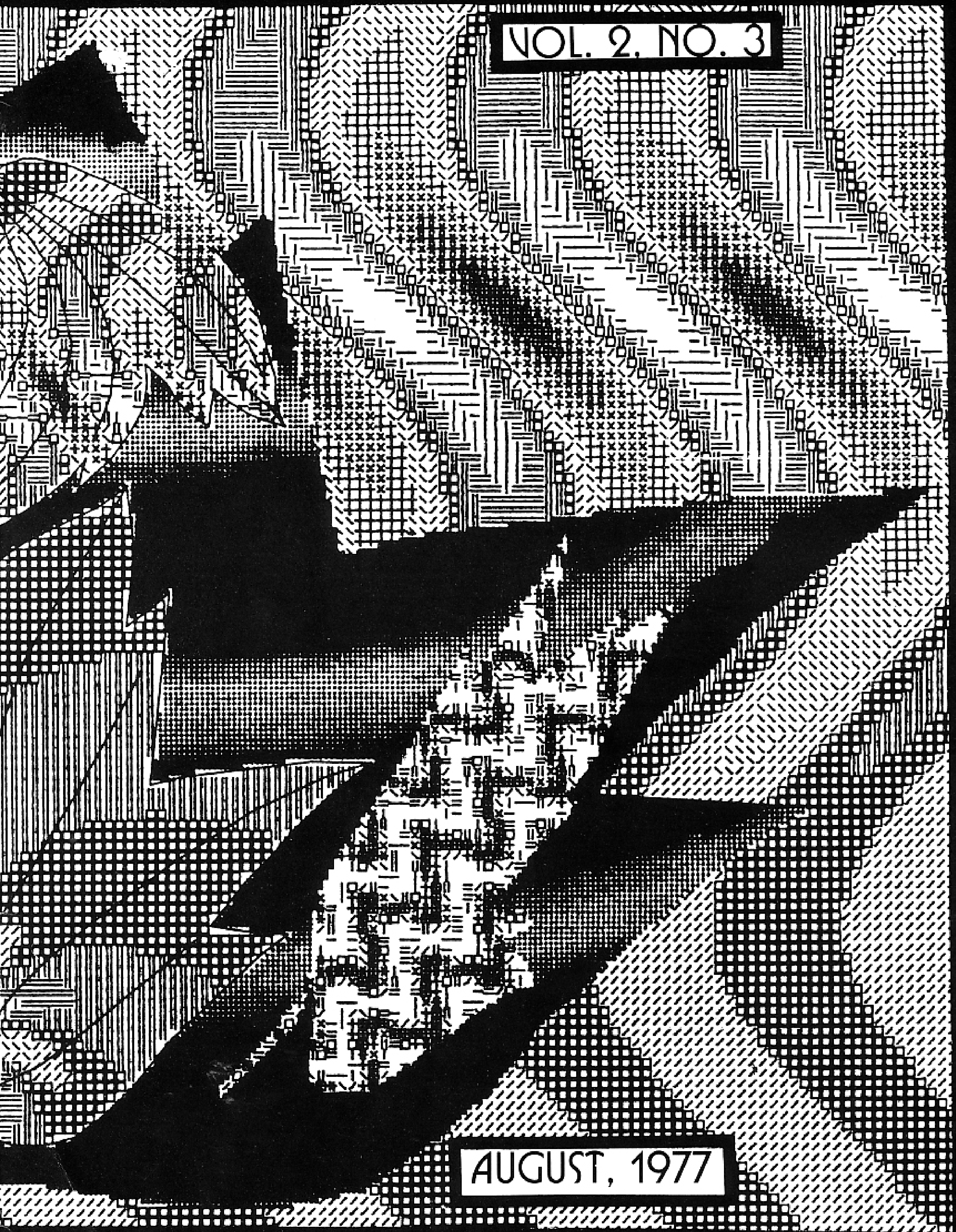
COMPUTER GRAPHICS AND ART

VOL. 2, NO. 3



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

THEME FOR THIS ISSUE: COMPUTER ART
Teaching computer art, research in computer art, the importance and potential of computer art -- topics for August.

IN THE NOVEMBER ISSUE:

- A PRAGMATIC APPROACH TO THE COMPUTER ANIMATION PROCESS by James R. Warner, Colorado Univ., Boulder, Colorado.
- THE FUTURE OF COMPUTER GRAPHICS by Jackie Potts, Social Security Administration, Baltimore, Maryland
- SCHERZO FOR MATRIX AND FIGURES by Matjaz Hmeljak and Edvard Zajec, Trieste, Italy (with programs and charts).
- PART II - DESIGN AND MATERIAL DEVELOPMENT by G. Hertlein.

EDITORIAL

SIGGRAPH - ITS POWER AND POTENTIAL FOR GRAPHICS PEOPLE

For almost two years we have been discussing the innumerable needs of graphics people. One of these needs is an urgent requirement for a Bibliography Center, similar to that of Computers and the Humanities magazine, the latter edited by Joseph Raben of Queens College in Flushing, New York.

There is a need for a Curriculum Resource Center, where class-tested techniques and syllabi for teaching computer graphics courses may be maintained and disseminated to interested persons. An example of such planning is the "Listing of Courses and Programs in the Field of Ethical and Human Value Implications of Science and Technology" published by Cornell University, edited by Ezra Heitowit and Janet Epstein.

Another example is the curriculum planning by the IEEE Computer Society. An example that is obvious for graphics people is SIGGRAPH, the special interest group for graphics people of the Association for Computing Machinery.

THE POWER AND POTENTIAL OF SIGGRAPH

A visit to the July, 1977 SIGGRAPH Conference in San Jose changed my ideas about the goals of CG&A, and suggested the necessity to implant some of these objectives within the power and potential of SIGGRAPH.

In listening to conference speakers, in studying the publications distributed there, in talking to conference leaders and attendees, it became obvious that many of the goals of SIGGRAPH were goals of CG&A. It was equally obvious that many of these goals require years to develop fruit, and that many of these projects require the collaborative efforts of many people.

The potential of this organization was first obvious in its ability to draw a large and highly knowledgeable audience to participate in this annual gathering. More impressive was the superior organization of every aspect of the conference. The appreciative attitudes and questions by hundreds of professional graphics people and serious students noted a high level of attendee expertise and interest. But beyond the significance of the speakers (which was obvious--the great and near great in graphics), was the meaningful quality of the three publications disseminated to participants as part of the SIGGRAPH conference:

- Preliminary Papers to Be Published in the Communications of the ACM;
- SIGGRAPH '77 Proceedings ;
- Status Report of the Graphic Standards Planning Committee of ACM/SIGGRAPH.

The above publications are a gold-mine for graphics professionals. The amount of time and effort expended by SIGGRAPH members and conference leaders is genuinely impressive. Their results are meaningful reading for every graphics person. This is important reference material for students and graphics professionals.

THE NEED TO COLLABORATE

A few years ago a research project required collaboration with a colleague for one year. This meant a marked departure in method, going beyond the "loner" researcher role, into a new relationship of working respectfully with another person. This experience of collaboration has remained fresh in my mind ever since.

My brief experience at SIGGRAPH impressed me strongly that many of the goals of CG&A should be accomplished in collaboration with SIGGRAPH. A study will be made, to survey what projects can and should be accomplished under the umbrella of SIGGRAPH. We shall attempt to study ways in which CG&A can be a helpful handmaiden to this group and to other associations interested in computer graphics and art. We will report back to you in a few months.

WHY COLLABORATE? WHY COMMUNICATE?

Graphics people have more things in common than things they do not have in common. Graphics is still new enough that the practice of computer graphics may still be considered esoteric, uncommon.

The requirements of one discipline, one application are often very useful in another area. There is a tendency to specialize -- and to become closed and narrow. There is a need to be open and interdisciplinary, to be technical, yet user-oriented. There is a need for disparate groups in computer graphics to communicate with each other -- to teach each other.

And yet there exists a stratification of graphics people, generally based on technical skills. I have alluded to this before, in other writing. There is a need for all these people to communicate respectfully with each other, if we are to grow. Each graphics person needs broadening, no matter who they are, where they are. What we're talking about is really "listening" to each other, really "talking" about what's important, rather than trying to impress each other with our limited knowledge.

These goals will continue to be important to SIGGRAPH and to this magazine. This editorial is an invitation to join SIGGRAPH and CG&A in this important goal of communication, to thereby grow in balance and knowledge -- and to advance the state of the art of computer graphics and art.

Grace C. Hertlein
Editor, CG&A

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RESEARCH AND TEACHING IN ART AND SCIENCE

By Dr. Vladimir Bonačić
Head of the Art and Science Program*
Bezalel Academy of Arts and Design
10 Shmuel Hanagid St.
Jerusalem, Israel

"The development of the Art and Science Program is to create for the students of Bezalel and other institutions an environment in which technology will serve not itself but human needs...for familiarity with the techniques and capabilities of modern technology will provide the student with the tools and an understanding of the environment in which humanity is a dominant factor. This exposure to ongoing research, e.g., computers in humanity, will enable the student to distinguish between humanity and technocracy, and give him and her the desire and impetus to create."

SUMMARY

The Art and Science Program set out as an internationally oriented interdisciplinary research and study resource. It aims at bridging the conceptual gap separating institutions of higher learning which deal primarily with "pure science" from those whose major preoccupation is with "pure art". Computers, by using complex heuristic programming, offer a potential means of creating a common language for art and science. The exploration and development of such a language is therefore a focal point.

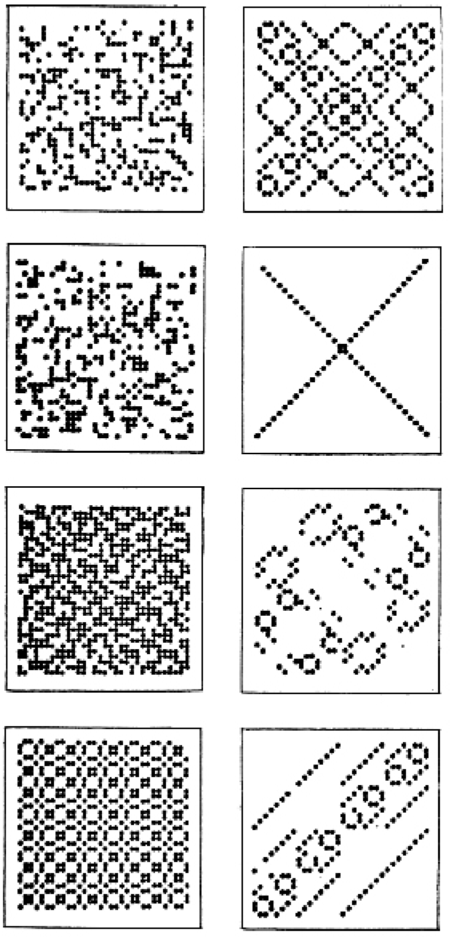
When the way of expression has a rich common denominator, and when meaning, whatever it may be or whatever its source, is part of the same complex computer language and when decoding semantically relevant information is finally presented to us visually or audibly, how close does music become to sculpture, or design to scientific discovery, or each of these to any other?

Communication, (through different languages) that usually limits us to a particular kind of expression, and which is based on different values, is a main stumbling block to the sharing of real insights developing between people from various fields of human activities, when interdisciplinary research is undertaken.

