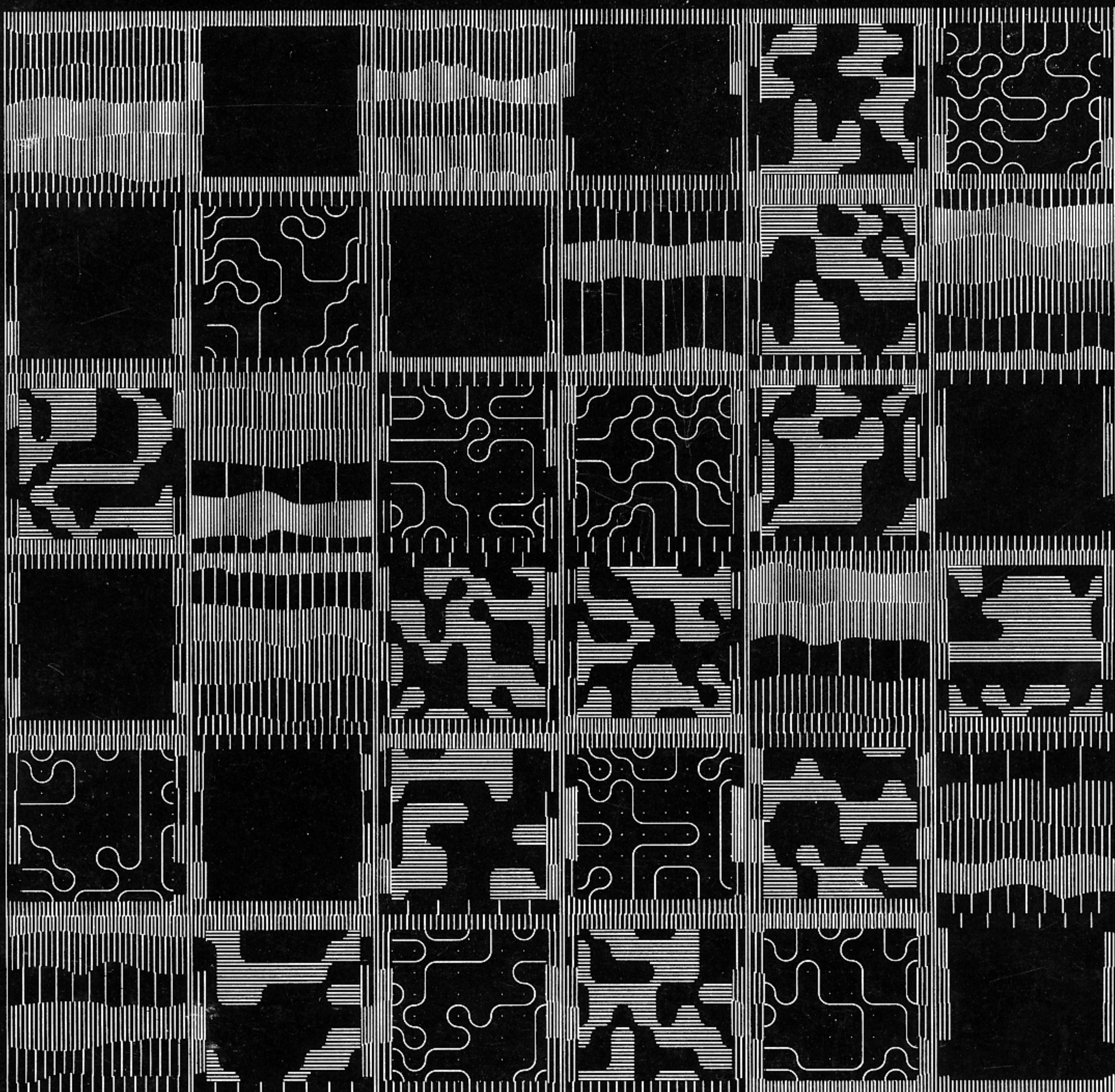
COMPUTER GRAPHICS AND ART

MAY, 1976
VOL. 1, NO. 2



VOL. 1, NO. 2
May, 1976

COMPUTER GRAPHICS AND ART

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

MAY: SPECIAL ART ISSUE

COMPUTER GRAPHICS AND ART

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

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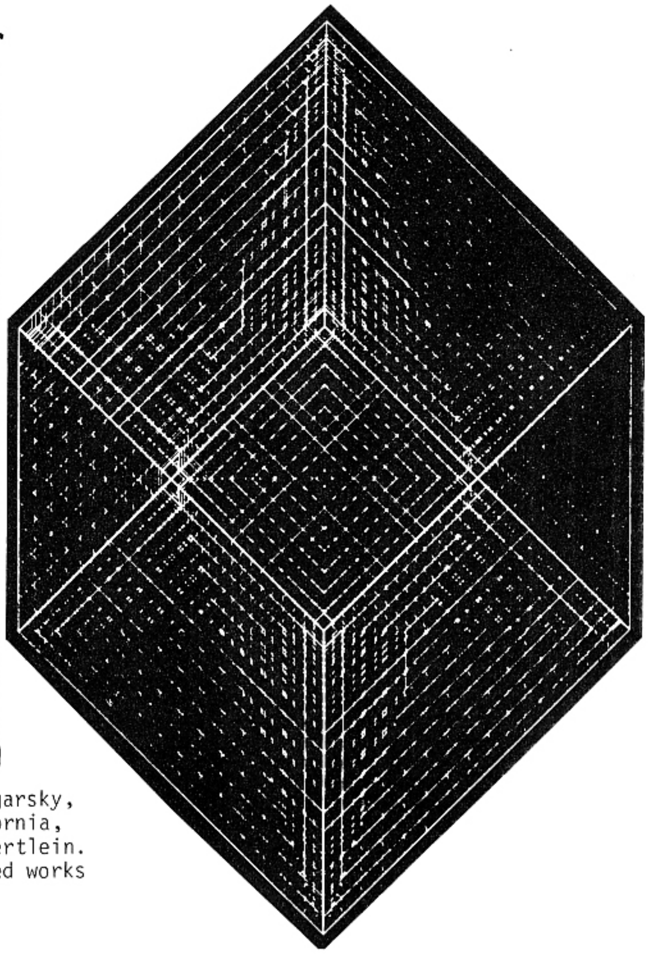


AT RIGHT: "From the Cube Series", by Howard Fegarsky, California State Univ., Chico, California, an advanced graphics student of G. Hertlein. (This is one of a series of 28 related works by Howard Fegarsky.)

EDITORIAL

THE STATE OF THE ART OF COMPUTER ART: PHASE TWO

IN THE BEGINNING

In Phase One of computer art, a new art form arose naturally (but inevitably) as scientists used the computer. Phase One began with the exhibition organized by Jasia Reichardt titled "Cybernetic Serendipity". The exhibition featured experiments in art and technology, in which scientists explored varied art forms and the computer. This happy accident was not an accident, for it was preceded by the Bauhaus experiments in mathematics and art, and the artistic world was populated with prophets who sought, via mathematics, to find new art forms. These people found computers, and gave us a new art medium that is now implanted in many art forms.

In Phase One, a great many of the practitioners of computer art were scientists, mathematicians, and individuals with strong programming backgrounds. Even in these early stages of Phase One, some classical works of computer art were created. A great many works of early computer art were merely visualizations from computer science, science, and mathematics. They possessed some charm, with moire, or interference patterns dominant in final works. Many of the artists in Phase One continue their computer art: Charles Csuri, Ken Knowlton, Duane Palyka, Manfred Mohr, Georg Nees, Herbert Franke, John Whitney, Michael Noll, and many others.

Randomization was very popular, along with decrementing, rotating polygon forms and transformations of patterns.

THE TRANSITION

Artists began collaborating with programmers. Braver souls learned programming and worked alone. Eventually a new breed of artist emerged: one with training in the fine arts, with new experiences with computers.

Many of these new artists became so proficient, that they worked entirely alone, and defected from the manual arts, to embrace the interdisciplinary areas of art and technology, with highly varied media experimentations, with highly diversified styles and products.

PHASE TWO

In coordinating the ICCH/2 Exhibition that will be shown at the NCC '76, I could strongly perceive a great difference between this new art and that of Phase One. The viewers agree also: this new art looks more like art. It is a more mature art form. It is more pleasing. It has more color, more form, more emotion, more poetry.

In Phase Two, computer art has been implanted in art. In Phase One, computer art output was from cathode ray tubes, animated systems and static plotters. There was an artistic war between the animated practitioners and those who desired static forms. Slight dogmas arose and fell with time. Didactic persons claimed that certain forms of computer art were more "pure" than other forms. I was criticized back in 1968 and 1969 for using too many art materials, and using computer art as an "art" medium. It was a great satisfaction to see the movement "back to art".

In Phase Two, computer art is taken from output devices, and is an intermediate step before implantment in art media. Photography is often the means by which computer art output is taken into silkscreening, etching, and lithography. Graphics explorations using overlays, Diazochrome acetates, photographic combinations, etc. are but a few new experiments.

But there will be other explorations—they are inevitable. And these new experiments, in Phase Three will be in heuristic programming that is aesthetic in final form. Thus far, the ideas and programs are interesting, but generally the output leaves very much to be desired. Artificial intelligence may give way to aesthetic intelligence and output! And this new art will be one in which we come full circle: mathematics, science, integrated with art.

CAN WE DEFINE ART?

There are measurable elements of art. See the May, 1974 Computers and People, "Computer Art: Towards a Measurable Analysis", by the editor. Art often possesses some of these qualities:

1. A new vision, which may be engendered by new ideas from other worlds other than art.

2. The microcosm and the macrocosm are revealed.

3. New materials and new tools give rise to new art forms.

4. The new medium is sufficiently learned so that the artists freely express themselves in varieties of highly personal products.

5. The "leap of the imagination" is the most important element of art, in which the mind and eye absorb and synthesize tools, materials, ideas, and life experiences.

Then art is born anew. This art moves the viewer and elicits an emotive, visceral, gut-level response, as well as an intellectual reaction. Art is a total experience. And computer art is becoming such a total experience.

In the very near future, computer art will become a common, accepted art form that many people will enjoy and practice. Computer art applications will be implanted in many useful, everyday functions as well. It is often a game, "esoterica mathematica", as one of my friends put it recently. May it grow in beauty. May it grow freely, without dogmas.

Grace C. Hertlein
Editor

INEXPENSIVE GRAPHICS FROM A STORAGE CATHODE RAY TUBE

BY CHARLES J. FRITCHIE, PROF. OF CHEMISTRY
& ROBERT H. MORRISS, PROF. OF PHYSICS
TULANE UNIVERSITY
NEW ORLEANS, LA. 70118

Many institutions do not have plotter capabilities, but can afford the inexpensive and reliable Tektronix 18" storage tubes. The techniques used by Professors Fritchie and Morriss are helpful in attaining finished, film output from these storage tubes, and the film output may then be taken into other art media.

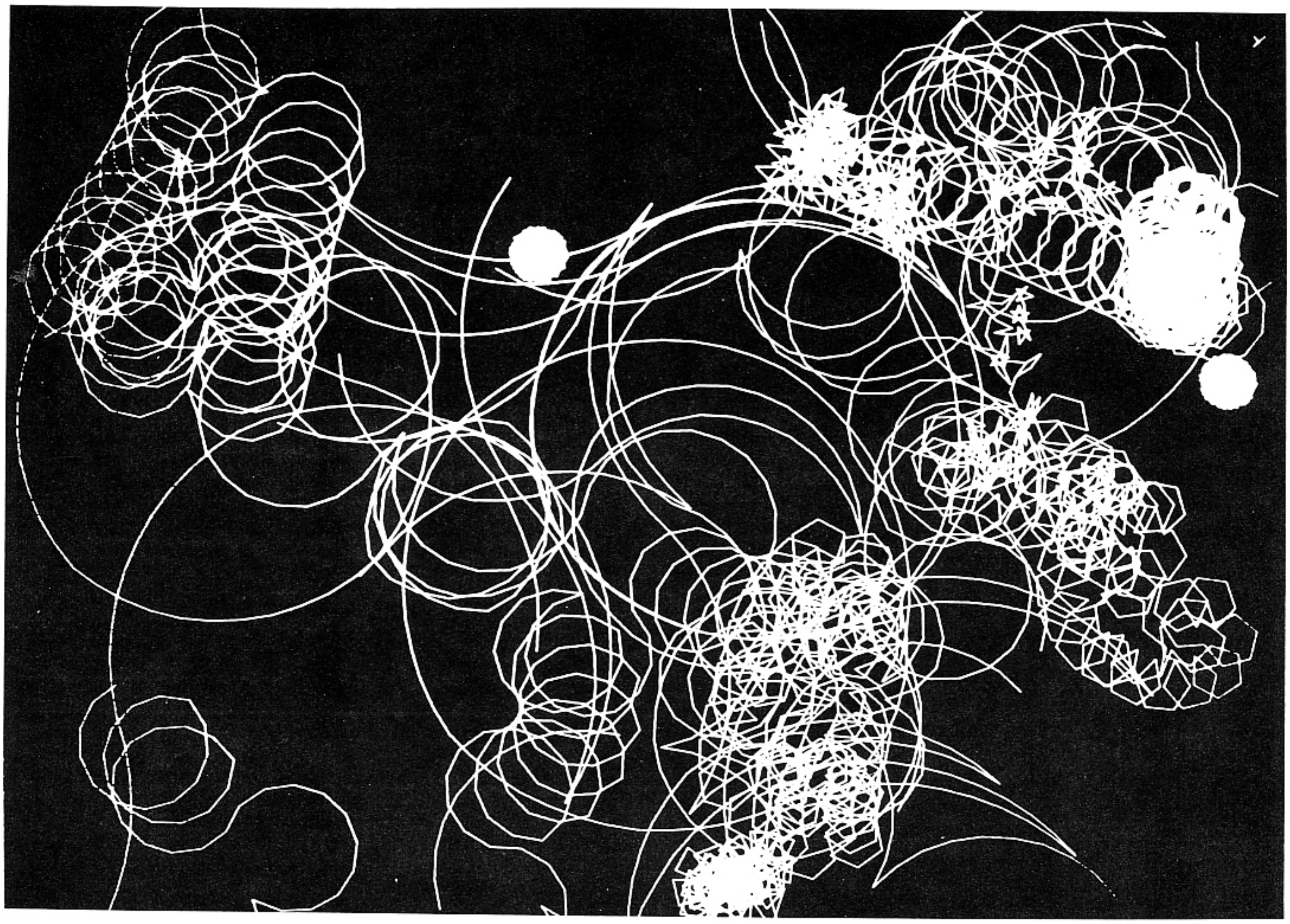


Figure 4, above: White images on a black background, typical of CRT (and microfilm) output. (For more examples of graphics by Professors Fritchie and Morriss, see page 32.)

We have been experimenting with graphics on a Tektronix 18" storage cathode ray tube for explorations in our teaching of Chemistry and Physics. The computer used in our work is an Interdata 7/16, and programs are written in FORTRAN.

Figures 1 through 7 were produced by a program that draws one or more sides of a polygon inscribed within a circle, then randomly picks a new circle tangential to the earlier one, and draws part of a polygon inscribed within the new circle. In figures 6 and 7, each curve produced this way is repeated after short horizontal and vertical translations.

Figure 8 was produced by a separate FORTRAN program that draws segments of polygons inscribed within concentric circles.

PHOTOGRAPHING CRT GRAPHICS

The graphics were photographed with a Miranda directly from the CRT, using high contrast copy film. Most were shot at f:4, using an exposure time of about one second and developed in D-19. Prints were then made using high contrast Agfa Brovira (Grade 6) for figures 1-5, 7, 8, and medium contrast Kodak Kodabromide (F-3) for figure 6, all developed in Dektol.

AN INVESTIGATION OF CRITERIA FOR EVALUATING COMPUTER ART

BY THOMAS E. LINEHAN
DEPARTMENT OF ART EDUCATION
OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

"In its brief history, computer art has stretched the full breadth of the continuum from static art object to dynamic 'real-time', including interactive displays...Is the work of art the computer-generated object, the generating program or both?"

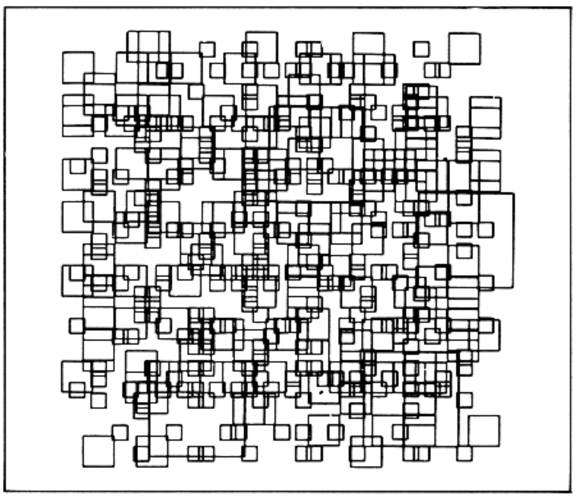
CHANGING CRITERIA FOR EVALUATING THE AESTHETIC IDEA

As the aesthetic object moves on a continuum from a stable, non-changing piece of material to a changing, progressively dematerializing expression of an aesthetic idea, criteria for the evaluation of the aesthetic object-idea must change as well. As physical structure dematerializes into conceptual structure, there are inherent problems for the critic. What is to be criticized, the fading ghost of matter, or the emerging aura of concept?

