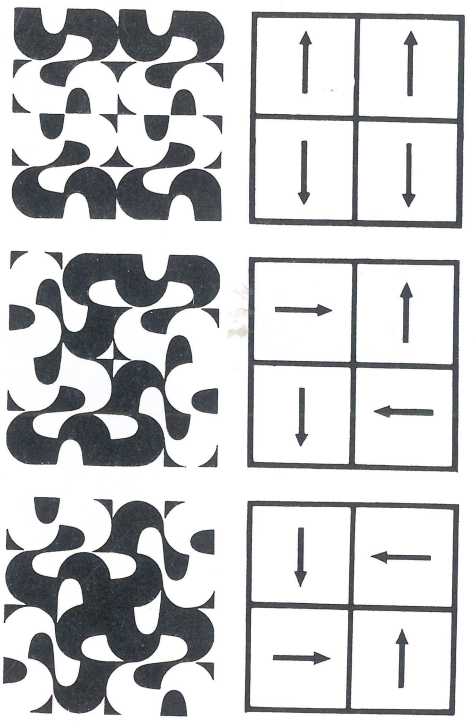
In conjunction with this, there is also the fact that a computer cannot generate any truly random number. For purposes of human observation the pseudo-random case which it is capable of suffices (e.g. the series of ciphers that may be stated after the comma of an irrational number). For art theory too, the probability element is a frequent object of discussion. Clearly in this way, creative phenomena allow themselves to be simulated, for which art itself furnishes a good example.



Random Variations by Vera Molnar, Paris.



ABOVE: Illustration of the "curved alphabet of form" of Manuel Barbadillo.



ABOVE: Variations of the alphabet of forms. For Manuel Barbadillo, the computer is a designing helper. Computer-generated designs are taken back into monumental manual paintings.

The spectrum of possibilities offered by mathematics is not by any means exhausted with this series of examples. Strictly speaking, what is involved in the above experiments is not even the constitution of inherent form but rather a sort of stocktaking of forms available in an area which has until now hardly served as a foundation in the process of artistic creation. It will first of all be necessary to become familiar with the newly discovered principles of organization so as to be able to constitute forms by their means. And then one will hardly confine one's self to a single discipline but will according to the hoped-for result, combine various methods. Their application will then be as self-evident as that of various auxiliary mathematical functions which have long been integrated into graphic production (e.g. extra- and intrapolations). Normally they will be applied when, on the basis of a few given fulcra, it is a matter of building up curves formed with the highest possible symmetry. A well-known artistic application is the step-by-step transition of two different forms into each other -- a few early examples thereof come from the Japanese art group, CTG, Computer Technique Group.

TOWARDS A RATIONAL AESTHETICS

The bridge between mathematics and art points to other important aspects which will not be further treated here but which still should be mentioned. Thus for example, the mathematization of art is a welcome hypothesis for any sort of rational esthetics. And incidentally, a long-held wish has been fulfilled in this way, to wit: the one for a universally serviceable notation for plastic art. Mathematical formalism as it is employed in computer programs may serve as a "graphic notation".

A further aspect of the link between mathematics and art lies in the fact, that in working with computer graphics, one becomes ever more familiar with the possibilities of visualizing mathematical processes. It is not unthinkable (Benoit B. Mandelbrot for example advocates this opinion) that in this manner a new intuitive way to the understanding of mathematical contexts is opening up. This possibility would be especially significant for education, where the abstract formalism of mathematics is generally considered frightening. Now all at once, mathematics is acquiring a new position in the neighborhood of performance and configuration. With the help of the computer, a sort of "mathematical theater" is being called forth as an instrument on which mathematics can perform.

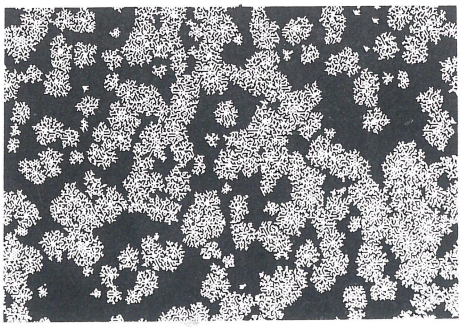
SUMMARY

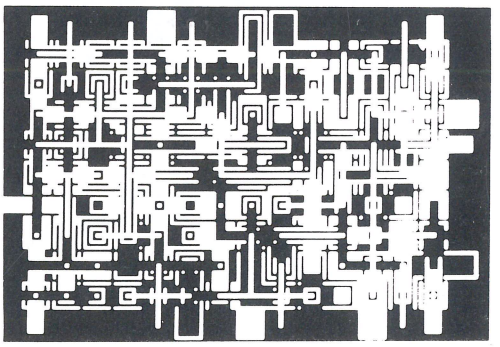
The treasury of forms now being revealed with the help of mathematics seems extremely foreign to the classically oriented art expert, which fact is actually also the reason that just these new configurations often meet with rejections, while that which can be recognized as the imitation of conventional paths in esthetics may rather expect approval. I am of the opinion that both sides can learn from the other.

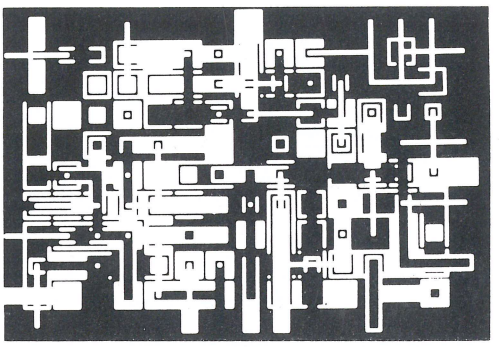
For the computer artist is is important to improve and to enlarge a feeling for form -- and in that a side-glance at the conventional art scene may help. It would also, however, be very suitable for the critics to give up their prejudices with regard to the forms of science and to give greater attention to the esthetic innovations that lie therein.

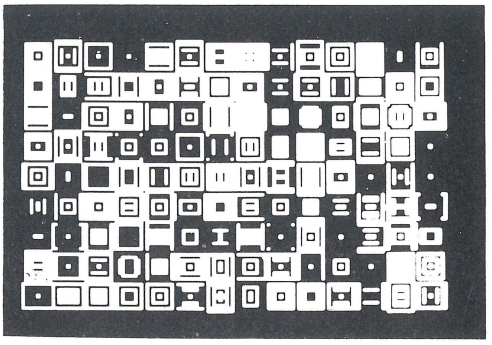
(For concluding references, see page 41.)

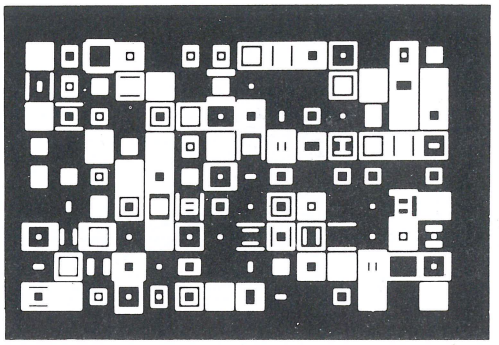
BELOW: Random variations of the square by Ken Knowlton, USA. The top pattern reveals random snowflake images. Note the relativity of these early Constructivist images to the present experiments of PIX-ART. The early Knowlton works remain superior examples of early computer art. Knowlton's ensuing works have always combined an excellent balance of mathematics and art.



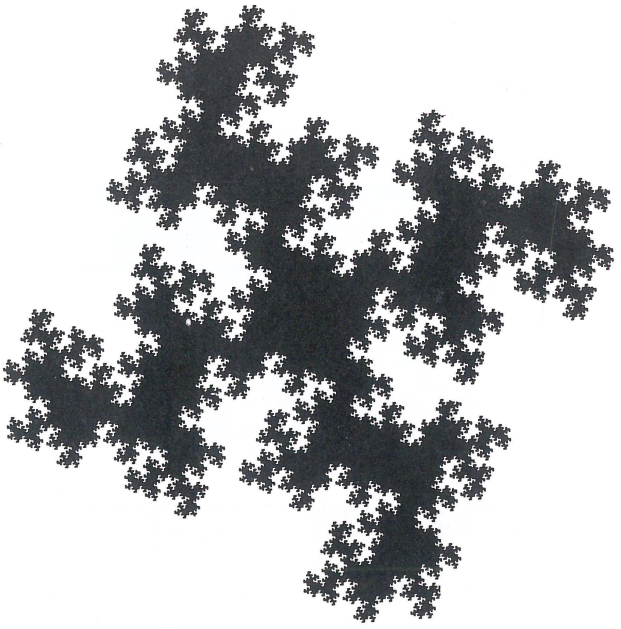




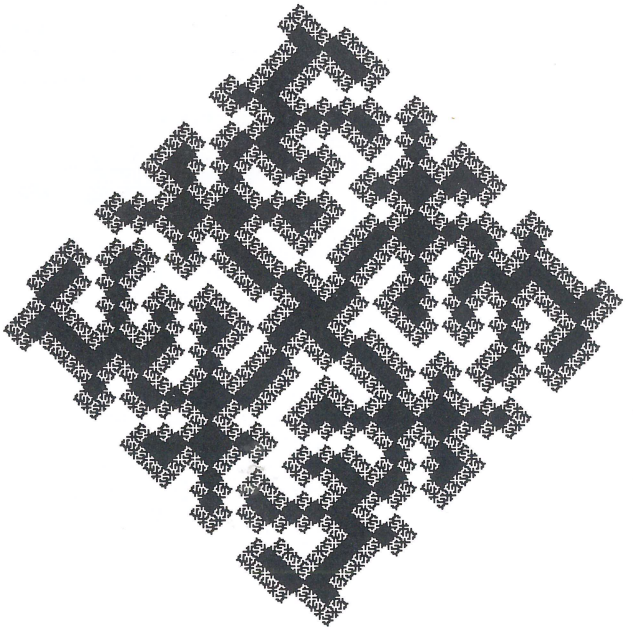




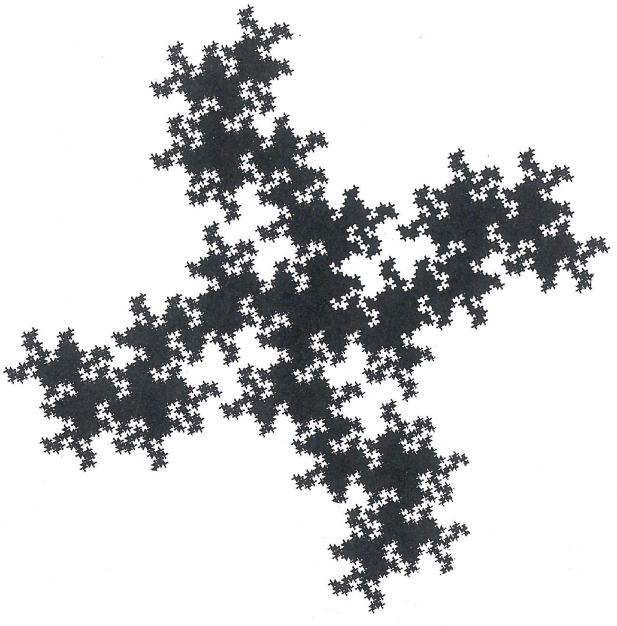
ON THIS PAGE: Just a mere sampling of the many superior illustrations from the text, "Fractals - Form, Chance, and Dimension" by Benoit B. Mandelbrot, IBM Business Machines, Thomas J. Watson Research Center. The text was published in 1977 by Freeman and Company, San Francisco, California.



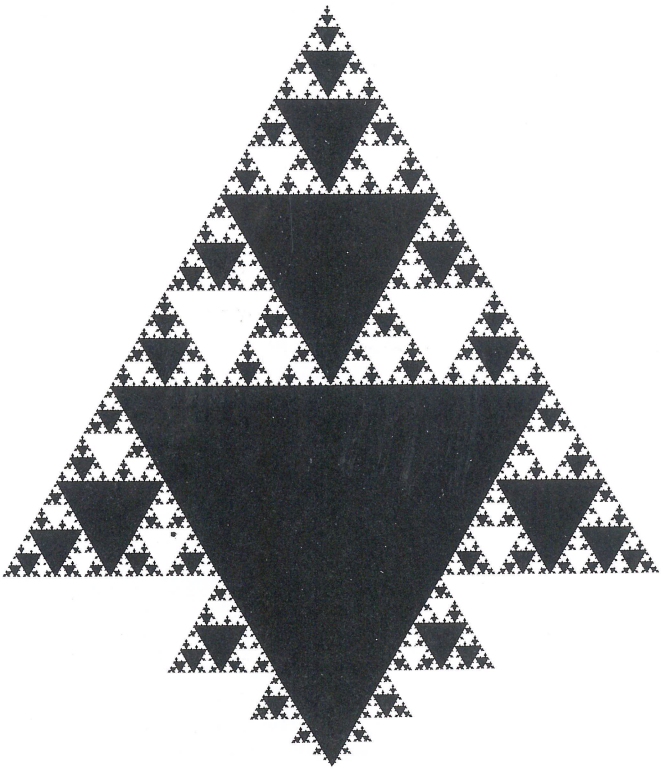
ABOVE: "A Koch Island and a Koch Archipelago" by Mandelbrot. (Coastline Dimension D=1.6131)



ABOVE: "Koch Island" by Mandelbrot. (Coastline Dimension D=1.7373)



ABOVE: Another "Koch Island" by Mandelbrot. (Coastline Dimension D=1.6667)



ABOVE: "The Arrowhead Curve" by Mandelbrot. (Dimension D=1.5849)

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Computer Sciences and all its sub-fields, Numerical Mathematics, Econometrics, Industrial Organization, Technical Change, Systems Engineering, Business Administration

Information Processing 80

Proceedings of the IFIP Congress 80, Tokyo, Japan, October 6-9, 1980 and Melbourne, Australia, October 14-17, 1980

edited by SIMON LAVINGTON, *Dept. of Computer Science, University of Manchester, U.K.*

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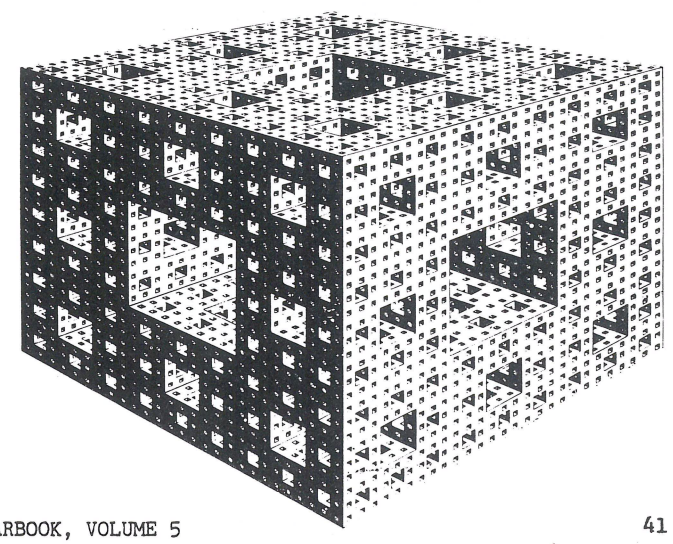
The 8th World Computer Congress is a milestone in the annals of the triennial congresses of the International Federation for Information Processing. It is the first time that an IFIP Congress has been held in the southern hemisphere and also the first time that a Congress has been split between two nations.

This book contains the full text of 36 invited and 114 submitted papers presented at this congress. They have been divided into ten areas, each containing papers from distinguished authors. As this is THE major international computer conference of 1980, the papers represent an important body of knowledge. All papers appearing in this volume are of an exceptionally high standard of quality, ensured by a panel of 582 referees who assisted the distinguished program committee.

CONTENTS: **Areas: 1. Theoretical Foundations of Information Processing.** Invited Papers: The Vienna Development Method (VDM) and its Use for the Specification of a Rational Data Base System *(E.J. Neuhold and Th. Olnhoff)*. Non Deterministic Programs: An Algebraic Overview *(M. Nivat)*.



NORTH-HOLLAND PUBLISHING COMPANY
Amsterdam *and* New York



MATHEMATICS PLUS ART

by Grace C. Hertlein, Professor
Department of Computer Science
California State University, Chico
Chico, California 95929

This brief article is intended as a complement to the superior ideas expressed by Herbert Franke in this issue, titled "Mathematics and Art". I have had for many years a great respect and admiration for Dr. Franke's writing, his philosophy, and his art. These ideas in no way negate his ideas about mathematics and art. They are intended to serve as a consideration of computer art as an enduring art form, going beyond mathematics and art into "pure" art.

