PAGE

The Bulletin of the Computer Arts Society
September 1976

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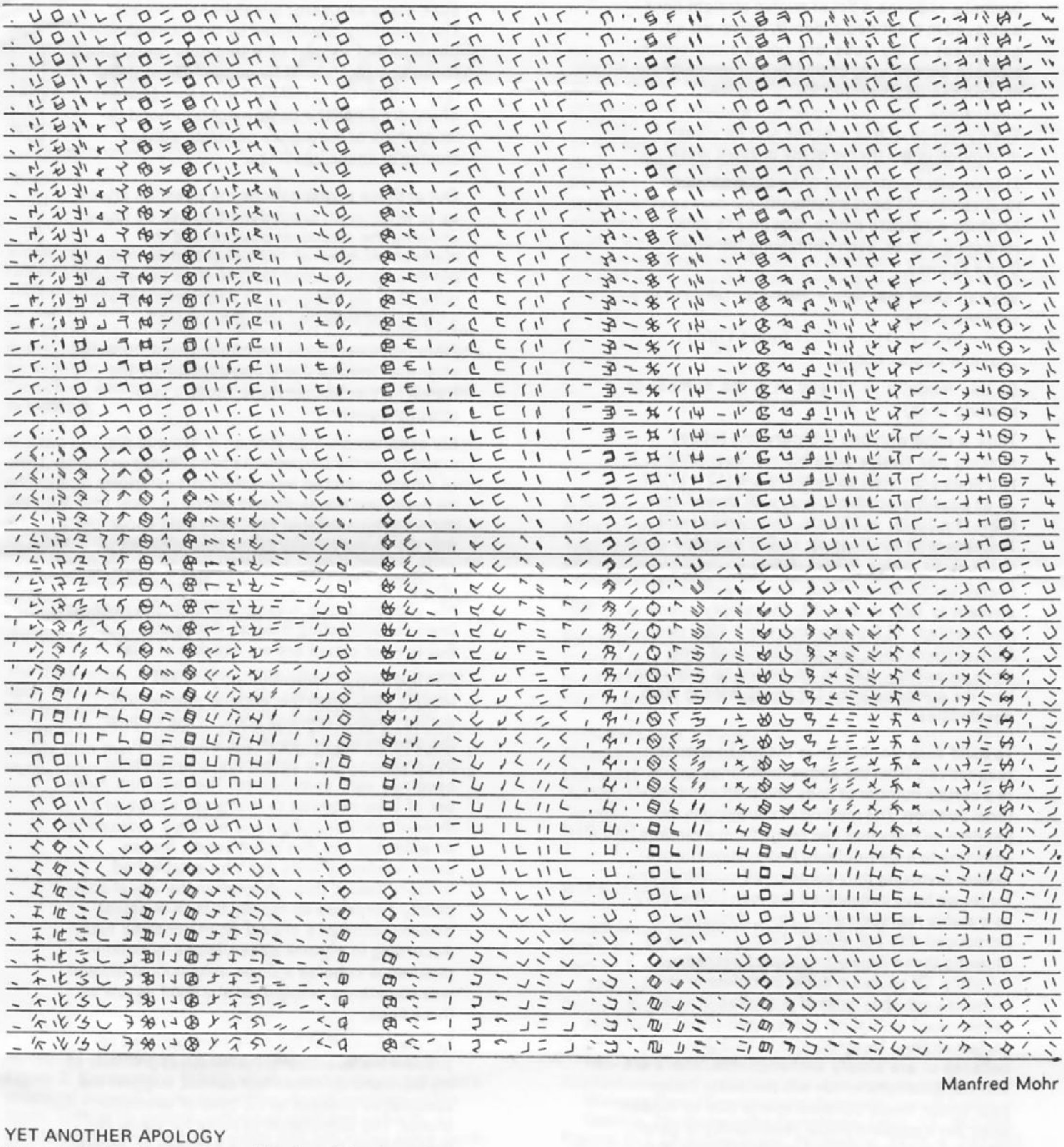


Manfred Mohr

YET ANOTHER APOLOGY

We apologise for the inordinate delay in publication of this issue of PAGE. We can only plead pressure of work: much of it creative, some even money-making. It is our earnest endeavour to publish more frequent issues of the Bulletin and we would be glad to receive any news, articles, pictures, diagrams and so on for future issues.

This issue has been edited by John Lansdown.

COMPUTER ARTS SOCIETY ADDRESSES

Chairman: Alan Sutcliffe, 4 Binfield Road, Wokingham, Berkshire
Secretary: John Lansdown, 50/50 Russell Square, London WC1B 4JX

Dutch Branch (CASH): Leo Geurts and Lambert Meertens, Mathematisch Centrum, Tweede Boerhaavestraat 49, Amsterdam, Holland
US Branch (CASUS): Kurt Lauckner, Mathematics Department, Eastern Michigan University, Ypsilanti, Michigan, 48197, USA

CUBIC LIMIT

GENERATIVE DRAWINGS
Part I Travaux de 1973–1975

The projective representation of a cube on the plane evokes the illusion of a three-dimensional figure. This illusion is built up in our brain by knowledge gained through experience in the perceptual (real) three-dimensional world. To draw a cube in two dimensions, for example, requires a set of twelve straight lines displayed in a defined order. If, however, edges (lines) of the cube are taken away consecutively, a dissolving of this three-dimensional illusion can be observed and a new, two-dimensional 'être-graphique' will appear. The dynamics of this process and its visual innovation is the theme of my present work.