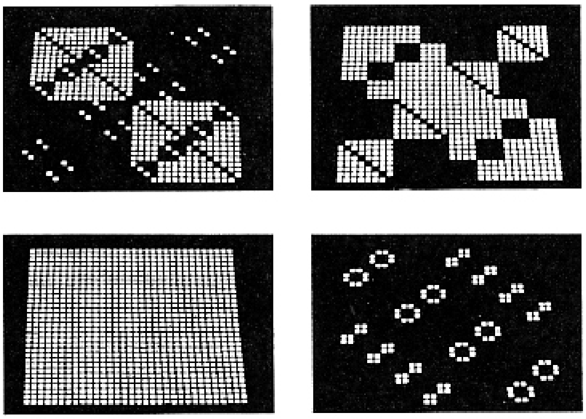
Computers used in this way already offer a common language to both the artist and the scientist and help to overcome the old concepts of separation. That is what Art and Science is basically about. (Additional material related to the conceptual development of the Art and Science Program (References 1, 2, 3) and review of work and activities by members of the International Advisory Committee, Sandberg and Moles, see Reference 4 is part of this brief paper.)

Certainly, the computer is not the only means of overcoming the concept of separation of different fields of human activities. Areas of research concentration are formally limited only by the subjective interests of the research worker, and by the general program of the institution under whose auspices on art and science the program is being carried out.

BELOW: Examples of patterns representing characteristic orbits of Galois fields. These mathematically derived patterns are used in kinetic computer computer art by V. Bonačić.



**Dr. Bonačić has recently resigned from the Bezalel Academy of Arts and Design and is currently seeking a position in the United States.*



ABOVE: Examples of four consecutive patterns generated by the "Dynamic Object" discussed in this article. The kinetic lights are controlled by a computer program.

But it is not unreasonable to expect the Arts Academies to be the most suitable place for engaging in experiments based on such concepts, if we accept the amount of freedom of expression and research that is more broadly defined and delimited in art and music, than in some other important but narrow subjects.

Our areas of interest are in the field of ethics, the sociology of art and science, hidden data structures, computer art (particularly the concept of a "dynamic object" when the computer system is an immanent part of a work of art and music), dynamic lighting of the environment, and some aspects of computer-aided design. These topics are considered attractive and promising, as well as relevant to the teaching program related to the same fields. It is obvious that the choice of research concentration (whatever priority might be considered most significant) is limited above all by the general social atmosphere, and the people available and only then by budgetary problems.

RESEARCH AND TEACHING (TOPICS OR REFERENCES)

(Editorial Note: In the foregoing material, each topic is considered also to be a Reference. Often a topic will reference another topic (or reference).

1. ETHICS - Seminars will include the following topics: awareness of ethics (alienated and open society), ethics of art and science, ethics and politics (underground ethics), proposal (Reference or Topic 5).

2. SOCIOLOGY OF ART AND SCIENCE - This seminar is to be planned.

3. HIDDEN DATA STRUCTURES - The first objective is to develop a group of generators and transformers which are capable of generating predictable non-limited numbers of structures in an n-dimensional coordinate system, with the assumption that the parameters of the generator, transformer, and resulting pattern are controllable.

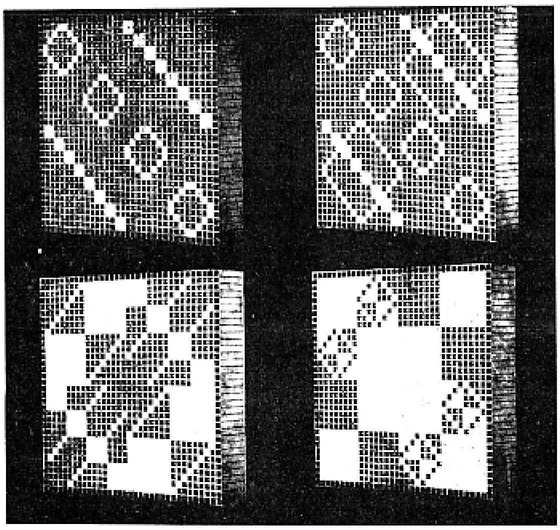
The second problem deals with the nature of pattern distortion and the subsequent building of language as a result of change in the parameters of generators and transformers in quasi-infinitesimal steps.

This will be accomplished through bit manipulation in order to avoid the uncontrolled perturbation arising from larger steps, already known from the coding theory.

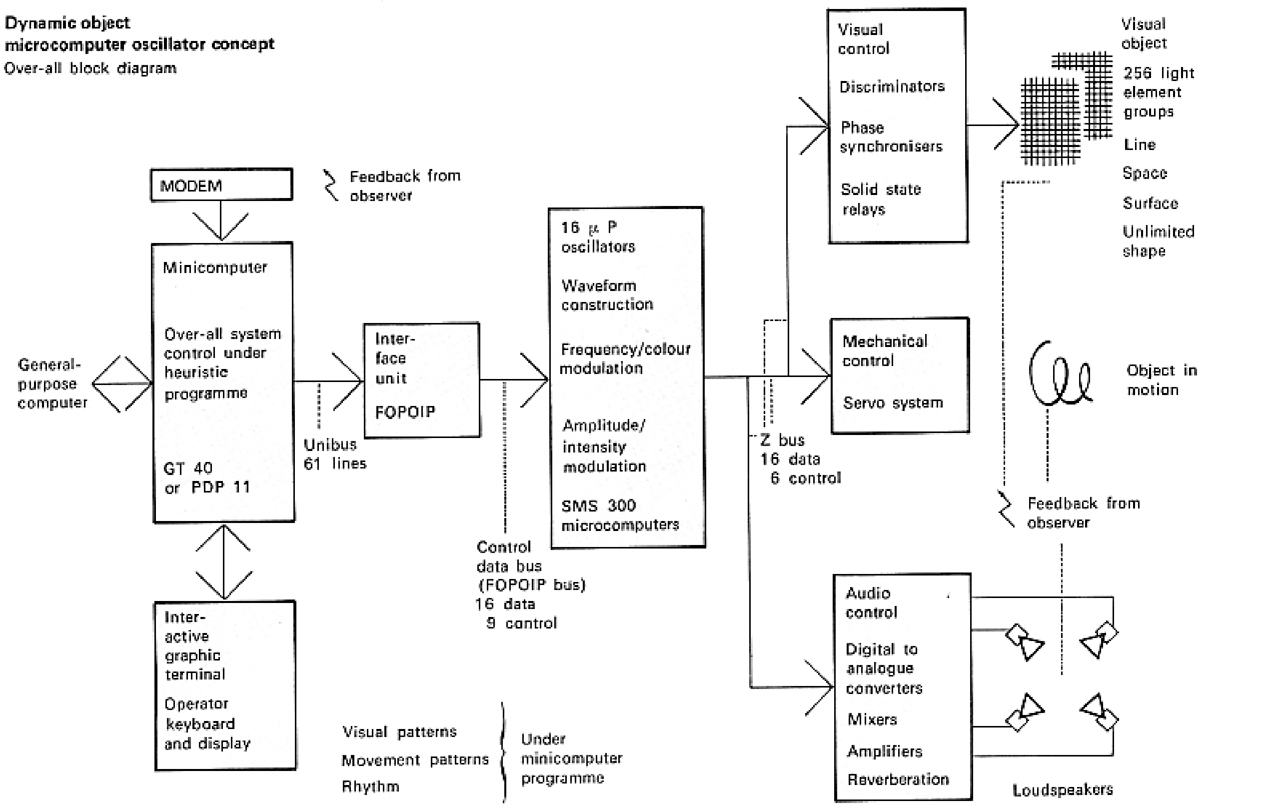
It is expected that in addition to problems of the development of indefinite period sequences using linear generators and transformers, more light will be cast upon structured forms in n-dimensional systems. This leads us to the problems of semantics and possibly aesthetics. The prediction of structures is mathematicaly complex; we do not have the appropriate means to predict or describe the logic of even relatively simple generated patterns using today's mathematical armamentarium, e.g., coding or automata theory.

It is hoped that we may contribute to a theory of describing distortion of patterns and language, allowing us to predict the effects of bit manipulation and thus establish a controllable relation between the smaller patterns which characterize the generator or transformer and the resulting large generated pattern, which is incomparably bigger. Also, it is reasonable to expect this work to provide a contribution to the problem of how to relate the observed pattern - produced by computer or other means - to its known generator. Research project (Reference 6), Ph.D. Thesis - research report (Reference 7), Notion of Formal Languages - Course (Reference 8).

4. COMPUTER ART/MUSIC (DYNAMIC OBJECT CONCEPT) - Focus point in research in the field of computer art is related to dynamic object (Reference 9) on the impregnable unity between the computer system and the work of art when meaning, whatever it may be or whatever its source, is part of some complex computer language; e.g., heuristic program, and where semantically relevant information is decoded visually or audibly. The dynamic object concept should be considered as a rich common denominator in research in the field of computer music, as in the field of fine arts or design, and even in some aspects of science.



ABOVE: Portion (or detail) of a Design for An Exterior Mural by Vladimir Bonačić. The patterns shown above (and on the preceding page) have been incorporated into this large mural. (A good proportion of V. Bonacic's works are in color.)



In addition to visual research where illuminated patterns are generated in space, (suspended by practically invisible conductors), new work has been done in "graphics". After two years of intensive research a phase has been reached of attractive results in which a pattern, with the help of a semiconductor light, generates a dynamic pattern in addition to a much larger pattern generated through the computer terminal. In other words, the microcomputer is a part of the "canvas" whose depth is less than the usual, even the smallest, frame. Since a new generation of microprocessors needs energy measurable to the millionth part of a watt, a small battery built into the "canvas" could work for a year without being replaced, or even energy from the surroundings could be sufficient to keep the "canvas" permanently alive. Course in computer use in the arts (Reference 10) discusses further details.

Two conceptually different lines of development towards computer use in the generation of complex sound/music by the help of the microprocessors which have recently appeared on the market are in progress.

Dynamic Object (Version B) - An Intel 8080 medium speed microcomputer controls the combining of 64 independent oscillators, each of which has a fixed frequency within the audible range. This range is represented by 8 octaves, each of which is divided into 8 frequencies coinciding with notes either on the well-tempered scale, or a scale generated by a combination of different structural patterns. The system is quadrophonic and any combination of oscillators can be added together on any of the four channels. Frequency modulation and reverberation are possible. Construction is now nearing completion (Reference 11).

Dynamic object (microprocessor oscillator concept) is a more ambitious program, where the oscillators are capable of complete control by a remotely located mini-computer system. The object comprises 4 microprocessors, each of which handles 4 oscillators, all of whose parameters can be altered within a matter of milliseconds. Each group of 4 oscillators shares a common bank of standard or remote computer-specified carrier shapes, and any one of 32 envelope shapes can be instantaneously re-specified for any oscillator. In addition to amplitude modulation using complex waveforms of infinitely adjustable attack time and shape, dwell shape and decay, and basic carrier frequency specifiable to within one-tenth of a semitone anywhere in the audio range (16 KHz to 20 Hz, and subaudio range to 1/30 Hz) there is also provided complete control of volume, phase, frequency modulation, frequency filtering and reverberation effects. The result is therefore an immensely powerful generator of exceedingly complex sounds, with ease enabling the production of existing musical instruments sounds, completely new musical sounds, imitations of thunder, bird calls, and the human voice.

The same dynamic object is also capable of controlling both 3 dimensional arrays of light elements, altering patterns, intensities and colour, and mechanical objects (speed, direction, angle, etc.).

The overall system provides the composer/artist with a completely new avenue for expression. The system can also be made to respond to feedback from the listener/observer, and with heuristic programs the mini-computer can supplement the composer's creation with its own acquired learning from the reception of the performance.