MATHEMATICS AND COMPUTER ART

The computer was invented during World War II for military, non-art purposes. Like other tools invented by man, this new tool is now used in the utilitarian and fine arts. /1/ After World War II scientists, mathematicians, and programmers who had access to these early systems began to create an experimental art, and at that natal period of computer art, they began to formulate philosophical ideas about this art that continues to this day. This early school of art considered that mathematically dominant computer art was more "pure" as an expression of the computer than works of art where the elements of art were strong (or dominant). They declared that the computer should be the dominant partner in this new art form. This subjective preference for mathematical dominance continues to this day. This is not to say that a computer art work should not reflect superior use of the computer. This preference clearly prefers the dominance of the computer and decisions made by the computer vs. decisions made by the artist.

We have two strongly opposing views: mathematics vs. art. However, these views need not be opposing. They may be unified or complementary. As any art form matures, there are bound to be many new branches from the original tree. Today in computer art, we have several main branches:

1. An art where mathematics strongly dominates,
2. An art where the fine and applied arts strongly dominate,
3. A balance of art, science, and mathematics,
4. An art where one element may moderately dominate.

COMPUTER ART AND ART

Ideally, computer art is a union of art and science. Since 1970 computer art is an art that has been taken back (or implanted) within other art forms. As art, it is judged solely on its merits as art. No amount of brilliant philosophizing about its mathematical purity, its logical genesis, etc. will transform it into art if it does not possess some of the attributes of art.

A writer or critic has to be quite brave to state what is or what is not art. This is as brave (or Quixotic) as to attempt to define the purpose of life, truth, man, etc.

However, to avoid it as a subject too complex to define is cowardly. I will not quote Aristotle, Plato, Ruskin, Pater, Berenson, etc. Having spent 37 years in the arts and having some ideas about art, I believe it is timely to re-open this important discussion: What are some of the attributes of enduring computer art?

Before considering some of these attributes of enduring computer art, it is worth noting that not all computer art needs to be considered as "enduring" art. Some works may be brief experiments, with specific objectives. Others might be artistic accidents -- or sketches for more important works. Not all computer art has to be judged by the severe measurement of enduring fine art. Not all manual art can be judged by this stringent standard. The works of art may be something pleasant, decorative, or visually interesting -- intended as an "art song", not as an opus meant for posterity. And in looking at this more tolerant view of computer art, perhaps we are taking ourselves too seriously as computer artists, writers, critics, etc., when we put all computer art under this scrutiny of "enduring" art.

But who then will judge whether computer art is "interesting -- or enduring". The originator of a work of art is too often not a good judge of the aesthetic content (or durability). The artist may confuse expressive ideas about the work or feelings experienced during the creation of the work -- and mistakenly attribute these to the final product. At times, an artist may underestimate the artistic content of the work and express a philosophy in words that is worlds apart (beneath) the final art. This is where the art critics, or groups of experts may give a more accurate assessment of the aesthetic merits of given works of art.

What are some of the criteria or attributes of enduring art?

AN EXPERIMENT: WHAT IS ENDURING ART?

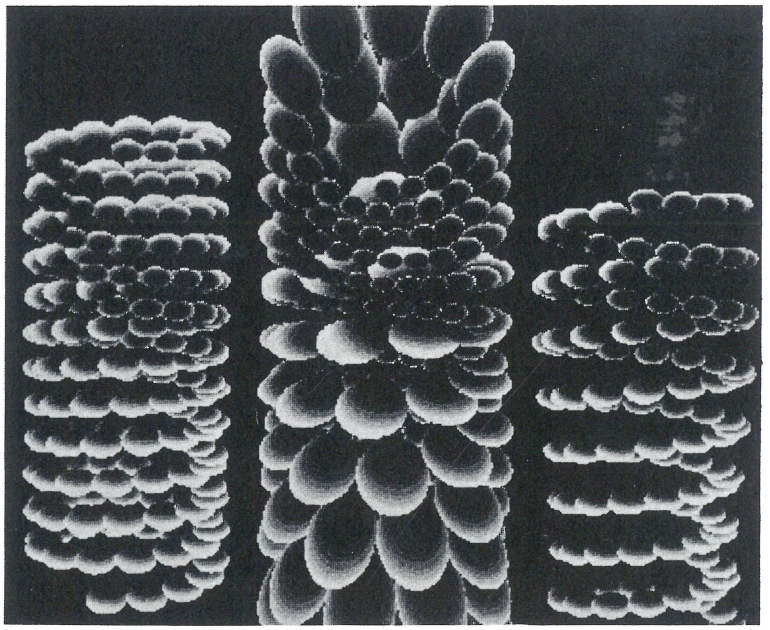
This semester, as an experiment, I took my class of 30 beginning computer artists (computer scientists) to an exhibition of Rodin's sculptures. After a brief lecture on Rodin and his work, we proceeded to the art gallery. Each person received a checksheet to record responses to the sculptures. We toured the gallery and briefly discussed each work. At the end of two hours of scrutiny, the majority of the students had drastically changed their ideas about art -- and they began to ask questions about what enduring computer art might be. They were immensely struck by the "enduring" quality of Rodin's work, and for the first time, they began to question their own computer art and its "enduring" quality. Here are some ideas from our discussions:

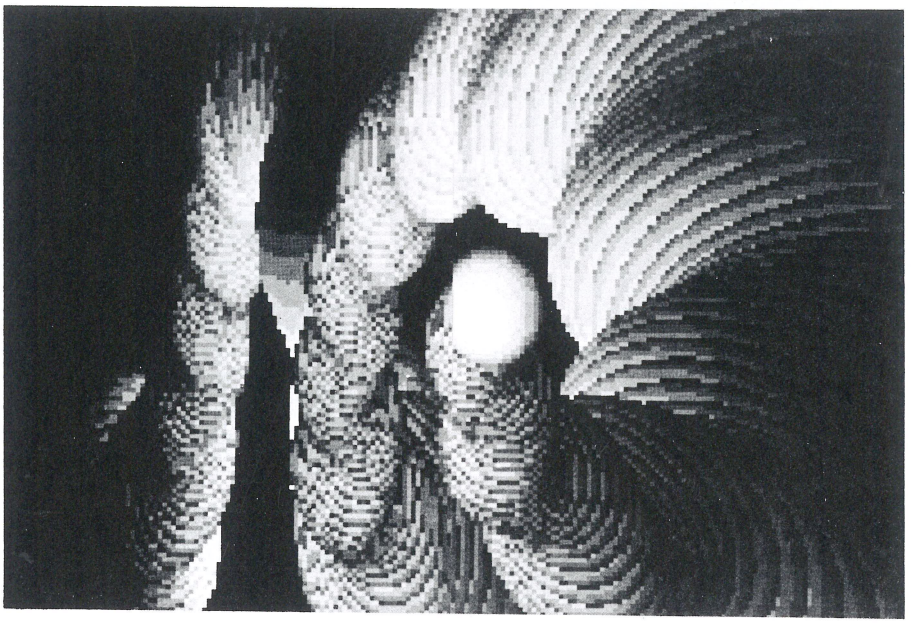
I. WHAT IS ART?

- A work of art communicates to a wide range of people, not just a limited audience.
- A work of art reflects mastery of the medium, going beyond knowledge of the system, to reflect superior use of the medium and new uses of the system.
- A work of art may say something that is of "universal" interest to other humans.
- A work of art need not be beautiful.

CHRIS FRENCH, ENGLAND: VARYING TRANSFORMATIONS OF SPHERICAL OBJECTS







- A work of art reflects the originating society and persons within that society.

- A work of art may be traced historically, related to the past, the present, and/or the future.

- A work of art should have qualities that communicate for some time, going beyond the transient statement, theme, or interest.

- A work of art may express elements of one or more of the human emotions, so that humans perceiving the art may be moved by it.

- A work of art may be so innovative that it completely transcends the past ideas, techniques and views of its time, to present a new vision, a new form.

- A work of art requires study -- it may not reveal its full import at first glance.

- A work of art should possess some of these qualities or attributes of art, but no one work can be expected to contain all these elements.

II. WHAT DOES ART ACCOMPLISH?

- Art reveals new images, new ideas, new ways of looking at man, the human condition, our earth.

- Art reveals a synthesis of past ideas within new transformations, new branches of the tree of art.

- Art gives new insights into the significance of man, his role, his destiny.

- Art gives us delight -- it refreshes our spirits, and it is recreative.

- Art reveals ideas we have dimly perceived, or have felt, and we recognize our own thoughts in these creations.

- Art sees the important, enduring ideas of man, going beyond the superficial, the trick, or the curiosity.

- Art unites dissimilar ideas, sees patterns in new combinations, not perceived by humans before.

- Art expresses beauty, joy, sorrow, peace, courage, the human virtues.

- Art reveals ugliness, sorrow, death, greed, the un-beautiful in man.

- Art gives us new vision, new hope.

III. STAGES OF ARTISTIC DEVELOPMENT IN COMPUTER ART

- Initial computer art may reveal decorative patterns or pattern manipulations.

- Early computer art may be something we can't execute by hand but can, with the aid of a computer.

- Beginning computer art may be a pleasing or interesting graphic or work of art.

- Early computer art may be visualizations from another field: mathematics, geography, geology, biology, physics, etc.

- Beginning computer art elicits our attention and liking for brief periods of time.

- More advanced computer art speaks to a wider audience of persons beyond computer science.

- More advanced computer art may be something we would like to have and keep, as something worth looking at for a prolonged period of time.

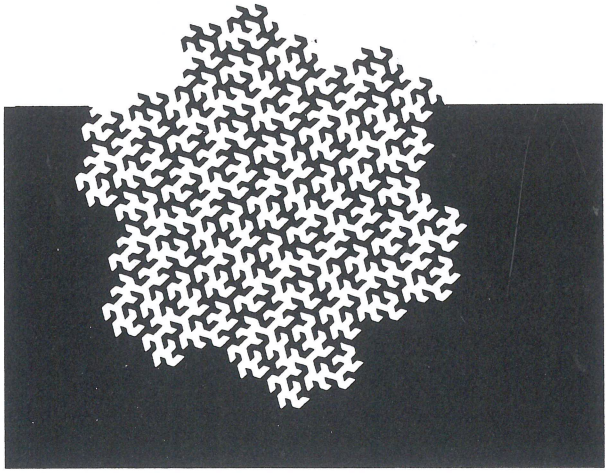
- Advanced computer art may be inspiring.

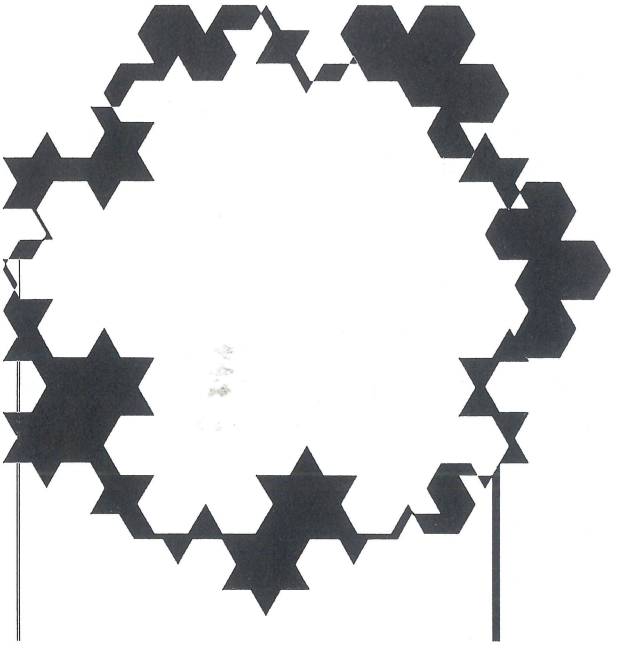
- Enduring computer art may take some time to develop -- meaningful computer art is not an "instant art".

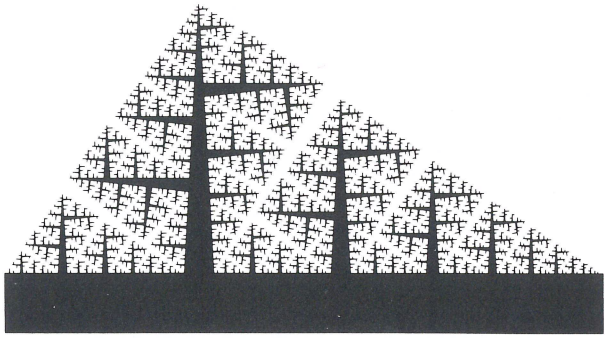
BELOW: "Liberation" by Maurice Escher, 1955, a lithograph (400x200), an example of enduring fine art, a transformation of pattern that communicates.

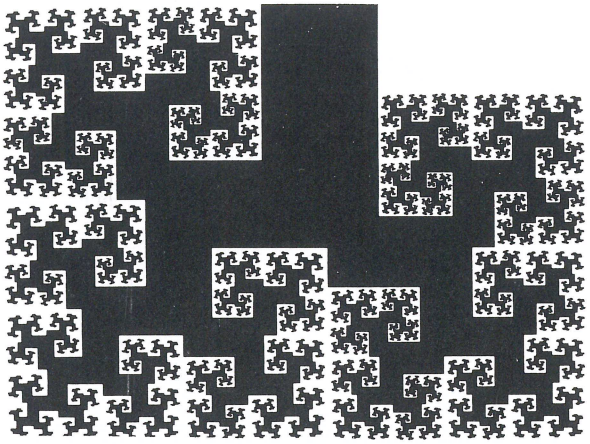


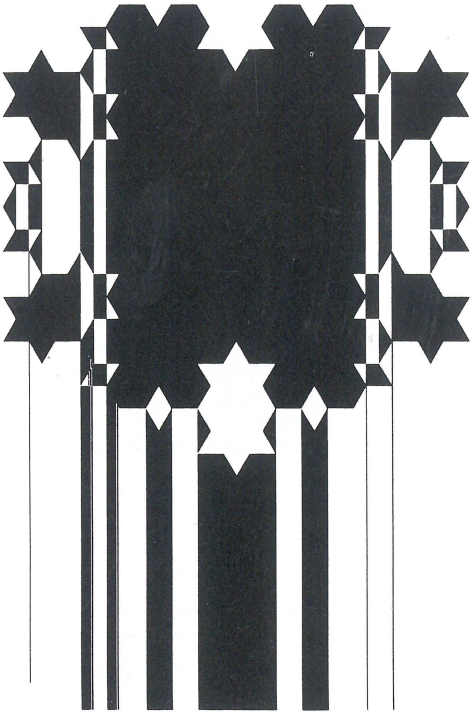
BENOIT B. MANDELBROT, USA: "Fractals - Form, Chance, and Dimension"







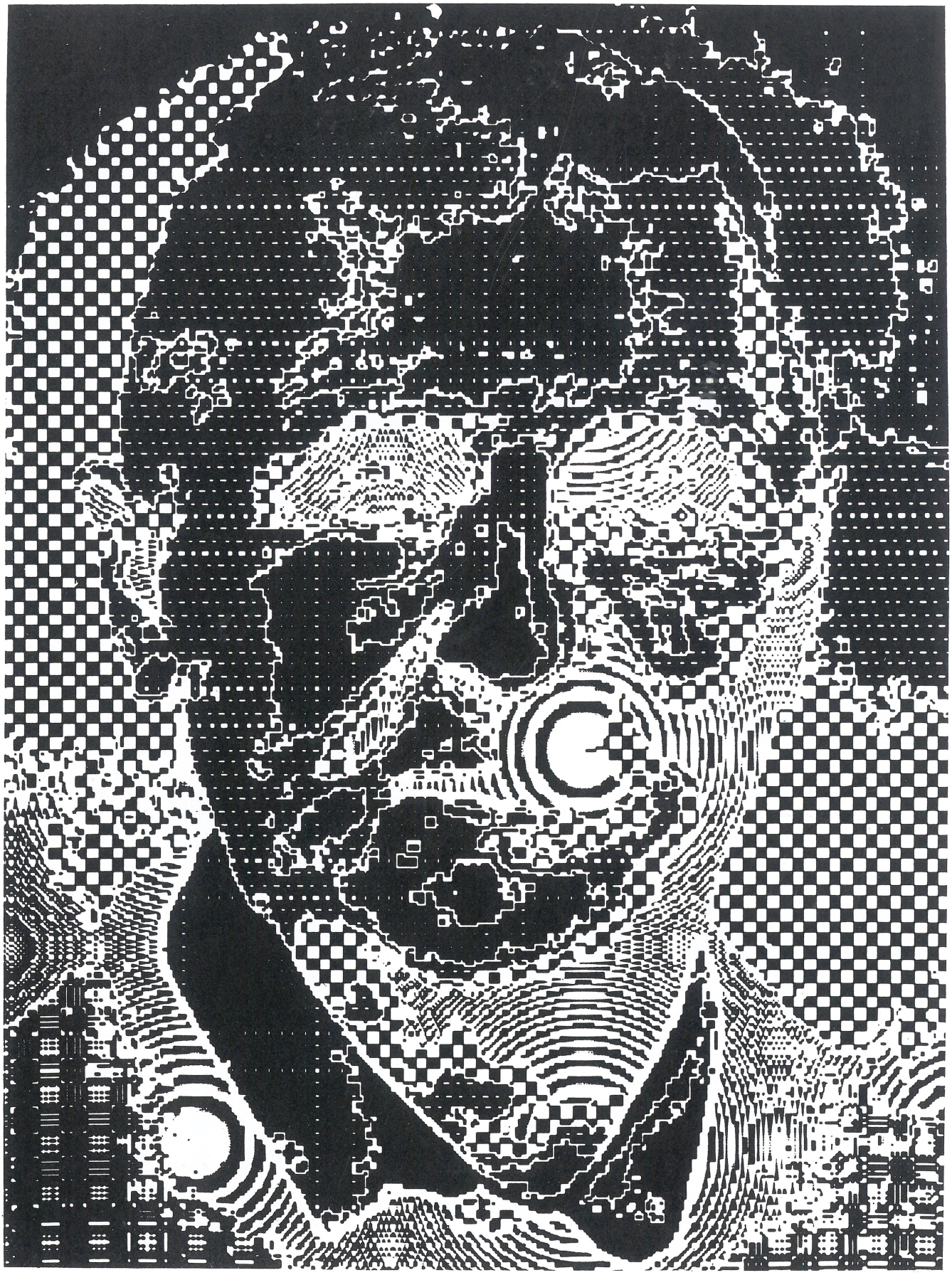




ABOVE: A few illustrations from the superb book by B. Mandelbrot, "Fractals - Form, Chance, and Dimension", a "must" for anyone interested in mathematics and art. This is a unique technical study with excellent illustrations.