This repertoire of twelve lines used as numerical values will be the syntactic elements out of which we create iconic, that means self-reflecting signes, each containing between 0 and 12 lines.

We can show that with n elements taken m at a time there are

$$((n) \times (n-1) \quad . \quad . \quad . \quad . \quad (n-m+1))/m!$$

possible combinations.

(In this model $n = 12$, and $m =$ the number of missing lines)

Thus, a cube with one arbitrary line (edge) missing has twelve possible representations. If two lines are taken away there are $(12 \times 11)/2! = 66$ possible combinations, with three lines $(12 \times 11 \times 10)/3! = 220$ etc. This number will increase with six lines up to 924 possible combinations and then decrease symmetrically to twelve combinations when only one line as an element is left. If $m = 12$, the empty space is represented. All together there are 4095 possible combinations. For completeness, one more possibility has to be added to this number: the complete cube (12 lines) making 4096 possibilities.

To build such iconic signes means to choose respectively from the above mentioned repertoire a certain number of lines and their combinatorial position. The method of choosing is dependent on rules that can range from a random selection to a well-defined and systematic procedure involving only some or all combinations. So far we have considered the Icon (cube) only as a stable representation. Now, if rotation is introduced into our model, the possibilities of showing these 'êtres-graphiques' increases infinitely. Of course a cube, complete or incomplete, which is rotated provokes in some cases visual ambiguity, since, seen under certain angles, foreground and background collapse or are simply exchangeable. There are line-combinations which will definitely disappear under these considerations due to hidden lines. An inevitable visual redundancy is generated by apparent coincidences of forms. But, in general, we can say that rotation in its visual aspect is in our model a very powerful and surprising mechanism for creating unexpected situations. We also can postulate that any graphic representation during a rotation and transformation process (from complete to incomplete cubes or vica versa) is essentially in a dynamic of change, showing the instability of a form at a certain moment — the breakdown of the three-dimensional illusion into a two (or even a one or a zero) dimensional 'realitor.' The instability manifested by the Icons should be regarded as part of a tentative morphology for an abstract 'visual language.' On a global level, within the given field-structure (matrix) of my drawings the basic neighbourhood relationships of the signes generate either cluster or linear 'readings.'

Out of these investigations the question arises as to whether an exact definition can be found showing the rotational position and the minimum number of lines required to maintain the three-dimensional illusion of an incomplete cube. Can we designate at what point there is a visual collapse into two dimensions?

(This collapse, if it is definable, could be called after the 'Théorie des Catastrophes' by the french mathematician René Thom, a catastrophy-point).

My experiments indicated an enormous discrepancy in the perception of sequences of different rotated incomplete cubes drawn on paper and the same sequences shown in an animated film. We could show that the direct access to the time-element in motion-pictures teaches the brain to remember and, therefore, to maintain the three-dimensional illusion; which means: filling in the missing lines and projecting them as if they still existed. But to what extent are we capable of this?

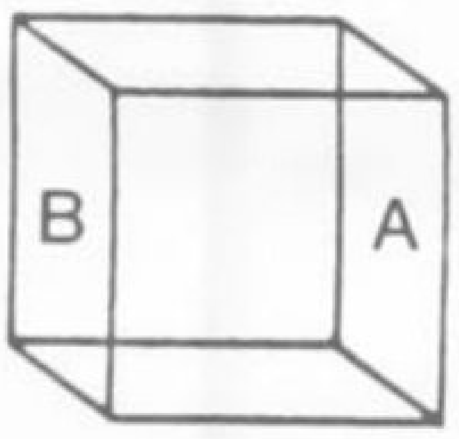
The learning or remembering process is relatively easy when the 'angular momentum' during rotation remains equal. If the angular increments are not equal during rotation, observation of this perceptual phenomenon becomes very complicated. The minimum number of lines required to recognize a cube as a three-dimensional figure is sensibly reduced in an animated film, but still it seems that an exact number of lines can't be established. In many cases, through rotation the visual complexity increases so rapidly that an eventual determination of a critical point becomes fuzzy. According to my onw observations in motion-pictures, a cube as a three-dimensional illusion was sometimes recognized at a level as low as three lines.

Let me stress that the rules here outlined represent the operational (generative) grammar of my work and do not, in fact cannot, suggest the associative process at the base of aesthetic choice. The formulation of rules for visual representation is inherently a process of 'artistic' intention. Thus my work is as much motivated by compositional needs as by analytic requirements. It is in just this interplay of analytic and aesthetic considerations that one approaches new areas of visual and intellectual exploration.