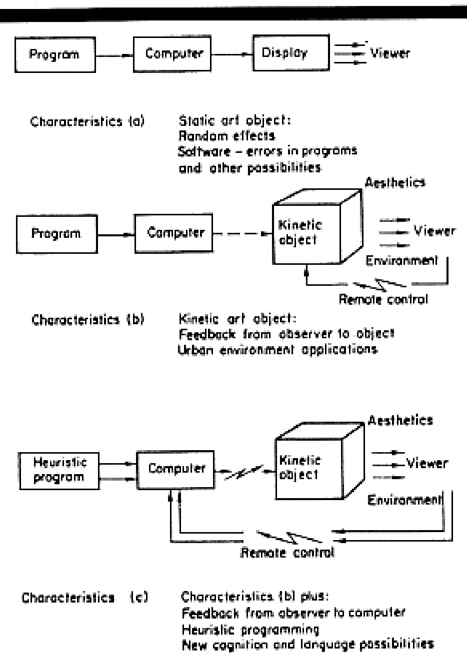
5. DYNAMIC LIGHTING SYSTEM FOR THE ENVIRONMENT - The following items have been completed, or are in stages of completion by the Dynamic Lighting System team: The heuristic program package (Reference 13) can calculate light distribution for environments containing flat surfaces and point sources. It can take into account any number of inter-reflections. It has been discovered through comparisons that for most situations one-reflection calculations are sufficient to obtain good results.

The real space model, which enables simple maneuvering of light sources in any space is being augmented to include goniometric measurements of light sources, measurements of reflectances of surfaces, and measurements of spectral distribution over surfaces.

A number of mathematical models have been developed towards solving the heuristic part of the package. These are in the stage of being tested comparatively (against each other) towards choosing the most efficient one.

The optics expert (Reference 14) is continuing to provide useful practical and theoretical advice.

6. COMPUTER-AIDED DESIGN - COMPUTER-AIDED DESIGN OF INTERACTIVE GRAPHICS (Reference 15) is based on man-machine conversation, yielding the ability to modify, recall, edit and store away graphic data including accurate drawings, charts, maps or diagrams, are extensively represented in Art and Science.



ABOVE: Three schematic diagrams illustrating the use of the digital computer in the production of art. Diagrams are by V. Bonačić.

An additional seminar is planned in picture processing (Reference 16).

Hardware and software necessary for general purpose computer-aided design, including some problems in architecture, is an immensely expensive item in our available budget. Certainly, equipment and software-wise, as well as in human power, these are usually the most expensive activities in computer research. But some aspects of use of the dynamic object might be considered as a further step in computer-aided design as well.

The model of a computer-controlled traffic system has been built. The system consists of one or more lines of discrete light units (semiconductor lights) fixed in the road surface, each defining a moving lane of traffic. In this new way of directing traffic, "dynamic" means movement and "static" means stop, and colour as code has no meaning in the classical sense; e.g., red, yellow, and green. Man thus becomes a part of the "dynamic line" and moves or stops with it. The system is to be used for: stop or go, emergency, speed control, slow down, converting direction, following--in airports, roads, intersections, parking directions, pedestrian walks, exhibition halls, large buildings, directories, and town plans, etc. (Reference 17).

7. MAP OF SITES - Currently Ms. Jaroshevich is working on producing a map of all neglected sites in problem neighbourhoods. She is investigating the possibility of organizing playgrounds in districts having the largest number of children without any spaces for play. She is personally cooperating with the Bar-Ilan University, the Hebrew University, the Jerusalem Municipality and Architectural Centre for beautification of Jerusalem.

8. RESEARCH IN ART PATTERNING - Dr. Richter's research is concerned with simulation as a basic process in art patterning. The work confronts already established interpretations of art patterns, as semiotic systems or as messages using some language-like forms. The clarification of borders in which art patterns can be interpreted as symbolic or language-like systems on the one hand and as simulation processes on the other, is crucial for understanding genuine as well as machine made arts.

9. LIBRARY CONCEPT - A comprehensive art and science library has been planned. The subject matter will deal with art and science as an interdisciplinary field and with other fields of human activity connected with art and science. The collection will include book and non-book material (slides, tapes, films, computer tapes). Profiles in INSPEC, NTIS and ISI are also within the scope and responsibility of the library. As a long term project, it is planned to process the collection and publish lists of various relevant materials. Such disseminated lists would be useful to anyone interested in art and science, its concepts and applications - research workers, students, educators or industrial planners, etc.

As research results are favourable, it is planned to continue work on already existing research projects.

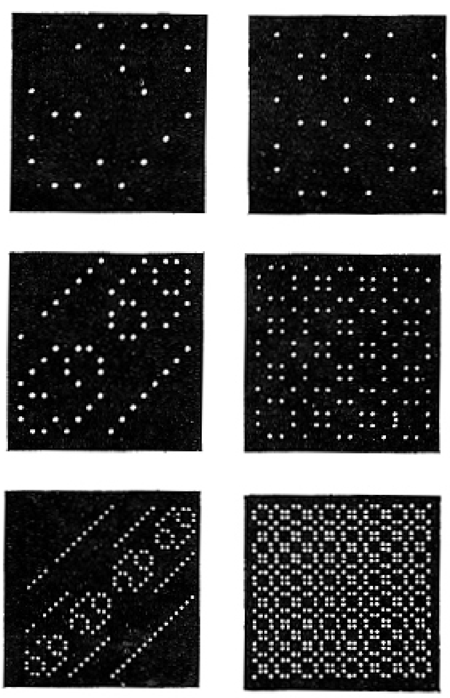
THE JERUSALEM PROGRAM

10. LECTURERS, LECTURES AND SEMINARS - A list of lecturers and their topics follows:

- Joseph Bodenheimer - Light and Colour
- Vladimir Bonačić - Computer Use in Art
- Miro Cimerman - Computer-Aided Design and Graphics
- Yits-hak Dinstein - Computer Picture Processing
- Dunja Donassy and Menachem Szus - Dynamic Lighting Systems
- Ithamar Gruenwald - The Interaction of Art and Science
- Ariel Moss - Microprocessors - A New Concept
- Marius Schattner - A Mathematical Approach for Analyzing Some Visual and Abstract Patterns
- Janos Schossberger - Subject and Object in Contemporary Thought
- Israel Shahak - Ethics, Art, Science (Political Opinions of B. de Spinoza, Creativity of Societies, Human Rights in Israel).

11. CONDITIONS - Any serious work is limited by our inadequate computer system. That is why it was planned to place aside "classic" concepts of computer graphics and computer-aided design, and to concentrate on the use of microprocessors, which is the only available alternative. The present veering towards humanities should be considerably increased, as the program cannot live in isolation from international communities. The planned exchange of people and ideas is very necessary.

12. STAFF - Interdisciplinary post-graduate study - international orientation - administration - budget -- these are topics for future discussion. The first date for Bezalel's Senate Committee's elaboration of Art and Science future had been set for January, 1977, but consideration is still in progress.



ABOVE: Additional examples of mathematically derived patterns characteristic of orbits of Galois fields, used in V. Bonačić's computer art.

SUMMARY

The development of the Art and Science Program is to create for the students of Bezalel and other institutions an environment in which technology will serve not itself but human needs. Familiarity with the techniques and capabilities of modern technology will provide the student with the tools and an understanding of the environment in which humanity is a dominant factor. This exposure to ongoing research, e.g., computers in humanity, will enable the student to distinguish between humanity and technocracy, and give him or her the desire and impetus to create.

NOTES FROM THE CATALOG OF THE BEZALEL ACADEMY OF ARTS AND DESIGN, JERUSALEM - 1977/78

(Since this issue focuses greatly on the teaching of computer art, additional catalog notes are given here.)

In 1973, Bezalel Academy, considered as one of the most open and free institutions in Israel society, became instrumental in launching this enterprise, in the belief that an international exchange of people and ideas would be given an excellent chance to develop and flourish.

The late Professor A. Katchalsky gave help and spiritual support to this program from the outset. He wrote: "The transition towards a new paradigm is a further step in an evolution of new structural patterns, in which art and science will form their own fields of expression intrinsically adapted to the needs of a truly modern society." Computers, by using complex heuristic programming, offer a potential means of creating a common language for art and science. The exploration and development of such languages is therefore a focal point of the programme.

Trends in modern art (reactions to it by society, social contribution of the artist, etc.) are discussed with students in the framework of an open seminar. The collection of the Israel Museum is used as a source.

The urban environment as a communication space: analysis of the interaction of private and public spheres of society, and the involvement of human beings with the urban environment.

Notions on formal languages: some basic concepts in algebra and formal languages are introduced. Kleene and Chomsky languages are discussed as well as the Turing machines.

Time and mind: discusses how modern physics can be reconciled with psycho-physical theories of awareness and memory systems. Acceptance of modern knowledge by society, problems of concept and survey of basic discoveries in contemporary science are presented.

According to present plans, Art and Science will establish itself, in the course of its natural evolution, as an interdisciplinary postgraduate study center with comprehensive international orientation.

THE NEED TO RELOCATE AND FIND A NEW ENVIRONMENT FOR THE PROGRAMME IN ART AND SCIENCE -

by Dr. Vladimir Bonacic

EDITORIAL NOTE: Here are some excerpts from a recent letter received recently from Dr. Bonačić. These comments are included here, in the hope that readers may offer help to Dr. Bonačić and his colleagues, to find a new environment for the Programme in Art and Science.)

...We do not see the possibility of continuing here in the present administrative climate in Jerusalem with activities on the same scale and especially for further development of research in the field "Computer in Humanities".

With your help, we would like to look for a suitable environment elsewhere where activities achieved within the Jerusalem Programme in Art and Science may have more chance for further development.

Certainly no environment would be willing to transplant any activities without preliminary proof that such direction is also worthwhile for its particular society. But a pilot project limited in budget and time might be acceptable.

If you know of any possibilities where one or two pilot projects could be carried out by Bonačic and one senior researcher, preferably beginning next academic year, please contact at your earliest convenience Dr. William Sandburg, 37 Dirk Schaeferstraat, Amsterdam, Holland, Phone 020 - 725 - 725385.

/s/ Dr. Willem Sandberg
Chairman,
International Advisory Committee
The Jerusalem Programme in Art and Science

/s/ Dr. Vladimir Bonačić
Head,
The Jerusalem Programme in Art and Science

COMMENTS ON THE MICROPROCESSOR OSCILLATOR IN ART (See page 6.)

...The dynamic object (the concept of the microprocessor oscillator) permits an artist to use the microprocessor as part of the "canvas" which generates light instead of reflecting it, opening immense new possibilities for expression in the fields of sculpture, music and other design, or in science, all of these possessing a rich common denominator in the form of the languages used.

Can we say that the humanization of art is taking place? Energy, communication, locomotion, the discovery of printing, even religious beliefs can be used by alienated societies in an ungenerous way -- directed against our fellow-men. But the development of a new language requires such a large number of people involved in the process, contributing to the sharing of the insight evolving between them, that the impact of the malignant influence of alienated social islands is less significant.

The establishment of a common denominator would lead to a greater probability of ethical evolution and thus the creation of a new paradigm for society.

(The foregoing are comments from "On the Boundary Between Science and Art by Dr. Vladimir Bonačić.)

BELOW: Poster of the first, successfully digitized Arabic characters for use on computers, using the conventional digital plotter. The original was exhibited at the 6th International Poster Biennale, Warsaw. For information on the characters, see Impact of Science on Society, Vol. 25, No. 1, January-March, 1975, p. 90-94.