HERBERT FRANKE, GERMANY: "Transformation, Anton Bruckner"

BELOW: A photographic reversal of the back cover, the "continent of man".



SOME QUESTIONS

The logical thing at this point would be to ask if we can subject computer art, which is a relatively new art form, to the same scrutiny as enduring art? I believe we can. However, it is only fair to admit that these criteria of art are ideals, and that very little in the manual arts can stand up to this stringent standard.

Computer artists are a very serious, earnest group of artists. As a minority of group of artists, our works have not received a warm recognition from the traditional world of art. However, no new art form that departs from the methods and views of the past is instantly accepted. It takes time for the new vision to become a recognized art form.

Can any group of artists pass judgment on their works of art? The answer is that only time itself can be the judge of merits of works of art. Only temporary assessments can be made.

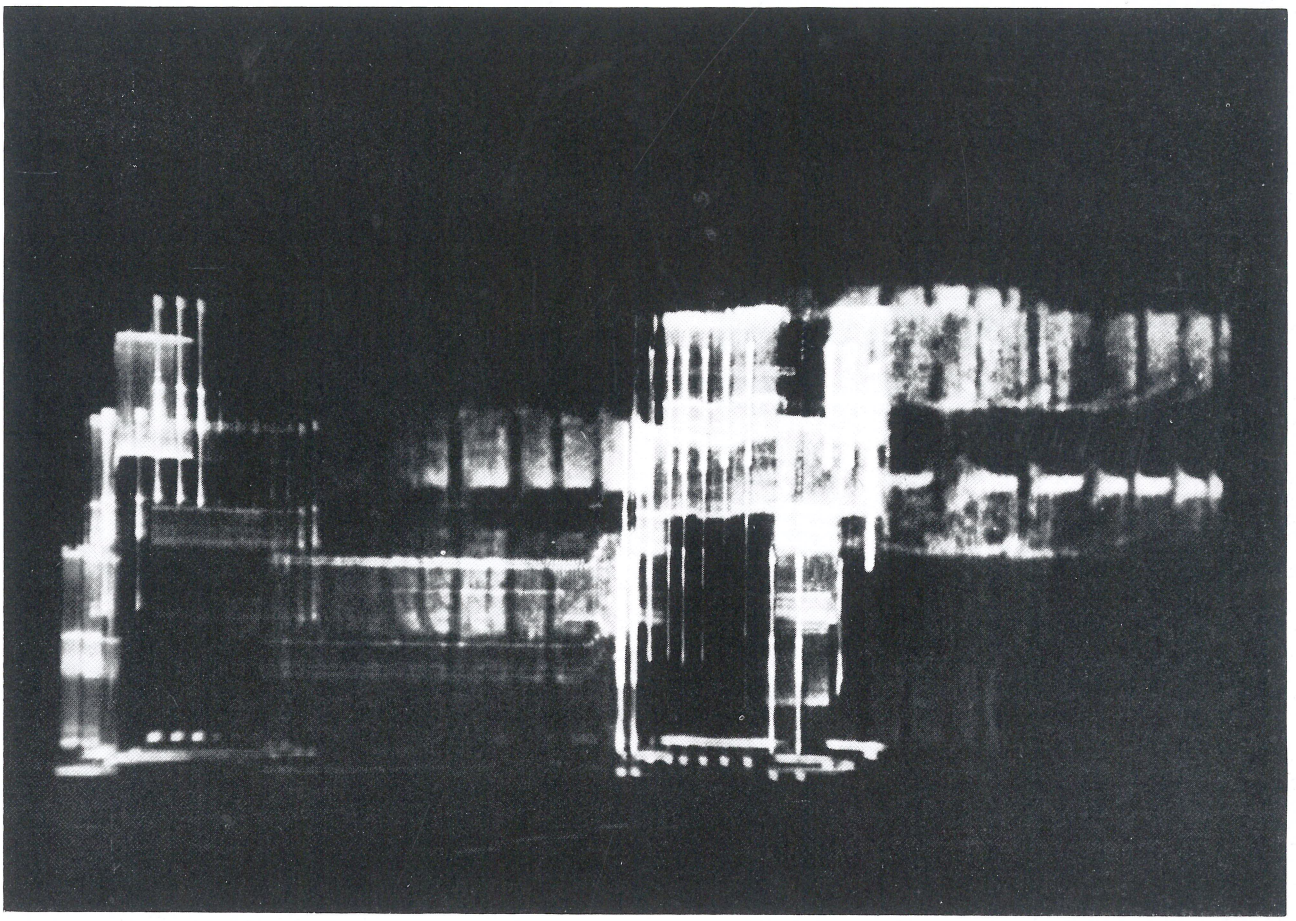
Is there one form of computer art that is more "pure" than the others? Is mathematics and art superior to art in which art aspects are more fully developed? I believe there is a need at this time to begin a taxonomy of computer art.

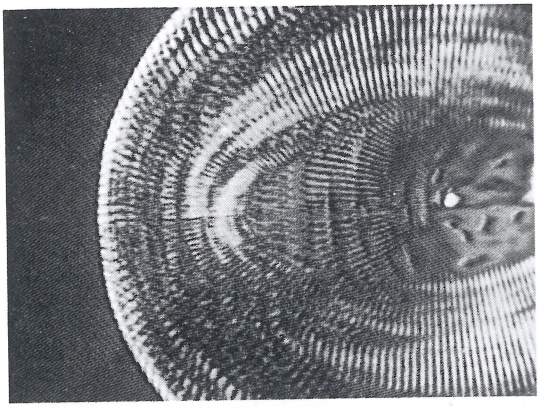
Computer art has matured sufficiently since the 1950s so that a taxonomy of forms should be recognized and utilized. To require computer art to fit into one pattern is intolerant and immature. Moreover, we need to remain sufficiently open in our judgments to allow for new emergent patterns and methods that are bound to evolve.

A great deal of the present controversy regarding the evaluation of computer art appears to be based on an either/or idea: whether the art is mathematically dominant and abstract or representational or natural in origin. Computer art does not have to be abstract or representational. What matters is the quality of the art, not its mode of presentation. I would refer the reader to the views of Edmund Berkeley since 1977 (see /2/, /3/) and my own comments (/4/,/5/) on this topic.

In 1974 I wrote an article, "Computer Art: Steps Towards a Measurable Analysis". /6/ The stylistic analysis of computer art was broken down into five major areas and listed some 192 items within these groups. A good proportion of these categories and listings are viable today. This is not to say that dissection of an art renders it understandable -- but continued analysis of computer art is mandatory.

BELOW: "Imaginare Architektur" by Otto Beckmann, 1977. This graphic, cited by Herbert Franke in his article, is an example of computer art that is innovative and thought-provoking. It is a good candidate for placement in the "enduring computer art" classification, contemporary and yet futuristic.





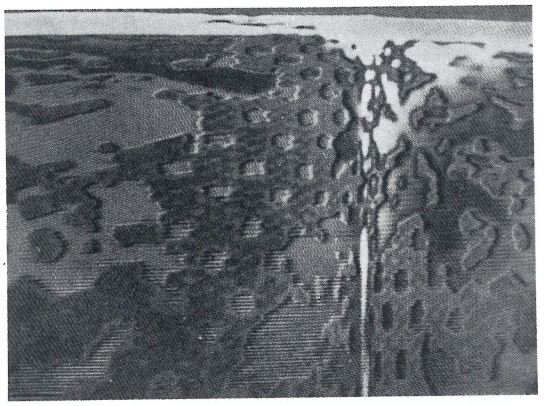
21st Century Sphere

ON THIS PAGE: Very innovative use of CRT images, reflecting superior use of the television medium.

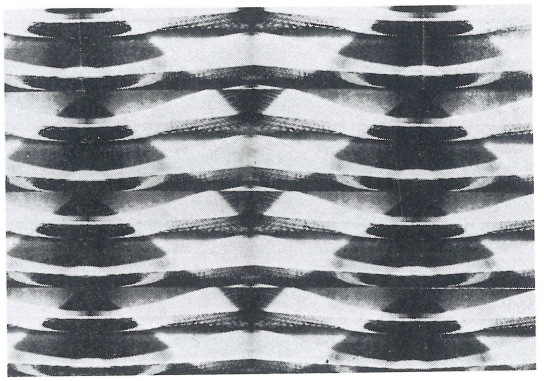
SUSAN CASEY, USA:

Designs for Textiles and Television

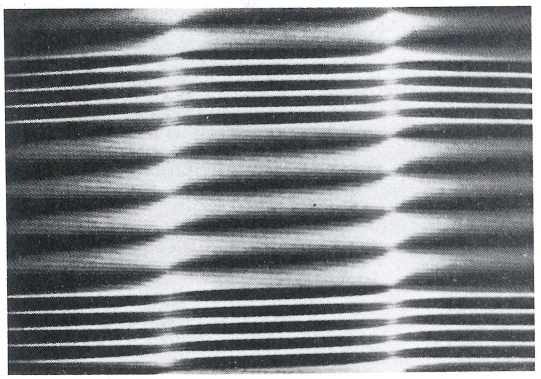
Textile patterns relate to man's early patterns and reflect creative, knowledgeable use of the computer medium. These images would also be innovative paintings and serigraphs.



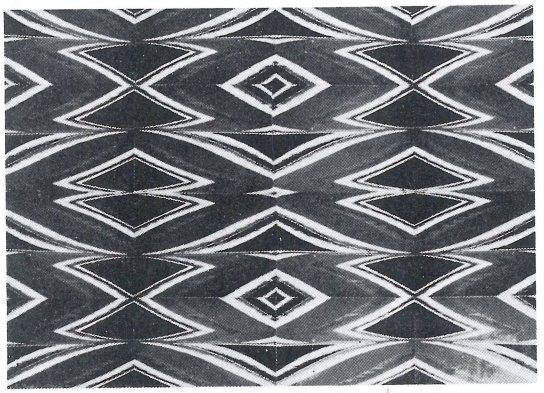
Sunscape



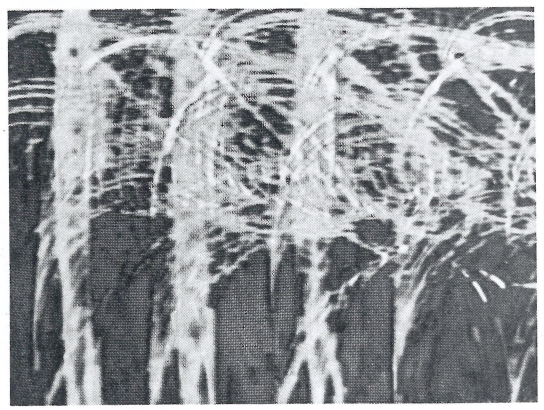
Metamorphosis II



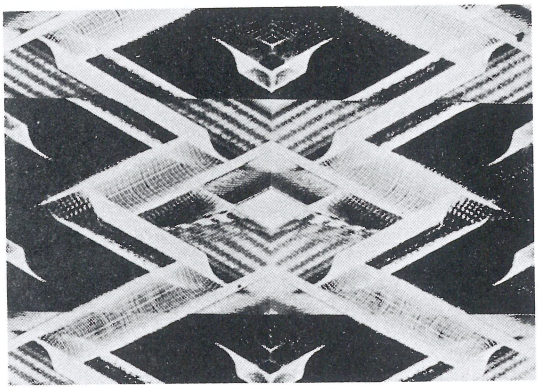
Interior Walls



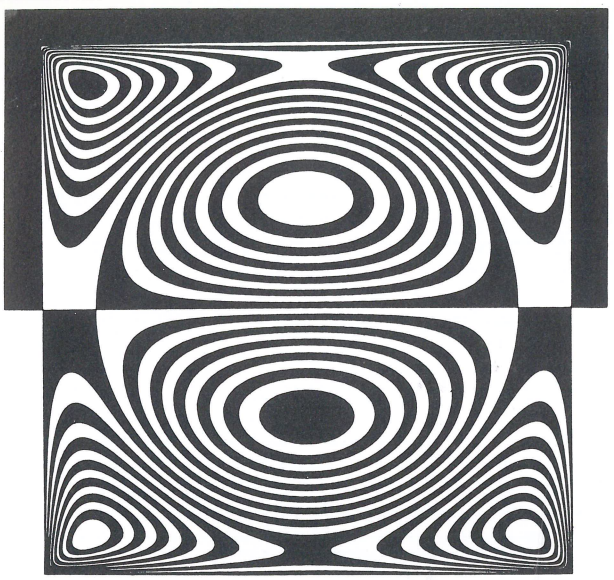
Computer Africa



21st Century Effects



23rd Century Architecture

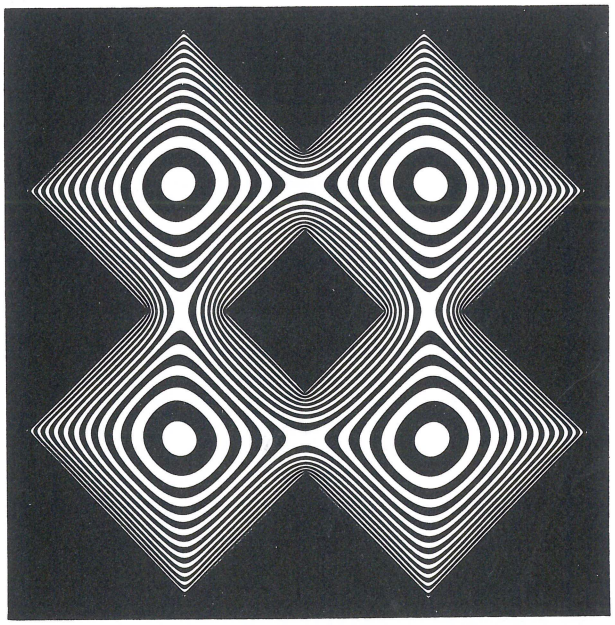


"Negative Reflection" transformation

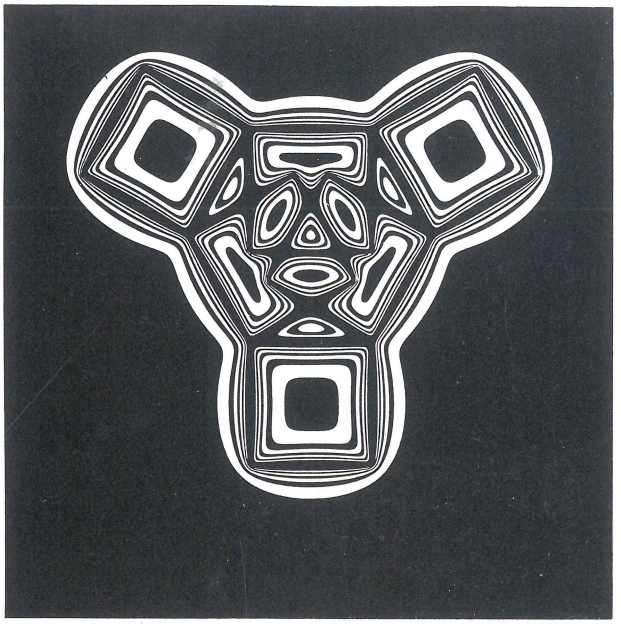
ON THIS PAGE: A variety of transformations by A. Giorgini. Computer images are printed in editions of serigraphs.