Manfred Mohr

MOHR'S CUBIC LIMIT and THE NECKER CUBE

Mohr's basic unit is an outline cube drawn from a particular viewpoint with the two faces in the fronto-parallel plane drawn the same size and shape. Such a cube possesses two fundamental perceptual qualities. Firstly, it evokes the perception of depth, that is, observers report the cube to appear three dimensionally; and secondly, the figure perceptually reverses, that is, the planes A and B in Figure 1 may be seen to exchange planes in space. This cube and



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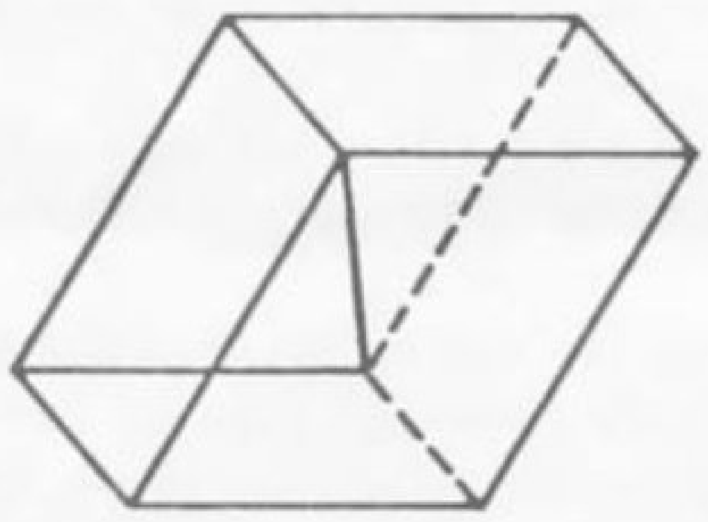

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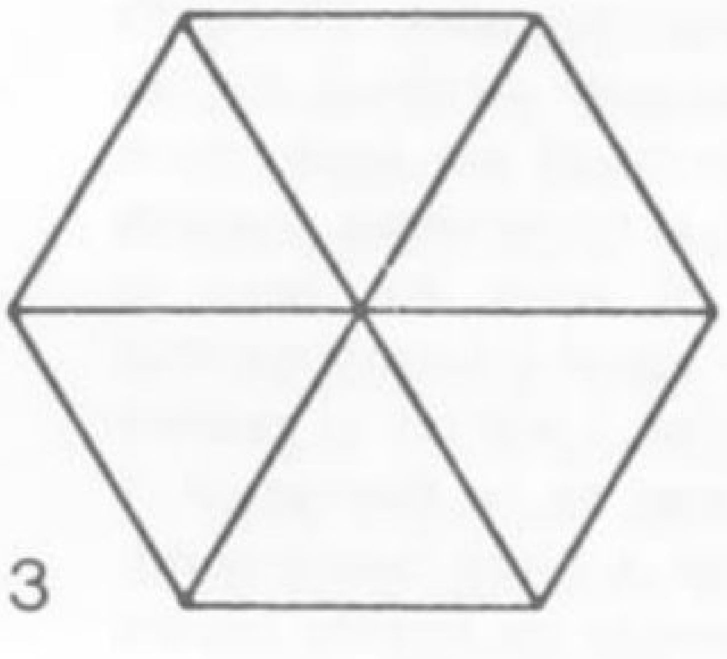
indeed its variants have become known as the Necker Cube, named after L.A. Necker a Swiss geologist who described in 1832 the reversal effect observed in the outline forms of various crystals. Figure 2 shows the original Necker Cube. The works of such artists as Josef Albers and to some extent Frank Stella are based upon Necker Cube type figures. Albers for example, uses combinations of partial cubes in his "structural constellations" whilst Stella's basic unit is shown in Figure 6.

It is the ambiguous depth properties of the cube which excite artist, computer graphist and experimental psychologist. In addition to asking the question posed by Mohr, namely when does the cube cease to appear as such when complete sides are progressively deleted, a number of other questions may be asked. For example, what is the influence of viewpoint upon the cube's perceptual qualities? How is reversal affected by complete or partial side deletion? What are the effects of rotation and of cubes drawn in perspective, upon depth and reversal? Some of these questions and phenomena are discussed briefly below.

The depth evoking properties of the complete cube depend upon the viewpoint from which the cube is drawn (this is also true for the cube's perspective). A cube such as that shown in Figure 1, reverses and evokes a cubical form more readily than that shown in Figure 3. All other things being equal, progressive side deletion will be more damaging to the



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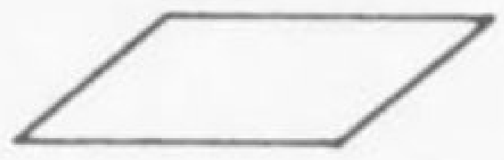
perceptual qualities of the cube in Figure 3, than that in Figure 2. Kopfermann (1930) investigated some of the cube's structural parameters by presenting various portions of the figure, such as its outline, individual sides and so forth. As may be seen from Figure 4 a single side will evoke some depth. Gregory (1970) has an interesting series of cubes in plane projection observed from different viewpoints. The cubes, presented as 2D and in stereopsis, are viewed with progressive side deletion. As might be expected perceptual depth degradation is much less in evidence for the stereo-view than for the flat cube, whilst a slowly rotated flat cube viewed as a shadow on a screen gives potent depth information. The essential features of the cube in producing depth and



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reversal would appear to be the vertices. Piggins (1975) has shown that as little as 12% of the total figure (Figure 5) will produce these perceptual qualities, if the line length is confined to the vertices. When the vertices are replaced by dots or the cube presented without the vertices the perception of depth and reversal are drastically reduced. Piggins has likened such 'cognitive space' to the effect produced by cartoonists and such artists as Picasso and Matisse with the minimum amount of line producing a maximum amount of space, area and solidarity. It is of note that the minimum amount of linear information to produce a depth effect and reversal rely's upon two lines forming an angle. This is shown in Figure 6.