SOME BRIEF NOTES ON COMPUTER ART AND TEACHING

by William J. Kolomyjec, Instructor
Department of Engineering Graphics
College of Engineering
Michigan State University
East Lansing, Michigan 48824

The Potential of the Computer

I have been generating computing imagery, as well as teaching computer graphics, both as a skill and as an art form, for several years. It has become part of my life. In retrospect, it was the potential of the computer as a design tool that made so much sense to me. I had to find out for myself how to do it. That was eight years ago.

An important observation I have made concerning computer graphics as "art" needs to be mentioned. One must remember that engineers and scientists were the originators of the medium we now use. Its initial purpose was not to make art.

Although their pioneering research and reports were full of vision and potential application, none could foresee the ramifications of their graphics systems within the realm of fine art. More significantly, it was these technically oriented people that provided the "classics" of computer imagery as we know them today. Perhaps this is why most computer generated imagery of the present appears to have been produced by the technocrat and not the humanist.

Beginning Experiences

I have had some interesting experiences both as an artist and as an instructor of computer art. As a beginning computer artist I had to learn the language of the computer before I could draw with the graphic peripheral equipment. This was no small task, and there was nothing in my formal art training which could have helped me relate the computer language to visual statements. Frankly, art history was easier.

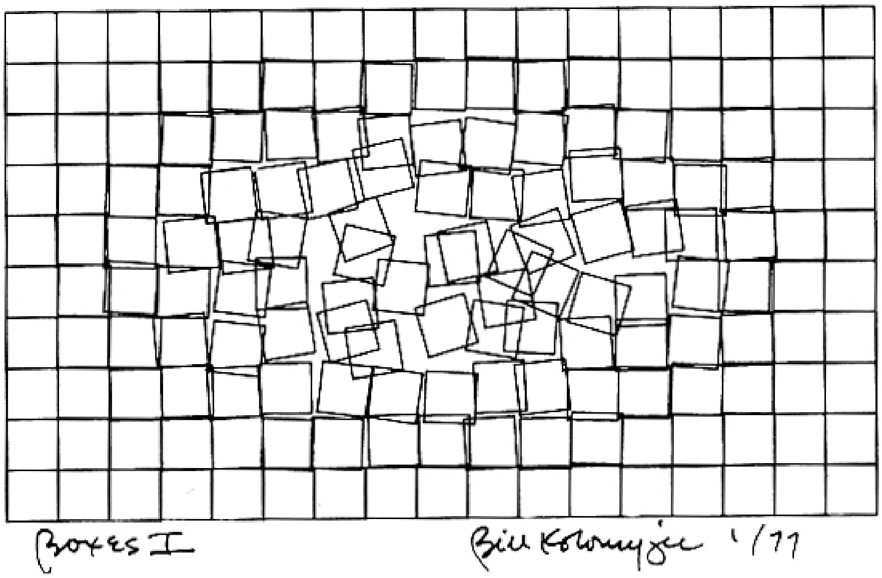
Practice and much experience were necessary to become a proficient programmer. Eventually, I could program, and I began to draw. I was an artist first, a computer programmer second. I kept demanding more versatility from the available equipment. Linear qualities were easier to master than the curvilinear. Algorithms became easier to program than digitizing representational imagery. These are but a few of the things one learns.

Teaching Computer Art

Now as an instructor of computer art, I can pass on my experiences to students. Ideally, I would like to have a balance of artist-humanist students and engineer-scientist students in my classes. I have found that although the technically oriented students can more readily program the computer, they lack the most fundamental skills of visual design. Conversely, the artist-humanist students can formulate beautiful imagery, but they have a terrible time programming.

Yet by concentrating on the basics of aesthetics and the rudiments of logic and programming, these two types of students in the environment of the classroom learn a common language by sharing and communicating experiences. They have the potential to influence each other so much that by the end of a ten week term, all participate freely in critiques of each others' works, and somehow their imagery is transformed by this interaction. Engineer-scientists learn about aesthetics by making visual images for critiques -- and similarly, artist-humanists learn about logic and programming.

BELOW: Boxes I by William Kolomyjec.



The Union of Art and Science

My personal belief about computer art is that it allows the integration of two separate disciplines. It is a sign of what is to come in the future. We have pursued specialization long enough, and our most significant contributions to come will be in combining disciplines that are presently divergent.

Computer art is one of the first aggregate activities of this nature.

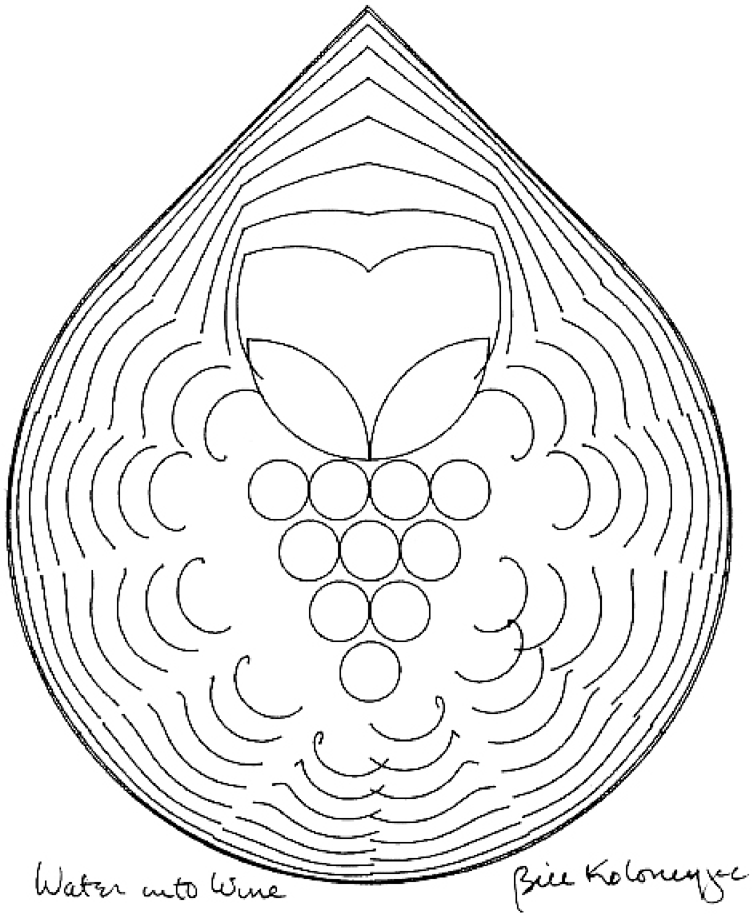
....

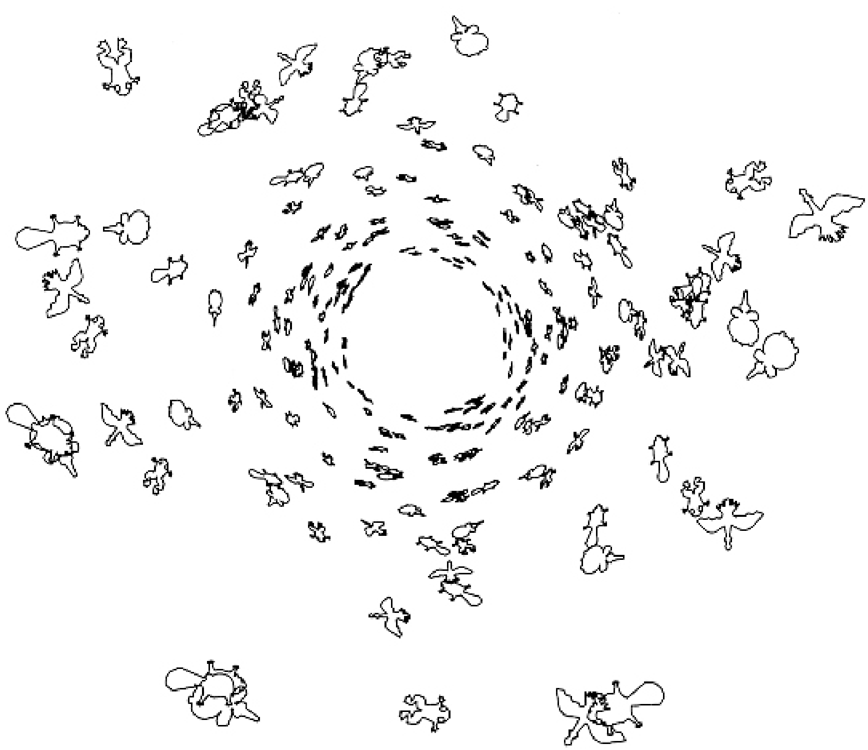
AT RIGHT: A mystical transformation of patterns, "Water into Wine" by William Kolomyjec.

BELOW: Frogs, geese, badgers, elephants, randomly rotate in diminishing forms in "Creature Tunnel" by Bill Kolomyjec. One wonders, is it the beginning or end of "creation"?

Editorial Comments: Much of William Kolomyjec's work makes use of specific algorithms of change, distortion and transformation, into which many forms of design may be added and varied. The artist's work also reflects a decided influence of the great printmaker, Maurice Escher, who also was concerned with the idea of transformation and timelessness.

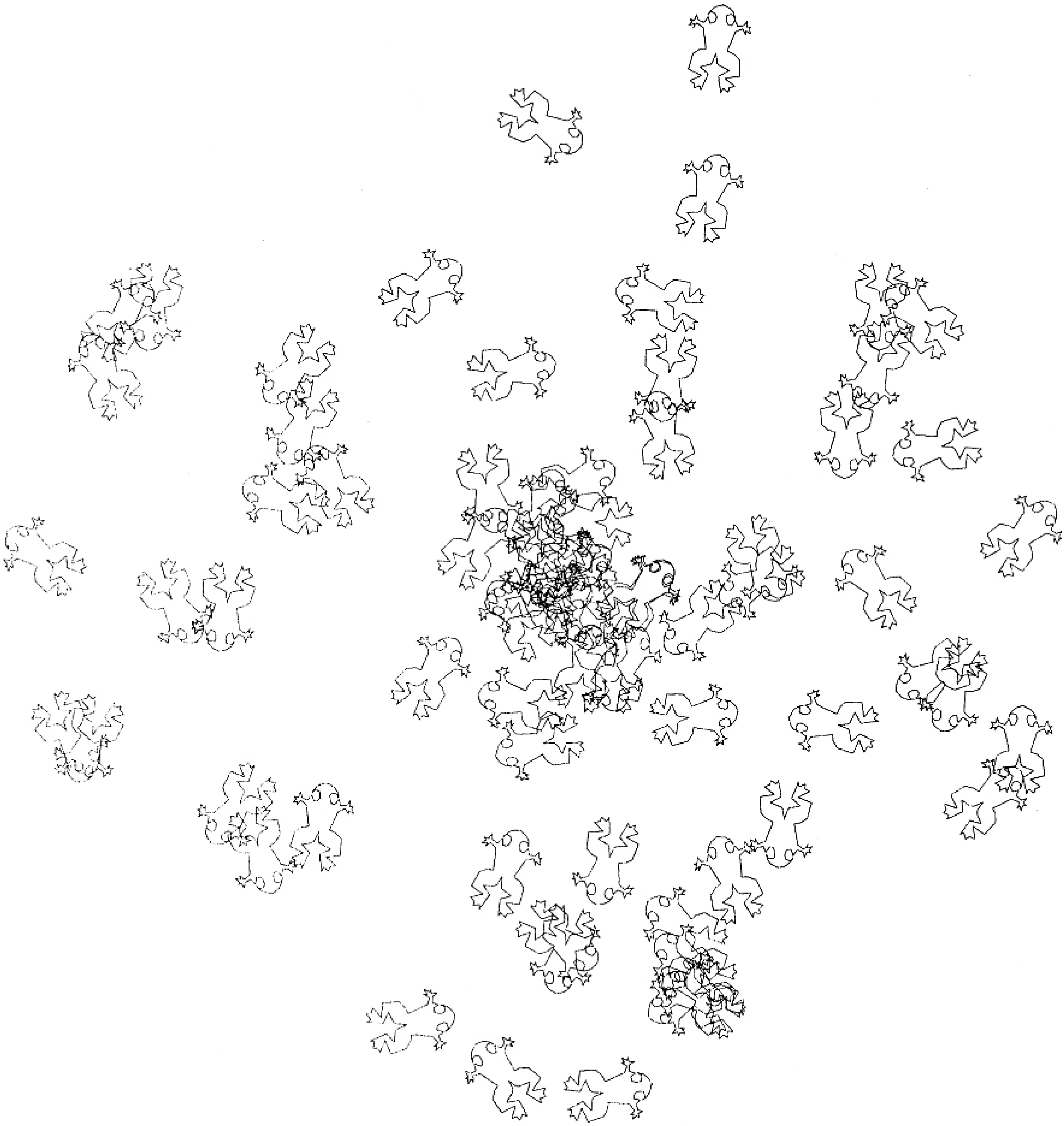
For other examples of Professor William Kolomyjec's work, see the August and September issues of Computers and People.