ALDO GIORGINI, USA: VARYING TRANSFORMATIONS

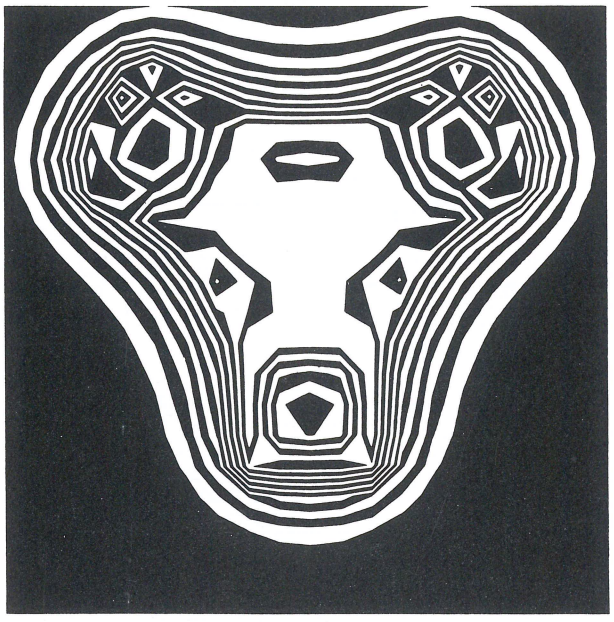
The large silkscreened graphics are impressive, uniting computer-generated images with contemporary fine art.



"X" optical transformation



"Kiss of Europa III"



"Kiss of Europa I"



"Kiss of Europa II"

CATEGORIES OF COMPUTER AND ART

The exhibition, "Cybernetic Symbiosis" was broken down into specific categories of computer art. A listing of eight of these categories was given in the catalog of the exhibition, in the 1979 CG&A Yearbook. Here is a revised listing of categories of computer art. In this listing, no one form or category is considered inferior or superior to the others.

1. EARLY COMPUTER ART (1950s)

Mathematically dominant analog graphics were displayed on TV-like monitors.

2. DIGITAL GRAPHICS, MATHEMATICAL DOMINANCE (1950 TO THE PRESENT)

As mathematics for computer graphics evolved, new variations of design techniques were discovered. CRTs replaced early monitors. Visualizations from many fields were considered as art.

3. ANIMATION, MOVING GRAPHICS (1950 TO PRESENT)

Animators began mathematical explorations of moving graphics in moving sequences on film. The school of moving vs. static graphics explored innovative methods of new computer graphics.

4. TRANSFORMATION, METAMORPHOSES OF PATTERNS (1960 TO PRESENT)

Artist-programmers experimented with algorithms to transform and alter given wire-cage patterns. The resultant designs on CRTs and plotters emphasized a new direction: metamorphosis of pattern. Mathematics dominated these transformations.

5. THE UNION OF ART/SCIENCE - EMPHASIS ON COLOR (1970 TO PRESENT)

Artists became sufficiently interdisciplinary in capacities to reflect the union of art/science. Increasingly, the computer is used as a designing colleague to create new families of forms. Output is taken back into the varied arts: sculpture, photography, lithography, etching, serigraphy, painting, sculpture, weaving, TV, etc.

6. ART DOMINANCE - ABSORPTION OF THE COMPUTER (1970 to PRESENT)

Groups of artists from fine art began to use the computer as another art medium. Art techniques, underpainting, overpainting, printmaking, painting techniques dominated. A strong art dominance indicated apparent absorption of the computer by art.

7. ART HISTORY - STYLISTIC ANALYSIS OF ART AND VARIANT CREATION (1960 TO PRESENT)

Groups of artists began stylistic analysis of art, with the creation of generative works in the original historical style. Output was varying, ranging from transformations to creative manipulation of generative works in a given style.

8. A DESIGNING COLLEAGUE - DESIGNS MEANT FOR PAINTING, SCULPTURE, WEAVING, ETC.

Absorption of the computer as a designing tool led groups of artists to use the computer merely as a device to design innumerable variations of given forms or combinations of forms. Works were intended to be executed manually or mechanistically.

9. APPLIED COMPUTER ART (1973 TO PRESENT)

Photography, film, television, advertising, package design, are the final forms. Works are intended for mass media consumption. Emphasis is often on combinations of media.

10. ART AND NATURE - NATURE VS. ABSTRACTION (1970 TO PRESENT)

Representational or lyrical motifs from nature are used as input source designs. Natural images are deemed more important than abstract forms. These are tastefully varied by the computer in new combinations, affording final works that transcend mere decorative pattern manipulation.

11. CONTINUED EXPERIMENTS IN ART

As each year passes, innovators find new ideas to explore. Colored graphics become available and are used more extensively. Solid-appearing systems are available. Animation becomes affordable and possible for more artists. Tablets, light pens use curved images, mathematical functions. Combinations of new ideas, software and hardware reveal a stream of new images, going beyond the past. The trend for experimentation is limitless.

THE FUTURE

In looking hard at some of these ideas, it appears that what computer artists are asking for is tolerance -- acceptance by the art world of the computer as a viable tool to use in the creation of art. Our gauntlet is to create art forms for a larger audience, not just for scientists, but for other human beings. Our task is to be modest, not declaiming and proclaiming this and that -- but to produce art forms that are so compelling and so provocative that people seeing them will be moved by them, inspired by them. Our task is to affirm our technological age and to present it affirmatively in the mirror of our creations.

Our world today needs the vision of an art that symbolizes a positive symbiosis of technology and human expression. Such an art will inevitably be accepted as a fine art form.

REFERENCES

/1/ Hertlein, Grace C., "The State of the Art of Computer Art 1979," Computer Graphics, July, 1979, Vol. 2, No. 6, p. 13-22.

/2/ Berkeley, Edmund C., "Computer Art: Possibilities for Future Improvement," Computer Graphics and Art, August, 1977, Vol. 2, No. 3, p. 22-25.

/3/ _____, "Computer Art - New Directions?" Computers and People, Sept.-Oct., 1980, Vol. 29, No. 9-10, p. 6

/4/ Hertlein, Grace C., In Defense, in Praise of Computer Art and Graphics," Computer Graphics and Art, November, 1977, Vol. 2, No. 4, p. 3.

/5/ _____, "The Criteria of the Computer Art Exposition of 'Computers and People,' in 1980," Computers and People, Sept.-Oct., 1980, Vol. 29, No. 9-10, p. 7, 13.

/6/ _____, "Computer Art: Steps Towards A Measurable Analysis," Computers and People, May, 1974, Vol, 23, No. 5, p. 13-17.

GERMAN COMPUTER GRAPHICS & COMPUTER ART SOCIETY

by The German Computer Graphics and Computer Art Society, Incorporated
Gesellschaft fur Computergrafik und Computerkunst (GCC)
D-8043 Unterfohring
Munich, Bavaria, GERMANY

THE COMPUTER GRAPHICS AND COMPUTER ART SOCIETY (GCC)

The Computer Graphics and Computer Art Society was founded on November 30, 1978. It is an incorporated association and certified to be a non-profit organization (number in the German register of associations: Munich 9477). The non-partisan and non-demoninational organization provides spiritual and material support for technical arts.

PURPOSE

It is the task of the Computer Graphics and Computer Art Society to foster technical and especially computer generated visual art. While the representatives of the established schools of art enjoy wide acceptance, the avantgardists of computer art have hardly any means at their disposal. The application of electronic media in art makes new fields of esthetics accessible and yields a high innovative potential. It is the constructive and artistic application of new technical means that serves the further development and integration of these techniques into our culture and civilization.

For example, what computer graphic artists have performed to reduce hostile feelings toward science and engineering is indispensable as a stabilizing factor in socio-cultural development. This is why this school of technical art deserves more acceptance and support.

Support is provided by the Computer Graphics and Computer Art Society in the form of consultation and advice, contacts, information on relevant activities and public presentation of all types of computer art.

The Computer Graphics and Computer Art Society is a forum for all those who are applying informatics and electronics in a free artistic way.

COMPETITION 1979

In the year 1979 the society arranged the first competition for computer graphics, with an expert jury awarding prizes for artistically outstanding graphics. This competition was repeated in the year 1980. The German branch of the computer company, National Cash Register (NCR), sponsored these competitions, granting about DM 20,000 ($12,000) in awards.

A special prize of the jury was awarded to the Study Group for Media Development of the Design Academy in Offenbach, headed by Professor Manfred Eisenbeis, for their video graphic system, MOSAIK. MOSAIK has been developed by order of the German Federal Postal Administration as a computer graphic system for VIDEOTEXT.

For the computer graphics competition in the year 1979, over 150 graphics were submitted. The jury, presided over by Dr. Herbert W. Franke, awarded prizes to the following artists:

FIRST PRIZE: Hans Korneder, Munich
MOTIF, 6 CENTERS (Figure 1)

SECOND PRIZE: Vera Molnar, Paris
LETTERS (Figure 2)

THIRD PRIZE: Axel Miessner, Grafelfing, West Germany
MOTIF, MAN OF MUNICH (Figure 3)

FURTHER AWARDS:

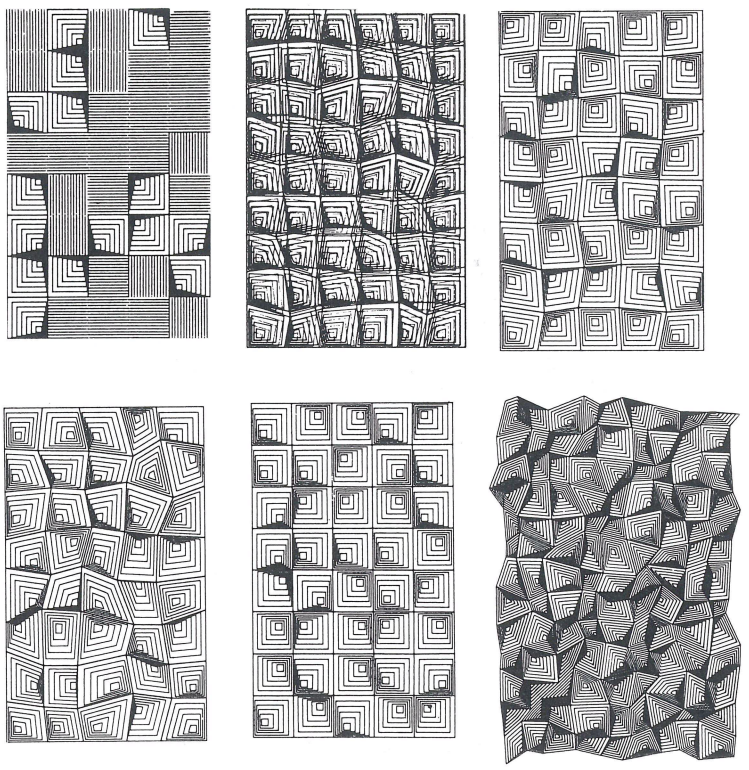
- Hermann Bense, Coesfeld, West Germany
- Robert Stoibert, Neubiberg, West Germany
- Reimer Harnisch, Furtwangen, West Germany
- Herbert Brun, Illinois, USA
- Arno Groth, Kiel, West Germany
- Karin Hohner, Lochham, West Germany
- Marita Schulik, Essen, West Germany

COMPETITION 1980

250 artists participated in the 1980 competition. The jury consisted of:

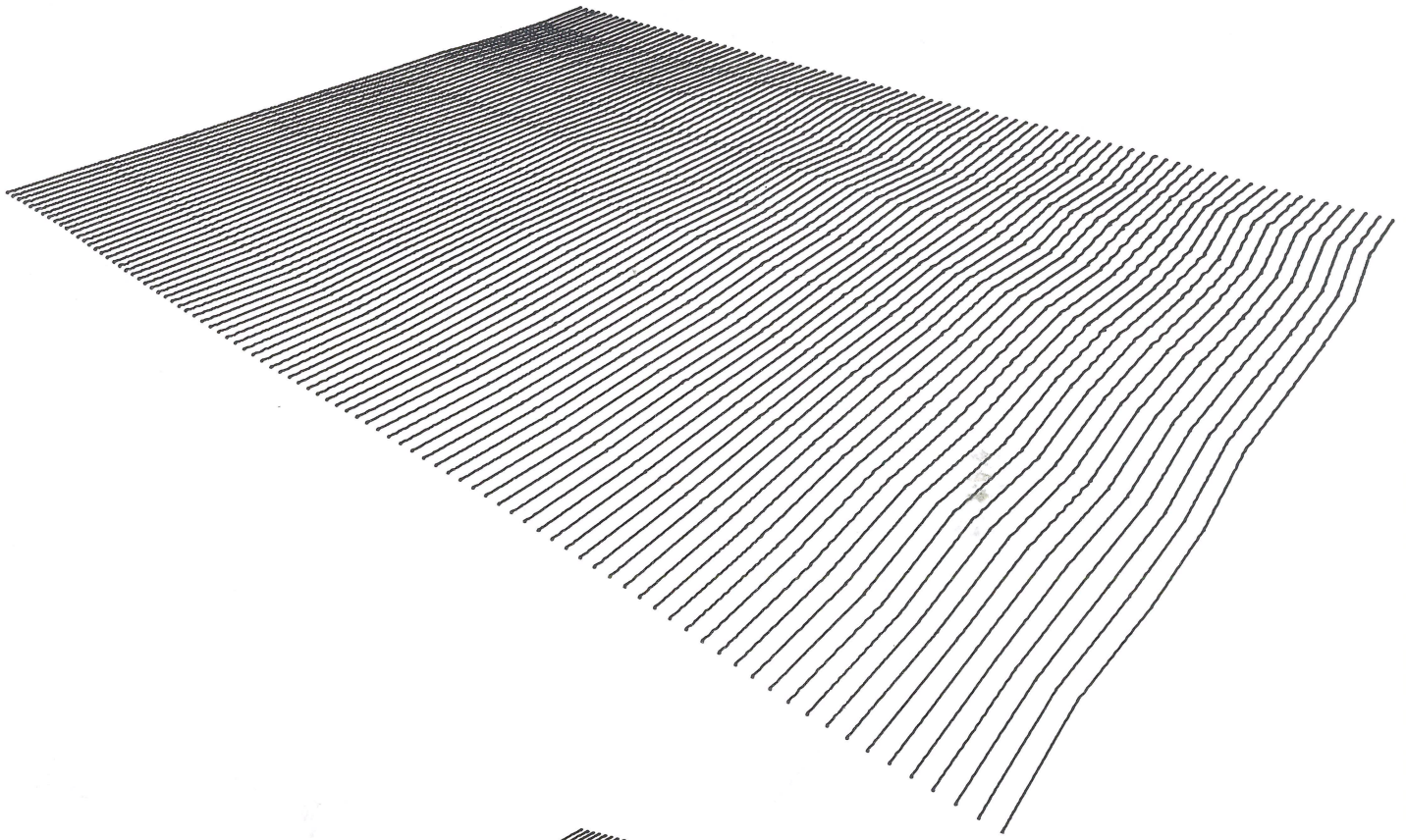
- Dr. Herbert W. Franke
- Professor E. Knoop
- Professor H. Daucher
- Reiner Schneeberger
- D. Pracht

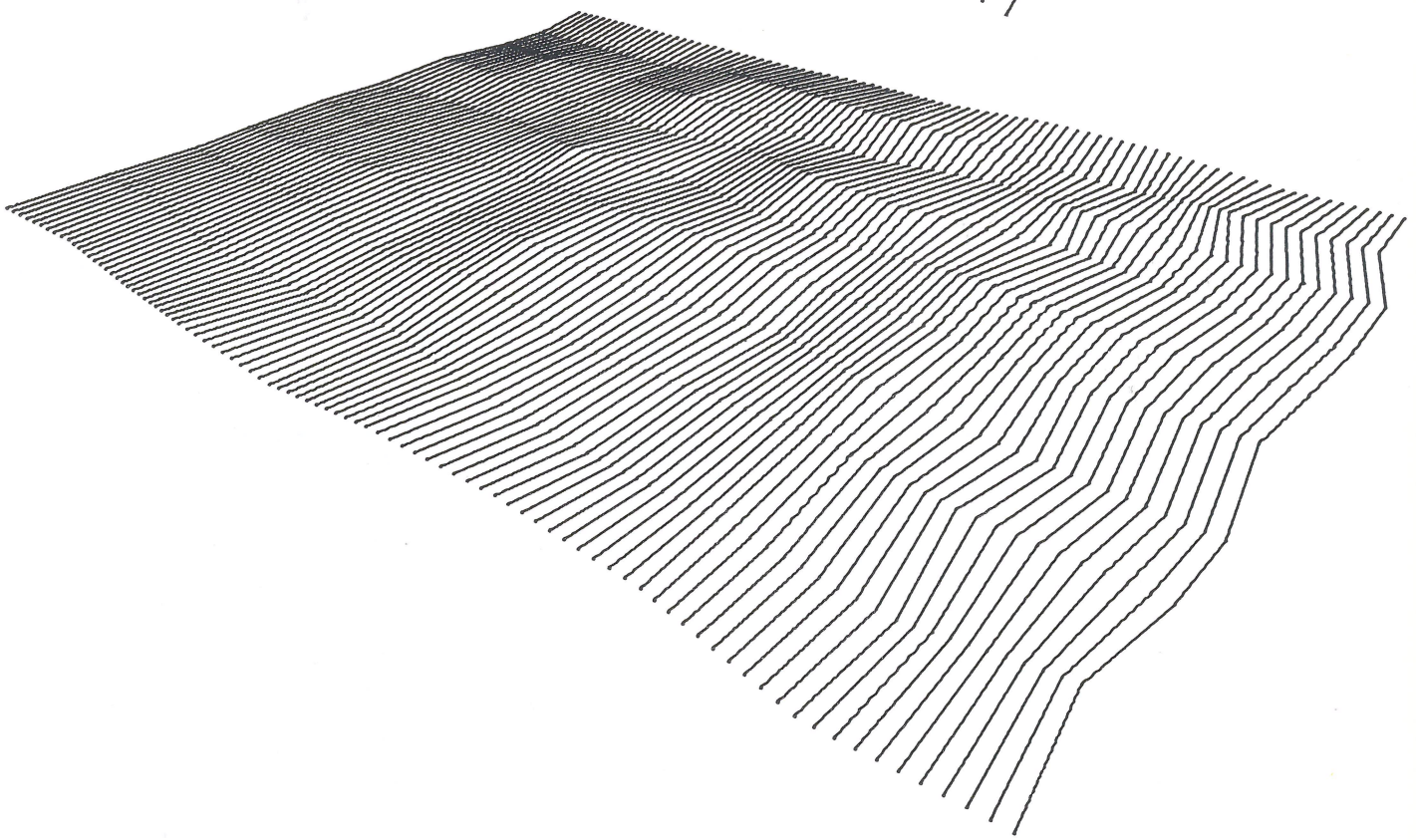
BELOW: "Six Centers" by Hans Korneder, Munich.