EARLY COMPUTER ART/AESTHETICS

In its brief history computer art has stretched the full breadth of the continuum from static art object to dynamic, real-time", interactive displays.[1] Several fine books by Jasia Reichardt, Herbert Franke, and Douglas Davis detail this progressive movement.[2]

Computer prints made from CRT displays or mechanical plotters first raised the issue for the critic as to whether man or machine were to be credited with this new type of "artifact." Another question raised was, "Is the work of art the computer-generated object, the generating program or both?" Early computer art objects also demonstrated a certain playfulness in regard to respected historical art work, (Charles Csuri, "Vitruvius Man," by DaVinci; Michael Noll, Variations on "Current" by Bridget Riley and "Composition with Lines," by Mondrian, etc.).



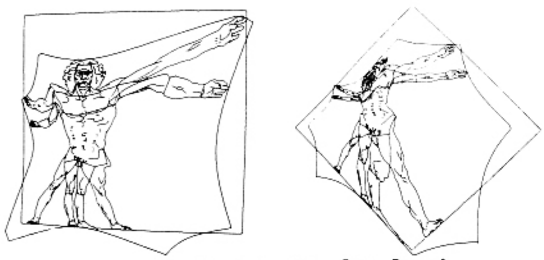
"Random Squares" by Herbert Franke, from the ICCH/2 Exhibition, a work related to the Mondrian studies by M. Noll.

THE MACHINE PROCESS AND SEARCH FOR AN AESTHETIC

These works appeared to be calling attention to the unique new dimension of the process by which they were made. Michael Noll in fact stated in this regard, "The artist's 'ideas' and not his technical ability in manipulating media could be the important factor in determining artistic merit."[3]

Harold Rosenberg was led to remark in the New Yorker, "The inspiration of machine art is problem-solving; its chief aesthetic principle is the logical adjustment of means to end." Both positions espouse the evaluation of "idea" as a principle focus for criticism.

Jack Burnham claims that the contemporary systems artist has brought us to a "post-formalist" esthetic.[4] This "post-formalist esthetic" is a "systems aesthetic."



"Vitruvius Man" by Charles Csuri

1. "Real-time" pertains to the performance of a computation during the actual time that the related physical process (the display) transpires in order that the results of the computation can be used in guiding the physical process.

   "Interactive" describes the inter-lay, the communication, the reciprocal stimulation that goes on between two or more reactive organisms. In this context, the organisms are the person(s) at the console, on the one hand, and the programmed computer(s) on the other.

2. Jasia Reichardt. The Computer in Art. New York: Van Nostrand Reinhold, 1971.
   Herbert Franke. Computer Graphics - Computer Art.
   Douglas Davis. Art and the Future. New York: Praeger, 1973.

3. A. Michael Noll. "The Digital Computer as A Creative Medium," in Computers and Man, Richard C. Dorf, Editor. San Francisco: Boyd and Fraser, 1974.

4. Jack Burnham, "Systems Esthetics," in Concepts in Art Education, George Pappas, Editor.

"A systems aesthetic presumes that the patterns of advanced technology should not be abandoned for simpler life patterns. Machines and information systems are not alien to human welfare, but appear to be compatible extensions of it. Within this context the place of the artist becomes less precisely defined. He is not so much an artisan forming handcrafted artifacts in the traditional sense, but someone supremely sensitive to the evolving environment."[5]

Burnham never explicates the criteria to be used in this proposed "systems aesthetic." He does, however, go on to point out that much of contemporary art appears to be calling for the end of formalist criteria.

"The specific function of modern didactic art has been to show that art does not reside in material entities, but in relations between people and the components in their environment."[6]

While early computer art graphics tended to create problems for the critic, and computer-animated films complicated the problems, Jack Burnham at least had the touchstone of the material object as the point of reference. Rightfully or not, the graphic work and the animated film could at least be subjected to criteria commonly used for works belonging to these classes. However, computer artists have raised distinct problems for the critics as their work dematerializes and moves on the continuum progressively closer to pure "idea" expression.

INTERACTIVE, REAL-TIME EXPERIENCES/OBJECTS

Recent computer graphics research offers the capability for the first time in history, for the human being to interact with an iconic representation in "real-time." Unlike film which is frozen in a static, periodic sequence, the "real-time" iconic representation is responsive to various orderings of its structure, surface qualities, and movements at human command given through computer mediation. The orderings can be made subject to human whim, randomness, or elaborate algorithms. Computer mediation provides the capability for an iconic representation to be exactly described as a symbolic representation (mathematical code) and for a symbolic representation to be exactly described as an iconic representation.[7] These representations can be made subject to motion, manipulations, and transformations, and maintain descriptive accuracy of one another. The linking together of these two separate modes of representation would appear to have great significance for art.

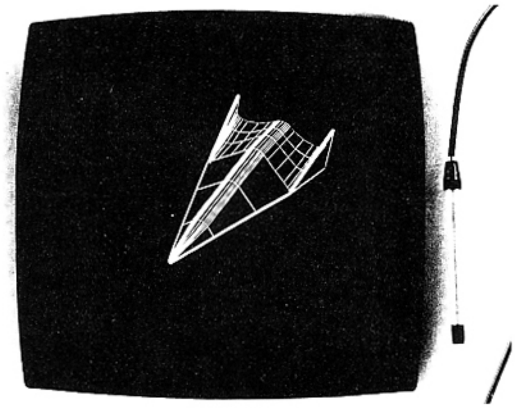
5. Jack Burnham, "Systems and Art," in Synergy Systems and Art. Research Study and Development in the Arts, University Extension, University of Wisconsin, Madison.

6. Jack Burnham, "Systems Esthetics," page 377.

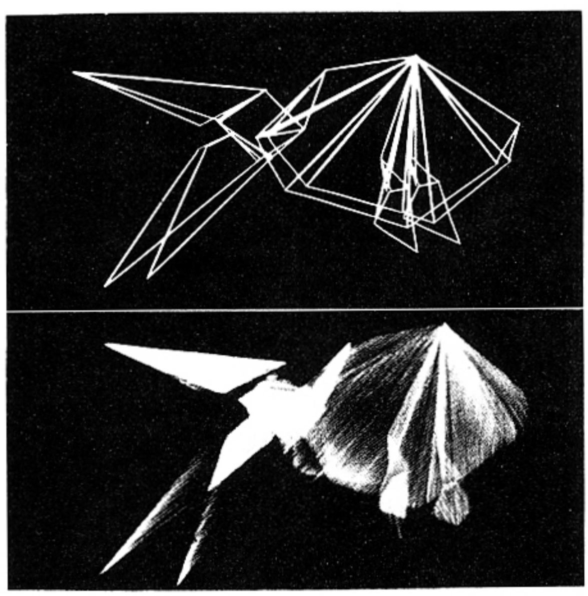
7. "Exact description" here means the capability of reproduction of one representation based on the code of the other. They clearly are not exact descriptions of one another in a perceptual sense.

Charles Csuri is exploring this significance with what he calls the "real-time art object."

"Real-time computer art objects are an intellectual concept which can be visually experienced rather than as a finalized material object. This kind of computer art exists for the time, the participant and the computer with the CRT display are interacting as a process. The art object is not the computer or the display, but the activity of both interacting with the participant. In addition to its artistic parameters, the content of this art form is dependent upon the dynamics of a real-time process which gives vitality and life to the visual display through animation and user interaction."[8]



Cathode Ray Tube with Light Pen
by Charles Csuri
(Graphic before Manipulation of Form)
BELOW: Charles Csuri, Module and Form Interactively Manipulated.



8. Charles Csuri. "Computer Graphics and Art," Proceedings of the IEEE, Vol. 62, No. 4, April, 1974, p. 511.

In this context, the traditional aesthetic object is not a "finalized material object," but rather a "visual experience." This experience is characterized by an "interactive quality" which has fixed "artistic parameters." It would appear that the artist in this case is acting like an "aesthetic manager" or an "aesthetic systems engineer." He determines the outside limits for the experience but permits a wide latitude of participant action within the set confines. While the "real-time computer art objects" may have qualities which visually resemble the traditional aesthetic object, these are in fact lists of coordinate data which are subject to constant change and manipulation. These lists of coordinate data are like physical pictures in only an analgous way.

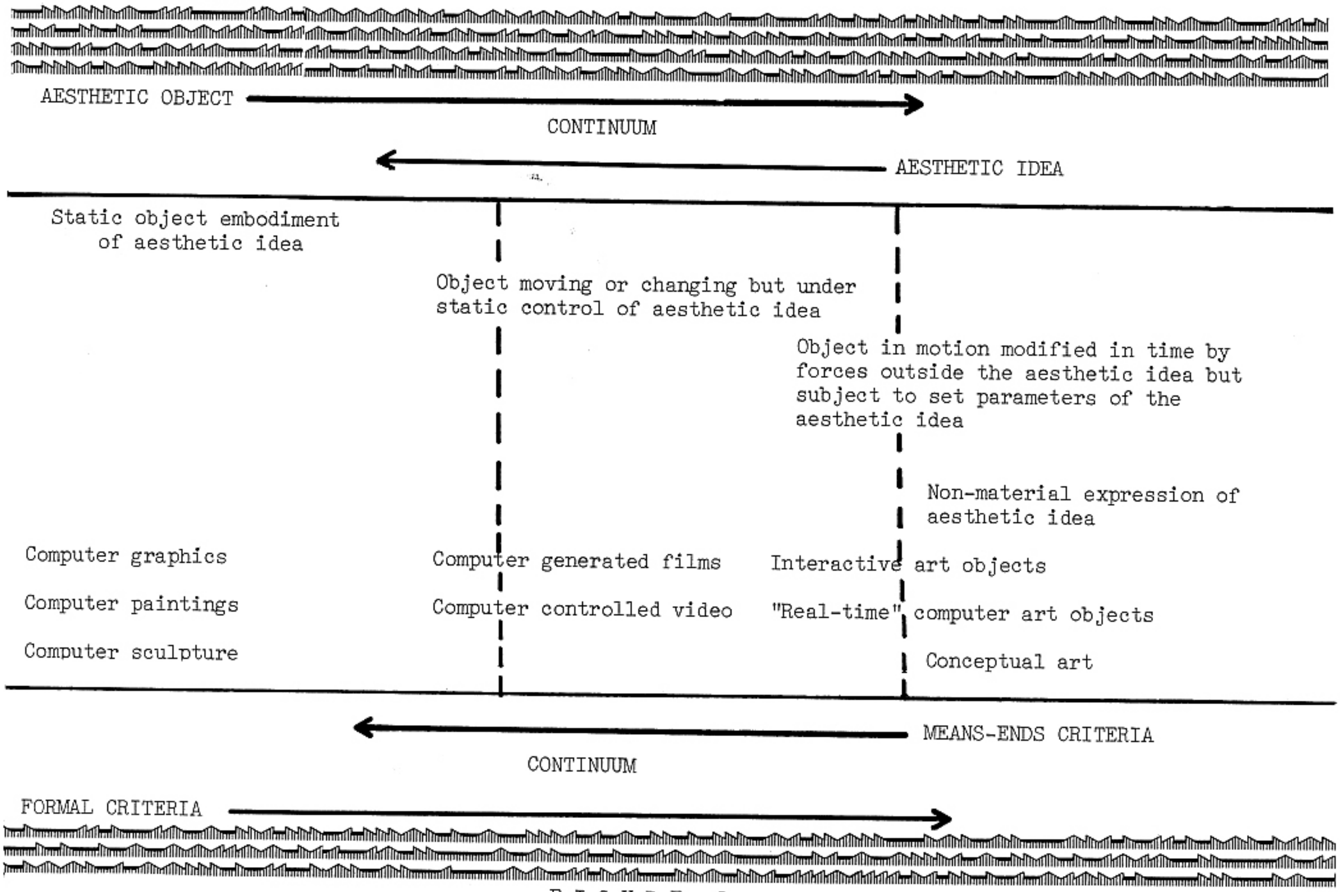
The serious problem for the critic is that formalist criteria which might look for such things in the aesthetic object as unity, complexity, balance, tension, expressiveness, etc., can only be applied to expressions of ideas or experiences in an ancillary way. When these are applied to literature, for example, the verbal components and structural organization are criticized, and these are seen as the aesthetic object.

In this sense, the "real-time computer art object" may be seen as akin to a work of literature and its components and structural organization subjected to a formalist criticism. A model of criticism taken from drama might appear more appropriate in that it could also account for spatial and temporal organization. Models for film criticism would appear to account for the periodic nature of the "real-time computer art object," but none of these can account for the crucial component of "interactiveness."

FORMALIST CRITERIA VS. MEANS END CRITERIA

It might appear that aesthetic systems designers have lead the critic to the point where formalist criteria can only be applied in a secondary way, and that means-end criteria become the primary touchstone for analysis and evaluation. Such criteria as utility, economy, efficiency, instrumentality, conservation, etc. are traditionally conceived of as extra-aesthetic. However, the continued application of formalist criteria to shrinking forms appears illogical.

Figure 1 depicts the progression of the computer art object from material object to expressive idea, and demonstrates the corresponding change in emphasis from formal criteria to means-end criteria. Essentially this sets up a system which accommodates at one extreme the evaluation of the systems artist's idea or concept. In current methods of phenomenological art criticism, this would be seen as committing the intentional fallacy. It is argued by proponents of this method, that the artist's idea or concept may never be known, and that criticism should only be based on the work itself. However, the systems artist works in a fashion different from his more traditional counterpart. A systems design method demands an elaborate plan — one in which goals, objectives and anticipated outcomes are clearly specified. Options within the system are clearly delineated, and the interaction of components is specified. The systems artist leaves "tracks" throughout the planning process in the form of flow charts, computer programs, and testing results. Consequently there is data on which the design process can be determined and evaluated.



F I G U R E 1.

While ultimately it is the "aesthetic outcome" which needs to be evaluated by the critic, a systems view would argue the necessary interconnectedness of outcome with the design and planning process.

Such a position is essentially consistent with the conception of the artistic process as qualitative problem-solving. This is a methodological conception of the artistic process. Ecker has developed this view in much of his writing.

> "...It may be said that qualitative problem solving is a mediation in which qualitative relations as means are ordered to desired qualitative ends. Thus to choose qualitative ends is to achieve an artistic problem. Whenever qualitative problems are sought, pointed out to others, or solved, therein do we have artistic endeavor -- art and art education."[9]

The term "quality" has been used to refer to a standard of excellence and to an attribute of something; however, Champlin and Villemain[10] argue for methododological definition as well. In the ordering of qualitative means, such as lines, colors, textures, the artist applies a "method" which searches for a pervasive quality which may be common to his previous work or consistent with a desired style. This pervasive quality acts as a "control" or directive criterion in the process of ordering qualitative means to qualitative ends.

In the case of the "real-time computer art object" a qualitative end might be described as a high degree of interactiveness between the program and the participant. The computer artist in this context, must order all "qualitative means" (programming features) to produce the desired end. The artist has elected to give up the object's stable form for a fluidity of form which is to be characterized by its "responsiveness." Consequently, it is subject to criticism using responsiveness as a criterion within a "means-ends" evaluative system.

In such a conception of the artistic process it is impossible to criticize the "qualitative ends" apart from the "method" and "means" and the problem solving process employing them. This conception more closely approximates the processes in which the systems artist engages and should begin to provide a context in which to criticize his work.

In summary, we are moving away from traditional, formalist criteria for evaluating computer art, as the medium of the computer becomes a larger territory in which greater numbers of artists explore the spectrum of a free continuum. We are fortunate that this new field has not yet solidified within dogmas. We are yet free to explore the continuum.

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9. David W. Ecker, "The Artistic Process as Qualitative Problem Solving," Readings in Art Education, Elliot W. Eisner & David W. Ecker, Editors. Waltham, Mass.: Blaisdell Publishing, 1966, p. 68.

10. F. T. Villemain and N. L. Champlin, "Frontiers for an Experimentalist Philosophy of Education," Readings in Art Education, pp. 444-453.

POTPOURRI

OFFER TO COMPUTER ARTISTS

Artists wishing to sell their work by direct mail to CG&A readers may send an illustration, a description and price material, to be published in this magazine. (See page 25 for example.) There is no cost for this service.

As this develops, we may have a section devoted to this service, and reader feedback on this is invited.

A NOTE TO AUTHORS

Flowcharts and Tables: Please send original and tables with your materials. Otherwise a great deal of time is spent by the staff in redoing Xerox tables and flowcharts. Or you may send photo-ready (offset, not Xerox) materials that are copy ready for the camera.

Illustrations for Articles, Papers: In a graphics magazine, it appears desirable to not merely refer to specific graphic uses and authors in written material, but where feasible, to include illustrations related (or closely related) to the written text. If a picture is worth a thousand words, then illustrations accompanying a text speak more fully. Also, the research described should have some illustrations of the final product.

WE NEED SUPERIOR BOOK REVIEWERS FOR CG&A. Current reviews of literature, films, new texts can be an invaluable portion of this periodical. These reviews may be short or long, and may include illustrations. Excellent models are in: the Scientific American, the Saturday Review, and Leonardo.

Richard Speer of Evergreen College, Olympia, Washington, is our Film Review Editor.

We invite someone to become our Book Review Editor. This department is one we wish to build up quickly as a reader service.

FORTHCOMING ISSUES

We would like to follow the theme format for successive issues. The third and fourth issues of CG&A are in process. Themes for these issues are:

1. GROUPS - Many superior groups of people are working together. Typical groups are: CAYC, Buenos Aires; the Architecture Machine Group, MIT; ARC, Kansas City, Missouri; GAIV, Paris, etc. There is a great benefit in the colleague/group approach to research and creativity. We invite your participation in this GROUP ISSUE.