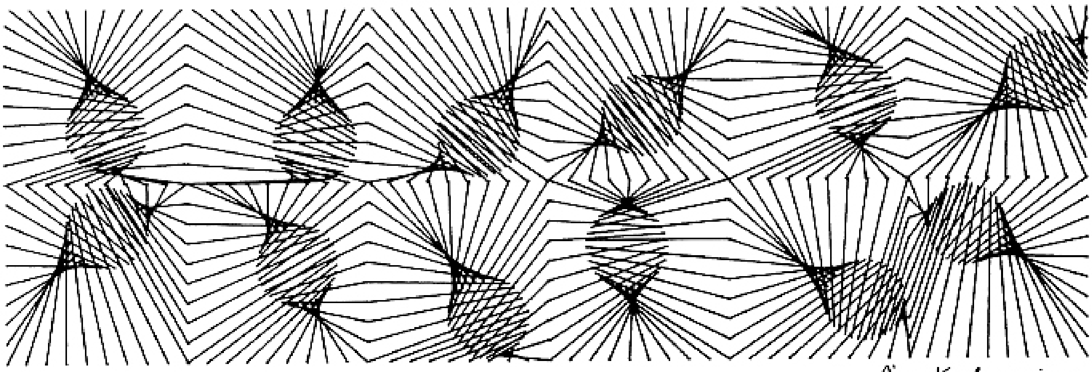




BELOW: "Frog Pond" by William Kolomyjec. Here are comments by the artist: "A digitized representation of a frog is randomly located in a circle (random radius and angle). After this relative position is determined, the image is rotated. This is my answer to Charles Csuri's 'Flies'. A digital computer and a plotter were used to execute this work."

On the opposite page, the program for the graphic is given. In using this program, other patterns or designs may be used. Combinations of related forms, as in "Creature Tunnel" will afford innumerable variations.





Organic Illusion (Detail) — Bill Kolomyjec

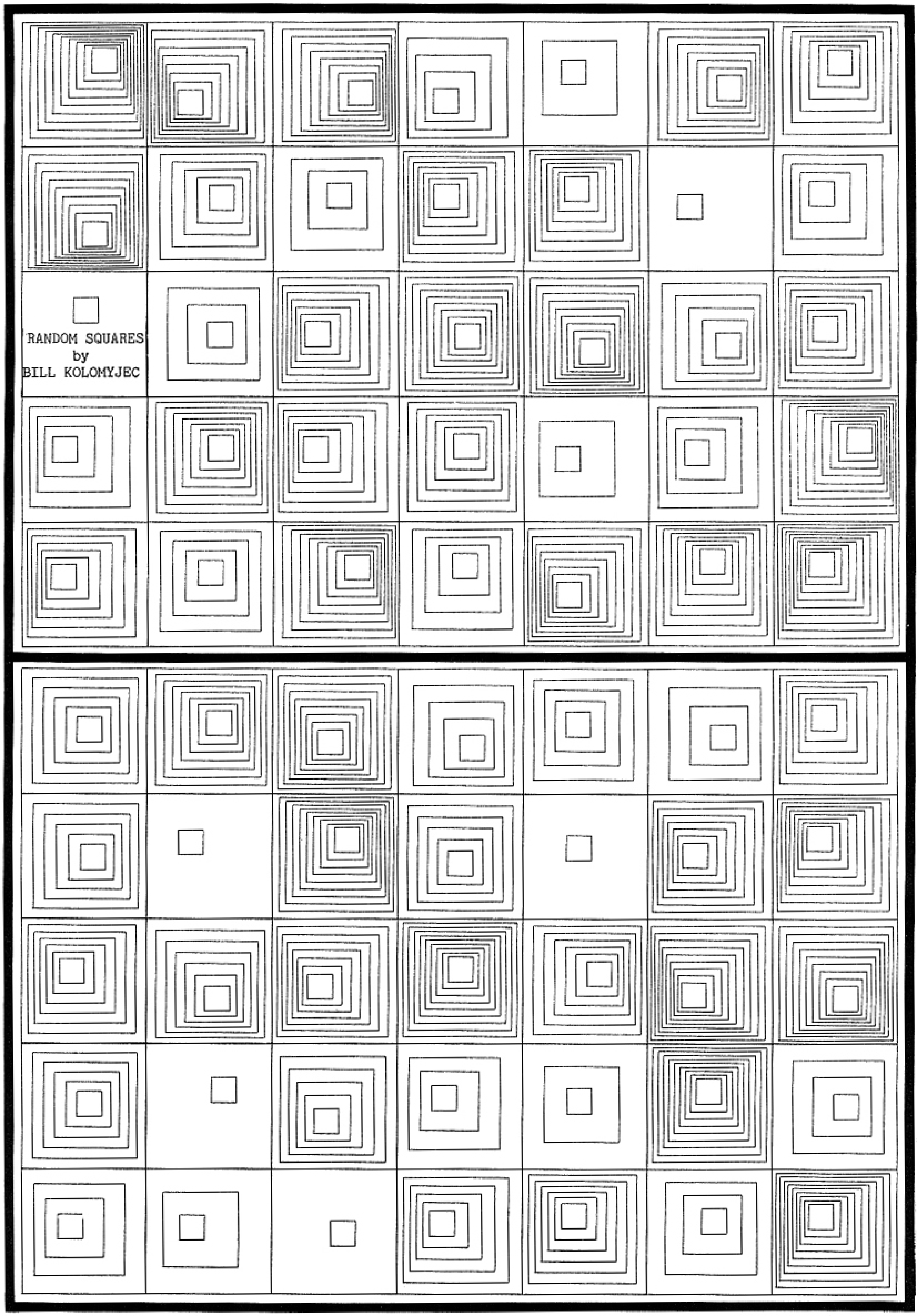
BELOW: Program for "Frog Pond" by Bill Kolomyjec-(Illustration on opposite page).

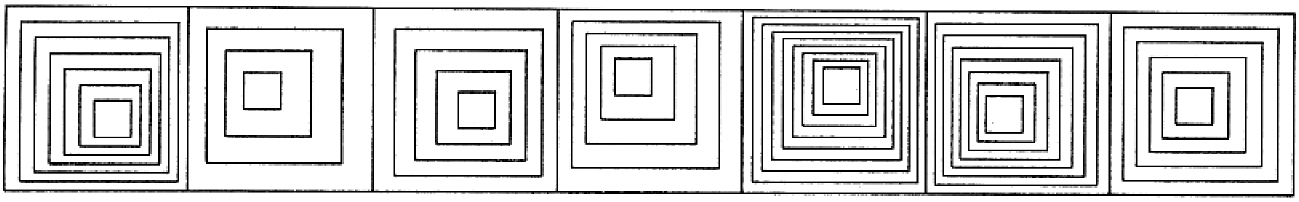
```
// JOB
// FOR FROGS
*ONE WORD INTEGERS
*NONPROCESS PROGRAM
*LIST SOURCE PROGRAM
*IOCS(CARD,1443 PRINTER)
C*******************PROGRAMMED FOR COMPUTER GRAPHICS AND ART BY BILL KOLOMYJEC
      DIMENSION FROG(100,2)
C                         DEFINE VARIABLES
      TWOPI=2.0*3.1415926
      RDIUS=5.0
      NFROG=75
      XMID=0.4
      YMID=0.4
      SIZE=1.
C                         INITIALIZE PLOTTER AND SET RANDOM NUMBER GENERATOR
      CALL HYPLT(0.,0.,0)
      CALL RANST
C                         READ IN DIGITIZED DATA (FROG) DESCRIBED IN COORDINATE PAIRS
      READ(2,800 )NUM
  800 FORMAT(I3)
      DO 100 J=1,NUM
  100 READ(2,801) FROG(J,1),FROG(J,2)
  801 FORMAT (2F5.1)
C                         ADJUST DATA (SIZE IS OPTIONAL SCALING FACTOR)
C                         XMID AND YMID ARE THE RELATIVE CENTERS OF FROG DATA
      DO 150 J=1,NUM
      FROG(J,1)=(FROG(J,1)-XMID)*SIZE
      FROG(J,2)=(FROG(J,2)-YMID)*SIZE
  150 CONTINUE
C                         BEGIN DISTRIBUTION AND DRAWING
      DO 200 J=1,NFROG
C                         RAD IS SOME RANDOM RADIUS BETWEEN ZERO AND RDIUS
      RAD=RANF(0)*RDIUS
C                         ANGLE IS SOME RANDOM ANGLE BETWEEN ZERO AND TWOPI
      ANGLE=RANF(0)*TWOPI
      XPOS=RAD*COS(ANGLE)
      YPOS=RAD*SIN(ANGLE)
C                         THETA IS SOME RANDOM ANGLE BETWEEN ZERO AND TWOPI
      THETA=RANF(0)*TWOPI
C                         LIFT PEN AT BEGINNING OF EACH FROG
      JPEN=2
      DO 300 K=1,NUM
      C=COS(THETA)
      S=SIN(THETA)
C                         ROTATION EQUATIONS
      XNEW=FROG(K,1)*C-FROG(K,2)*S
      YNEW=FROG(K,2)*C+FROG(K,1)*S
C                         ADD RELATIVE POSITION TO ROTATED FROG AND PLOT
      CALL HYPLT(XPOS+XNEW,YPOS+YNEW,JPEN)
      JPEN=1
  300 CONTINUE
  200 CONTINUE
C                         TERMINATE PLOTTING
      CALL HYPLT(0.,0.,-1)
      CALL EXIT
      END

FEATURES SUPPORTED
 NONPROCESS
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR FROGS
 COMMON        0  INSKEL COMMON        0  VARIABLES      440  PROGRAM      280

 END OF COMPILATION
```