FIRST PRIZE, GCC 1980 COMPETITION: ROBERT STOIBER, MUNICH, GERMANY

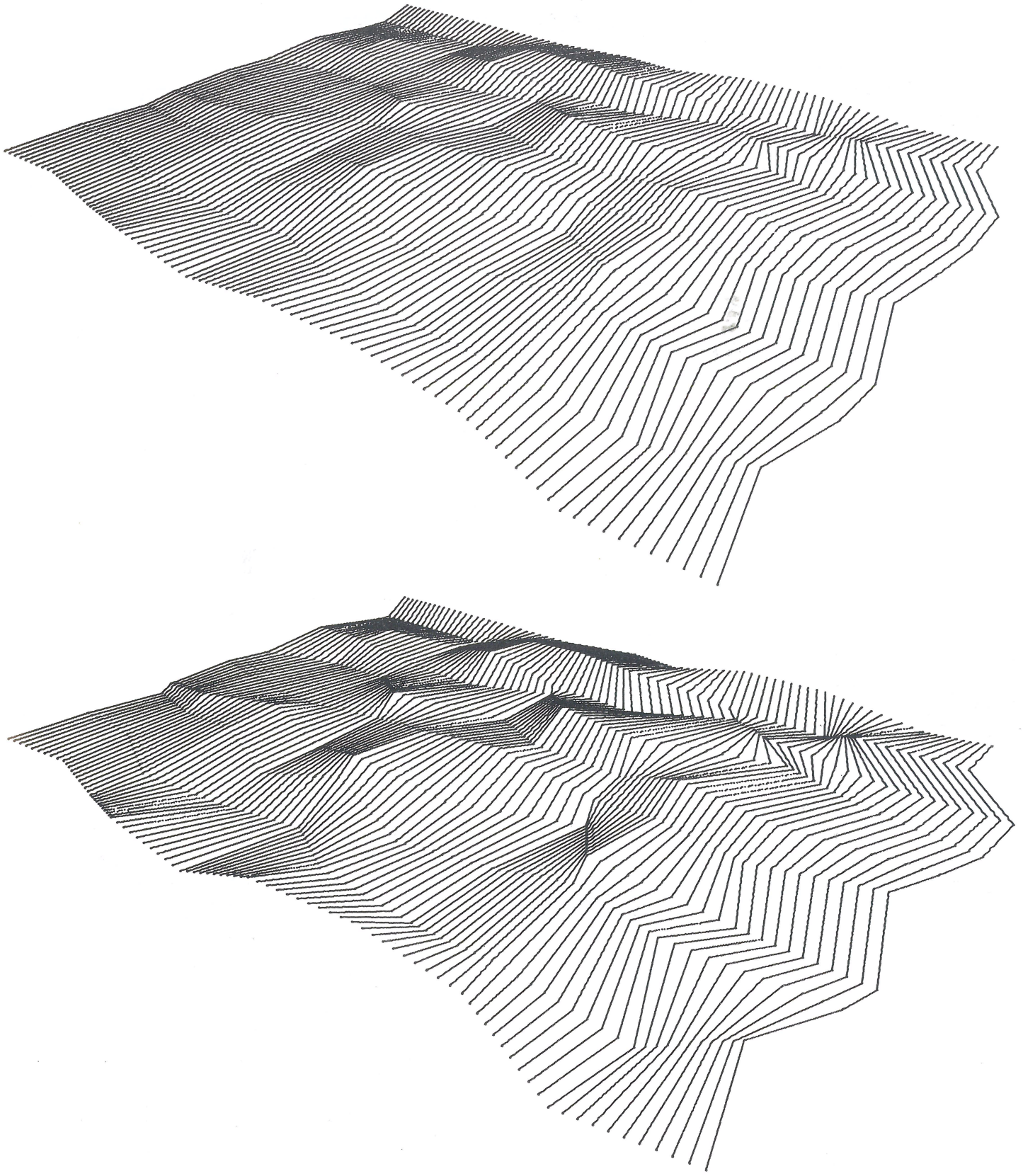
"Ebene im Umbruch", a series of six explorations, using the perspective functions of the GCC PLOTSOFT basic functions of SNE COMP ART. The works are presented here in their original size, as the series becomes more complex and dynamic in form.

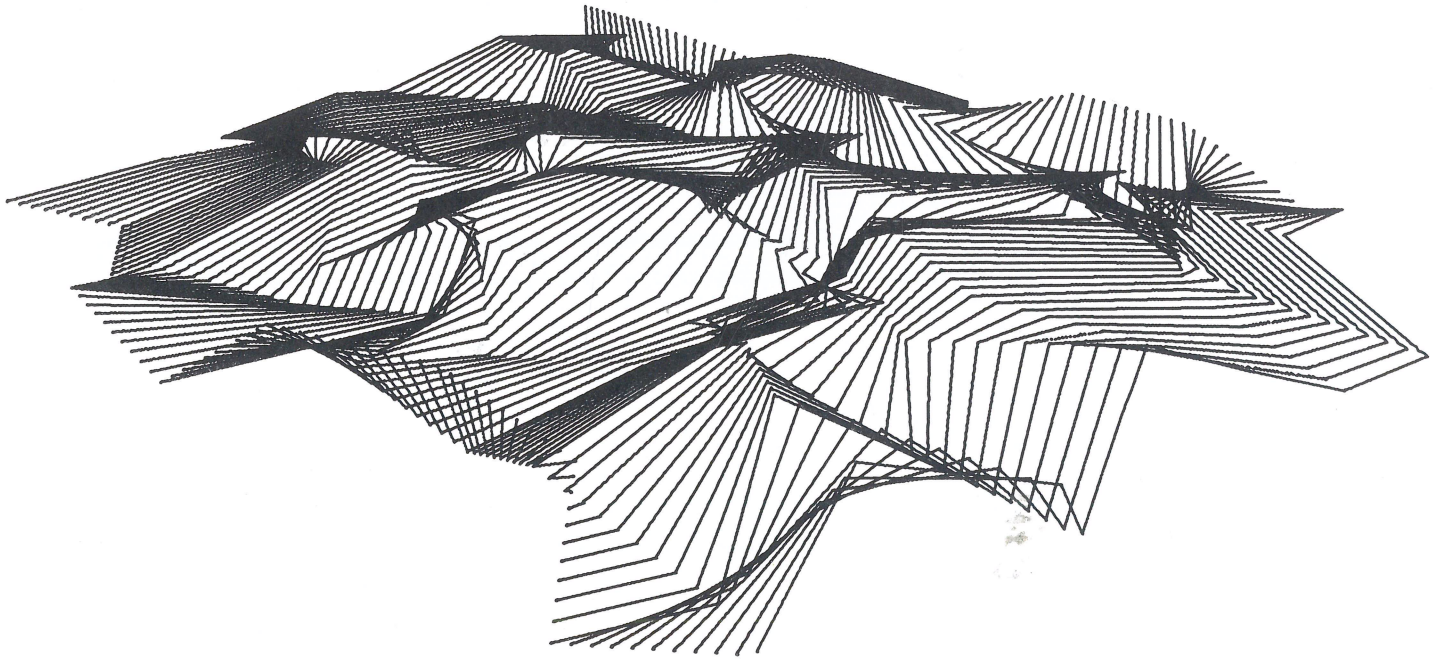




ROBERT STOIBER, MUNICH, GERMANY

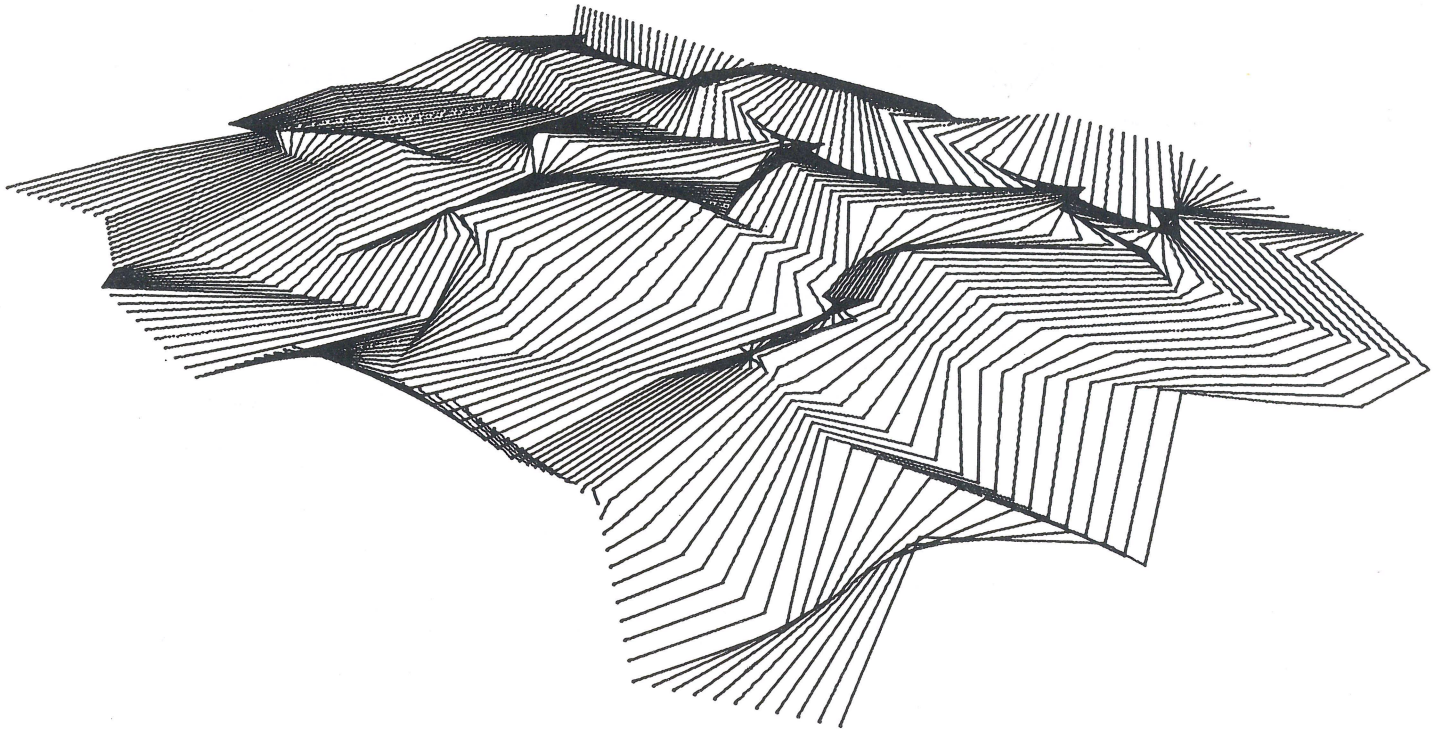
Graphics 3 and 4 from the "Ebene im Umbruch" series. The Z axes become more dominant as the series progresses, resembling abstract geologic patterns from nature.

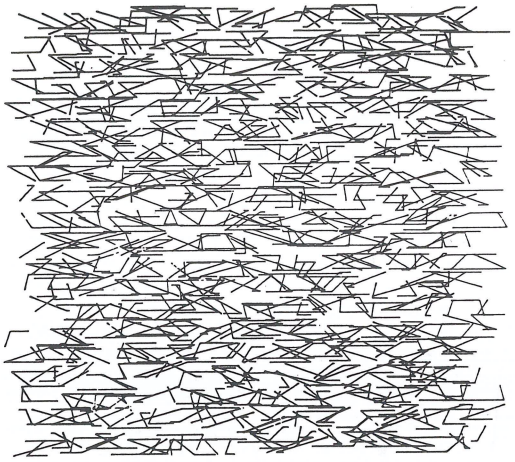




ROBERT STOIBER, MUNICH, GERMANY

Graphics 5 and 6 from the GCC prize-winning series by R. Stoiber. Here the patterns are convoluted and twisted, resembling faults from geological deformation. The final works were printed in a limited edition of fine art prints, along with other GCC prize-winning graphics.





ABOVE: "Letters" by Vera Molnar, Paris. All the artist's works are taken into fine art, in manually-painted (computer-designed) canvases.

The following artists were awarded prizes in the 1980 competition:

FIRST PRIZE: Robert Stoiber, Neubiberg,

The following artists were awarded prizes in the 1980 competition:

FIRST PRIZE: Robert Stoiber, Neubiberg, West Germany
MOTIF, RIBBONS

SECOND PRIZE: Claudia Keller, Dusseldorf, West Germany

THIRD PRIZE: Christian Cavadia and Jerome Hecquet, Paris

FURTHER AWARDS:

- Hermann Bense, Coesfeld, West Germany
- Drago Vukovic, Paris
- Karin Hohner, Planegg, West Germany
- Udo Hebisch, Soest, West Germany
- Hans Korneder, Munich, West Germany
- Fromund Kloppe, Russelsheim, West Germany
- Wolfgang Beyer, Freiburg, West Germanh

SERVICES

From its beginnings in 1977, the GCC could place at the disposal of its members, varied computer systems. One of these systems was a SALOTA MFC 512-typed computer system (Z80A, 64 KB, 2x512 KB Floppy-Disk) with an operating system CDOS by Cromenco. A generous donation by the Kontron Elektronik Company of two plotters, a Houston HIPLOT and Houston COMPLOT DP 1010 enabled the GCC to set up a complete computer graphic service for members and interested persons. A 3-D graphic software PLOTSOFT and a new version of the computer art system, SNE COMP ART, was implemented, with Hans Korneder heading the undertaking. At present, this software is expanded by the study group computer film and video-art, to enable interactive working at the screen, and transfer to video equipment is being developed.

In addition, information on new ways of cooperation and innovations available at the demonstration center of the society is supplied periodically to the members in the form of circular letters known as GCC-INFO letters.

MEMBERS

The society was founded by computer graphic artists assisted by Dr. Herbert W. Franke and Reiner Schneeberger in Germany in 1977. Today it comprises approximately 300 members, including artists, data processing specialists, designers, photographers, etc. Dues are DM 60 ($35 approximately) annually.

BOARD OF DIRECTORS

At present the members of the board are:

Andreas Nottebohm, painter and video artist in New York

Reiner Schneeberger, computer graphic artist in Munich

Heidi Vogl, lawyer in Munich

ADVISORY BOARD OF ART EXPERTS

The artistic quality of the activities of the Computer Graphics and Computer Art Society is supervised by the advisory board of art experts consists of:

Dominic Boreham, Chief Editor of the computer art periodical, Page, London, England

Manuel Barbadillo, free-lance painter and computer graphic artist, Malaga, Spain

Roger Coqart, photographer and computer graphic artist at the Free University, Brussels, Belgium

(See the next page for conclusion of art experts.)