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A further effect noticeable upon reversal of the cube is the apparent size difference between the side observed furthest away and that observed closest. Fisher (1967), Mefferd, Leppmann and Wieland (1968), and Gregory (1970) all report that the face of the cube reported nearest looks largest.

Past experience with various perceptual phenomena would indicate that Mohr will meet with much individual differences in his progressive side deletion experimentation; he will also have to present 5019 stimuli to do a complete job.

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SPACE DRAWINGS

TONY LONGSON

Recently (10th May – 4th June 1976), Tony Longson showed a number of fascinating drawings and sculptures at an exhibition in the Hatfield Polytechnic where he is a research fellow.

The following are his programme notes:

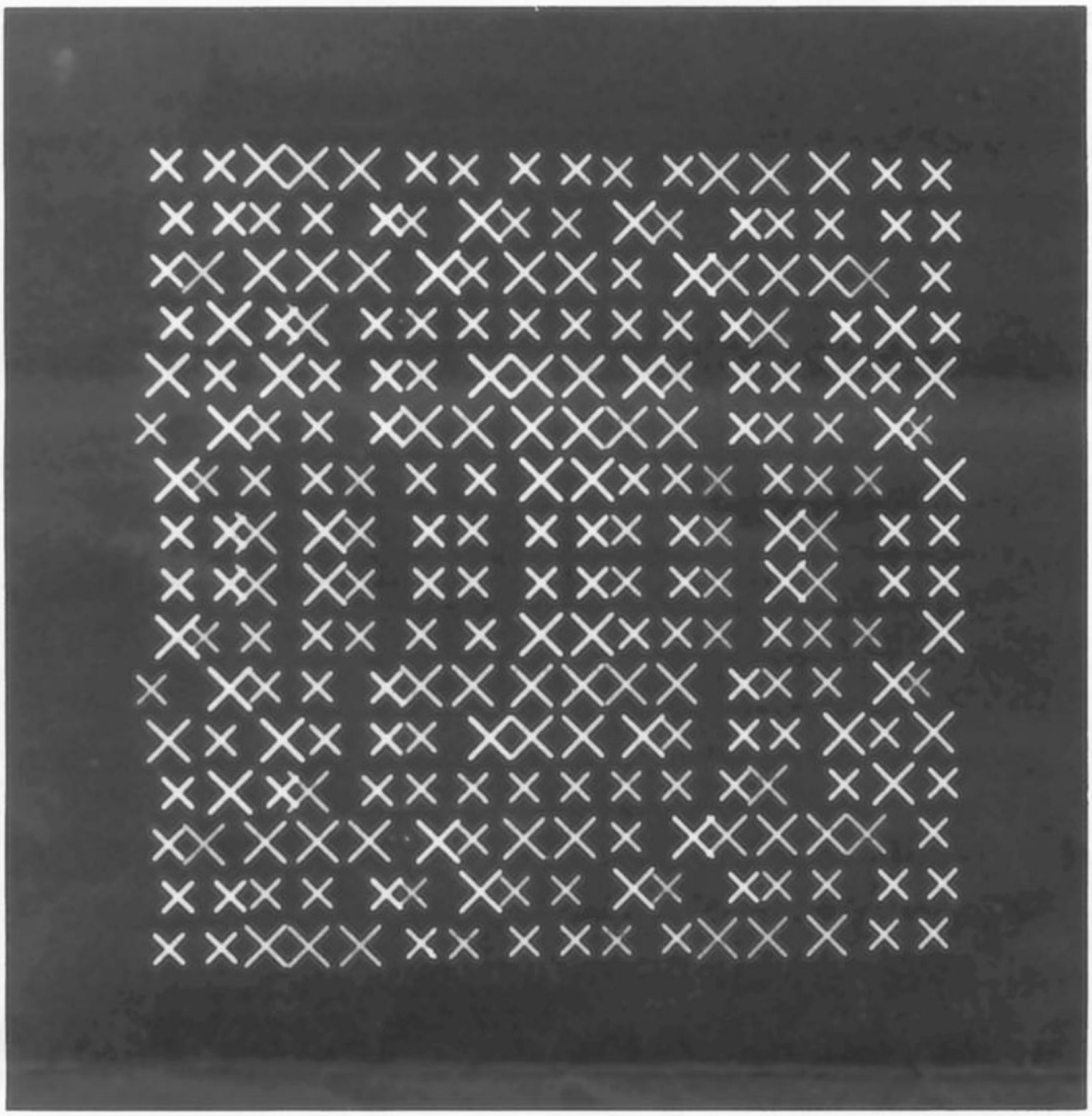
Sight is what interests me – in particular the richness of being able to see space – and this is what makes me make things.

The constructions I make are like drawings in space. They are made up of simple elements, such as lines and dots on clear sheets of material, which direct the way we see, and perhaps show us new things about the way we can see. Within these main aims there are other areas that interest me; the ambiguity of things that are flat yet appear to be three dimensional, and far more exciting, things which we know are in space which appear to be flat. I also like the distinction between pattern and not pattern; for example, recently I've been trying to spread small dots within a square in order to achieve a kind of "grainy" surface. It's very difficult. I tried several random processes, but eventually had to determine precisely the pattern of individual dots so that no strong pattern groups were apparent.