RANDOM SQUARES
by
BILL KOLOMYJEC



BELOW: Program for "Random Squares", illustration on opposite page. The top illustration is for the program listed. The second (bottom graphic) is a variation.

```
// JOB
// FOR RDMSQ
*NONPROCESS PROGRAM
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
*IOCS(CARD,1443 PRINTER)
C*******************PROGRAMMED FOR COMPUTER GRAPHICS AND ART BY BILL KULOMYJEC
      DIMENSION A(4,2),B(4,2),AA(4,2),BB(4,2)
C                     PROVIDE MEMORY FOR 2 SETS OF SQUARES, RANDOMIZE
      CALL RANST
C                     DEFINE VARIABLES
      NUMX=5
      NUMY=7
C                     BSS=THE SIZE OF THE SIDE OF THE SQUARE, SSPCT=THE PERCENT
C                     OF THE SIZE OF THE INSIDE SQUARE
      BSS=1.25
      SSPCT=0.20
      HFBSS=BSS/2.0
C                     VLIMT IS THE MAXIMUM AMOUNT THE INNER SQUARE MAY VARY
      VLIMT=HFBSS-(BSS*SSPCT/2.0)
C                     SET UP CORNERS OF BIG SQUARE
      A(1,1)= HFBSS
      A(1,2)= HFBSS
      A(2,1)=-HFBSS
      A(2,2)= HFBSS
      A(3,1)=-HFBSS
      A(3,2)=-HFBSS
      A(4,1)= HFBSS
      A(4,2)=-HFBSS
C                     SCALE DOWN SMALL SQUARE BY SSPCT
      DO 100 J=1,4
      DO 100 K=1,2
  100 B(J,K)=A(J,K)*SSPCT
C                     INITIALIZE PLOTTER
      CALL HYPLT (0.,0.,0)
C                     BEGIN DRAWING RANDOM SQUARE MODULES
      DO 200 J=1,NUMY
      YC=FLOAT(J-1)*BSS
      DO 200 K=1,NUMX
      XC=FLOAT(K-1)*BSS
C                     ADJUST OUTER SQUARE TO RELATIVE LOCATION
      DO 201 L=1,4
      AA(L,1)=A(L,1)+XC
      AA(L,2)=A(L,2)+YC
  201 CONTINUE
C                     DETERMINE X AND Y VARIANCE BASED ON VLIMT
      XVAR=RANF(0)*VLIMT-(VLIMT/2.0)
      YVAR=RANF(0)*VLIMT-(VLIMT/2.0)
C                     ADJUST INNER SQUARE TO RELATIVE LOCATION, ADD VARIANCE
      DO 202 M=1,4
      BB(M,1)=B(M,1)+XVAR+XC
      BB(M,2)=B(M,2)+YVAR+YC
  202 CONTINUE
C                     DETERMINE RANDOM NUMBER OF INTERVALS (BETWEEN 2 AND 10)
      NSPCS=9*RANF(0)+2
C                     PLOT EACH MODULE
      DO 203 N=1,NSPCS
C                     P CALCULATES RELATIVE SPACING BASED ON NSPCS
      P=FLOAT(N-1)/(NSPCS-1)
      X=AA(4,1)+P*(BB(4,1)-AA(4,1))
      Y=AA(4,2)+P*(BB(4,2)-AA(4,2))
C                     MOVE THE PEN TO THE LAST CORNER OF THE SQUARE
      CALL HYPLT (X,Y,2)
C                     PLOT INTERMEDIATE SQUARES
      DO 300 I=1,4
      X=AA(I,1)+P*(BB(I,1)-AA(I,1))
      Y=AA(I,2)+P*(BB(I,2)-AA(I,2))
  300 CALL HYPLT (X,Y,1)
  203 CONTINUE
  200 CONTINUE
C                     TERMINATE
      CALL HYPLT (0.,0.,-1)
      CALL EXIT
      END

FEATURES SUPPORTED
 NONPROCESS
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR RDMSQ
 COMMON        0  INSKEL COMMON       0  VARIABLES     110  PROGRAM     444
```

COMPUTER GRAPHICS FOR INTERIOR DESIGN STUDENTS AT PURDUE UNIVERSITY

by Kingsley K. Wu, Associate Professor
Victoria J. Willis, Assistant Professor
Department of Creative Arts
Purdue University
West Lafayette, Indiana 47906

ABSTRACT

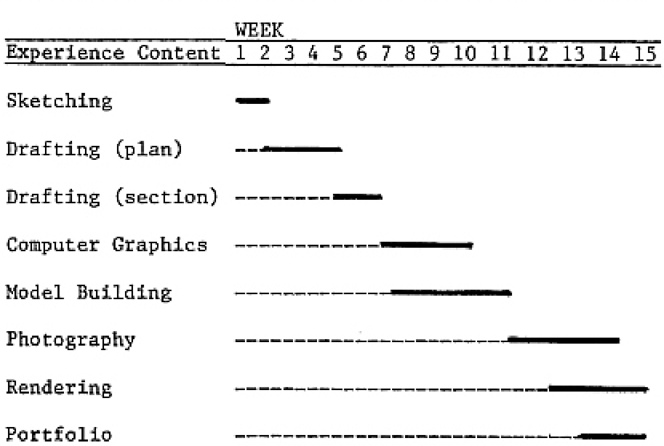
By means of a user-oriented hidden-line removal program and some brief instructions on how to keypunch and submit card decks, sophomore Interior Design students in the Creative Arts Department of Purdue University are being taught the use of computer-generated graphics as a technique for previewing the design of architectural spaces.

INTRODUCTION

This paper describes the use of a hidden-line removal program used by Interior Design students. The program allows the students to receive electrostatic and/or ink plots of architectural forms and spaces as three-point perspective views.

The students are introduced to computer-generated graphics as a part of a course devoted to various presentation media and techniques. The course is offered to second semester sophomore students enrolled in the Interior Design curriculum through the Department of Creative Arts at Purdue University.

The course consists of mini-packs of experiences set in the following chronological order within a 15-week semester.



STUDENT OBJECTIVES AND EXPERIENCES

Approximately thirty-five students are enrolled in the course, which is divided into three sections which meet at different times during the week.

It is the goal of this course to provide the students with direct experiences in architectural drafting and presentation techniques, as distinct from a course dealing with the creative or design experience. The students, therefore, are asked not to design their own buildings, but to choose spatially complex buildings that are usually found briefly documented in recognized architectural periodicals.

Using only limited information, the students are asked to explore, understand, and fully document the spaces within the buildings they choose, by means of the media present in each of the mini-packs. The students have had a course in basic architectural drafting and are taking a course in rendering concurrently with this techniques course.

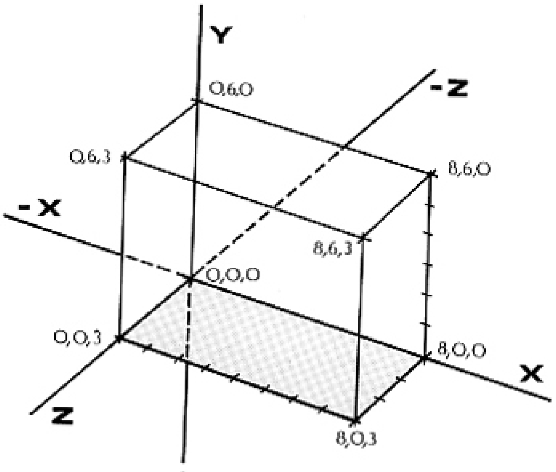
On the whole, they have had no contact with the computer. After an approximate one and one-half hour theory and procedure discussion provided by the instructor, students are equipped to produce the illustrations as presented in this article. The instructor is available from this point on to help locate any errors which may occur.

THE GRAPHICS PROGRAM USED IN TEACHING

The program used to generate graphics is a user-oriented hidden line removal algorithm capable of generating three-point perspective drawings. It is capable of making up composite objects by using such standard elements as line, plane, prism, cone and cylinder. Holes may be inserted in any plane, resulting in views of walls with doors or windows. One may also rotate and/or translate any of the shapes. A staircase, for example, can be generated on its side as a many-sided prism, which is then rotated 90 degrees to the upright position.

All shapes and forms are defined by specifying the coordinates of corners, end points, nodes, or vertices. Coordinates are set within X, Y, and Z axes and specified in units, which in this case, are incremented in feet or decimal fractions thereof. (See Figure 1.)

In order to lessen the possibility of confusion for beginning students, they are asked to set the origin of the axes at the lower rear left hand corner, as in Figure 2. In this way, one may make maximum use of the quadrant that contains all positive coordinates. Negative coordinates, of course, can be used, as when an observer moves behind or beneath the structure.



Above: Figure 1 - Basic coordinate system for determining X, Y, and Z coordinates of points that define each geometric shape.

A perspective view is generated by means of an "observer" card with the coordinates of a point at which one is standing, and a point at which one is looking. Each observer card will generate an additional view.

LEARNING TO USE THE SYSTEM

At the beginning of the segment on computer graphics (see the Experience Content breakdown referred to earlier), students are given a brief description of the keypunch machine. A few of the more advanced (or more adventurous) students do successfully input their data through various remote terminals located on campus. Most students, however, will input their data through punched cards.

Computation is accomplished through the Purdue Computing Center, which maintains dual CDC 6500 computers. Students are encouraged to plot several views by using the Gould Electrostatic Printer, which has a turnaround time of 1-3 hours.

When they have corrected all errors and have obtained several desirable views, they resubmit their card decks to obtain CalComp ink plots of those views (Figures 3 through 8). A CalComp plot usually requires an overnight wait.

VALUE OF THE LEARNING EXPERIENCE

In this particular course, computer graphics is not intended to supplant the more traditional renderings of the student's project, nor does it serve as an end in itself. Instead, the creation of these outline drawings serves the following purposes:

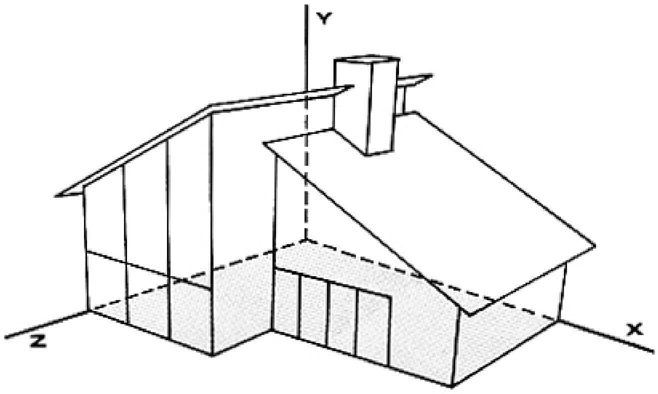
1. Full and accurate comprehension of the studied space is a prerequisite to the computer graphics experience.

2. Through specification of a variety of spectator positions, a student may receive rapid feedback of a "total sense" of the space under study. The most advantageous spectator position may then be utilized in perspective renderings drawn by conventional means.

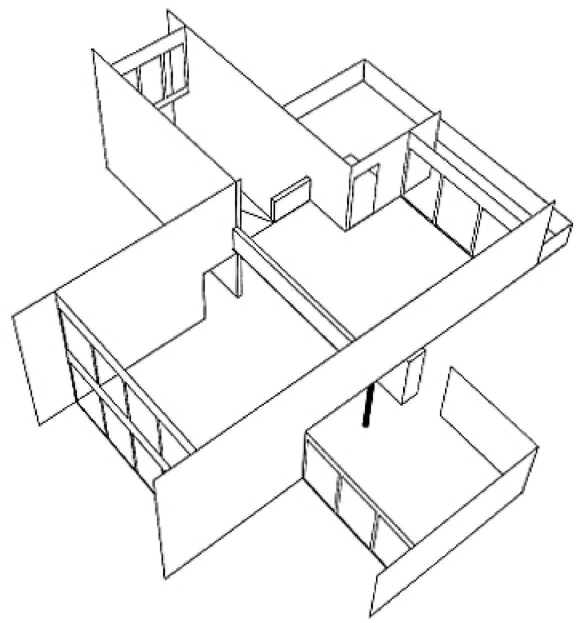
3. These outline drawings can serve as a basic framework upon which the student can superimpose shades, shadows, textures and color.