BELOW: "Man of Munich" by Axel Miessner, Grafelfing, West Germany.



Dr. Herbert W. Franke, computer artist, international authority and writer on computer art, and co-founder of GCC

Grace C. Hertlein, computer artist, writer, editor and publisher, and Professor of Computer Science, California State University, Chico

Gottfried Jager, Professor of Photographic Art at the Design Academy, Bielefeld, Germany

William Kolomyjec, computer artist and lecturer for computer graphics at Michigan State University, East Lansing

Francois Molnar, Professor for Theory of Art at the University of Paris I (Sorbonne)

Klaus Staudt, Professor at the Design Academy in Offenbach, Germany

PUBLICATIONS AND EXHIBITIONS

Since its formation in 1977, the German Computer Graphics and Computer Art Society (GCC) has issued more than 400 publications, mainly in the German-speaking countries, in the years between 1978 and 1980. Several broadcasting companies have reported on the GCC competition. An exclusive report on the computer graphic and computer photographic work of leading artists of the GCC and the University of Munich art professorship, under the esthetic guidance of Reiner Schneeberger has been published for Graphic Design International 2 (ABC Publishing House, Zurich, New York). The GCC has designed and photographically realized an exclusive series of computer graphics for first presentation at the Hannover Fair on behalf of the Tax Advisory Association, DATEV. In cooperation with Scandecor International (Sweden), orders were placed with several computer graphic artists of the GCC to produce computer graphic posters. The "SOLATRON" motif of this poster series has sold extremely well in Germany.

Furthermore, the GCC carried out various minor orders to prepare motifs for annual reports and similar purposes on behalf of a variety of organizations, including the Bavarian Metal Industry Assocation. It also arranged several exhibitions, among others, in the municipal museum of Munich and in the "familia" shopping mall in Heidelberg.

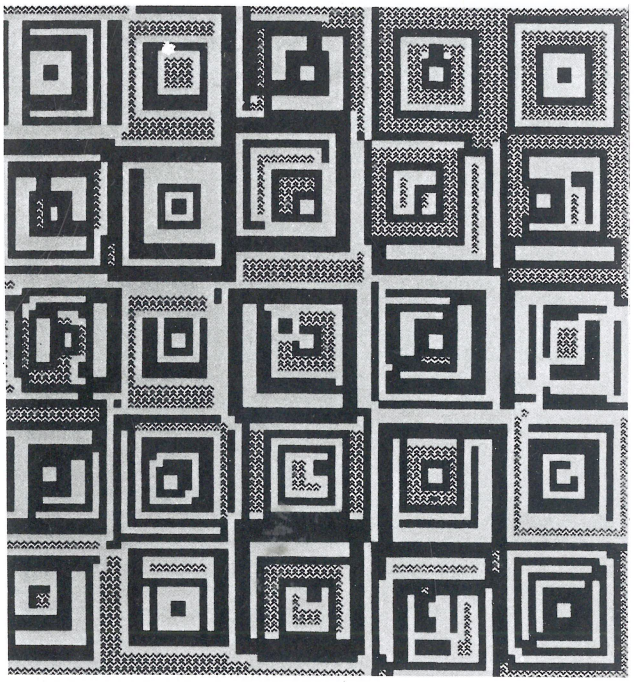
MEMBERSHIP

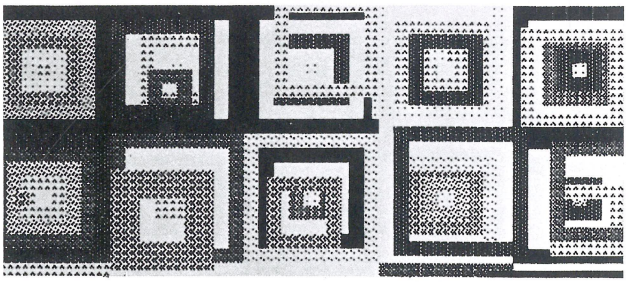
The association admits as members: natural persons of full age, legal entities, scientific institutes, artistic organizations, authorities and not incorporated societies from Germany and abroad if they are willing to engage in activities related to the association.

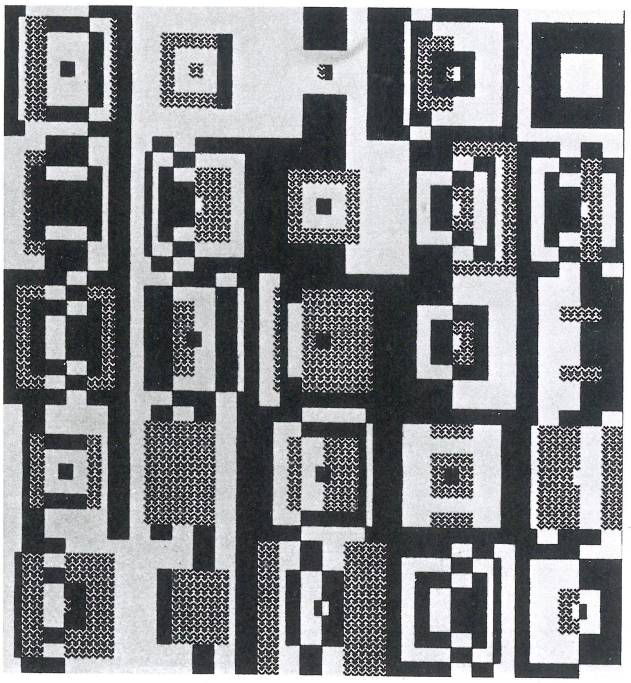
Those interested in further information may write:

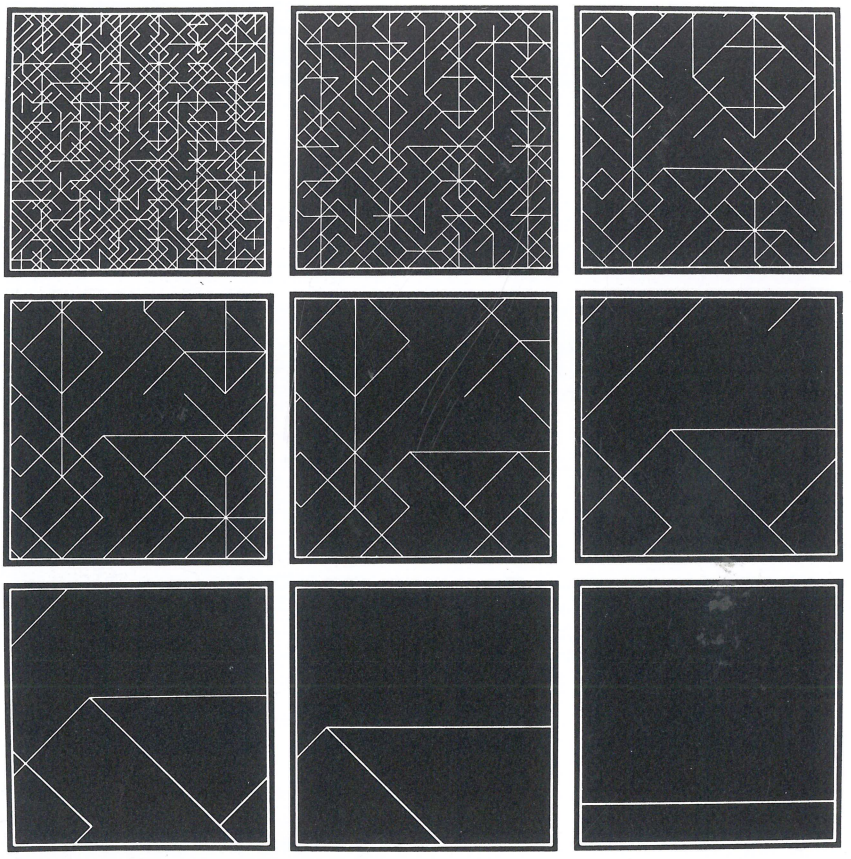
The German Computer Graphics and Computer Art Society, Incorporated (GCC)
D-8043 Unterfohring
Munich, Bavaria, GERMANY

CHIHAYA SHIMOMURA, JAPAN: PICTURE TRANSFORMATION









GRIDS AND COMPUTER ART

by Roger Coqart
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Faculté des Sciences Appliquées
Laboratoire Jacques Verdeyen
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1050 Bruxelles, BELGIUM

Grids have been used in art since the very beginning of our civilization. Grids in art have had both artistic and functional purposes. Description of the traditional uses of grids in the varied arts have been published on different occasions. /1/, /2/

We may briefly remember that the Egyptians used grids to establish a canon of figure proportioning in wall frescoes. This method for establishing size relations for the human body remained a traditional device afterwards.

During Medieval and Gothic times, grids were used as a transference device from a sketch on paper to large painting surfaces. Islamic art makes use of nonfigurative or "abstract" compositional structures, of which the grid is often the basic element. In Op art, one way to produce visual illusions of motion or image fluctuations is through repetition of points or lines. Ordinary graph paper has become a relatively common drawing surface for artists, as a basis for design development.

In the last few years I studied computer generated grid structures, which I consider as autonome works of aesthetic nature and which I use in large size paintings and murals or in conceptual panels (3 to 5) using a series of computer-generated drawings. An example of this is shown in Figure 1, where I want to illustrate the use of cropping the original grid of Figure 2 with a zoom-like effect. Each one of the nine obtained drawings shows an entirely different composition and could be used independently.

Another example of isolating a relatively small part of a computer-generated grid is shown in Figure 3, where the different stages of decision are marked by different coatings of white paint on canvas. (See page 60.)

The accent of my work lies not on the sophisticated use of the computer or its languages but on the utilization of isolated details or of ideas. This way of working may be dictated by the photographic work I have done for almost twenty years.

The grids which preoccupied my art for the last few years are principally of two types. Figure 4 shows an example of a grid based on the distribution of randomized arrangements of simple line elements. The number of elements or

density of the grid is determined at the conceptual stage. The grid is plotted line by line after the introduction of the chosen sequence of the number of elements to be traced in one module. This sequence can be reduced to a single element or be extended to the whole drawing.

A certain visual play is obtained between the line intersections and the gaps by the suppression of some lines. These gaps can be created by blank modules which dramatically underline the symbolic value of some compositions, as shown in Figure 4, where each grid reflects some components of the single basic module, and where the whole composition reflects the simple logic used in this kind of geometric abstraction.

Another type of grid I use is seen in Figure 5. It is a combination of multiple grids. One grid is formed by the regular alignment of small squares in rows and columns. This grid seems to lie in the foreground with another grid as background, formed by the overall picture behind the individual squares or "windows" within which may or may not be a grid -- or parts of a grid. The small squares are either blank or contain one or more line elements arranged in an arbitrary order. (See page 59 for examples.)

Random numbers are used to determine the direction of the lines to be traced, their starting point and the sequence in which they are to be traced in each of a series of the squares. The choice of the number of elements in each square depends on the predetermined program.

The random numbers are used here in a statistical sampling procedure, in order to take advantage of the properties of combinatorics as a means of attaining a definite structural order through objective handling of geometric line elements. Indeed, the range of possible permutatations of the encoded line elements offer a wide variety of entirely different pictures.

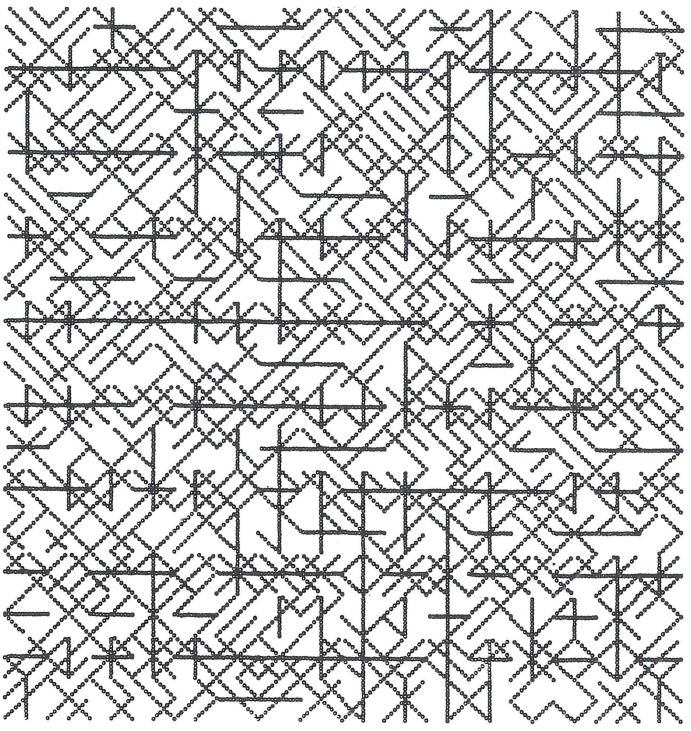
The use of statistical sampling excludes human intervention and insures the objectivity with which the picture is executed. Digital computers offer the most effective way of dealing with this kind of approach.

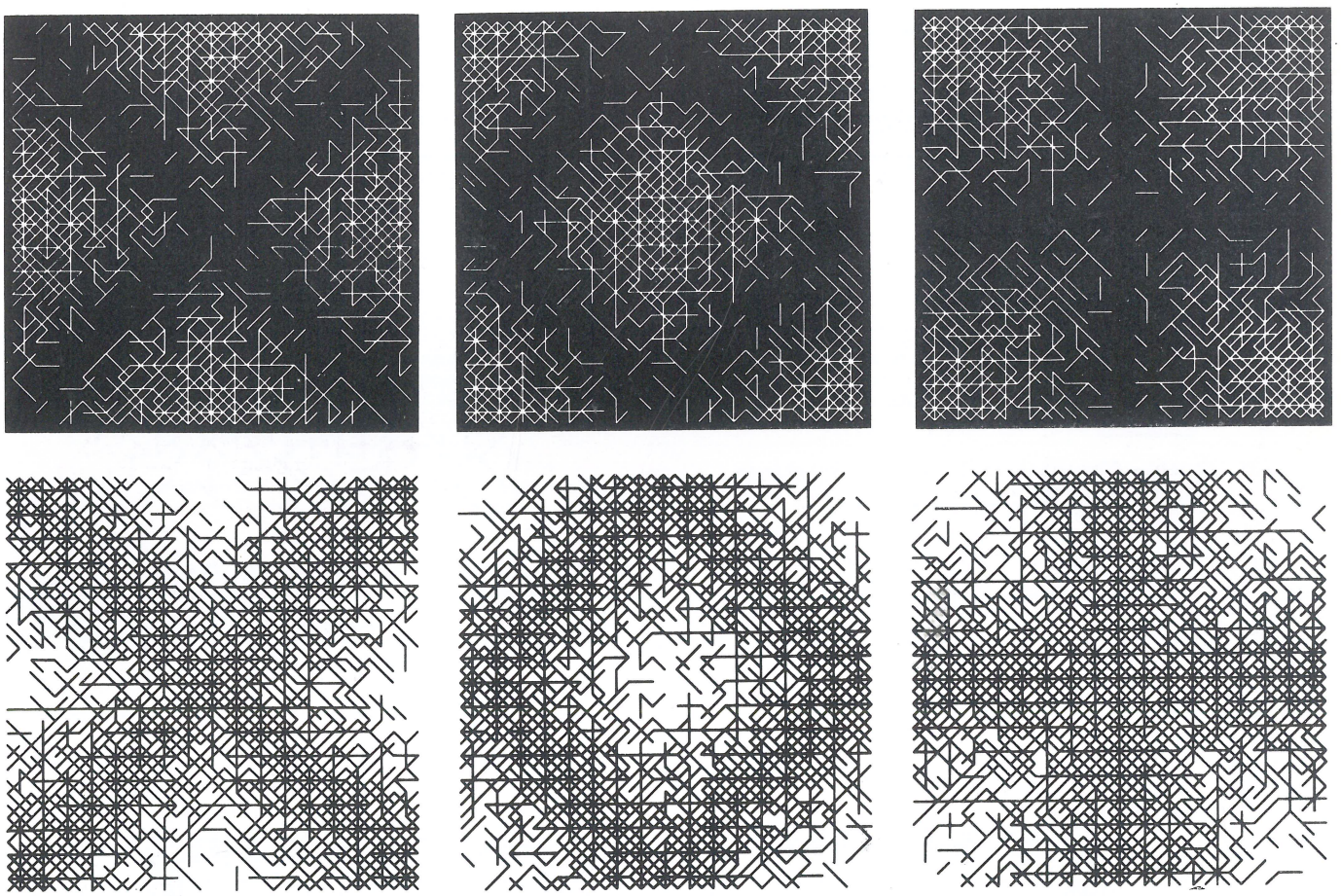
I own an already old-fashioned WANG 600 system with cassette as well as floppy disk storage, and it is equipped with an incremental plotting writer. The exclusive language of this system is not the most elegant form of program publication, and exchange of programs is limited to owners of identical machines.