This interest in sight as a motivation stems from the time I studied Fine Art at Reading University. Terry Pope introduced me to his "extended parallax" glasses which, by increasing the distance between our eyes, dramatically heightens our impression of the space surrounding the objects we are looking at. I went on to build glasses which reduce the distance between our eyes, and was equally impressed with the new reading of space that they offered. It occurred to me then that there were many different possible configurations of two eyes which might provide exciting visual results. However, it was not until I came across computer generated stereo pairs that I realised I had a relatively simple way of checking all the alternatives.

So having turned to computers with that specific problem I began to see many ways in which they could extend my work. First of all I was interested in getting the computer to draw three dimensional objects. I set out to design objects which could be rotated into certain positions where they would appear to be flat. It was an interesting exercise as it made me aware of the many conventions we adopt, such as perspective, overlapping, and shading to depict space on a flat surface. Of course my first drawings were simple isometric projections. I went on to do exactly the reverse – that is to make three dimensional drawings which appeared to be flat from certain viewpoints. There was something attractive about seeing this unfamiliar situation.

Initially I thought it was enough to have someone else do the programming. Now I use computers in many aspects of my work (supported for two years by the Arts Council and Hatfield Polytechnic) and I find that I need to have control over every stage of the process. This means programming in FORTRAN, BASIC, and POP2 (more of that later), and being able to manipulate the various machines. Hatfield's main computer is a PDP-10, but there is also a small computer with a refresh display system and light pen which is connected to the 10. The majority of my work starts on this visual display, though not as an end in itself, rather as experiment towards making drawings in three dimensions. My latest sequence of work has been to investigate certain of the thresholds in the way we see. I enjoy visual information that will waver between two states, but never be both at the same time. I wanted to explore information that was highly structured, and yet at times seemed to be haphazard. I chose very small white dots as the elements to be seen against a black background. The geometry was to make a perfect matrix of dots within a twenty by twenty square, though as the dots could be on any one of the four separate layers which made up the drawing, that geometry would only be visible from face on. (Because of the diminishing effect of perspective, I made the dots and the matrix slightly larger as a function of their increased distance.) Added to this structure, I made the arrangement of dots symmetric about both horizontal and vertical axes, (would that be obvious in the piece of work?). The square matrix was the only structuring that I wanted to be apparent in the work. From every other viewpoint the dots themselves had to have this grainy quality, that is, to have no local groupings which would be recognisable as patterns. This, of course, is the most simple explanation of something that has to be seen. The visual response that an object like this solicits is something that cannot easily be described. In the end, the whole is more than the sum of the parts.



To make the work, I've been using a numerically controlled three axis milling machine, which accepts information as co-ordinates on paper tape, and cuts corresponding lines or dots into the component sheets of clear perspex. It provides the necessary accuracy. Ironically mistakes are far easier to detect in visual information that is highly structured.

Well, there are significant problems in using a computer to creative ends; one obvious one is that the common output devices produce images with that characteristically dull quality about them. Also I find that each construction demands a totally new approach, and that rather goes against one of the fundamentals of a computer, the ability to repeat the same task reliably many times over; but what I see as their greatest limitation to creativity is possibly also the very area of greatest potential. The limitation is this — a computer needs to have the problem closely described, and there are ingredients of creativity which cannot be described.

The potential, then, is to simulate the creative process itself. How can I do that? First I have to isolate those aspects of creativity which I do know about; simply recording them from my own methods. The computer has to have this information and non-numeric languages are available for expressing it (POP2 is one of them). Heuristics is a tested method for "best bet" decision making where there are too many choices to investigate. And there is the kind of associative memory system which reinforces itself over a period of "experience" of right and wrong choices. Hopefully this memory is common to an extended sequence of investigation. Given this situation, perhaps we can discover some of the mystery of creative thinking. I anticipate one serious problem. If the computer does make that kind of intuitive leap that we associate with being creative, how will I recognise it for what it is? At least I am learning more about my own working methods — at best the computer may assist decision making in a naturally creative way.

from Creative Computing

SIXTEEN: A RESEARCH TOOL?
New member SAR Scrivener writes:

I am by training an artist; first at Leicester Poly and then at the Slade School of Fine Art. For a number of years I have been interested in kinetic, cybernetic, and computer type art. At the Slade I was able to use U.C.L's IBM 360 computer to produce graph plotted drawings. Currently I am engaged as a research student at Leicester Poly. The project is concerned with the design of computer systems for artists and creative designers.

The program described below relates not to this project but to work produced as a result of my own special interests. The notes were originally produced to accompany a recent teaching exercise at the Slade and are not intended as an exhaustive description. They do, however indicate something of how the program works and its objectives. The enclosed drawing is an example of the hardcopy output from the program. No particular aesthetic value is attached to its selection.

SIXTEEN is regarded as part of an on-going body of work of which some of the global objectives are listed below.

- i. To provide a means by which the spectator may participate in the experience of creative exploration.
- ii. To examine modes of explorative behaviour.
- iii. To provide data for research into
  - a. possible collective preferences or 'best pictures'.
  - b. the identification of factors influencing these preferences.
- iv. To apply the concepts and principles of visual psychology to explore visual information structures.
- v. To explore how different control, or organisation principles, influence the generated visual structures.