2. APPLICATIONS - All disciplines are requested to send highly varied materials for this special APPLICATIONS ISSUE. Some materials have been received. Emphasis will be on a host of very different applications, of diverse materials.

WANTED: SYLLABI that have been class-tested in graphics for reader use.

NCC '76 ART EXHIBITION-NEW YORK CITY, JUNE 7-10

Four distinctive art exhibits have been gathered by Jackie Potts for NCC '76 — the largest and most international exhibition of computer art shown in the U. S. to date. Here are notes on the four exhibits, and comments by the artists in the SDL Collection. (Comments by the artists are from the SDL Portfolio, the ICCH/2 Exhibition Notes, and correspondence from the editor's files.)

NEW YORK HILTON SITE OF ART EXHIBITION

Four distinctive exhibitions of computer art have been gathered together for the 1976 National Computer Conference to be held in New York City from June 7-10. This particular exhibition represents the largest showing of computer art under the sponsorship of one organization and reflects a tendency of groups to share and disseminate works for the benefit of a larger audience.

The NCC '76 ART EXHIBIT is chaired by Ms. Jackie Potts of the Social Security Administration, Baltimore, Maryland (and Advisory Board Member of CG&A).

This very large and distinguished exhibition of computer art will be shown at the New York Hilton in the Rhinelander Gallery from June 7-10 in adjoining galleries (Rhinelander North, Center, and South).

Grace Hertlein, CG&A Editor, will give daily gallery tours of the exhibition from 10:00 A.M. to 4:00 P.M. at the Hilton in the galleries.

Included in the NCC '76 ART EXHIBITION are four groups of works:

- The Systems Dimensions Limited Collection
- The Touring Exhibition of Computers and the Humanities (ICCH/2)
- The Henry Christiansen Collection
- Juried works from individual artists

THE SYSTEMS DIMENSIONS LIMITED COLLECTION

The SDL Collection of computer generated art was commissioned by Systems Dimensions Limited, a leading Canadian-owned company in the information industry. The collection contains one of the firsts in computer art: a series of important international computer artists' work in serigraphy (silk-screening) in limited, numbered, signed editions. The SDL Collection marks a trend towards editions of computer art works, in which a very limited edition of superior graphics are printed and signed by the artist, as in manual fine art printmaking. Each numbered, signed work is considered as an original print. The SDL Collection is a very striking, handsome series of such prints. Represented in the Collection are works by:

Manuel Barbadillo, Spain
Hiroshi Kawano, Japan
Kenneth Knowlton, USA
Manfred Mohr, France
Georg Nees, Germany
John Roy, USA
Zdenek Sykora, Czechoslovakia
Roger Vilder, Canada
Edward Zajec, Italy

THE TOURING EXHIBITION OF COMPUTERS AND THE HUMANITIES (ICCH/2)

This is a large exhibition of invitational, international computer art, containing over 150 works by fifty-six artists and groups. It is circulated in the United States in honor of the Tenth Anniversary of COMPUTERS AND THE HUMANITIES, a scholarly journal that reports on the entire spectrum of computer applications in the humanities. The Journal, (CHUM), is edited by Dr. Joseph Raben, Queens College, Flushing, New York.

The ICCH/2 ART EXHIBITION was organized by Grace Hertlein for the Second International Conference of Computers and the Humanities, held at the University of Southern California in Los Angeles in April of 1975. Additional coordination for preparation of the exhibition was by Dr. R. Hirschmann of USC, in conjunction with the Faculty Colloquia on Technology and Man.

Many of the works are quite large, and reflect a very new trend in computer art: one in which the computer is used as an intermediate device, and the final art forms are taken back to fine art in varied media. Sculpture, painting, etching, lithography, textile design, photography, are a few examples. The resultant art work looks more like art, yet reveals the unique characteristics of computer art.

Fifty-six artists and groups from Spain, Germany, Yugoslavia, France, Canada, the United States, Sweden, Brazil, Austria, Italy, Israel, and Russia are represented in ICCH/2.

An alphabetical index of artists is given on page 29.

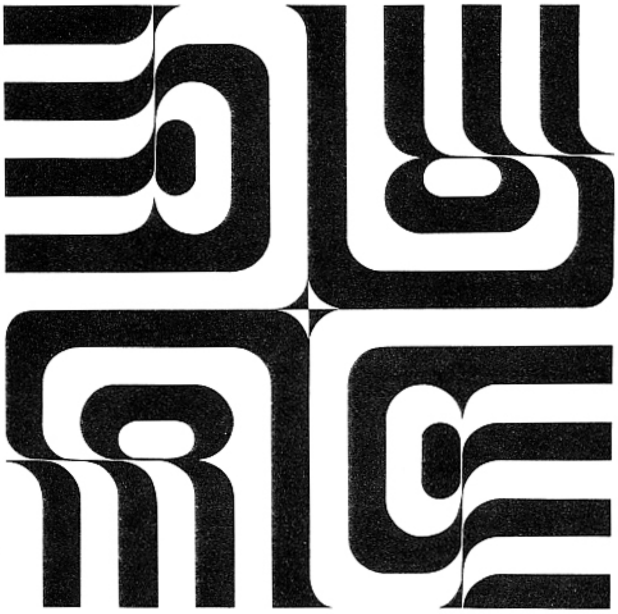
THE HENRY CHRISTIANSEN COLLECTION

Another "first" in computer art will be the East Coast Showing of the Henry Christiansen Collection, entitled "Computers for People Who Can't Read but Love to Look at Pictures." Dr. Christiansen, Professor of Civil Engineering at Brigham Young University, will exhibit thirty-nine mounted color photographs of continuous color tone images which are shaded drawings (rather than line drawings) of finite element systems.

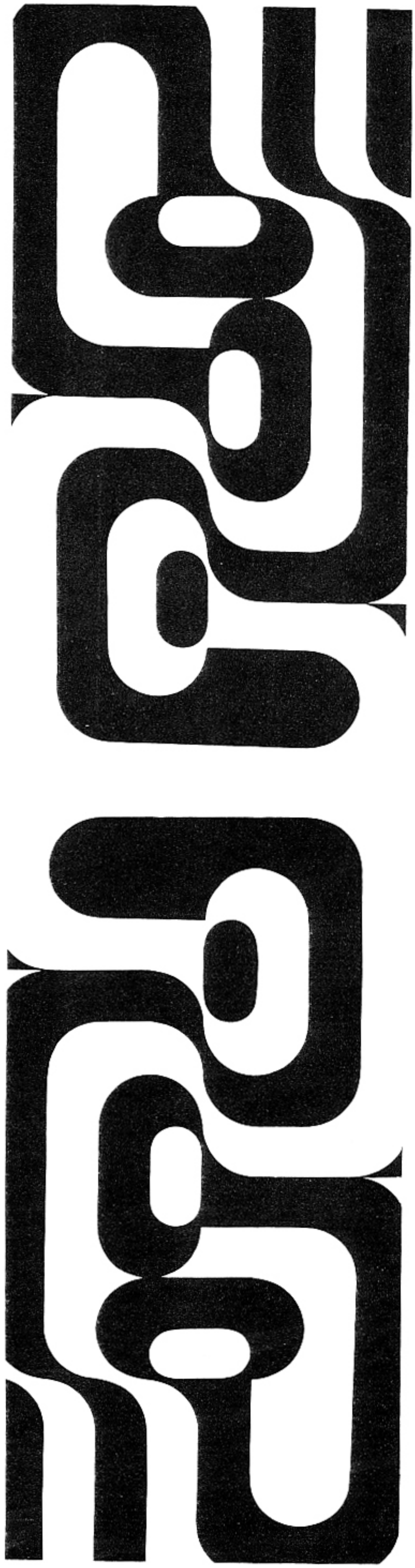
OTHER ART DETAILS

The Bicentennial theme will be carried out with two 7 feet by 9 feet scanchrone reproductions of George Washington and Abraham Lincoln produced by a process called Blockpix. These images are made with an electro-optical processor which is part of an optical computer system, in which the output of the processor is recorded by photography.

DON'T FORGET TO ATTEND AND BID ON THE ART AUCTION. (See NCC '76 PUBLICITY FOR DETAILS.)



"Aeleana," Serigraph by M. Barbadillo, from the SDL Collection



MANUEL BARBADILLO

"Starting with these modules, I try to express myself as the poet does with words: by combining them, or establishing relationships between them, so as to create a rhythmic pattern.

Basically, my painting is a research on the problem of space, which in my work is an element hierarchically equal to form, like a complementary form or anti-form, in the same way that silence — pauses — in music is a modulating element as important as sound, with form being neither one or the other, but the result of combinations between them. In my pictures, space, rather than being a neutral emelent — a mere support for form — is a participating one, and the paintings, better than of form and background are composed of positive modules (black on white) and negative ones (white on black). This principle of oppositions and opposites complementarity is essential in my work, where it is present from the level of independent modules to that of very complex compositions. I believe it to be a statement on the bipolarity or dual nature of things, a notion antiquity held as the golden rule of the Universe.

The computer has been a great help to me. Properly programmed it will produce a great number of designs to study and compare, to choose or to get a stimulus from. It has revealed compositional rules I had been using in my pictures without really being conscious of them and has allowed a great deal of systematization in my research. Since I am more interested in speed than in perfection of drawing, I prefer a line printer — with asterisks roughly filling in the shapes — to a plotter.

The final versions of my works I usually produce by hand."

(Comments by the artist from the ICCH/2 correspondence with the editor.)

HIROSHI KAWANO

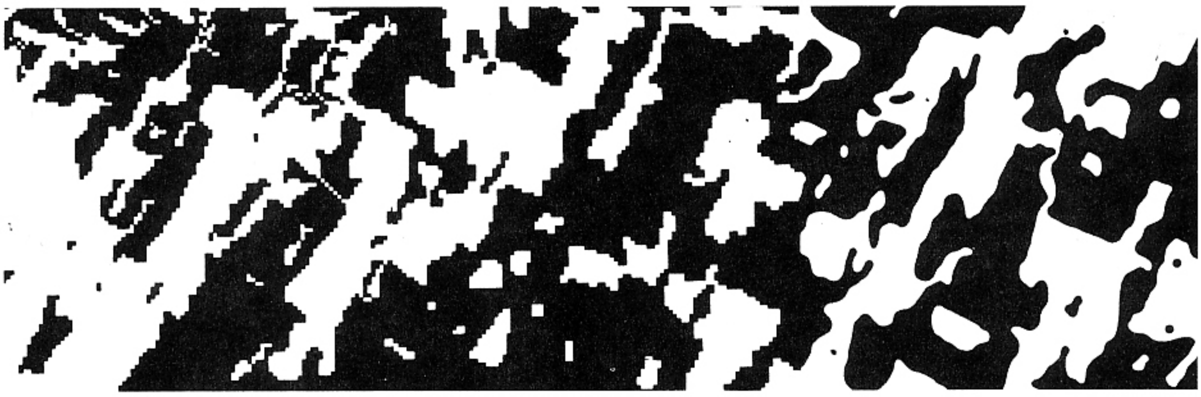
"My computer art is not only fine art, but is also the result of aesthetical studies, through which I wish to throw light on the logic of human art by using the information processing model of the computer.

I think that computer art should not be mere computer-aided art, which is now becoming popular as a device which adds eccentricity to human art. It must be the creative activity of the computer which thinks freely, like a human being. The problem of the computer is not its human-like behavior, but its non-human behaviour. My computer art is only the beginning of scientific studies about art, and so the works have not yet such an artistic value as human art has. But I think that this is caused not by the crudity of the digital computer, but by the unripe reasoning of the aesthetician thinking about art. In the future, excellent human-like computer art will perhaps be produced as scientific aesthetics make further progress.

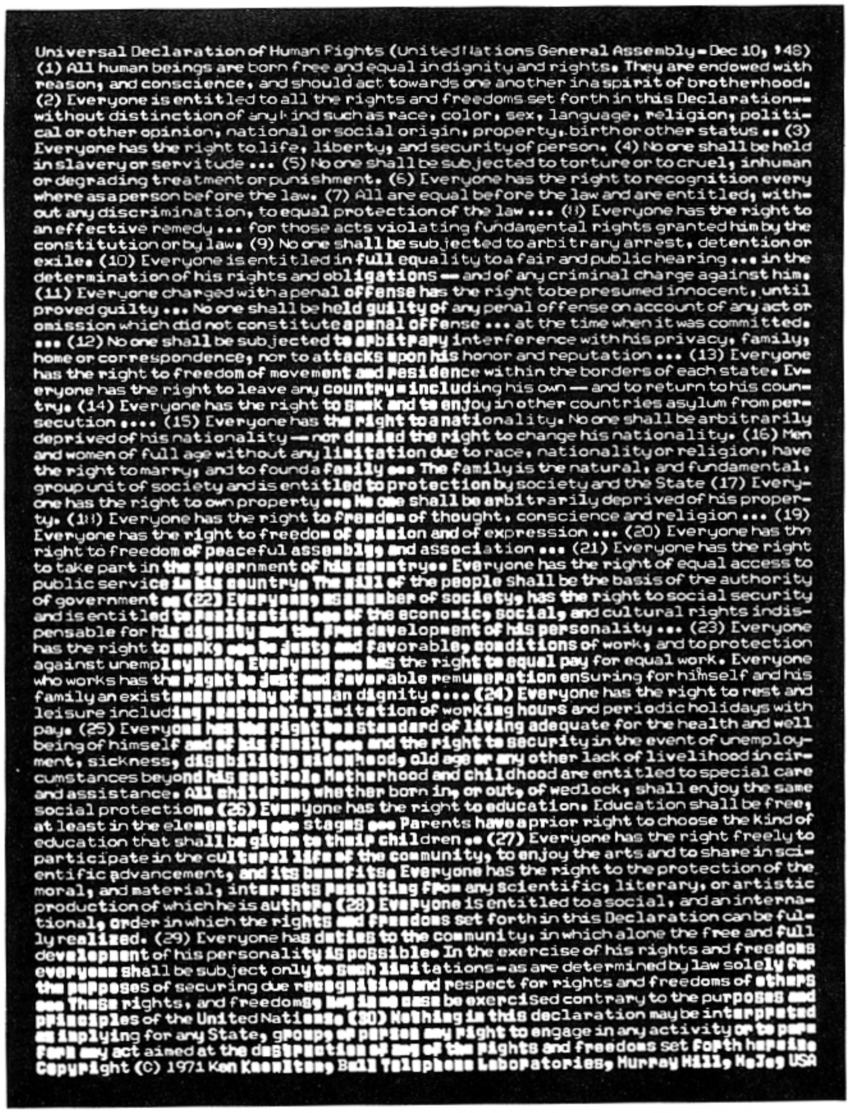
Now, I call a computer's imitating human activity and creating a work of art art simulation. The computer must recognize the algorithm of art in order to simulate human art. The art algorithm describes a method to solve art problems; that is, how to create such and such a work of art through a computable formula. We need to build a mathematical model of artistic activity in order to describe the art algorithm as a program. I have built this art model by means of the theory of information and the MARKOV-process theory.

"Simulated Color Mosaic" by Hiroshi Kawano, from the SDL Group.

If we can describe this process of art simulation in computer language and give that description to the computer as a program, the computer will look at the various data-pictures, capture their image, and subsequently create an infinite variety of new pictures from the images it has grasped." (From the SDL Portfolio Notes.)



Black and white illustrations of computer printouts by Hiroshi Kawano — in the ICCH/2 EXHIBITION. The upper strip reveals the grid-like output, while the lower portion is altered through a transformation technique.



"Universal Declaration of Human Rights" by Kenneth Knowlton

KENNETH KNOWLTON

"It is quite clear that computers will be used more and more extensively in the production of new designs and other static and dynamic visual images; our visual experience will thus be enriched.

It is too early to call the results art, and this will be the case for a long time to come because the complexity of the process intrudes — although it fascinates the viewer, it also separates him from the artist.

To say that the medium is the message is to say, unfortunately, that there is no message in the ordinary sense."

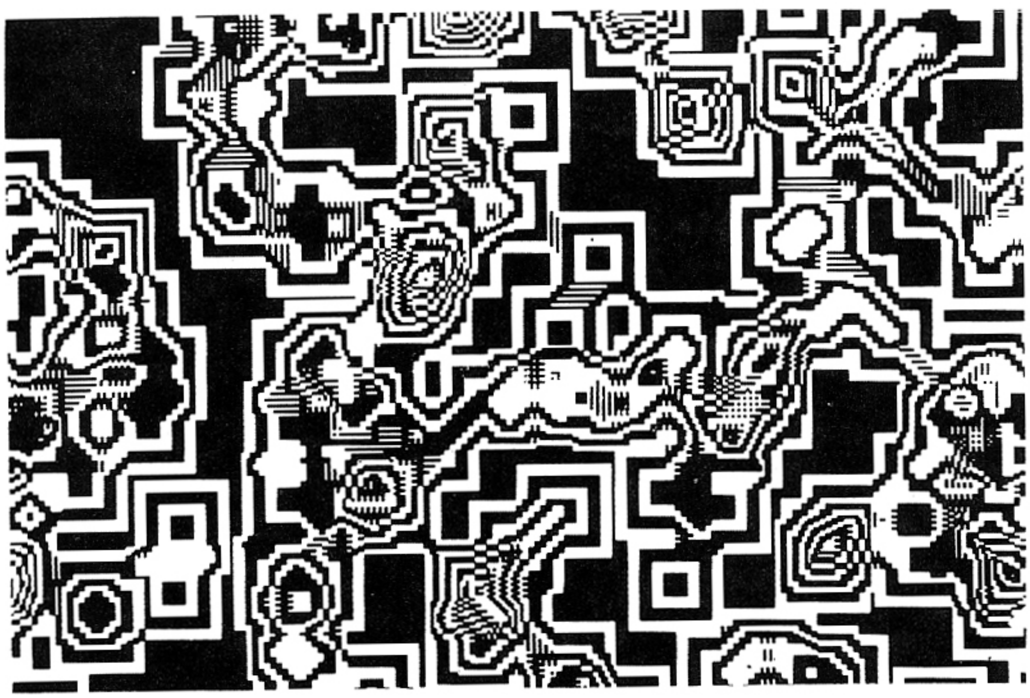
(Comments by the artist are from the SDL Portfolio.)