Since my quest is not one of technological perfectionism nor a thirst for sophisticated software, but the pursuit of objectivity in the construction process of geometric abstraction, this elementary equipment is most satisfying at this stage of my work.

Parallel with the computer-assisted grid constructions, I continue my experiments and research in photography. Back in 1973, when I began experimenting with computer graphics, the first work has strongly inspired by my works in photography -- so actually the process seems to be reversed, and my photography is now influenced by the computer-assisted work, as seen in Figure 1, page 57.

BELOW: Figure 2 by Roger Coqart, a combination of grids. Note the effectiveness of the computer graphic planning taken back into the varied arts.





ABOVE: "Positive Grid Structure" (3,4,11) and "Negative Grid Structure" (2,8,10) by R. Coqart, Figure 4. Final works were painted on a large plexiglas mural.

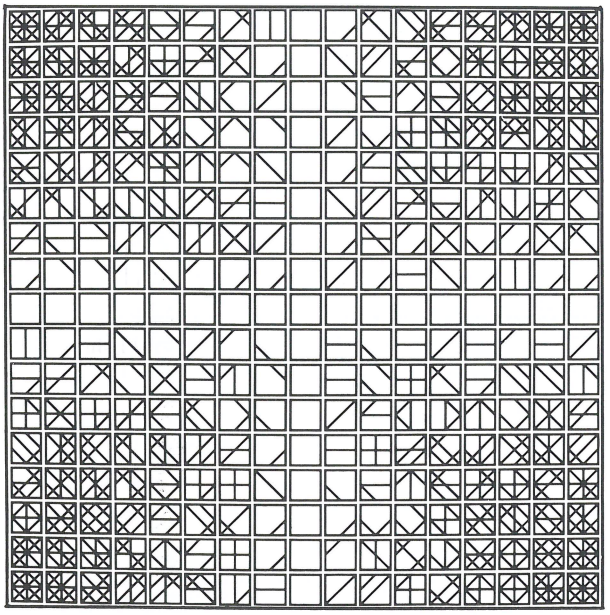


Fig. 5
Roger COQART - 1980
(enamel on plexiglas)

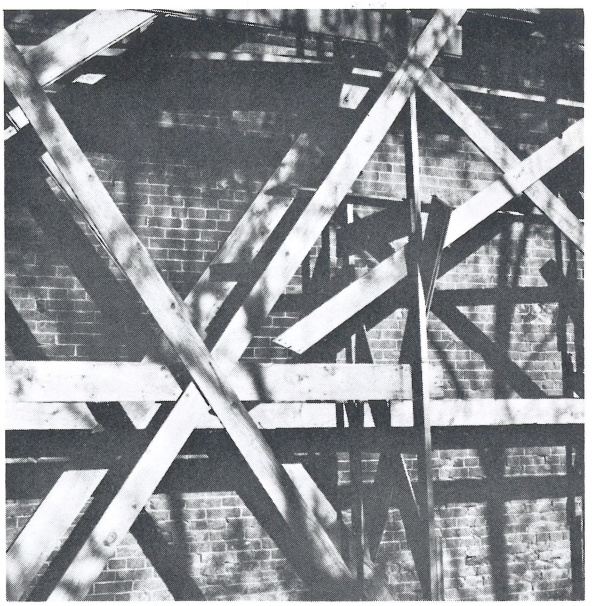


Fig. 6
Roger COQART -
Jamestown, California

This interaction is certainly not one of the least advantages for any artist to learn computer programming. Not only the subject matter is influenced, but also the approach of the medium itself, because of the habit of analyzing facts, figures and ideas in programming the computer.

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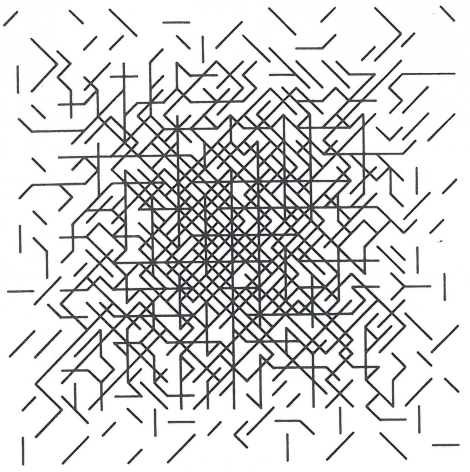
/1/ Davis, J. W., "Unified Drawing through the Use of Hybrid Pictorial Elements and Grids," Leonardo 5, 1, 1972.

/2/ Goldin, A., "Patterns, Grids and Painting," Artforum 50, September, 1975.

/3/ Coqart, "Graphics Applications: Paintings, Computer Graphics and Art, Vol, 1, No. 3, August, 1976, p. 24.

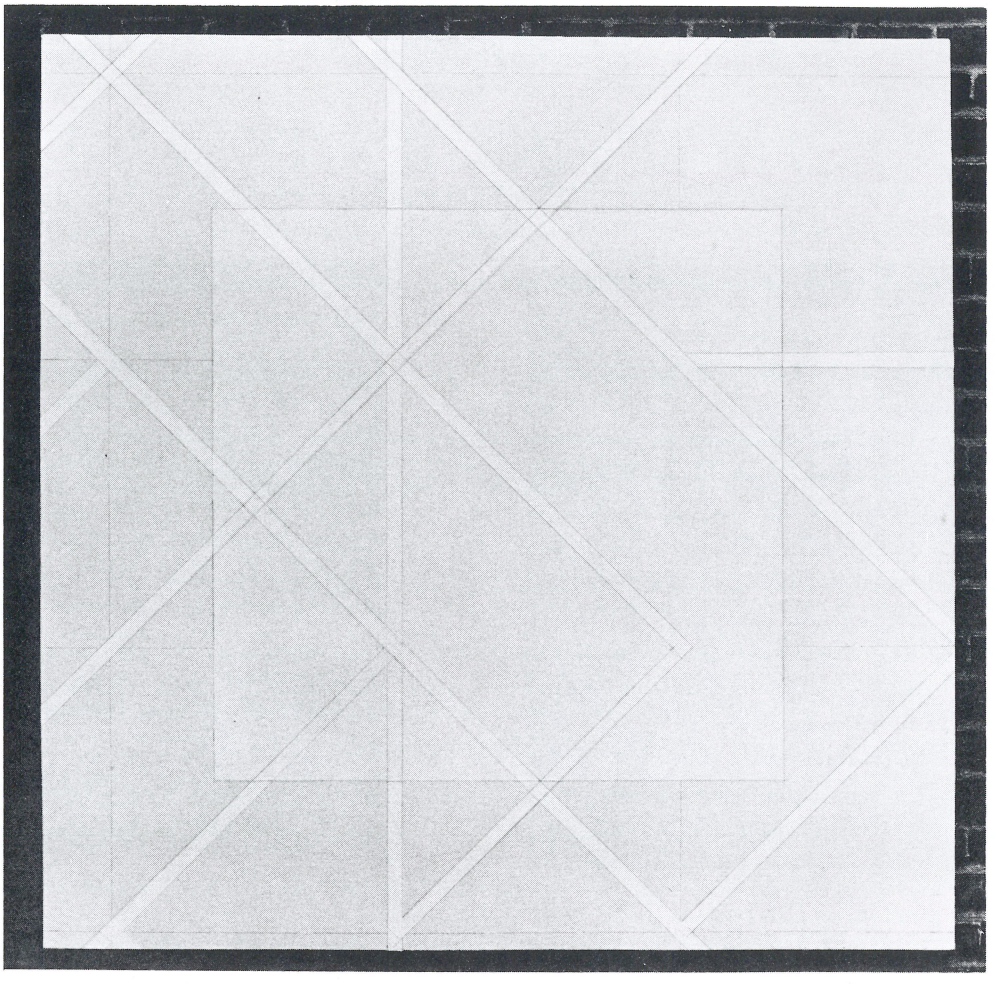
/4/ Coqart, "Computer Graphics: Grid Structures," Leonardo 11, 1978.

/5/ International Survey of Computer-Assisted Art, Page 43, January, 1980.



ABOVE: "Concentric Construction, Positive", by Roger Coqart. All of the artist's computer works are taken back into the arts. Computer output is an intermediate stage of the creative process -- not the final form of art.

BELOW: "Computer-Designed Painting", Figure 3, by Roger Coqart.



COMPOSITION AND TRANSFORMATION OF DIGITAL PICTURES FOR PLASTIC PURPOSES

by Hervé Huitric and Monique Nahas
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Our graphics have been realized on a television coloured screen connected with a computer. Each point on the screen has a quite rough definition, visible on the picture. Each point can receive a colour chosen among 4096 possible tints, obtained by the combination of 3 components, red, green and blue of 16 values each.

We build groups of pictures defined by variations of colors, which are in general continuous. Each family is generated by a program leading to a group of pictures obtained by variation of constitutive parameters. We use basic programs to complexifize continuous series.

In a second series of programs, we effect transformations on the previous pictures. They are principally:

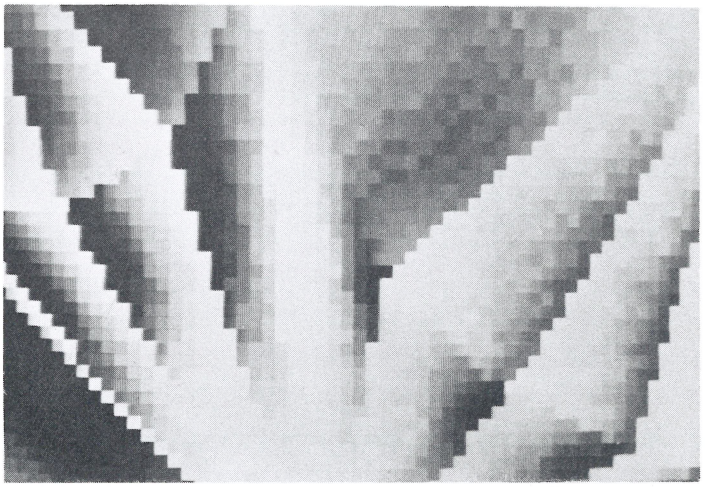
- Mixing programs of several pictures (one picture can appear in transparency on another)
- Filtering programs used to intensify or locally reduce down colours
- Application programs of technics coming from the study of digital pictures: histogram modifications, Fourier transformations, etc.

At the present stage of "formal" works on the picture, the meeting of varied researches was inevitable:

- digital image processing
- synthesis of realistic pictures
- recognition of shapes
- artificial intelligence
- visual perception
- digital music

From this synthesis, we wait for a better understanding of coloured structures. As plasticians, we perceive an unequalled blossoming of new ideas in the near future. We present here, briefly, tools that we use to generate and transform pictures for artistic purposes by computer.

Our works are realized on a colour system of video visualization, comprising 4047 pixels of definition (1). The colour assigned to each pixel is defined by the value of 3 components: red, green and blue, each coded on 4 bits, which allows 2^{12} (4096) colors per pixel. We have considered that the number of available tints allows an approach to the continuous space of the set of colours in which we have built surfaces. The pictures are defined by 3 functions $f_i(I,J)$ with values in (0,15) giving the value to the coloured components i at the point of the coordinates (I,J) of the screen.



ABOVE: The process of triangulation appears on the picture.

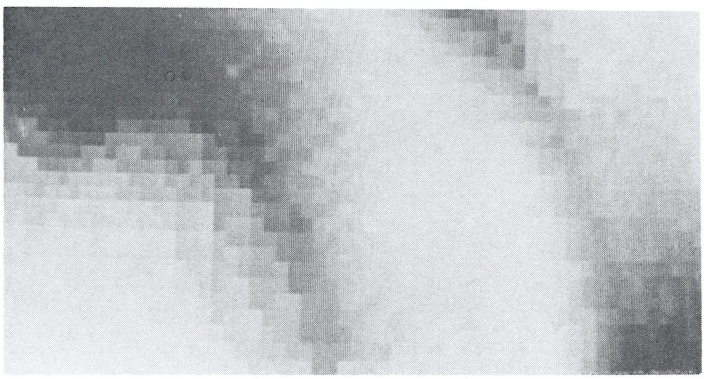
By choosing regular smooth functions, we ensure a continuous distribution of the colour on the screen (a continuous series). Each coloured component varies according to a set of level lines defined by the equations $F(I,J)=C$ where $0 \leq C \leq 15$. The coloured move of the picture results from the interference of the 3 sets of level lines.

Practically, we have split up the surfaces to recover in triangular elements and to obtain some complex lines of level we have juxtaposed arcs of circles and segments of lines. This had led us to a basic program written in LISP language, describing a continuous series, the lines of level being either circular or linear, and demarcated by any triangle.

Afterwards, we have iterated this program. The iterative structure appears or not on the final picture, according to the parameters characterizing the color, depending on each triangle (photos n° 1).

PHOTOS n° 1

BELOW: Continuous series where the iterative structure does not appear on the picture. Note that the black and white illustrations do not reveal the full import of these transformations.



Then we have stocked these pictures on record and settled operators of pictures, which was possible by a technique of "Fichiers d'ecran" (2): operators of mixing, filtering, distortion following a curve.

As an example, we have the mixing of two pictures following a barycentric relation, which allows one to obtain a picture in transparency on another. The operator is:

$$m(I_1, I_2) = \frac{a I_1 + b I_2}{a + b}$$

$a > o$, $b \geq o$ where I_1 and I_2 are 2 pictures.

The mixture being defined on each point I, J of the screen. We obtain by this method a series of pictures defined by

$$I_n = m(I_{n-1}, I_{n-2})$$

which converge rapidly towards the picture.

$$\frac{b I_1 + (a+b) I_2}{a + 2b}$$

Reciprocally, any picture can identify itself to an element of this series and own, then a family tree (photos n° 2) made of light and dark filterings of the starting picture.

Each operator of mixing leads, the same way, to a succession of pictures convergent or not.

For example, we made use of the formule

$$I_n = \sqrt{I_{n-1} \cdot I_{n-2}}$$

which increases the proportion of black in the pictures.

We utilized later, techniques coming from the digital pictures processing works (3)

- the modification of histograms, especially the equalization allowing the user to accentuate contrasts and bring outlines of level. Thus one can obtain skeleton pictures that we can later mix to the starting picture in order to produce the intensification wanted. (Photos n° 3)

We have utilized the expansion in series of Fourier and in a similar way used Walsh functions to make filtrages of high frequency of our pictures. Progressive filtrages leak to a series of images falling flat on the average value of the starting picture.

We have utilized too, the series of Fourier to work out synthesis in continuous series. Keeping the limit to only a few harmonics, we obtain very regular continuous pictures, forming our new basic pictures.

To build some pictures having a very wide frequency spectrum, we have utilized modulating frequence (4) avoiding the FFT transformation.

With quite a limited number of parameters, we were able to obtain a great diversity of pictures and some enrichment of colors.

For example, let us suppose the red component be defined in the following way:

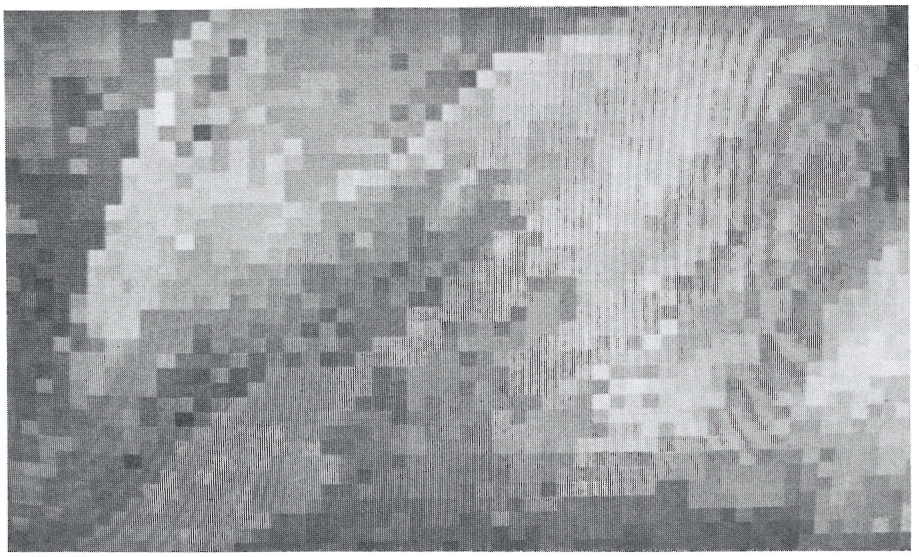
$$R = R_0 + R_1 \cdot \sin(W_1 . I) . \cos(W_2 . J)$$

Where W_1 and W_2 are the spatial pulsations bound to the size of the screen.