I make no claims to originality in the methods employed by the program SIXTEEN to generate drawings. Such methods are common practise in computer art. I do not regard this as problematic. In response to a more scientific attitude affected by my research activities at Leicester Poly, the products of other workers are seen as the basis for comparison and expansion.

However, in order to contribute some originality might be expected. This I believe is the conception of the spectators role. This is not new in itself but in SIXTEEN it does go beyond theory into practise.

Many of the achievements of computer art exist primarily in theory. A lot of the literature has been devoted to speculations on how the computer might come to affect a change in art and artists. In practise its 'effects' have remained largely untested. The implementation and operation of SIXTEEN as a truly interactive system provide a basis for testing whether quantitive change (the system allows the exploration of many possibilities in a short duration) can affect qualitative changes (does the system change artist/spectator attitude and experience).

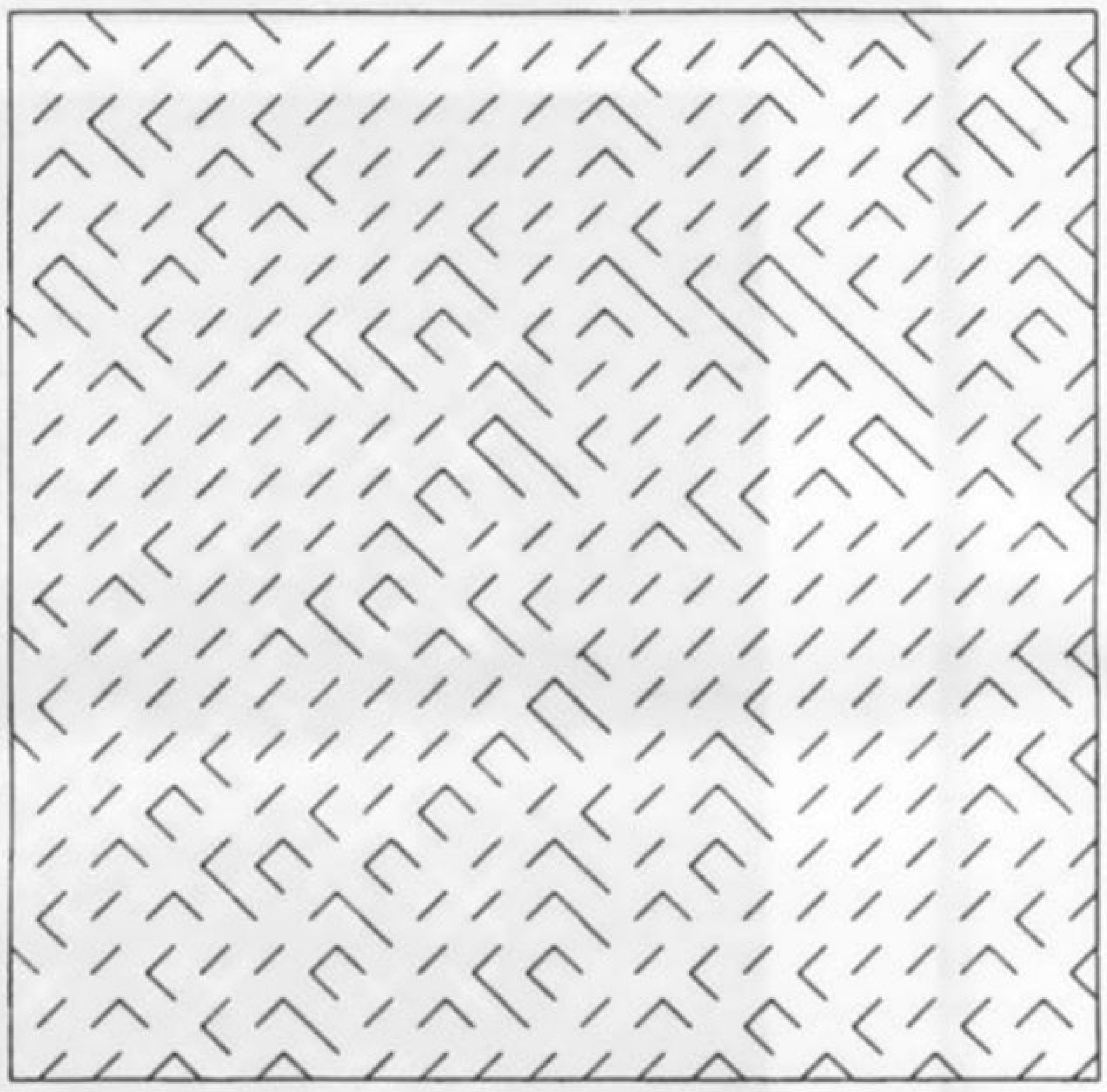
SIXTEEN is an interactive program capable of producing a class of drawings. A drawing consists of:-

- a) a picture surface which is divided into 400 cells arranged in a 20 x 20 square matrix,
- b) graphic elements, of which there are sixteen, one to each cell of the matrix.

The cells of the matrix and the graphic elements are related such that an element will fit into a cell without overlap.