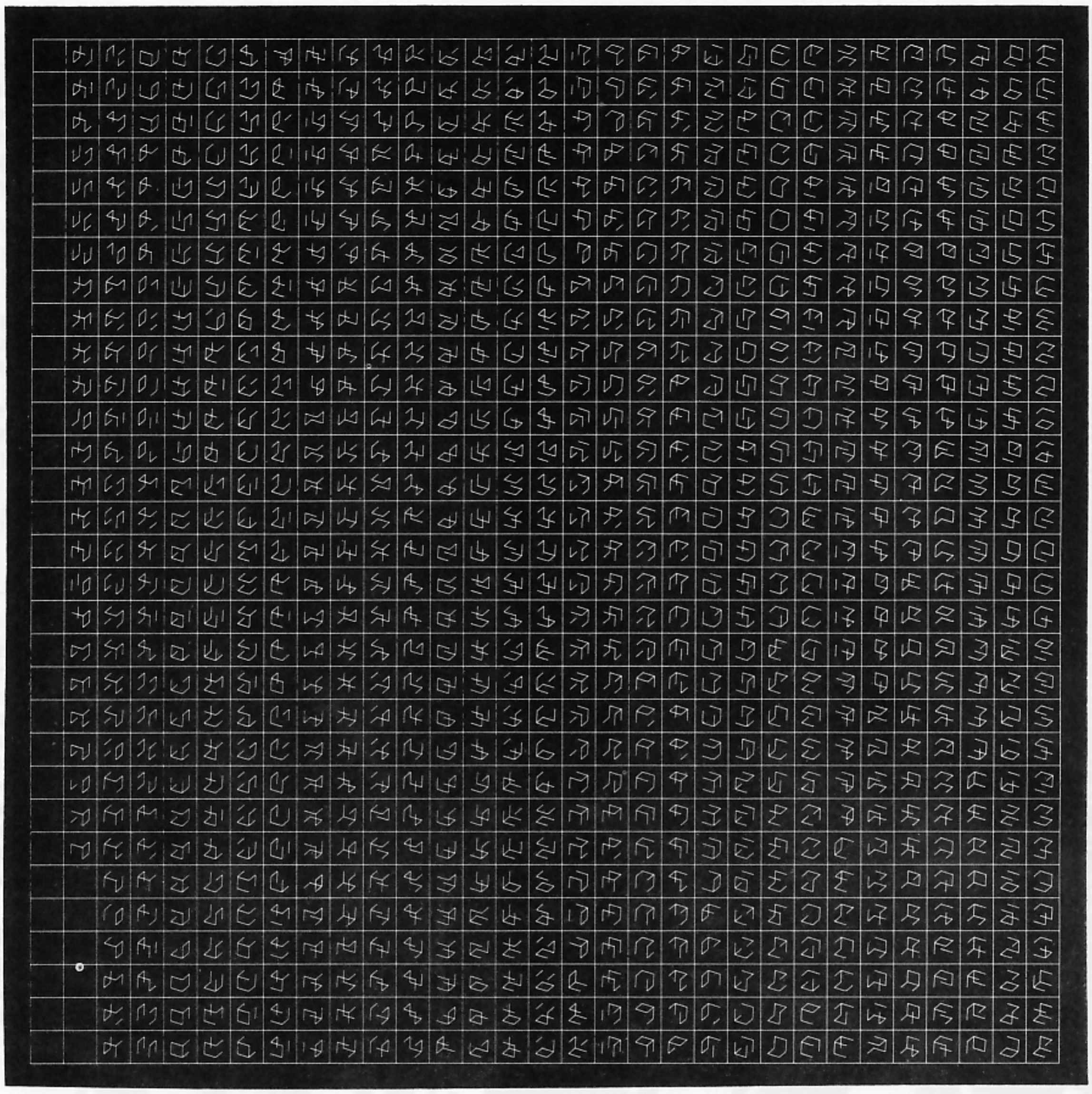
Editorial Comments: Kenneth Knowlton is one of the most important, universally respected computer artists. His capacities as a scientist are equally balanced by his sensitivities and his imagination, as displayed in his innumerable art works. The graphic at left conveys more than just interesting technique— it is social commentary, something lacking in most computer art, which all too often, is mere decoration, and frequently, manipulation of materials and design in repetitious, and non-inventive ways.

Ken Knowlton is perhaps one of that growing number, of "New Renaissance" people, who live equally at home in the world of art and science.

At right, Detail of "Tapestry I", by Ken Knowlton and Lillian Schwartz, from the cover, Computers & People, 8th Annual Computer Art Exhibition.

Works by Ken Knowlton and Lillian Schwartz are included in the ICCH/2 Exhibition.





Manfred Mohr. "The Cubic Limit Series" — one of four works from ICCH/2.

MANFRED MOHR

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

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

...We do not have to ask: What can the computer do, but reverse the question by asking ourselves: What do we want to do? and then consider whether the help of a machine could be useful for our purpose.

If the answer is positive, we have to find ways of asking the machine the right questions in order to get reasonable results, amplifying our thoughts and intentions. Proceeding in this way is an important step towards a systematic approach of aesthetical problems. Abraham Moles once said: 'La machine ne pense pas, elle nous fait penser.'

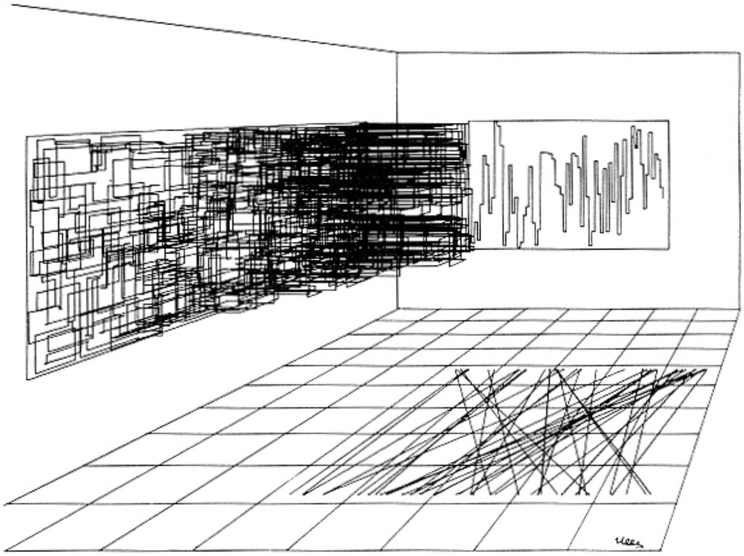
Breakthroughs in human development are always accompanied by radical changes of attitude towards the so-called human values. It is, for example, from a practical (and philosophical) point of view evident that one should simply be ready to leave the most possible part of a work to a machine when it becomes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

(Notes by the artist are from the SDL Portfolio, and correspondence to the editor.)

GEORG NEES

"The future of the computer as an art medium will very much depend on whether some pieces of computer art will gain and reveal depth. This may take place by stratifying and structuring computer drawings and sculptures in both a more natural and more intricate way than this is done now. The objects generated can be abstracta or they may represent visualizations of concepts out of other fields of thinking and experiencing.

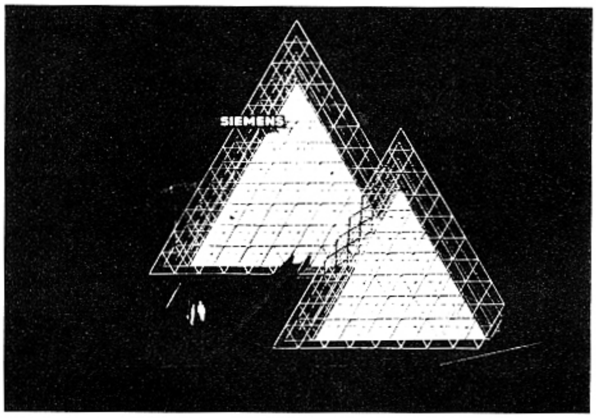
...But there is quite another viewpoint, which holds that computer art should be absorbed, as early as possible, by the purely functional structures of technologies of the future, which allow man to convert into reality his potentialities for moulding matter in every positively synthesizing way conceivable. It is certain that more sophisticated computers will then be the agents, of secondary priority only to man. Yet I think that computer art, as a consequence of such a phase of absorption, will display a tendency to free itself again and take a step forward, in order to be able to function as an independent source of innovation."



G. Nees, "Max Bense Museum" - from the SDL Collection.

DESIGNS FOR THE HANOVER FAIR, 1970

Below, the Siemens-Stand at the Hanover Fair. The line drawings at the bottom explore various parameters -- to find different solutions, resulting in a decision to choose the bottom left graphic as the final form.



The final design, model and graphic.

TWO AND THREE DIMENSIONAL DESIGN by G. Nees

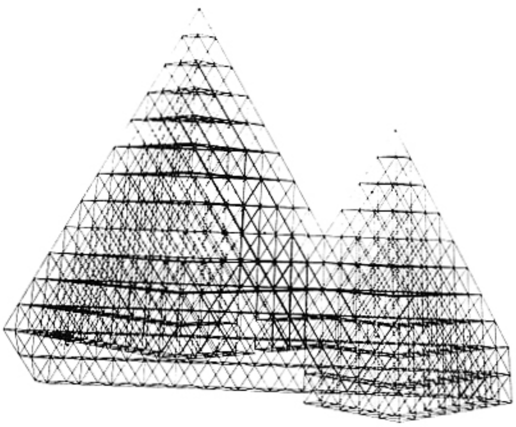
"While the use of computers in research, technology and administration has long since become standard procedure, its application in the various fields of design is still in its incipient stage.

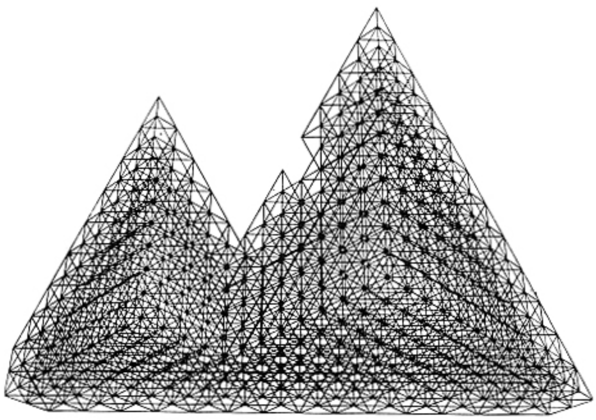
...After 1969, when the first computer sculptures had been displayed in the Siemens stand at the Hanover Fair, the computer's aid was also enlisted for design problems. The computer was now confronted by the necessity of solving the practical problems of industrial design. In structural design, however, the multiplicity of forms is limited by practical requirements.

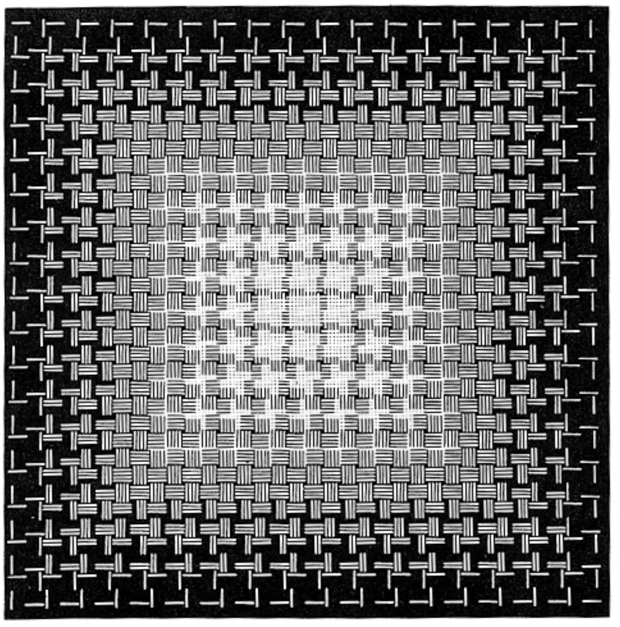
Designing with computers has barely begun. ...Most of the spheres which go beyond daily routine phenomena must still be explored.

Man must still define his position and function in the sphere of informatics. The future still holds a lot of surprises in store for us — and for the experts too."

(From NOVUM Gebrauchsgraphik, Heft 8/1972, Nees.)



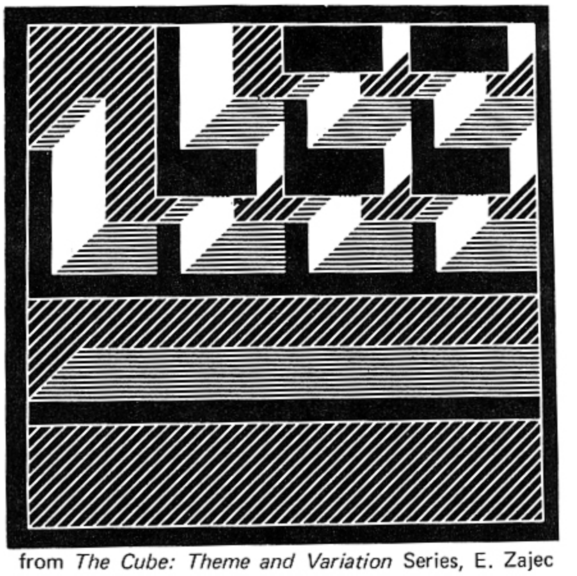




"Segrid" by John Roy, from the SDL Collection.

JOHN ROY

"At the present time there is a tendency to consider the computer generated product as being the only relation between art and the computer. I believe, however, that as our experience with the use of the computer in art develops, we will learn to give at least equal consideration to the programmer's art."



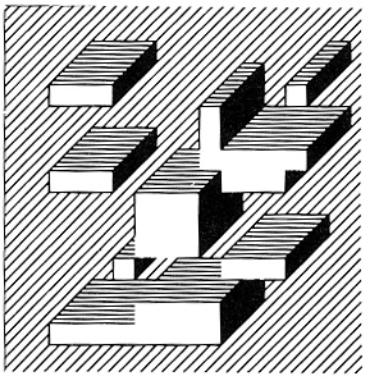
from *The Cube: Theme and Variation* Series, E. Zajec

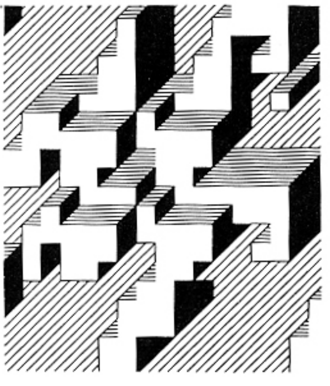
From SDL and ICCH/2.

EDWARD ZAJEC

"The impact of the computer as an art medium can be felt already in the gradual shift from an art essentially static, contemplative and introverted, to a dynamic, interactive, extroverted art, from an object oriented art to a process oriented one. Artists no longer concern themselves solely with the sublimation and expression of their internal struggles in the form of finished objects, but are concentrating on developing processes demanding involvement and participation from the spectator.

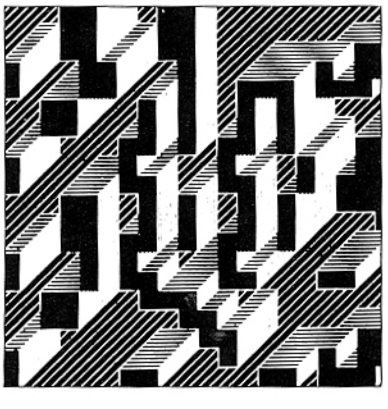
It is with this view in mind that an appropriate answer can be given to the very relevant and often posed question of what can be done with a computer and could not be done without it. With a computer we can describe and communicate the organization, structure and dynamics of any given message, leaving it open at the same time to different interpretations and modifications, or better: only with a computer can we untie the constructive aspects of an idea from its material features, and observe and articulate them in time through direct interaction. This, for now, is the most important contribution, the meaning which the theory of information and the use of computers have brought to aesthetics."