4. The computer is fast becoming a tool readily available to the interior design profession. This brief introduction to computer graphics provides students with exposure to an area of future development in the professional world.

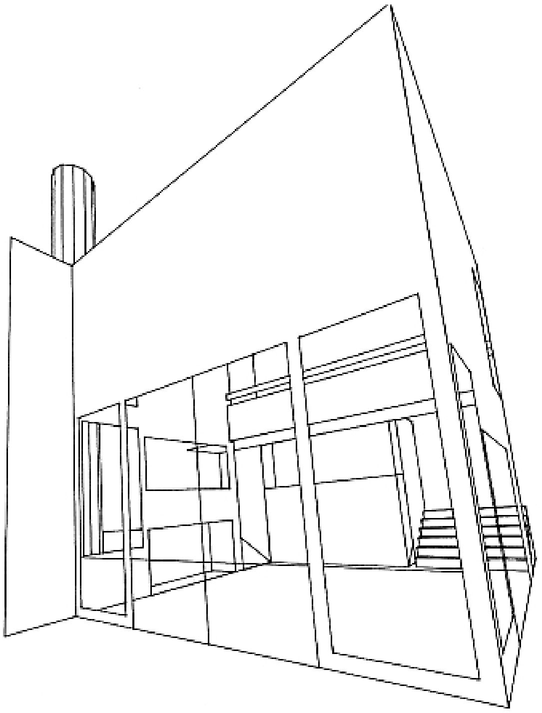
5. It is our hope that some students will go beyond this initial contact, not only to continue using the graphics package while in school -- but to pursue coursework in programming, and to become involved with interactive graphics. This would be the ultimate goal of the designer, as the computer may then be utilized as a tool during the creative process of design itself.



Above: Figure 2 - By placing the origin at the left rear of the floor plane, one may make maximum use of the positive quadrant.



Above: Figure 3 - Various standard forms are used in this example: planes, holes, prisms (as in railings, at the edge of the interior balcony) and a cylinder (as seen in the pipe column). See the next page for concluding figures.



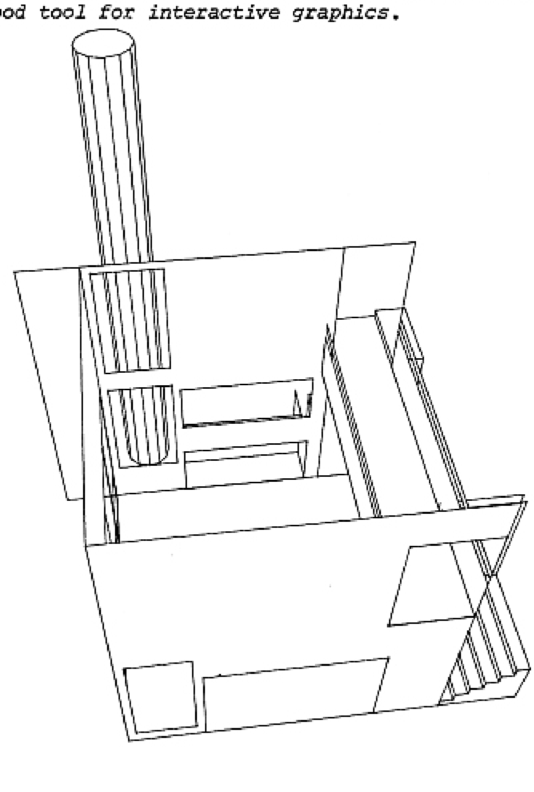
Above: Figure 4 - Holes are used where the building was designed with penetrating spaces.

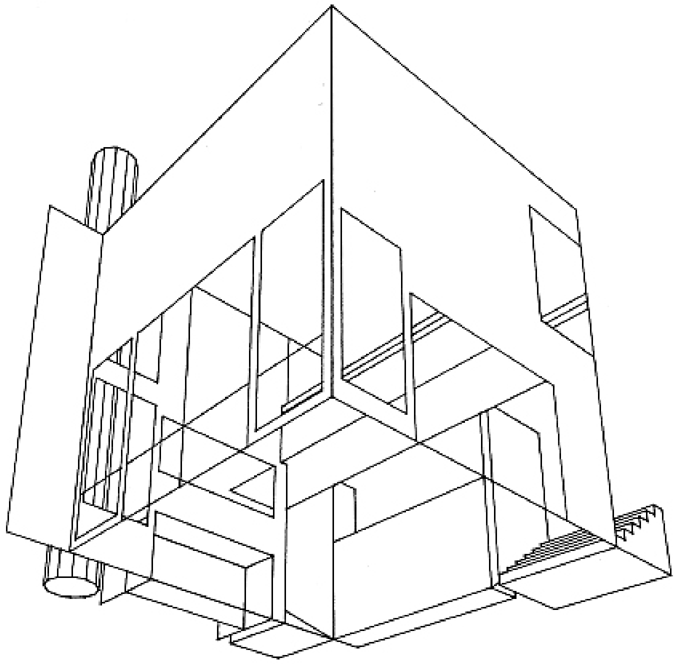
Bottom: Figure 5 - The addition of a card with a different observer location results in an additional output. One may have as many views as one's time limit may allow.

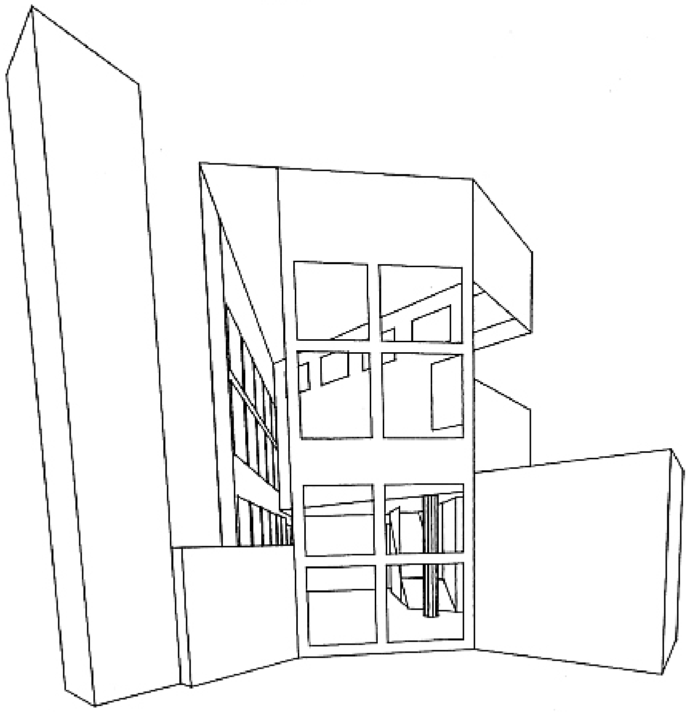
Right, Top: Figure 6 - Removal of the floor plane and the use of negative Y values will generate a view such as this.

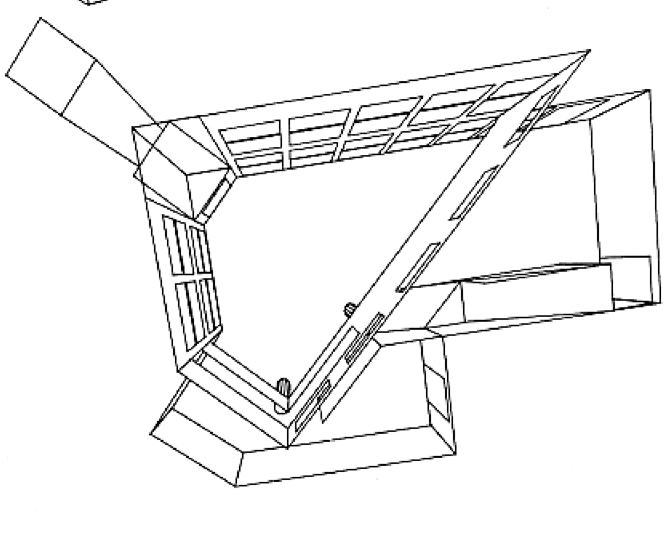
Right, Middle: Figure 7 - The "hole" specification can be used to best advantage where walls have a large number of windows.

Right, Bottom: Figure 8 - The ease in rotating the object to different view points makes this program a good tool for interactive graphics.









RE: VIEWING

by Charles Glassmire
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BACKGROUND

When Leonardo introduced multiple vanishing points into the flat space of Medieval painting, men's eyes lowered from the sky to the horizon, and fifteenth century painting began to emphasize a more realistic view of life and art. Seeing it another way, an artistic tradition began centering on the reproduction of familiar objects from the world of men, rather than from the world of the spirit. Accuracy came to have a certain artistic value in the schema of things.

Not too long thereafter, Newton and Leibniz proposed an accurate way of viewing continuous motion over a distance as a series of fragments. The method was called Calculus, and it relied upon a radical notion dormant since the time of Zeno's Greece. It was at that moment in time that the formal structures of the Renaissance world began to emerge, and thus, inevitably, to crumble.

MOVEMENTS IN ANIMATION

Movements in Animation by Brian G. D. Salt, Pergamon Press, Elmsford, N. Y., 1976., Volume 1 (text), Volume 2 (tables), is priced at $100.

This little known set of references was written as a practical handbook and tabular reference for the motion picture animator and animation stand operator in the film industry. Yet it strikes me that the set might be very useful to many areas of computer graphics, particularly the computer animator.

The author of the text, Brian Salt, correctly observes that motion in animation is wholly illusory, the illusion being produced by a rapid succession of static images. If the illusion is to be satisfactory, the relationship between any one image and those preceding and following is critical. The motion must be pre-analyzed, since no real motion occurs, so as to be created effectively.

These same considerations apply to the graphics plotter arranging arrays of calculated dots, plotter symbols or typographic characters. The total object illusion depends upon the interrelationships of plotted points.

Devices such as interpolation, spline calcation, and other such "tricks" allow the plotter to "fill in" or "smooth out", or otherwise adjust the relationships of parts of the image, in the same fashion as the animator deals with the temporal relationships between plotted frames.

ANALYSES OF MOTION

These two volumes provide handy mathematical analyses of some types of common motion. Volume one contains theory and derives the functional relationships. Types of motion analyzed include:

- linear moves,
- sinusoidal fairings,
- moves in constant acceleration,
- exponential moves,
- rotations and circular pans,
- simple harmonic motion,
- moves along curves (exact and approximate methods,
- coordinate systems.

There is nothing startlingly new here, but techniques of motion analysis from the observer's point of view are often avoided in standard mechanics courses, and volume one provides a useful reference to these methods.

Volume two is simply a book of tables with tabular values calculated. Buy volume one, and generate your own tables with your computer.

The appearance of these volumes at this point in time suggests that we have reached a point of significant mathematical control over the conventional motions of real life, and prompts some observations about the past history of the aesthetic problem which confronts the computer animator arising from the history of the last century.