The program generates a particular member of the class of drawings in the following way:-

1: a cell in the matrix is selected,
2: a graphic element is selected and assigned to the cell,
3: the next cell is selected and the process, 1&2, continues until every cell of the matrix is assigned an element.



The order in which the cells are assigned elements is prescribed and invariant. The selection of one element, from the sixteen possible, to be assigned to a particular cell is determined in accordance with predefined probability weightings. The probability weightings of the elements are constant during the generation of a drawing but they may be redefined prior to a generation cycle (a "generation cycle" being the process of filling the matrix with elements).

The program is interactive the user sitting at a VDU in order to interact with the computer. In the first instance, a drawing is displayed in which all elements have equal probability weightings. The user can choose either to continue or terminate the interaction. If he chooses to continue he has the option of redefining the probability weightings of the elements. A new drawing is then generated in accordance to these redefined weightings and displayed on the VDU.

The process of redefinition and generation continues for as long as the user desires. The results of any generation cycle can be plotted. In this way the user generates a subclass of drawings belonging to the class of drawings.

This facility for changing the weightings of elements allows the user to apply some control over the characteristics of the drawing that is generated. The generation of a particular drawing cannot, except in the case where all but one of the elements have a probability of zero, be predetermined but the boundaries of a subclass can be specified. In this way the user can apply some control on the overall appearance of the drawing generated.

The graphic elements are related to cells such that an element can connect to a cell at four points located on the medials of its boundary edges. A graphic element is constructed of straight lines which connect points on adjacent boundary edges. Sixteen distinct elements are possible in which adjacent points are, or are not, connected by lines, e.g. the case in which all the adjacent points are connected by lines results in a closed square figure. It is therefore possible for an element within a cell to be connected to elements within a maximum of four of its adjacent cells.

Essentially there is nothing individual or original about the generation of a particular drawing since, theoretically at least, any individual can cause the same drawing to be produced. Individuality is more likely to be demonstrated in a sequence of drawings. Such a sequence provides a crude representation of the decision making process of the user.

The program embodies a world of possibilities, these being the class of drawings it is capable of producing. The program allows an individual to explore this world of possibilities.

First International Conference on Computer Music

October 28-31, 1976 at the
Massachusetts Institute of Technology

in conjunction with the
1976 ISCM World Music Days
Boston, Massachusetts USA

Papers Discussions Demonstrations Concerts

The third annual US Conference on Music Computation will again bring together leading composers, scientists and engineers involved in the application of digital technology to the creative musical arts. This year's conference at MIT will coincide with the 1976 Festival of the International Society for Contemporary Music (October 24-30), held for the first time in the United States. Schedules have been interleaved, making it possible to attend both the Conference and World Music Days. Certain events are jointly sponsored.

Call for Papers

The Conference wishes to entertain papers and discussion in the following areas:

Software Synthesis Techniques
Hardware Synthesis Techniques
Digital Control Systems
Sound Analysis/Synthesis and Perception
Input Representation Languages
Compositional Procedures
Protocols of Man-machine Interaction

Presentations will be limited to about fifteen minutes. Persons wishing to present a paper or report should submit an abstract not exceeding 200 words, in English, typewritten, and suitable for pre-conference publication.

Audio-visual aids available: 2 x 2 slide projector, overhead projector, 3/4" video cassette player, 1/2" video tape player, 1/4" 2- and 4-channel audio player (7½ or 15 ips).

Deadlines

Abstracts must be received no later than Wednesday, September 15, 1976. Notification of acceptance will be mailed on Monday, September 20. Mail abstracts, together with a list of audio-visual requirements, to the Conference Chairman.

Concerts

The Conference will sponsor three public concerts of electronic music. One is an official ISCM concert and will include works by Barbaud (France), Wiggen (Sweden), Radovanovic (Yugoslavia), Raxach (Netherlands), Laporte (Belgium and Boretz (USA). Composers are invited to submit computer-produced works for consideration for the remaining concerts. Tapes should be 2 or 4-channel, on 1/4" or 1/2" tape, recorded at 7½ or 15 ips. Include a brief program note describing the synthesis method and facilities used. Tapes must be in the hands of the Conference Chairman by Friday, October 1.

Registration and Housing

There will be a Conference Registration Fee of $30, or $20 if paid by October 1. Student rates are $15 and $10, respectively. Early registrants will be sent pre-prints of the conference program and abstracts. Conference participants will also gain free admission to certain ISCM functions. A joint ICCM-ISCM Banquet, however, is optional at $15.

Housing arrangements are the responsibility of individual participants. Return your forms early.

Registration and housing forms may be obtained from:
Conference Chairman
Barry Vercoe
Computer Music Conference
Run 26-313
Massachusetts Institute of Technology
Cambridge, Mass 02139 USA.

AUTOPROD

AUTOPROD is a versatile piece of graphics software developed by Col. F.A.N. Hitch of the Department of Land Surveying at the North East London Polytechnic.

A comprehensive variety of projections, including perspectives, are possible, with hidden edges removed or shown as dashed lines. The viewpoint can be inside or outside the object.

The object to be depicted can be defined in three ways: by sets of co-ordinates, from the library of standard shapes, or by writing "W-subroutines" which enable the user total flexibility of description.