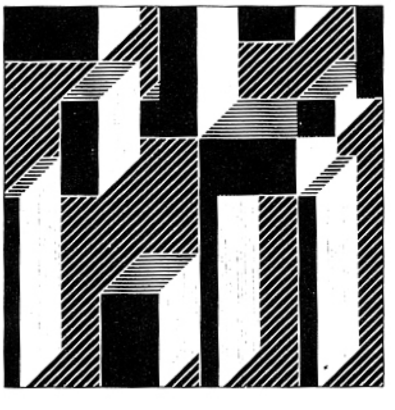


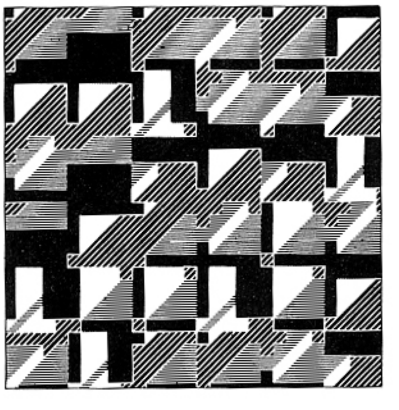


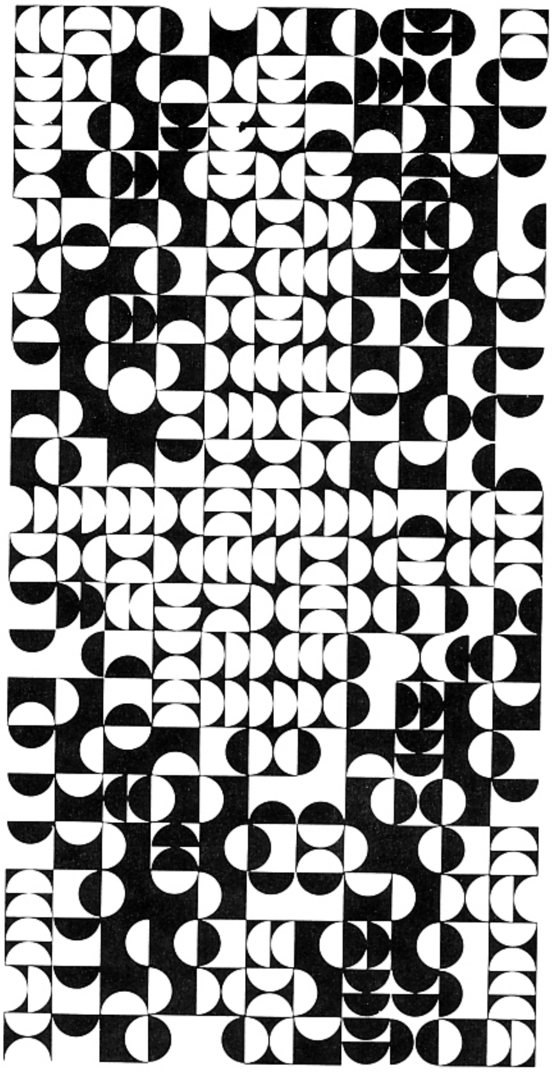
Edward Zajec explores transformations of forms, in a series of related works. The forms yield varied perceptions, as in op art, depending upon the focus of the viewer.

Examples from the ICCH/2 Exhibition.







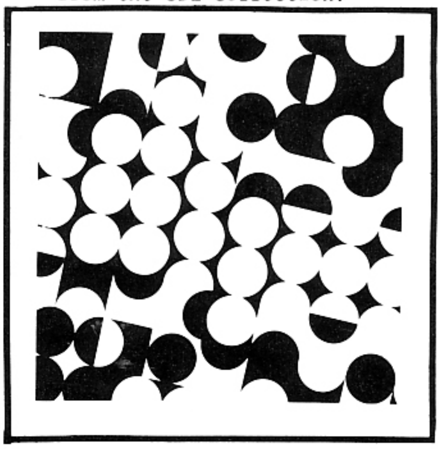


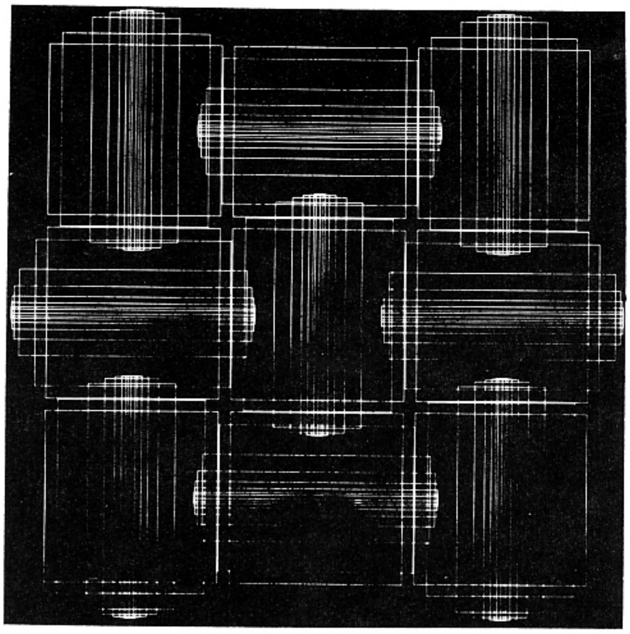
"Structure" by Z. Sykora

ZDENEK SYKORA

"I began, in 1961, to make paintings of a geometrical, abstract kind in which the composition results from the repeated use of one or more basic elements characterised by a unique shape and by specific internal geometrical patterns. I soon realized that I was running into combinatorial complexities that might be easily resolved by means of a computer. Hence my collaboration with Jaroslav Blazek, a mathematician."

"Black-White Structure" by Z. Sykora, from the SDL Collection.





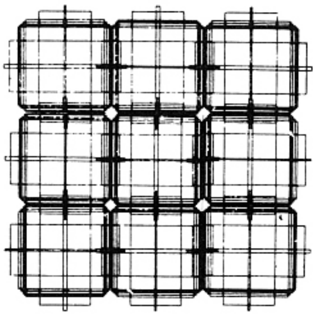
Roger Vilder, "Variation on 9 Squares," from the SDL Collection.

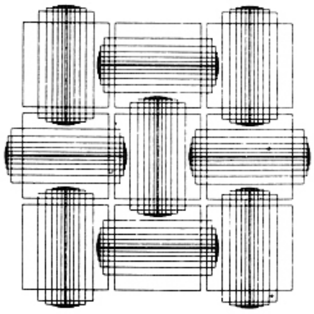
ROGER VILDER

"When I began to work with computers, my first reflex was to recreate on the cathode-ray tube most of the visual phenomena I had created by mechanical means. Soon, I realized the amazing potential of the computer and began to expand my ideas into more graphically oriented work. As a result, I produced some short animated films.

I found myself very much at ease with a computer, mainly because I was already used to working within a well defined system, with the constraints of mechanics. Yet, there is a great difference between computer art and other media. The exchange, while the process of creation is happening, seems more alive because of its instantaneity. It is almost like having a conversation with someone from which something visual results. This very aspect of the computer, along with its extraordinary speed of execution, is what I appreciate most when working through this medium."

(Below, the artist explores variations on a theme of the nine squares. The computer works bear a strong, familial resemblance to the luminal sculptures.)





Digital Computer Based Sculpture Composed Of Coloured Elements

BY LAWRENCE J. MAZLACK
COMPUTING AND INFORMATION SCIENCE
UNIVERSITY OF GUELPH
GUELPH, ONTARIO, CANADA

"Math is often said to be an art form...This paper describes a project that explores the distinctions between math and art, and media art as math."

ABSTRACT

This paper describes a current research project on three-dimensional colour pattern development using a cellular growth concept. The techniques employed differ radically from the most commonly used form of computer generated colour pattern development, i.e., line development by function tracing with post pattern development colouring. The method under consideration produces rectilinear colour patterns which are "grown". The growth technique is similar to a letter by letter development of a crossword puzzle. Colour selection and the extent of a given coloured area is machine generated by a combination of random, statistical and artistic techniques.

INTRODUCTION

Most computer determined colour patterns, be they commercially or esthetically oriented, consist of graphical output (artwork, cartoons, industrial drawing, etc.) and are based upon the use of functions, whether singularly or repetitively performed. Colouration has generally been introduced after the initial pattern generation. This paper reports on a computer based technique for generating three dimensional translucent structures composed of elements of varying colours. These structures are generated by non-functional pattern construction with construction time colouration.

The constructions are rectilinear patterns of varying colours. The colour patterns are developed by a growth technique utilizing a precedence ordering of the matrix points being coloured.

The requirement for the growth of a colour pattern is thought to be similar to the requirements for the growth of a crossword puzzle in a letter by letter mode. The author has had considerable successful experience in machine development of crossword puzzles (1,2). Additionally, there are similarities to the growth pattern of Conway's (3) life game.

The entire area of rectilinear colouration is relatively unexplored; "colouring" has been utilized by Strong and Rosenfield (4) to define cloud regions. However, this "colouring" limited itself to grey scale differentiation and did not deal with non-grey colours. Additionally, most rectilinear investigations of coloured patterns have usually been grey scale investigations, and have dealt with picture cleaning and edge definition.

Potential utilitarian applications are in the areas of fabric design and cartoon colouring. The study of the interrelationship of colours can be dynamically explored. On a less utilitarian basis, the definition of what art is, and the question of whether or not it can be completely mathematically defined will be partially illuminated.

PRESENT USE OF COMPUTERS IN THE ARTS

This project is essentially an exercise in the use of computers in the creative visual arts. So it is quite reasonable to ask, "Where and how are computers presently used in the creative arts?"

Computers are used in many places in the creative arts. They are most used in the arts which can be continuously repeated or statically presented or examined. These arts are those of music and visual art, both static and moving. There have been computer music compositions (5) and formal computer art exhibits (6,7). Often areas such as the dance (8-11) are also investigated, but not to any significant extent.

Machines have been used in the arts for purposes of instruction, analysis, manipulation, performance, and creation. This proposed project is one that combines performance and creation.

For various historical, practical and chance reasons, music has had the longest ongoing relationship with computers. So, in examining the area of computers and music, we can get a good idea of the potential depth and breadth for computers in the visual arts.

MUSIC AND COMPUTERS

The utilization of computers in music has been very deep and broad. On a relatively simple level, computers have been used to select operas (12) analyze instruments (13) and to accomplish some of the more mechanical aspects of transposition (14) and display (15, 16).

A great deal of work has been done in connection with the utilization of electronic music synthesizers, including their programming (17). However, synthesizers are inherently analogue machines, and hence a discussion of them is not appropriate here.

MUSIC CREATION

However, it isn't really new news that a computer can be used to analyze almost anything that can be quantified, and the question really is, "Can it be used as a creative tool?" In music, creativity is displayed in either performance or in composition.

MUSIC PERFORMANCE

From the earliest days, computers have been used in musical performance, often by amplifying the RF noise from the machines' registers. Presently machines are used as instruments (26,27). To what extent that this is a creative activity by a computer is open to question.

MUSIC COMPOSITION

Composition is a much richer area of investigation for computer input into the creative process. Various approaches have been made. Some workers have attempted to define the musical properties of instruments (28) and then to use these defined properties in composition. Others have attempted to use a knowledge of information theory (29) in the composition process.

In general, most compositional efforts have not been tied to any rigid mathematical analysis (30), and have instead attempted to apply general theories of musical composition. Both general purpose computer languages (31,32), simulation languages (33) and special composing languages (34) have been used in composition attempts.

CRITICAL RESPONSES

Often, an indication of the viability or impact of a technique is critical discussion. Discussion by musical reviewers has been intense and varied. It is difficult to categorize the criticism.

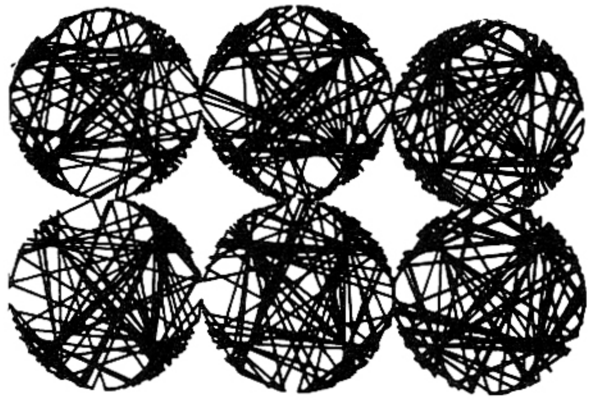
Other than critiques of individual pieces of work, the discussions often have been conducted on a highly emotional basis, with computer music enthusiasts and detractors often doing battle. However, only the randomists (Cage (35), Xenakis (36) have attained real acclaim. Instead, what computer music has triggered is a considerable discussion on the definition of music as art (37,38) and the question of the nature of esthetic perception (39,40).

SUMMARY - MUSIC

In summary, it can be seen that there is a considerable body of experience in using the computer in the art of music. This experience extends throughout the field — in its mechanical, performance, and compositional aspects. It is an accepted part of the music scene open to the normal forms of critical analysis and discussion.

Score by Hubert Kupper, Dusseldorf

Designs for Textiles by Georg Nees



using the EUNET language developed by Dr. Nees and Professor Eusemann.

VISUAL ARTS AND COMPUTERS

With the rich depth of computer use in music, one would expect to see an equally rich development of computers in visual art. Computer visual output is at least equally suitable for the production of creative works as are the audio capabilities of a computer. Starting then, at least equal, in terms of direct computer output, it would not be surprising if computer visual art were at least as successful as computer music. But this is not the case, in my opinion. There have been some successes, notably the art films of Knowlton and Schwartz, the interactive cartooning supported by the NRC (41), and Kunil's fashion design application (42).

However, computer visual art (created, aided, or implemented) has not become an important part of the visual art scene.

COMPUTER VISUAL ART IN MOTION

Video

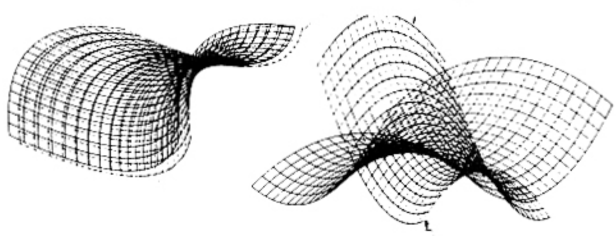
Video art would seem to be a natural mode of expression for art projects utilizing the computer, as even 5K mini-computers can have a colour graphic capability. Yet, although video art itself is important to the art world, even having special issues of art magazines devoted to it (43), very little (44) has been done in the area of computer-aided video art.

Animation

The area where computer-aided visual art has had its greatest impact is in the area of animation (45). Generally, the process has been interactive (46). In the case of animation, I feel the computer is strictly a cartooning aid.

Computer Movies

Several artists have created computer-aided films. The best known are the works of Knowlton and Schwartz (47) and those of Whitney (48).



Detail, M. Stephens

STATIC TWO DIMENSIONAL VISUAL ART

In my opinion, static visual art is presently not very developed. In drawing, there are some plotter demonstration routines, and a few attempts to use the machine as an artistic drawing instrument (49).

Rectilinear colour pattern generation usually has resulted from attempts to simulate natural patterns (50) or as the result of the display of mathematical functions. Creatively, the machine has been used in support of a painter (51) and in textile design (52).

THREE DIMENSIONAL VISUAL ART

Three dimensional computer aided art falls into two areas, the illusionary objects of holography (53,54) and those of sculpture (55-59). Neither area is very rich in examples of pieces of work.

SUMMARY, VISUAL ART

The only present application of computer visual art that is at all significant is the narrow area of computer assisted cartooning, in my opinion. The areas of static two and three dimensional art are almost barren. The barrenness can be seen by the almost total lack of critical examination of the question of computers in visual art.

CROSSWORD PUZZLE GROWTH AND COLOUR PATTERN GENERATION

The author developed a technique for the construction of crossword puzzles based on statistical letter by letter word construction operating through a tasking technique. The tasking concerned itself with the ordering of the letter spaces to be filled. The solution ordering was initially determined by a heuristic ordering which was machine expanded from an initial partial list of the letter spaces to be filled to a final ordering of the letter spaces. The ordering list expanded as the solution expanded. Usually, several partial lists were produced before the final list was developed. In addition, the ordering of the solution list varied according to a machine learning technique.

Normally, the puzzle constructor requires a certain amount of heuristic restructuring of the initial solution ordering. For example, Figure 1 shows the initial and final ordering of à puzzle that was successfully built by the constructor.

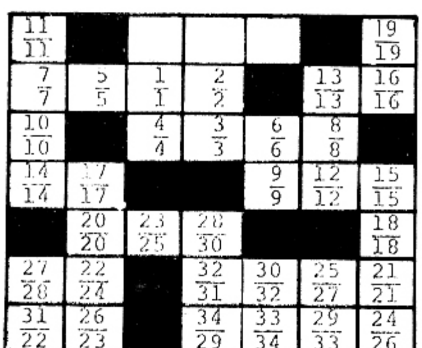


Figure 1. Reordering of initial solution ordering.

Likewise, a colour pattern generator finds it useful to occasionally reorder the determination of the colours with all solution point ordering being placed on a precedence list or stack.

If we consider a crossword puzzle to be a matrix filled by symbols of varying densities selected by a non-arbitrary process, it is now possible to relate crossword puzzles to rectilinear colour patterns. Rectilinear colour patterns may be thought to be a matrix filled with varying lines selected by an arbitrary process.

Colour selection in pattern by local area expansion is very similar to the construction of crossword puzzles by a letter by letter process. Of course, puzzle construction by the non-local method of whole word selection would probably not provide a very good analogous technique for colour pattern development.

The technique of colour selection contains the following major areas of interest: ordering of matrix point development, heuristic machine ordering of the initial solution point precedence and solution colour selection.

INITIAL SOLUTION POINT ORDERING

There are two different approaches to the question of initial solution point ordering: random initial ordering and constrained initial ordering. Random initial ordering may require more cycles to attain a solution, but the final results may eventually be said to be more pleasing.

Constrained initial ordering may be due to several things. If it is desired to predetermine some colour points in the final solution, the initial ordering of the solution points should give higher precedence to those areas adjacent to the predetermined points through a means of weighting the desirability of various point solutions. This weighting could be based on a functional relationship between the predetermined matrix point or points, and the points to be coloured. For example, Figure 2 shows a simple matrix with two points initially coloured ((2,2) and (2,3)).