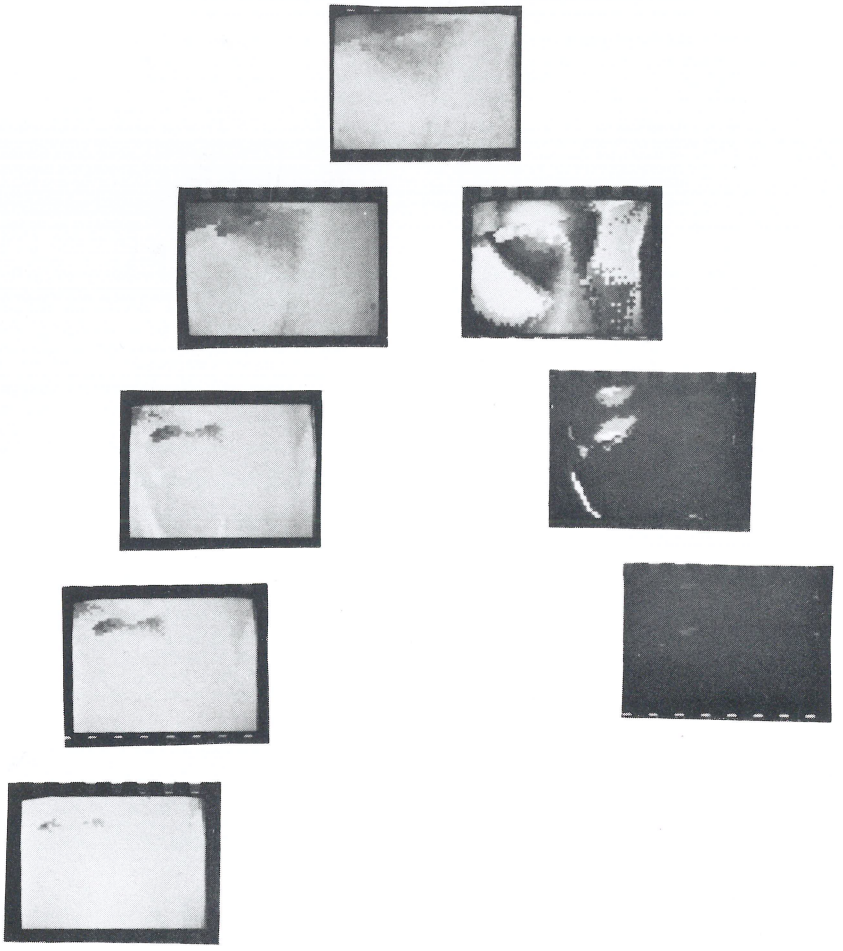
We modulate each function:

$$R = R_0 + R_1 . \sin(W_1 . I + J_1 . \sin\Omega_1 . I) . \cos(W_2 . J + J_2 . \sin\Omega_2 . J)$$

BELOW: N° 3 - Initial picture that will be varied sequentially and transformed via mathematics.



PHOTOS n° 2



Example of light and dark antecedents of a picture

above : initial picture A

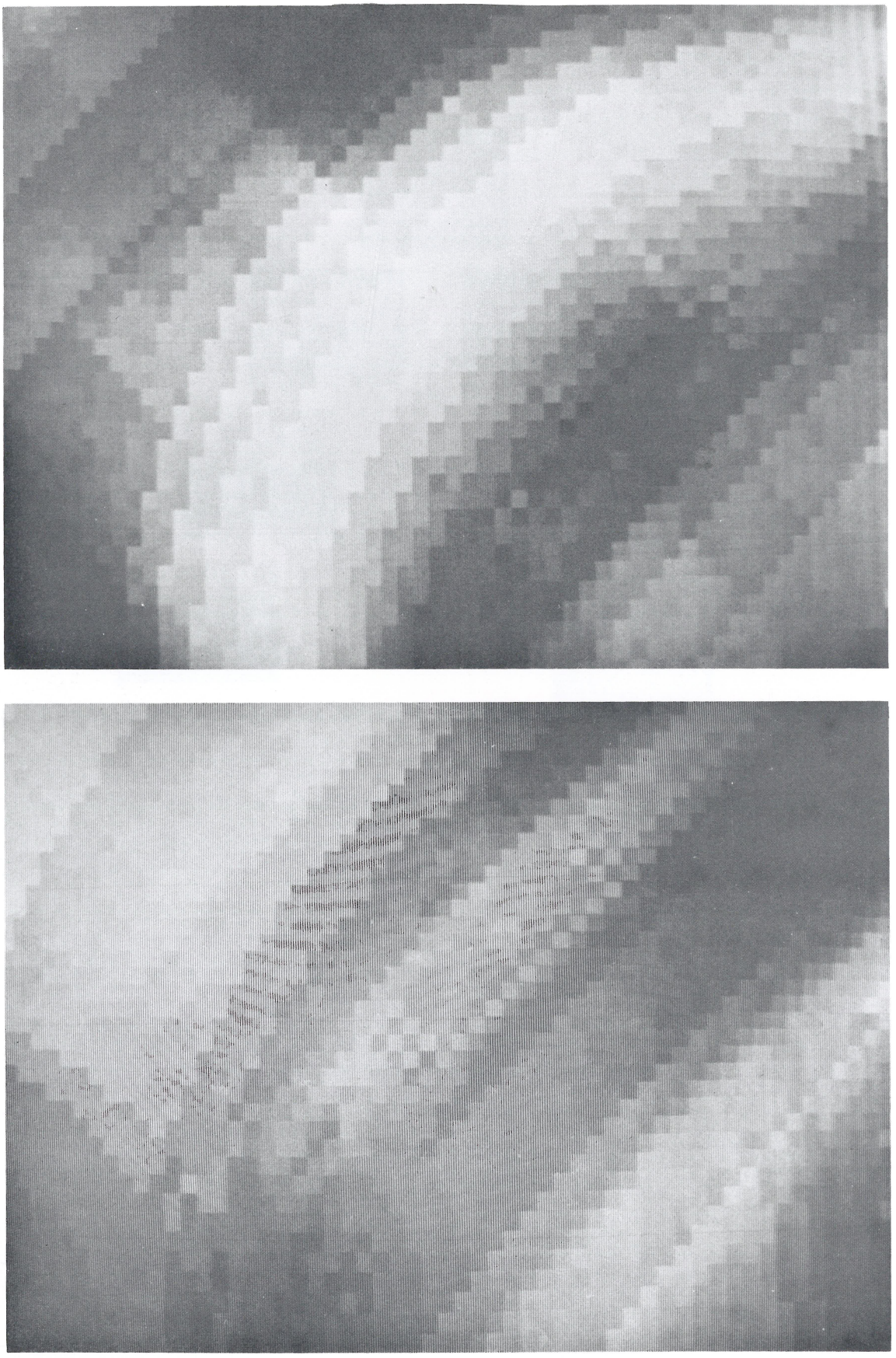
below : its light antecedents C and dark ones S

below : light antecedents CC of the picture C and dark ones SS of the picture S

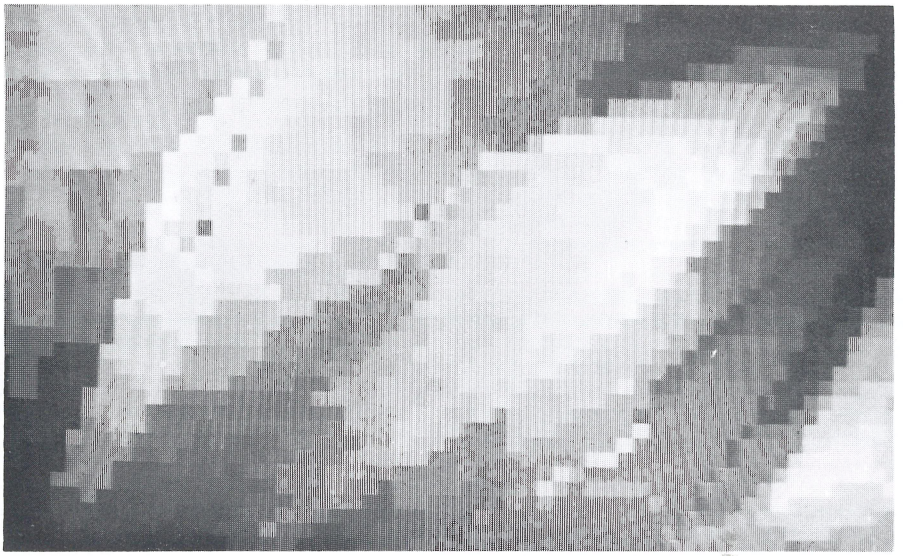
below : light antecedents CCC of the picture CC and dark ones SSS of the picture SS

below : light antecedents CCCC of the picture CCC

PHOTOS n° 4



Examples of frequency modulation of the same picture



ABOVE: Picture obtained after equalization of the histogram.

The 2 indexes of modulation J_1 and J_2, and the 2 modulating frequencies

$$\frac{\Omega_1}{2\pi} \text{ and } \frac{\Omega_2}{2\pi}$$

form the parameters of the program for each colored component (Photos n° 5).

At the present time, we dispose of a new peripherical comprising 125,000 pixels (5) on which we can start to investigate some graphic elements. Thus we consider the volume by enforcing to the 3 coloured components a relation as follows:

$$\alpha_1 \ R + \alpha_2 \ B + \alpha_3 \ V = L$$

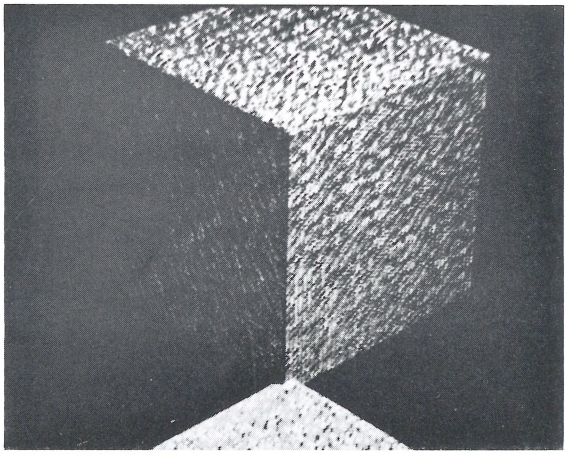
Where α_1, α_2, α_3 are some ponderations:

$$\alpha_1 + \alpha_2 + \alpha_3 = 1$$

and L is a factor of brightness, proportional to the cosine of the angle of the normal to the considered surface and the direction of the luminous source.

Our basic continuous series become coloured triangles defined in the space, the iteration producing a certain space effect.

It is our opinion that all works made in this mathematical manner using commputers cannot allow plasticians (artists) to remain indifferent. There is no doubt that a new aesthetic quality is emerging as a result of mathematics and computers.



AT RIGHT: An early example of a cube by Nahas and Huitric, using mathematics to texture and shadow 3-D visualizations of patterns.

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REVIEW: INFORMATION PROCESSING '80

This is a review of some of the papers presented at the 8th World Computer Congress, held in Tokyo, Japan on October 6-9 and in Melbourne, Australia on October 14-17, 1980. The IFIP Proceedings has a total of 1070 pages. It features the full text of 36 invited and 114 juried papers on a wide range of significant topics. Subscription information is given on page 41 for those wishing to purchase the volume for their own or institutional/departmental library reference.

The proceedings are organized into ten specific areas, including hardware, software, data bases and information systems, etc. The majority of the papers that I found subjectively provocative were in the areas of Computing in Science and Industry; Social and Economic Implications; Information Processing and Education, and Computers in Everyday Life.

One of the benefits of an international congress vs. a national congress is of course the presentation of a world view. Nations are still provincial in their attitudes, believing that what goes on within their own borders is the ultimate in civilization and accomplishment. In this IFIP Proceedings, a surprising number of papers represent a concern for relationships between the government and the governed; the worker and automation; the education of the disabled; communications between people -- all going beyond consideration of hardware, software, and data bases.

As a library reference, this is a superior addition because of its international scope and content. As a suggestion to IFIP and other conferences it would aid in the dissemination of important information if modules of each proceedings were available to interested persons. (In this case, there would be 10 modules.) Using this method, significant ideas could achieve a greater effect on the computer world and present a more affordable means of permanent access to these ideas. While the Proceedings are an invaluable library addition, the ability to secure specific sections of interest would be a fine gift for the computing community.

GRAPHICS PAPERS

Since this is a graphics publication, I will briefly list twelve papers that are of interest for graphics professionals. They are listed in the order of their appearance in the text. (I did find the first two named more provocative than the others, however.)

1. LINES, CURVES, AND THE CHARACTERIZATION OF SHAPE by Herbert Freeman, Rensselaer Polytechnic Institute, Troy, New York, USA.*

2. AUTOMATIC PATTERN RECOGNITION - A CHALLENGE TO COMPUTER TECHNOLOGY by Teuvo Kohnen, Department of Technical Physics, Helsinki University of Technology, Espoo, Finland.*

3. BEYOND CAD TO COMPUTER AIDED ENGINEERING by B. R. Borgerson and R. H. Johnson, Manufacturing Data Systems, Inc., Ann Arbor, Michigan.*

4. HANDWRITING INPUT SYSTEM FOR JAPANESE by O. Kato; T. Fujita; M. Niwa; T. Morishita; N. Fujii; and J. Tanahashi, Information Processing Laboratory, Computer Systems Division, Fujitsu Laboratories Ltd., Kawasaki, Japan.

*Denotes Invited Paper

5. USING CONTEXT IN THE GLOBAL RECOGNITION OF A SET OF OBJECTS: AN OPTIMIZATION APPROACH by M. Berthod and O. Faugeras, Le Chesnay, France.

6. A KNOWLEDGE-BASED EXPERT SYSTEM FOR AUTOMATIC ANALYSIS AND SYNTHESIS IN CAD by Mehmet Dincbas, Department of Computer Science, Toulouse Cedex, France.

7. A MULTISENSORY ELECTRONIC SYSTEM FOR DEVELOPING HANDWRITING SKILLS WITH BLIND TRAINEES by Iain D. G. MacLeod, Canberra, Australia, and J. J. Jackson and John B. Eulenberg, Michigan State University, East Lansing, Michigan.

8. THE IMPACT OF COMPUTERS ON ARABIC WRITING, CHARACTER PROCESSING AND TEACHING by Ghassan A. Kubba, Baghdad, Iraq.

9. USER INTERFACE DESIGN IN THE SMALLTALK PERSONAL COMPUTING SYSTEM by Alan Kay, Palo Alto, Calif., USA.*

10. A SPATIAL GRAPHICAL MAN-MACHINE INTERFACE by F. Herot, Computer Corporation of America, Cambridge, Mass., USA.

11. USING A HOME MICROCOMPUTER TO TEACH A DYSLEXIC CHILD TO READ by John Pollard, Australian Atomic Energy Commission Research Establishment and Glen Campell, Division of Basic Education, Department of Technical and Further Education, Sydney, Australia.

12. SOFT TYPOGRAPHY by Christopher Schmandt, Architecture Machine Group, MIT, Cambridge, Mass., USA.

PROVOCATIVE, IMPORTANT PAPERS

Here is a brief listing of papers not relating to graphics, but of social significance.

1. RATIONALISATION AND MODELLIFICATION: TWO COMPLEMENTARY IMPLICATIONS OF INFORMATION TECHNOLOGIES by Wilhelm Steinmuller, University of Regensburg, Federal Republic of Germany.*

2. THE IMPACT OF COMPUTERIZATION ON THE RELATIONSHIP BETWEEN PUBLIC ADMINISTRATION AND THE CITIZEN by Francoise Gallouedec Genuys, Centre National de la Recherche Scientifique, Paris, France.

3. THE ENCOURAGEMENT OF EFFECTIVE COMPUTER USE IN DEVELOPING COUNTRIES by W. F. Smyth, International Labour Office, Geneva, Switzerland and N. W. N. Jayasiri, National Institute of Business Management, Colombo, Sri Lanka.

4. A COMPUTER TRAINING SCHEME FOR THE DISABLED by Shiela M. Blackmore, St. Leonards, NSW, Australia.

5. COMPUTER TECHNOLOGY AND MEDICAL COSTS by Bruce I. Blum and Richard J. Johns, Johns Hopkins University, Baltimore, Maryland, USA.

INFORMATION PROCESSING 80 - PROCEEDINGS OF IFIP CONGRESS 80, Edited by Simon Lavington, Department of Computer Science, University of Manchester, U.K. c 1980: North-Holland Publishing Company, Amsterdam, New York, Oxford, 1070 p. ISBN: 0 444 86034 7