Plane surfaces and visible lines can be coded by quoting the co-ordinates of their limiting vertices. Proportions, scale, position and rotation of lines, plane polygons, simple prisms and circle/sector approximations can be set by the user. The program then loads details of points, lines and faces automatically.

Many more user facilities are built in. For example the system can generate edges when two shapes pass through each other. In this way partition walls running the whole length and breadth of a building can be defined and the inner corners of the rooms are automatically generated.

The drawings themselves can be defined in four ways: by basic projection, by generalised projection, by programmed sequences, and by program interaction.

The basic projections are perpendicular along one of the reference axes, and central orthogonal – the conventional perspective view towards the origin of the reference axes.

General projections cover such areas as the tilting of the picture plane; the absolute scaling of a planes dimensions so that they are in proportion to the distance from the viewpoint, and an "inverted perspective" which enables all sides of an object to be illustrated simultaneously.

The package was developed for an IBM 1130 with single disk and 16K core, and will run on any machine with a FORTRAN compiler and graph plotter output facilities.

Details from

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COMPUTER GRAPHICS AND ART

We welcome publication of a new magazine, **Computer Graphics and Art** edited by Grace C. Hertlein and having an impressive array of contributory editors and advisory board members. Its format is similar to that of its sister publication **Computers and People** and is obtainable from Berkely Enterprises, Inc. 815 Washington Street, Newtonville, Mass. USA 02160 for $10 a year in US and Canada and $13 a year elsewhere. An interesting idea is that artists wishing to sell their work by direct mail to CG&A readers may submit illustrations, a description and price material, to be published in the magazine.

COMPUTER ARTS SOCIETY ANNUAL REPORT 1975-76 to the British Computer Society

The main activity of the British Group during the year has been work on the display of computer arts for the new Science Museum Computer Gallery. The display of representative works on slides, film and tape covers the creative uses of computers in graphics, animation, music, ballet and poetry.

A new work – the Animated Algorithm or The Mole – has been designed by the group and built under our supervision. This has involved the cooperation of CAP (programming), Leicester Polytechnic (microprocessor and electronics), Glazebrook Electronics (constructing the special display panels), as well as the Science Museum and ourselves. The system is now undergoing final tests and will be installed later this year.

One display of lights is an art work controlled by an algorithm which the visitor can interact with to vary the rules. A second display shows the flow chart of the rules and this can be followed in slow mode.

The bulletin of the group PAGE has continued during the year but only just: one issue has been produced.

Our monthly meetings have continued and though there is no formal speaker there is sometimes an overseas visitor and always there is a lively discussion.

We have continued to deal with a steady flow of enquiries from students and others interested in our area of activity.

In the absence of any other candidates George Mallen continues as treasurer, John Lansdown as secretary and Alan Sutcliffe as chairman for another year.

IRCAM

Luciano Berio is preparing an exhibition concerning the history and developments of electronic music which will be shown in 1977 at Centre Beaubourg, Paris as one of the most important events related to the opening of IRCAM.

The exhibition will be mainly of a didactic nature and presented by an elaborate system of slide projections (40 screens) and multitrack sound equipment in a 500-seat hall.

Among many others, the work of one of our Honorary life Members, Peter Zinovieff, will be well represented.

Announcement of MEDINFO 77 The Second World Conference on Medical Informatics

The Second World Conference on Medical Informatics will be held in Toronto, Canada during August 8 – 12, 1977, simultaneous with IFIP CONGRESS 77.

MEDINFO 77 will be of interest to medical professionals; computer professionals; government departments (hospital administrators and all those involved in the financing and management of health care institutions); and those concerned with the patients' view of changes in procedures for the delivery of health care.

There are two current world-wide trends which combine to make this conference particularly relevant at this time. These trends are increasing costs of the delivery of health care and a move towards smaller and cheaper computer hardware, particularly for mini-computers, microprocessors, and intelligent terminals.

The conference will focus on the following themes:

1. recent technological innovations
2. cost-effectiveness criteria
3. critical aspects of acceptance by medical staff
4. patient-related factors

The papers to be presented will explore these themes in the areas of:

a) clinical medicine
b) education
c) evaluation of health care information systems
d) management
e) public health
f) research
g) services and special care
h) social, legal and political aspects

IFIP CONGRESS 77

IFIP CONGRESS 77 and its Exhibition will mark the first return to North America in more than 12 years for this triennial gathering of information scientists.

Most of the display areas will be concentrated within the newest exhibition facilities in Toronto: the fully air-conditioned centrally located exposition floor of the Congress Host Hotel, the Four Seasons Sheraton complex opposite Toronto's City Hall. More than 30,000 square feet of space will be allocated to dramatic demonstrations and exhibits of the latest trends in global information processing.

A conference badge provides admittance for all CONGRESS 77 registrants. In addition, more than 20,000 other potential and existing users are expected to visit the exhibition representing a sophisticated level of computer technology within the North American data processing community.

Visitors to the 4-day exhibition will enjoy an exciting, rewarding opportunity to study at first hand the latest development in large and medium scale central processing units, small processors and systems for business, government, science, communications and technology, new trends in peripherals and data entry systems, plus a comprehensive range of design applications, software and services that should challenge the imagination of both first time users and dedicated professionals.

For more information about your visit to, or regarding exhibiting at IFIP EXHIBITION 77

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