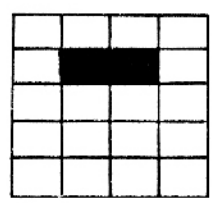


Figure 2. Matrix with two precoloured points.

Figure 3 shows a possible linear weighting scheme to be used for the initial solution precedence ordering for the simple precoloured matrix shown in Figure 2. Such a simple weighting scheme does not take into account things such as other precoloured areas, the colour of the precoloured area, and geometrical factors, such as edge nearness, center nearness, and moments of inertia. A non-linear weighting function might be preferable, especially if more than one point is to be precoloured.

1	1	1	1
1			1
1	1	1	1
2	2	2	2
3	3	3	3

Figure 3. Linear precedence weighting radiating from precoloured spaces.

The weighting of the uncolored matrix points would eventually produce a precedence stack of the form of Figure 4. The precedence stack would determine the solution order of the uncoloured points. The precedence ordering between equally weighted points was arbitrarily selected.

The initial colouration points would not be subject to change as coloured pattern was developed by the constructor (just as the initial words in the puzzle constructor were not subject to change).

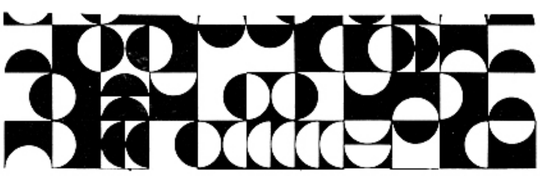
PRECEDENCE RANK	MATRIX LOCATION	POINT WEIGHT
1	1,1	1
2	1,2	1
3	1,3	1
4	1,4	1
5	2,1	1
6	2,4	1
7	3,1	2
8	3,2	2
9	3,3	2
10	3,4	2
11	4,2	2
12	4,2	2
13	4,3	2
14	4,4	2
15	5,1	3
16	5,2	3
17	5,3	3
18	5,4	3

Figure 4. Precedence stack for the linear weighting of Figure 3.

COLOUR SELECTION

In filling the crossword puzzle matrix, various statistics regarding the permissible letter pattern for legitimate words were developed. These statistics were both combinatorial and positional in nature. A necessary minimum set of statistics was determined. Of interest to the colouring problem is the different patterns developed with the use of different statistics. Figure 5 shows some of the variations due to differing statistics used in the construction of the same crossword puzzle.

(See Figure 5, above, right.)



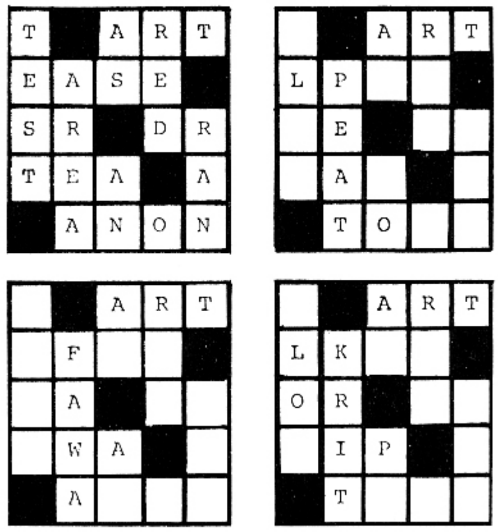


Figure 5. Variations in final crossword puzzle matrix. Solution due to the use of different statistical subsets.

Similarly, colours in a pattern may be selected according to combinatorial rules. The rules for crossword puzzle construction were developed from existent letter patterns called words. As a result, the results were constrained by past experience, but not in an attempt to recreate past patterns (which is required for word formulation). Likewise, the colour choices should be on past artistic experience.

The knowledge of compatible colour selection is well advanced. A major item for the colour pattern generator is in the choice between competing colours which are each individually compatible or acceptable in a given local area. The machine can make this choice by first composing a list of suitable colours for a matrix space and then choosing between them by a weighted randomizing technique. This technique is similar to the ones used in composing stochastic music (60-65). Stochastic music is probably the most successful of all the computer based arts.

The list of suitable colours would include both positive and negative criteria. For example, red may be added to the potential colour list for a matrix point, because it is compatible with all local colours. Green might be excluded from the same list because another occurrence of green would conflict with a limitation on the number of occurrences of a given colour.

The colour weighting factors before random choice could be either artist or machine developed. For example, the artist might desire to produce a predominantly green and blue work, and thus would increase the weight of blue and/or green in the colour list whenever blue and green are permissible colours for a matrix point. For example, if the list of permissible colours for a given point is shown in Figure 6, a triple weighting for blue, and double weight for green would result in the list of Figure 7. Then, when a random colour selection would be made from the list of Figure 8, a greater weight would be made toward blue and green. The weighting process does not actually require the generation of an actual expanded list as shown in Figure 7. The weighting can easily be accomplished functionally.

```
blue
green
yellow
```

Figure 6. List of permissible colours for a point.

```
blue
blue
blue
green
green
yellow
```

Figure 7. Weighted list of permissible colours for a given point.

A SIMPLE EXAMPLE

A simple, unsophisticated example of colour pattern generation follows. This example is intended to illustrate the growth process, and does not describe a developed colour combination definition. Colour compatibility was based on a simple colour wheel. A 10 x 10 matrix of points was coloured. A "white" or zero colour border was specified. A simple matrix point was precoloured.

COLOUR COMPATIBILITY

In a simple colour wheel, a given colour, its adjacent neighbours, the opposing colour and "white" are all mutually acceptable. The colour compatibility matrix used is shown in Figure 8.

Matrix point colour	0	1	2	3	4	5	6	7	8
0	1	1	1	1	1	1	1	1	1
1	1	2	2	0	0	2	0	0	2
2	1	2	2	2	0	0	2	0	0
3	1	0	2	2	2	0	0	2	0
4	1	0	0	2	2	2	0	0	2
5	1	2	0	0	2	2	2	0	0
6	1	0	2	0	0	0	2	2	2
7	1	0	0	2	0	0	0	2	2
8	1	2	0	0	2	0	0	0	2

Figure 8. Colour compatibility matrix.

The use of the colour compatibility matrix allows for both the specification of simple colour weighting factors and the determination of allowable colour combinations. The use of the compatibility matrix can produce both the list of permissible colours illustrated in Figure 6, and the weighted list of permissible colours illustrated in Figure 7. The mechanisms involved are very similar to the process of "best" letter selection in the crossword puzzle constructor and will be demonstrated below.

THE COLOURING

The initial coloured point, and the matrix's "white" or number zero border is shown in Figure 9. The resulting linear weighting of the matrix points for Figure 9 is shown in Figure 10. Note that the border colours ("0") do not contribute to the weighting, nor are they weighted. The first four iterations can be seen in Figure 11.

```
000000000000
0          0
0          0
0   5      0
0          0
0          0
0          0
0          0
0          0
0          0
0          0
000000000000
```

Figure 9. Initial solution matrix with single precoloured point.

```
3222223456
3211123456
3210123456
3211123456
3222223456
3333333456
4444444456
5555555556
6666666666
7777777777
```

Figure 10. Weights for initial matrix shown in Figure 10.

```
000000000000   000000000000   000000000000
0208022600 0   0208022600 0   C20802260010
0111060005 0   011106000510   011106000510
C51556565  0   051556565500   051556565500
010555655  0   010555655560   010555655560
005045656  0   005045656000   005045656000
050405555  0   050405555510   050405555510
050040456  0   0500404560 0   050040456000
0          0   0118404062 0   011840406260
0          0   0          0   C18843456220
0          0   0          0   081844050210
000000000000   000000000000   000000000000
```

Figure 11. First three iterations of the example problem.

The selection of subsequent colours was made by forming a combined list of weighted colours. This process can be illustrated by examining the process of the addition of the fourth colour to the solution. First, it was determined that the immediately adjacent colours were 1,0,5. Second, by using the colour compatibility matrix of Figure 8, the weighted permissible colour list of Figures 12 was developed. Then, the random number of 8 was generated. Thus, the fourth colour on the list, or 5 was selected, as can be seen in Figure 11. Figure 13 contains the final solution, as well as three other intermediate solutions.

```
0
1
1
5
5
```

Figure 12. Weighted colour list to determine the fourth colour to be added to the solution.

```
000000000000
0208022600  0
0111060005  0
051556565   0
010555655   0
005045656   0
050405555   0
050040456   0
0           0
0           0
0           0
000000000000
```

```
000000000000
020802260010
011106000510
051556565500
010555655560
005045656000
050405555510
050040456000
011840406260
018843456220
081844050210
000000000000
```

```
000000000000
0208022600  0
011106000510
051556565500
010555655560
005045656000
050405555510
0500404560  0
0118404062  0
0           0
0           0
000000000000
```

Figure 13. Various additional stages of the example pattern colour development.

FULL SCALE PROJECTS

Several two and three dimensional pieces were completed and exhibited. The two dimensional pieces were composed of coloured opaque elements, both rectangular and circular. The pieces were arranged according to the pattern indicated in a rectangular mold made for the occasion, and then were cast into clear plastic.

The three-dimensional pieces were formed using 9/16" clear glass marbles of up to sixteen different colours. The marbles were placed in an empty plastic box made for the occasion, and then cast in clear plastic. When removed from the mold, the finished piece was illuminated from the bottom to provide interior illumination.

These pieces, especially the three-dimensional cases, were judged to be aesthetically satisfying. They were works which were truly three-dimensional. Most sculpture is essentially two-dimensional and designed for execution from a single perspective. The computer pieces were not executed from a specific perspective. In addition, they were translucent.

FULL SCALE EXAMPLE

One piece developed was composed of a 22 x 22 x 22 matrix of coloured points. The initial coloured points were:

LOCATION	COLOUR
6,6,9	9
11,15,13	6
16,12,11	2
5,15,11	12
10,5,12	12
15,11,6	12
2,20,20	0

The precedence weighting for each point was obtained by:

$$\text{weight}_j = \min(c_1 d_{11}, c_2 d_{21} \ldots c_i d_{ij} \ldots c_n d_n)$$

where
j = uncoloured point being weighted
n = number of initially coloured points
c_j = weighted factor colour i
d_j = distance from colour i to point j

The weighting factors for the initial precedence weightings were:

COLOUR =	0	1	2	3	4	5
WEIGHTS =	1.33	1.32	1.25	1.18	1.10	1.00

COLOUR =	6	7	8	9	10	11
WEIGHTS =	1.00	1.00	1.10	0.90	1.25	1.32

COLOUR =	12	13
WEIGHTS =	0.90	9.90

The resulting precedence weighting can be illustrated by layer 11:

19	19	19	19	19	19	19	19	19	18	14
19	15	15	15	15	15	15	15	15	15	14
19	15	11	11	11	11	11	11	11	15	14
19	15	11	7	7	7	7	7	11	15	14
16	15	11	7	7	7	7	7	11	15	14
12	12	11	7	7	7	7	7	11	12	12
12	9	9	7	7	7	7	7	11	12	10
12	9	6	6	6	6	6	7	11	12	10
12	9	6	3	3	3	6	9	11	12	10
12	9	6	3	3	3	6	9	12	12	10
12	9	6	3	3	3	6	9	12	12	10
12	9	6	6	6	6	6	9	12	12	10
12	9	9	9	9	9	9	9	11	11	10
12	12	12	12	12	12	12	12	11	7	7
16	16	16	16	16	16	16	14	11	7	3
19	19	19	19	19	16	16	14	11	7	3
22	22	22	22	19	16	16	14	11	7	3
25	25	25	23	19	16	16	14	11	7	7
28	28	26	23	19	16	16	14	11	11	11
32	29	26	23	19	16	16	14	14	14	14
33	29	26	23	19	19	18	18	18	18	18
33	29	26	23	23	22	22	22	22	22	22

NOTE: Because of space, the above is the left portion of the weighting of layer 11. Below is the right portion of layer 11:

14	14	14	14	14	14	14	14	18	22	25
11	11	11	11	11	11	11	14	18	22	23
11	7	7	7	7	7	11	14	18	20	20
11	7	3	3	3	7	11	14	18	18	18
11	7	3	0	3	7	11	14	15	15	18
11	7	3	3	3	7	11	12	12	15	18
10	7	7	7	7	7	10	10	12	15	18
7	7	7	7	7	7	7	10	12	15	18
7	5	5	5	5	5	7	10	12	15	18
7	5	5	5	5	5	7	10	12	15	18
7	5	5	5	5	5	7	10	12	15	18
7	5	5	5	5	5	7	10	12	15	18
7	5	5	5	5	5	7	10	12	15	18
7	7	7	7	7	7	7	10	12	15	18
3	3	7	10	10	10	10	10	12	15	18
0	3	7	11	12	12	12	12	12	15	18
3	3	7	11	14	15	15	15	15	15	18
7	7	7	11	14	18	18	18	18	18	18
11	11	11	11	14	18	20	20	20	20	20
14	14	14	14	14	18	22	23	23	23	23
18	18	18	18	18	18	22	25	25	25	25
22	22	22	22	22	22	22	25	28	28	28

The colour compatibility matrix was:

1	2	3	5	5	5	7	5	6	7	7	0	9
1	3	4	0	0	0	9	0	0	0	2	4	0
1	2	4	6	2	0	0	9	0	0	0	2	0
1	1	6	4	6	2	0	0	9	0	0	0	0
1	0	2	6	4	6	2	0	0	0	9	0	0
1	0	0	1	6	4	6	2	9	0	0	0	0
1	9	0	0	2	7	4	6	2	1	0	1	0
1	0	9	0	0	2	6	4	6	4	1	0	0
1	0	0	0	0	9	2	6	4	6	2	0	0
1	0	0	7	0	0	0	2	6	5	6	2	0
1	2	0	0	9	0	0	0	2	6	4	6	0
1	6	2	0	0	0	0	0	0	2	6	4	0
0	1	1	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	11	1	1	1	1	1	1

The resulting colour distribution was:

CONSTRUCTION LIST

2216 of colour number 0
775 of colour number 1
1091 of colour number 2
942 of colour number 3
969 of colour number 4
465 of colour number 5
308 of colour number 6
470 of colour number 7
1073 of colour number 8
1199 of colour number 9
1080 of colour number 10
51 of colour number 11
4 of colour number 12

The number of unresolvable matrix points is 5. Unresolvable matrix points are assigned 0 as a colour at construction time.

SUMMARY

Computer driven graphics are defined, in the final analysis, by mathematical statements. Math is often said to be an art form. Many media artists believe that what they do may be ultimately quantifiable. Some of modern art, such as the works of Mondrian, would appear to be readily quantifiable. This paper describes a project that explores the distinctions between math and art and media art as math.

Although computers are widely used in the art of music, their use in the visual arts (except for cartooning) is very sparse, in my opinion.

The project utilizes rectilinear colouration of a point matrix. Most existent rectilinear applications have been in the area of scene analysis and edge clarification. Non-functional machine shape definitions is a largely unexplored area, as in the whole area of coloured machine pattern generation.

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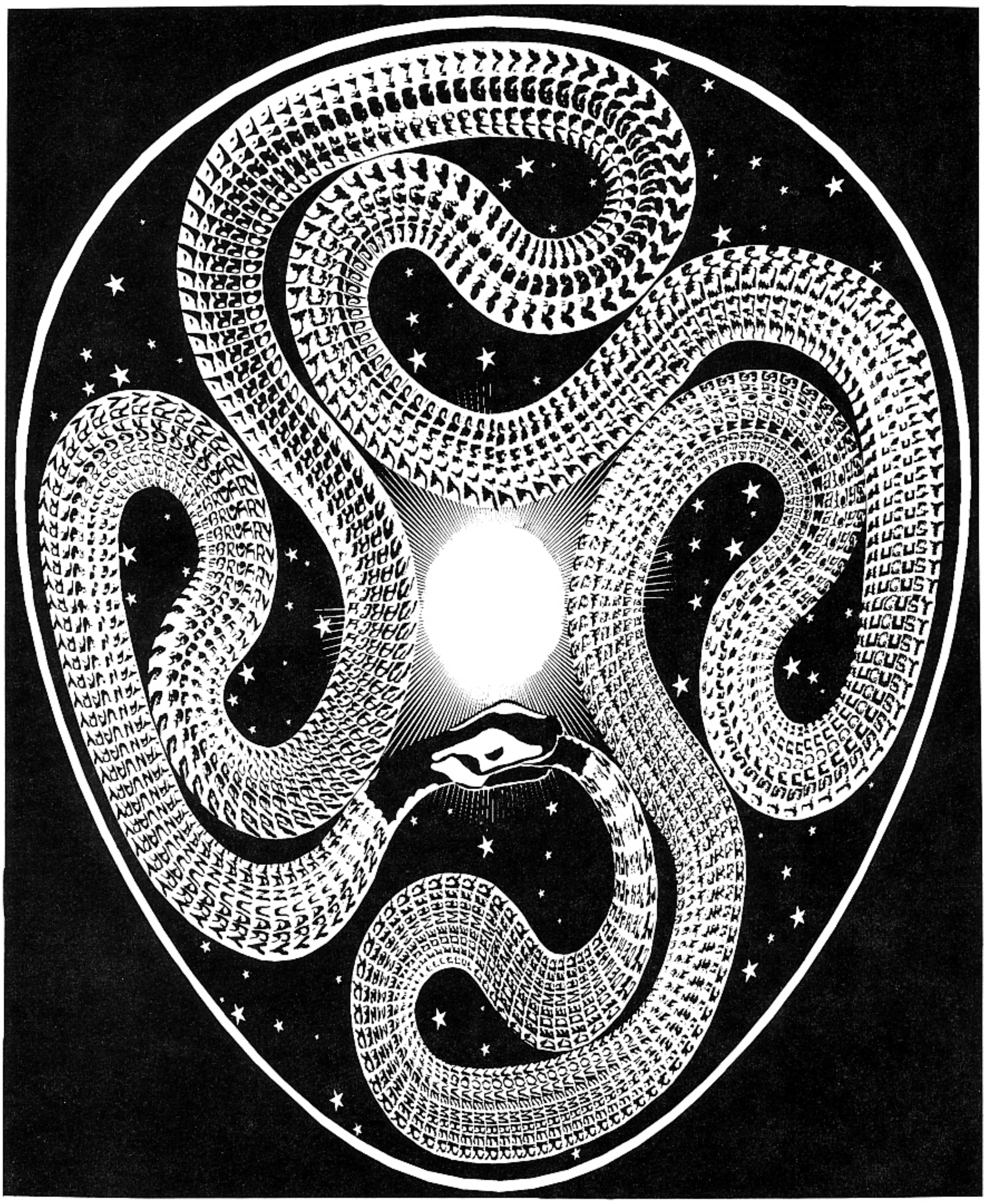
(PLEASE TURN TO PAGES 28, 29 FOR CONCLUSION.)

# of shoes and ships and serpents...

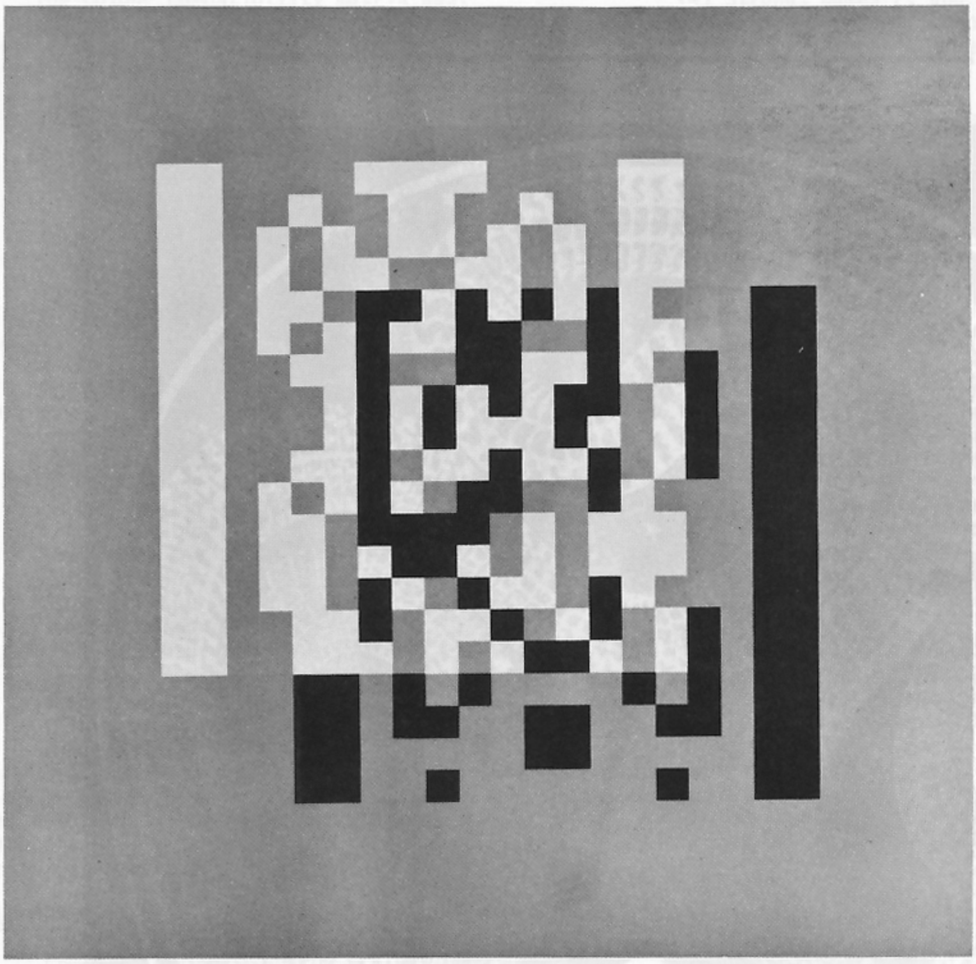


THE RAINBOW'S EGG by Colin Emmett, London, England

"The actual print is silk-screened, the background being dark blue, and the white areas in this picture are gold. The patterns on the snake, which represent the year, are printed as a spectrum of colours using the 'blend' effect possible in silkscreening. The print measures 25" x 30".

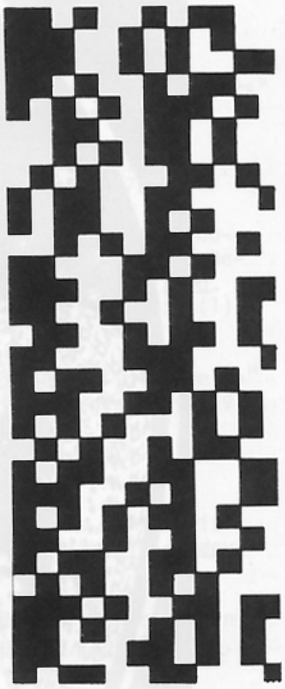
The cost of the print is $30 for each print. It is published in a limited edition of 100. Each print is signed and numbered. Only 100 copies of this version will ever exist, and as such they will retain their value as original works of art."

Readers interested in this work may contact Colin Emmett at: Flat 4, 73 Anson Road, London NF OAT, England.



...at left,
acrylic on linen,
by J.C. Marquette

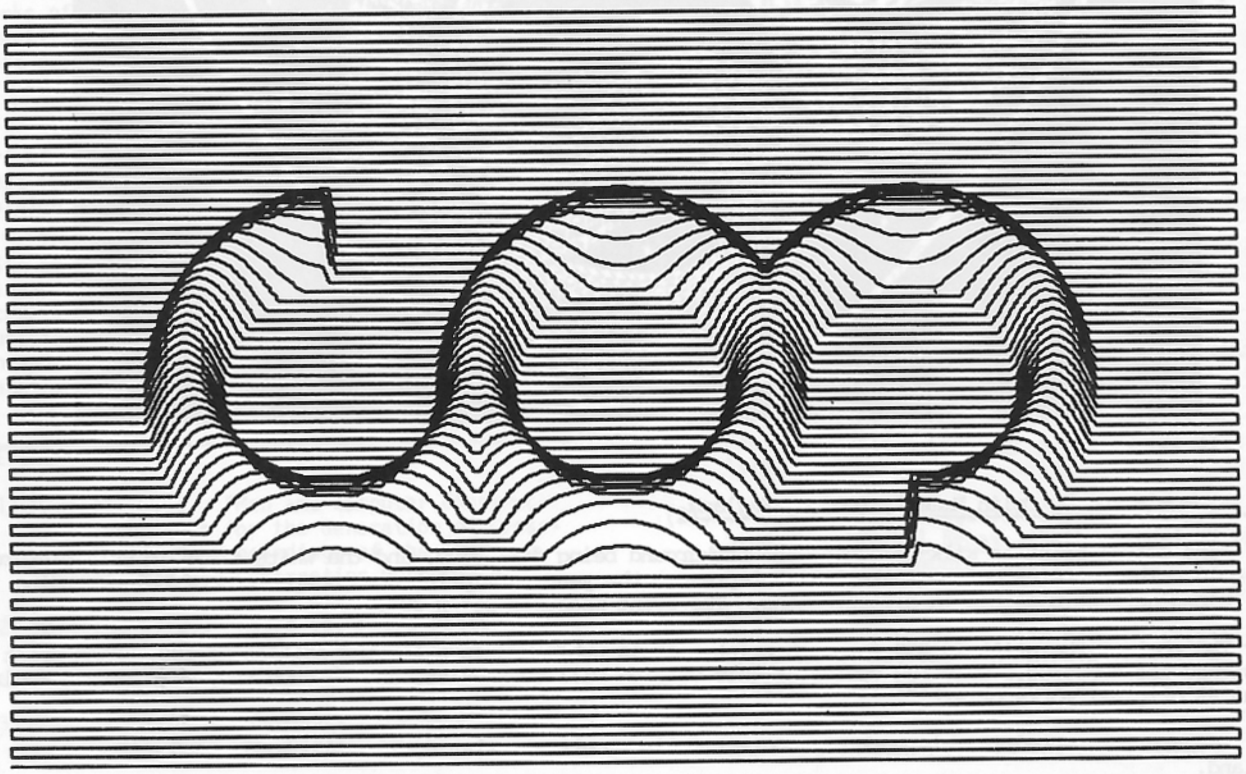
From a series of five related canvases, exploring nuances of subtle variations



"Detail from Tapestry" by J.C. Marquette

"Harmonic Story" by Jean-Claude Marquette, Paris

"Topographic Form" by Sture Johannesson and Sten Kallin, Malmo, Sweden

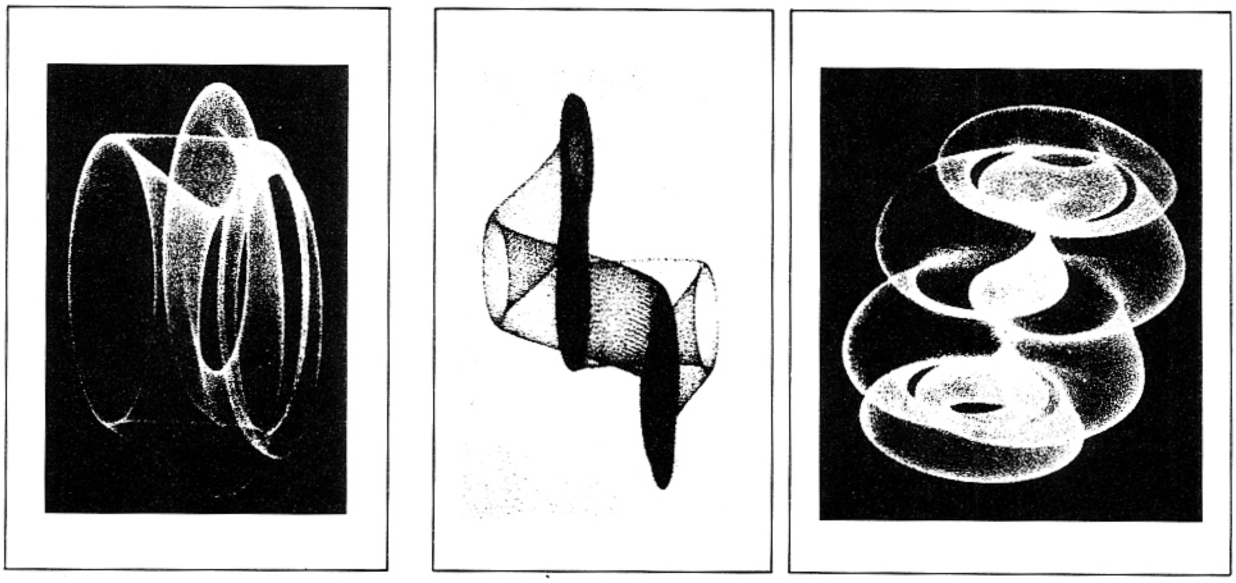


Serigraphy in three colors

NCC '76

Because of the number of artists represented in the ICCH/2 (International Conference of the Computer and the Humanities), the reader is referred to the August Annual Art Issue of Computers and People for many other illustrations from this exhibition.

The works on pages 26 and 27 illustrate very clearly the highly personal, highly varied approaches and final presentations of international computer artists. The works by Franke and Kallin and Johannesson are silkscreening, while the Marquette final works are canvases.

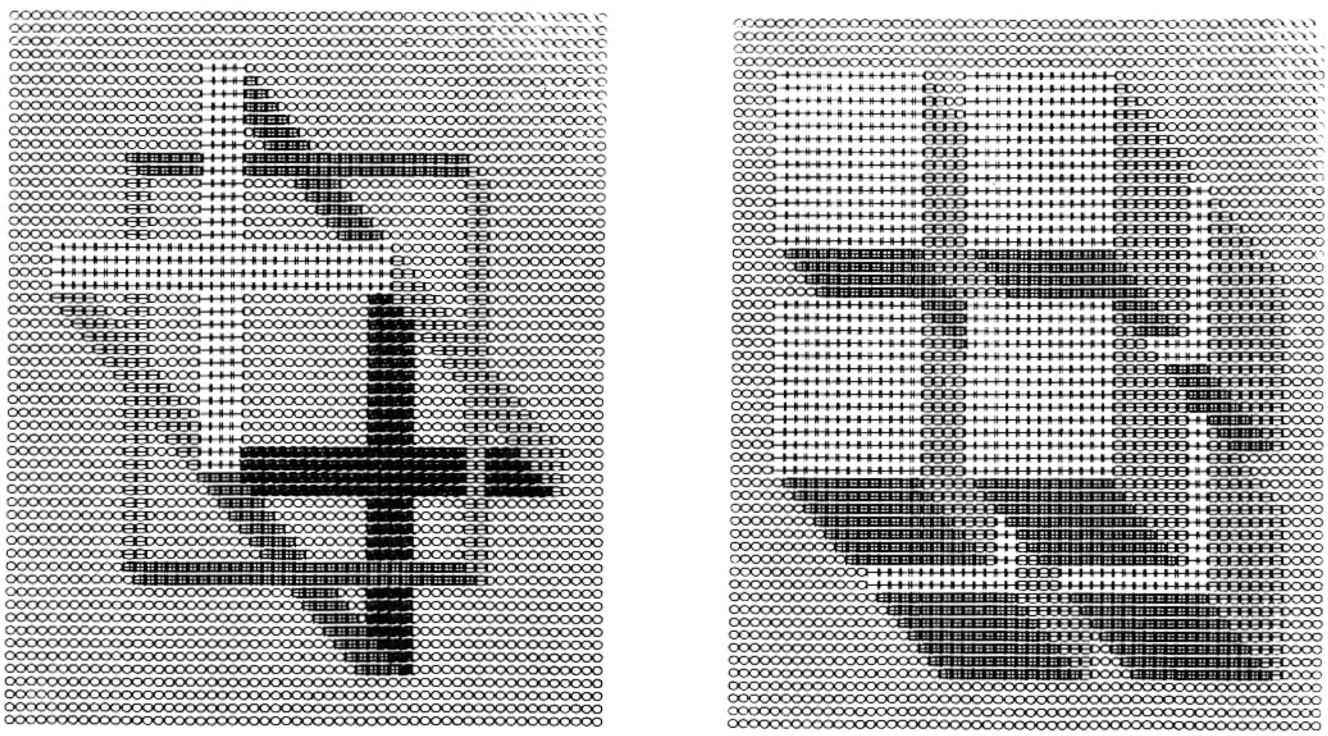


"Analog Graphics" by Herbert Franke, Munich

Above, Herbert Franke explores the "opposite" of highly detailed, linear computer graphics by using a grained screen in developing the final images used in his silkscreened editions. The works recall the earlier constructions of Naum Gabo, and the Constructivist Manifesto.

In the seven graphics of the "Kubus-Serie", from the ICCH/2 Exhibition, Klaus Basset presents a series of permutations based on the cube. The works of Basset also recall the early Bauhaus constructions -- yet are reminiscent of the transformations in the recent Scientific American.

Below: "Kubus-Serie" by Klaus Basset, Stuttgart



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See the August Issues of Computers and People, Berkeley Enterprises, Newtonville, Mass.

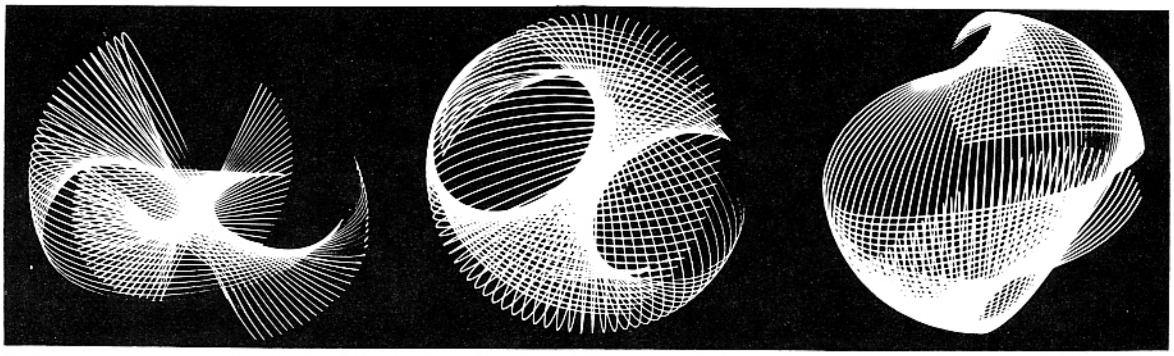
The Spring (Bibliography Update) Issues of Computers and the Humanities, Pergamon Press, N. Y., for definitive state-of-the-art bibliographies, according to specific categories within each field. (Examples: The Visual Arts; Music, Etc.)

BELOW: Graphics by Herbert Franke, from the August, 1974 Art Exhibition of Computers & People.

MORE NCC '76

LISTING OF COUNTRIES, AND ARTISTS REPRESENTED

Alexanco, Jose Luis - SPAIN
Alton, Lawrence - USA
Arveiller, Jacques - FRANCE
Audoire, Louis - FRANCE
Barbadillo, Manuel - SPAIN
Basset, Klaus - GERMANY
Beckmann, Otto - AUSTRIA
Bonacic, Vladimir - ISRAEL
Britton, Tom - CANADA
Cohen, Dan - USA
Cordeiro, Analivia - BRAZIL
Cordeiro, Waldemar - BRAZIL
Delgado, Gerardo - SPAIN
Dunker, Kenneth - USA
Dupre, Fanie - FRANCE
Dupre, Jacques - FRANCE
Dvizenije Collective Movement - RUSSIA
Etra, Bill - USA
Etra, Louise - USA
Franke, Herbert - GERMANY
Garrison, David - USA
Greussay, Patrick - FRANCE
Groupe Couleur de Belfort - FRANCE
Halgand, Jean-Claude - FRANCE
Harvard Spatial Analysis Group - USA
Hertlein, Grace - USA
Holzhauser, Karl - GERMANY
Huitric, Herve - FRANCE
Johannesson, Sture - SWEDEN
Kallen, Sten - SWEDEN
Kawano, Hiroshi - JAPAN
Land, Dick - USA
Leavitt, Ruth - USA
LIMSI Groupe - FRANCE
Marquette, Jean-Claude - FRANCE
Mezei, Leslie - CANADA
Mikulic, Tomislav - YUGOSLAVIA
Milojevic, Elizabeth - CANADA
Milojevic, Petar - CANADA
Mohr, Manfred - FRANCE
Molnar, Vera - FRANCE
Nahas, Monique - FRANCE
Nake, Frieder - GERMANY
Nash, Katherine - USA
Nees, Georg - GERMANY
Palyka, Duane - USA
Pavlin, Sergej - YUGOSLAVIA
Schwartz, Lillian - USA
Segui, Ana - SPAIN
Segui, Javier - SPAIN
Sevilla, Soledad - SPAIN
Shao - Paul - USA
Whitney, John - USA
Zajec, Edward - ITALY
Ziljak, Vilko - YUGOSLAVIA
Zotti, Anton - GERMANY



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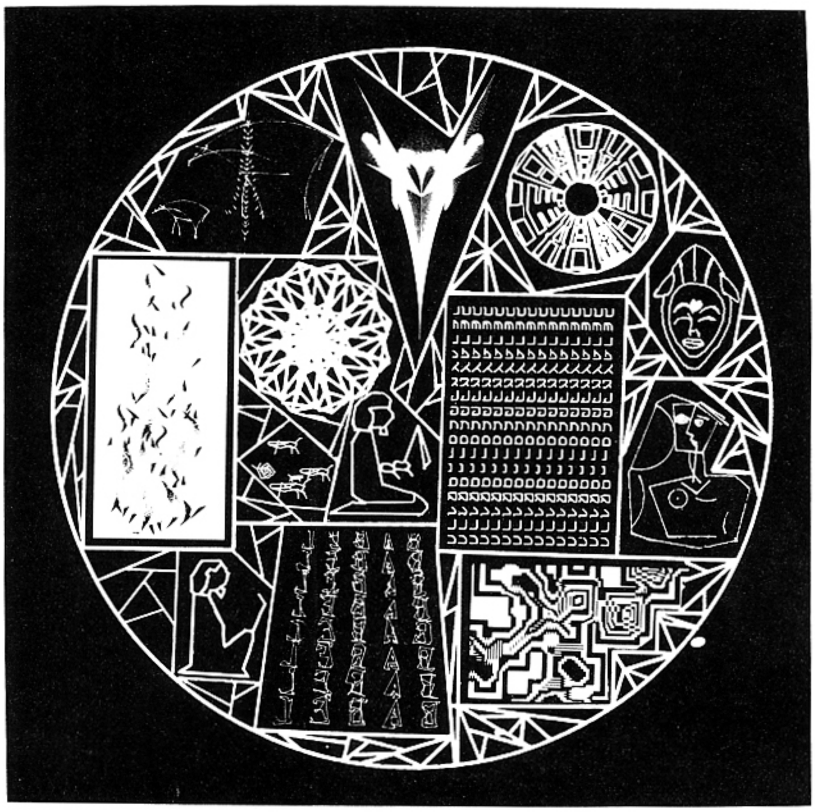

COMPUTER COLLAGE #1 by Grace Hertlein. A stained-glass design of computer graphics designed for the international periodical, Computers and the Humanities, to be used for a five year period. Each year, the color of the cover is varied. (This year it is a rich red.)

The graphic was first printed in the August, 1974 Art Issue of Computers and People. Readers will recall details from Charles Csuri, Lloyd Summer, Leslie Mezei, Lillian Schwartz, Ken Knowlton, and Grace Hertlein. Egyptian hieroglyphs are by Elizabeth Meyers, formerly of the University of Iowa, Iowa City. Other patterns are by Hertlein students.

The reproduction is a reverse image, white lines on a black background, as are the other prints in Series #1 - Art Reproductions.

The set of three graphics is on art paper, 8 x 10 inches. Prepaid subscribers may order these graphics by the set (three reproductions) for a cost price of $2.50 per set. This includes postage and handling.

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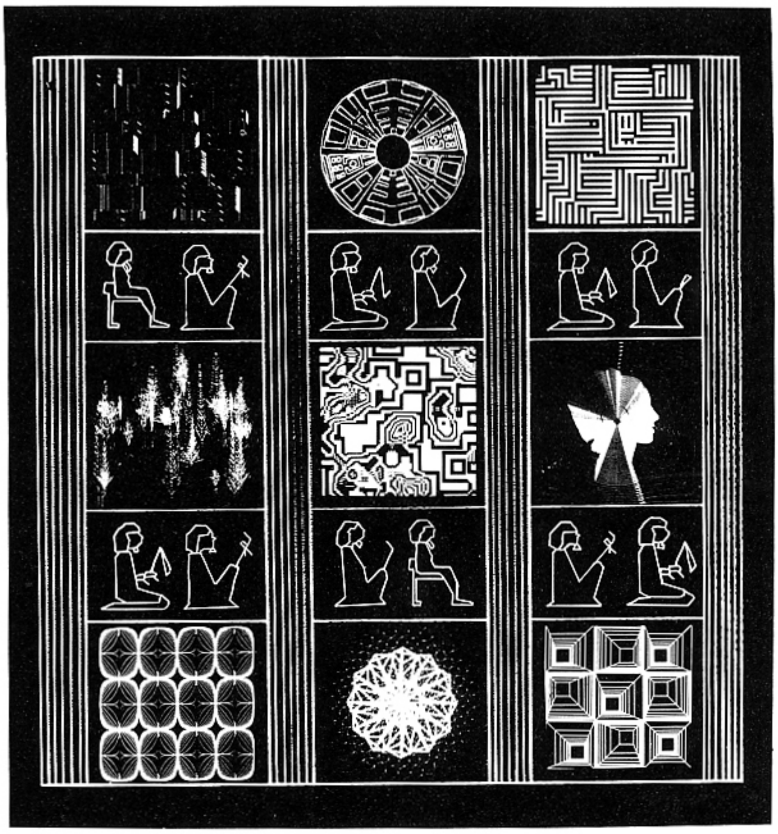
Above, COMPUTER COLLAGE #1 -- At right, COMPUTER COLLAGE #2.

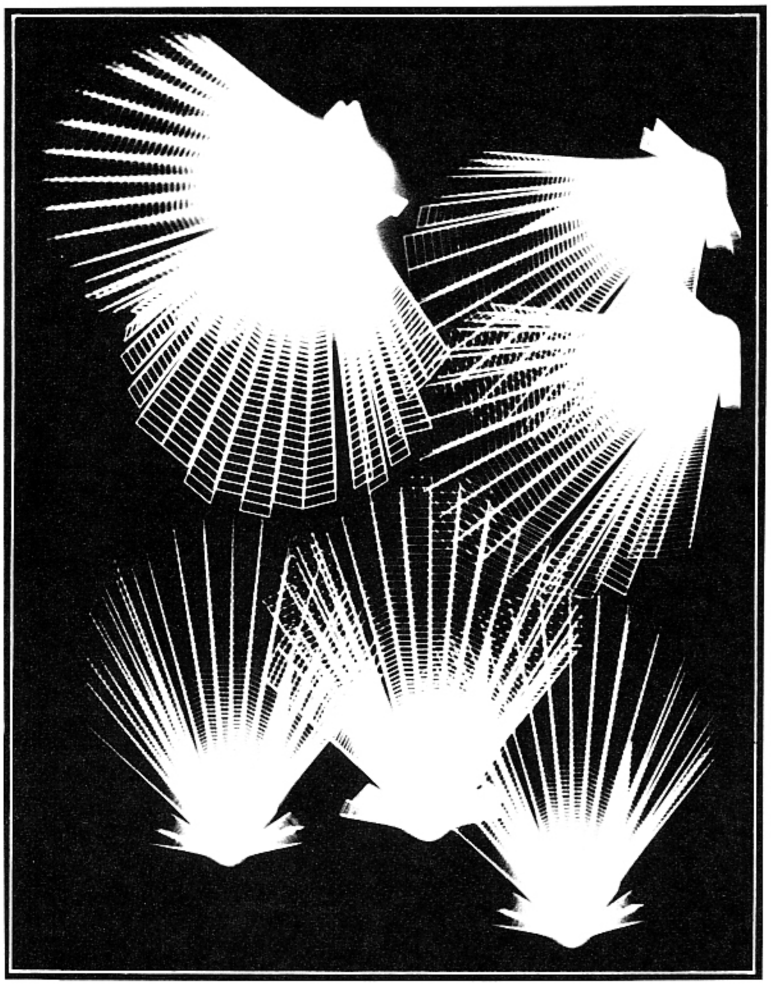


COMPUTER COLLAGE #2 by Grace Hertlein. This was an alternate design for the above periodical. Here a more static composition relates to column-like separations, recalling minimal Greek columns, emphasizing the classic quality of all related art forms, including the computer. The popular portrait by the Japanese Computer Technique Group is used, with details of the tapestry graphics by Kenneth Knowlton and Lillian Schwartz. The hieroglyphs of Elizabeth Meyers form a continuity.

This graphic has not been printed elsewhere.

Other patterns are by Hertlein and her students, along with details from Computers and People.

(See page 31 for order form, that may be Xeroxed and sent to CG&A, Chico, Ca.)
PLEASE ALLOW THREE WEEKS FOR DELIVERY.



SEA FANS by Grace Hertlein. This graphic originally appeared as a 1974 cover for the magazine, Computers and People. The original work was in black ink on white paper.

This graphic was the result of experimentation with the microfilm plotter at the University of Iowa, Iowa City, during the summer of 1974. Microfilm output opened up a whole new avenue of exploration, in which the film output was taken into generative photography, serigraphy, use of acetate Diazos, etc. For details on the potential of computer art taken via photography into varied art media, see the June, 1975 Proceedings, CCUC/6 (Computers in the Undergraduate Curriculum), Texas Christian University, Fort Worth, Texas, "The Microfilm Plotter and Computer Art". (If you do not have access to these proceedings, write the editor for a ditto copy.)

The technique of photographic reversals of computer art is becoming increasingly more common. A great many computer graphics are more aesthetic in their reverse form, where the innumerable lines, in a white pattern, are more restful and contemporary than in their counterpart forms of black ink lines on white paper.

NOTE ON FRAMING: Plexiglas 8 x 10 inch boxes are very effective, as well as white mats with stainless steel frames. Traditional wooden frames are not as compatible with contemporary graphics.

- -

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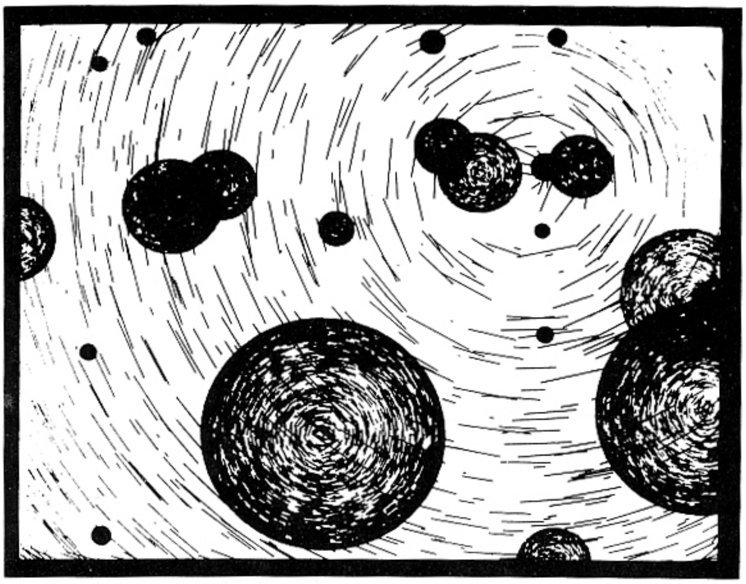
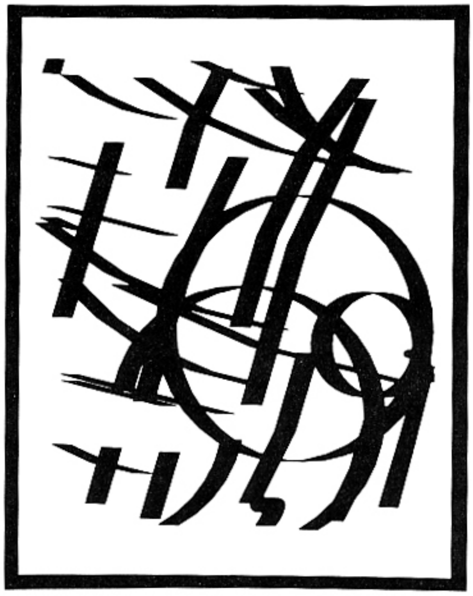
INEXPENSIVE GRAPHICS FROM A STORAGE CATHODE RAY TUBE

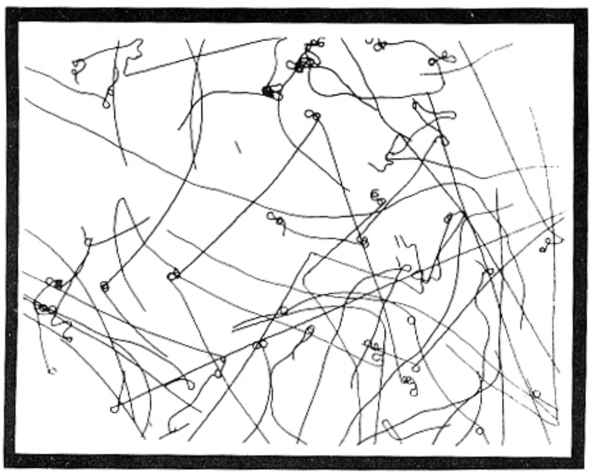
CONCLUSION: More graphics from the storage cathode ray tube by Charles Fritchie and Robert Morriss. A range of final styles is presented, ranging from brush-like calligraphy, to direct drawing, with very personal, free forms resulting.

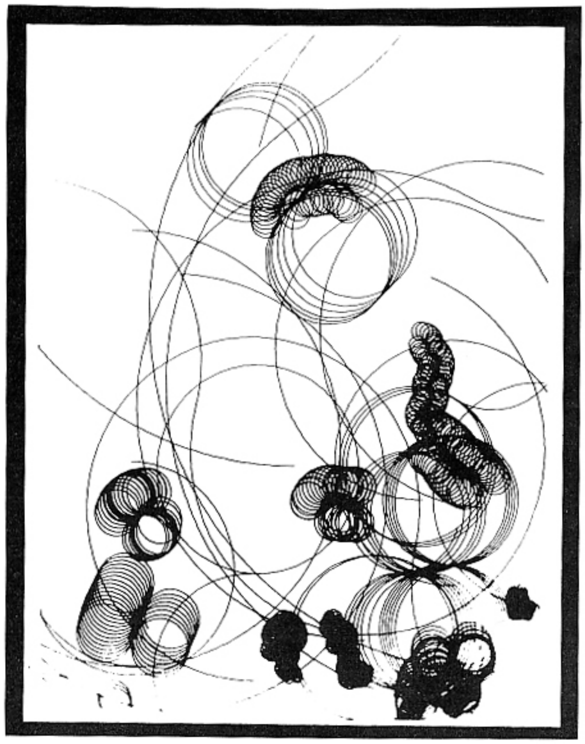




Above, left: Figure 8, whirling forms in space. Above, right: Figure 7, with brush-like calligraphy patterns. Bottom, left: Figure 2, node-like, delicate tracings. At the right, bottom: Figure 3, forms resembling slinky wire sculptures. (Interested readers should write Professors Fritchie and Morriss for more details.)

COMMENTS: The graphics on this page were originally developed with white lines on a black background. To experience a new view of these CRT graphics, they were rephotographed by CG&A in reverse, using a copy camera. The free forms are more dominant in these versions, resembling works that might be accomplished by using a light pen or a digitized tablet. Photographic manipulations of computer art often yield more interesting results than the primary art output.





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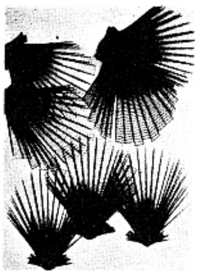

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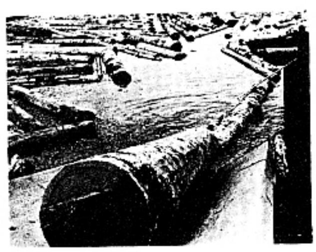

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