REALITY AND PORTRAITURE

For three hundred years after Leonardo, the steady gaze of Renaissance men reproduced objects on the canvas from a world which never moved faster than a galloping horse. Indeed, any one who could afford to have his portrait painted (mostly the upper and merchant classes) was asked to sit quite motionless, while the painter captured a "likeness". Every portrait artist knew that the likeness musn't be too accurate (at least if he was to have a steady income). Thus somehow in the process, unflattering wrinkles and moles disappeared, noses were straightened, and weak chins were miraculously strengthened. (See the next page for examples of "hyper-realistic" portraits by Albrecht Durer and Rembrandt.)

PHOTOGRAPHY VS. PAINTING

It wasn't until the process of photography was revealed to the French Academy in 1839 that "realistic" reproductions were improved upon. But exposure times for the early plates were so long that the only objects that could be photographed were motionless trees and buildings. Paris was depicted in minute detail as a dead and lifeless city. Its people moved far too rapidly about their business to register on the slow photographic plates. (A study of these early photographs reveals this static quality.)

Above: Examples of highly realistic portraits that were executed before the invention of photography. At left, Detail of a self-portrait by Albrecht Durer. Right, detail (or portion) of a portrait by Rembrandt of his mother, painted in 1639.

These difficulties didn't bother the general population, and they seized upon the mechanical image-maker with a surprising passion. Within a few years portraiture was technically improved, and lines formed at the Daguerrotypist's shop, sometimes for hours.

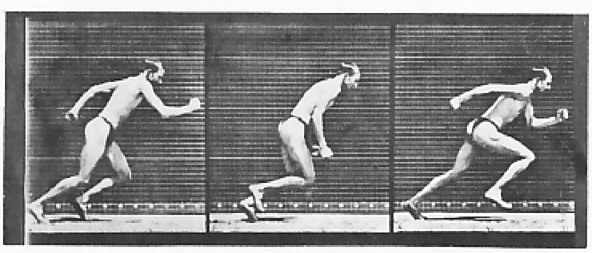
"Robert Taft estimates that in America by 1850 some two thousand operators were serving a population of about twenty-three million." /1/

EARLY PHOTOGRAPHIC PORTRAITS

The portrait process required the sitter to don his best suit of clothes and place himself in a chair before the camera, inserting his neck into a kind of iron collar for immobility; then to suffer in motionless silence while the portraitist counted off the minutes. The stiff unsmiling "likeness" which resulted is a classic example of the process whereby we shape our tools, and then our tools shape us.

Immediate confusion resulted between the photographic image and its corresponding real object in nature. Excited journalists and wags sang the praises of the new invention:

"Jules Janin wrote that the daguerrotype: 'is not a picture...you will write to Rome: send me by post the Dome of Saint Peter's; and the Dome of Saint Peter's will come by return mail'. Le Moniteur Universel stated the equation of picture and reality still more explicity: 'This is nature herself...we count the paving stones, we see the dampness caused by the rain, we read the inscription of a shop sign'." /2/



Above: "Man Running" by Eadweard Muybridge, a precursor to present-day animation. His studies influenced photography and animation greatly.

This epistemological confusion remains with us to the present day.

THE EYES OF THE NEW AGE

Some painters declared that painting was dead; others that painting was freed from the drudgery of making portraits. In any case, the influence of these two media upon each other was immediate and powerful. /3/ It sometimes seemed that the object-in-itself got lost in the battle of processes. The mechanical image maker was destroying every sense of man's unity in a new world of change.

The photograph played a central role in shaping the eyes of the new age. Less than thirty years after Daguerre's revelation to the world, the Impressionist painters appeared with a startling new vision which was strongly influenced by the camera eye. As usual the critics were outraged. It was the same old argument: "A cow should look like a cow".

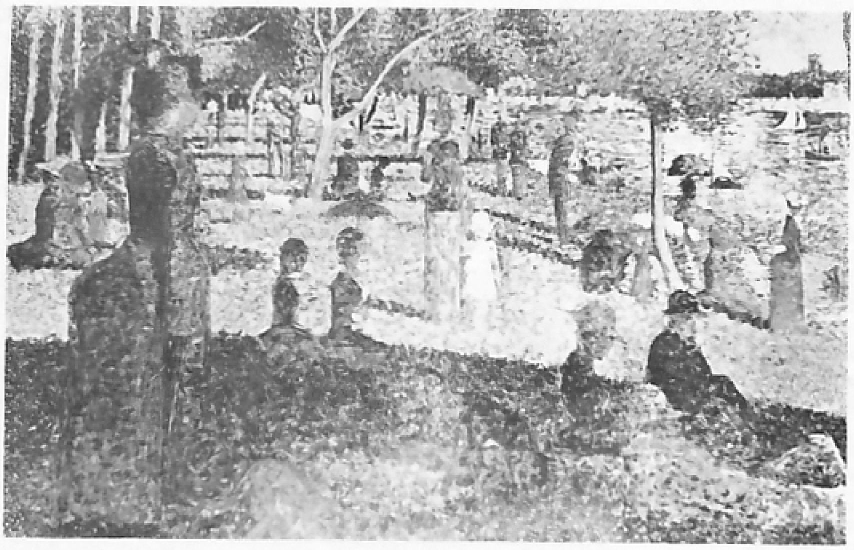
The American art critic S. Hartmon wrote:

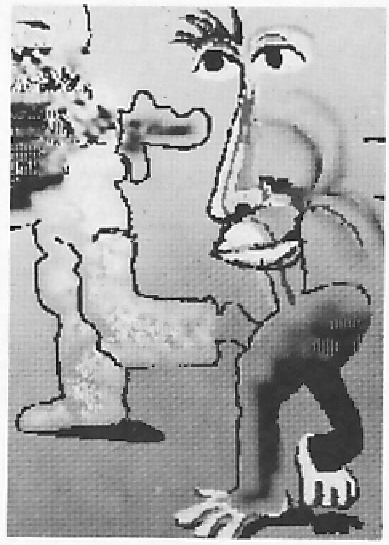
"The Impressionist painter depicts life in scraps and pieces, as it appears on the ground glass of the camera...Impressionistic composition is unthinkable without the application of (lens) focus...and it was the appearance of photographic images in the (18)60's that taught the painter to see and represent life in focal planes and divisions..." /4/

OPTICAL PAINTING

Seurat, a leader of the Pointillist school of painters, claimed to be the first to invent what he called "optical painting". The Impressionists said that they were depicting nature as it really was. The Pointillists applied pigment to the canvas with only the tip of the brush, constructing the image meticulously from tiny dots. This style depicted apparently solid forms when viewed from a distance, but when the viewer approached the canvas, the illusion of solid object reality was shattered. This ritual destruction provided resonances still felt by the image-making systems of the twentieth century: photography, half-tone lithography, motion pictures, television, and computer graphics.

Above: A patient lady sits rigidly for her "likeness, while the portraitist counts the minutes.





Above: The effect of light and shadow in the work of Seurat, the pioneer of Pointillism. At right, above: A marked contrast in mood and subject matter is a detail of "Strange Bird" by Duane Palyka. The "impressionism afforded by the Evans-Sutherland frame-buffer system gives the computer artist a renewed creative vocabulary. Below: Detail of "Cybernumerics" by H. Philip Peterson is another example of "computer impressionism".

As the real object was replaced by the illusion-of-real object in the time's eye, it became evident that the cement holding together nineteenth century reality was quickly evaporating. The very dimension of space was challenged, and as Heisenberg has neatly demonstrated to modern physics, when a physical quantity is closely observed, the act of observation changes it. The process of observation is inherently a distorting process. Thus when the standards of dimension were scrutinized, the cultural sense of time could not remain unaffected. The Lorentz Transformation later demonstrated that length is a function of time.

As the nineteenth century dissolved into the twentieth, the change was abrupt, silent and total.

COMPUTER GRAPHICS AND THE IMAGE-MAKER

Three quarters of a century later, the field of computer graphics devotes an intensive main thrust of theory and aesthetics towards rectifying the disaster, reassembling the image-object from the fragments left by Seurat a century ago into a viable and aesthetically acceptable three-dimensional solid form in time. The image-object is once again under smooth and total control of the image-maker. When the task is done, the hidden dimension of a new universe will be revealed to those with the courage to see.

"The history of the living world can be summarized as the elaboration of ever more perfect eyes within a cosmos in which there is always something more to be seen." /5/

REFERENCES

/1/ Beaumont Newhall. The History of Photography. New York City, N.Y.: Museum of Modern Art, 1964.

/2/ Rudisill, Richard. The Mirror Image. Albequerque, New Mexico: New Mexico Press, 1971.

/3/ Coke, Van Deren. The Painter and the Photograph. Albequerque, New Mexico: University of New Mexico Press, 1964.

/4/ Muybridge, Eadweard. The Human Figure in Motion. New York City, N. Y.: Dover, 1955.

/5/ De Chardin, Teilhard. The Phenomena of Man. New York City, N. Y.: Harper & Row, 1958.

Below: Detail of "Cybernumerics" (see discussion above), a portrait of Norbert Wiener.

COMPUTER ART: POSSIBILITIES FOR FUTURE IMPROVEMENT

by Edmund C. Berkeley, Editor
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"Why is it that computer art up till the present has been judged inadequate by so many non-computer persons? I think there are a number of reasons; and I think that if these reasons are considered carefully by computer artists, and removed, computer art could become interesting, important, rich in impressions, and really beautiful."

FIFTEEN YEARS OF PUBLISHING COMPUTER ART

The magazine "Computers and People" (formerly "Computers and Automation") has been publishing computer art in its August issue for 15 years, from 1963 to 1977 inclusive. First we called the art section of the August issue a "Computer Art Contest", and awarded a first prize, and displayed the latter on the front cover of the August issue. The August issue was devoted during those years predominantly for displaying new forms of computer art. But after some years we renamed the August art section and called it a "Computer Art Exposition". I would estimate that we have published something like 500 pieces of computer art in total over these 15 years.

THE QUALITY OF COMPUTER ART?

With 500 samples to refer to, has any computer art been published in "Computers and People" that is really beautiful, interesting, important, and rich in impressions?

I have to confess that I doubt it. Certainly if we consider the comments that we have received from many non-computer people and many non-computer critics, the verdict is either no or very little. They look at the art; they become quickly bored, and they soon look at something else.

Why is it that computer art up till the present has been judged inadequate by so many non-computer persons?

I think there are a number of reasons; and I think that if these reasons are considered carefully by computer artists, and removed, then computer art could become interesting, important, rich in impressions, and really beautiful.

COMPARISONS WITH GREAT PAINTINGS

None of the computer art which we have published, it seems to be, can hold a candle to some of the great paintings of the great artists:

- "La Source", a lovely nude girl, holding up an urn on her shoulder out of which water is flowing, by the French painter, Ingres; in the Louvre of Paris;
- "Wheat Field and Cypress Trees" by Vincent Van Gogh, a vibrant flowing golden field merging with an intense blue-green sky; in the National Gallery, London;
- "The Artist's Garden" by Claude Monet, a sun-filled garden with a small girl, clad in blue and white leading other figures down the garden path, from the National Gallery, Washington, D.C.;
- "The East Wind" by Dugald Stewart Walker, an illustration for an edition of Hans Christian Andersen's "Fairy Tales", printed about 1910.

Above: *The Artist's Garden* by Claude Monet. (See comments above.)

COMPARISONS WITH GOOD PHOTOGRAPHY

None of this computer art, it seems to me, can compare with black and white photographs of such subjects as these:

- a stream with rapids and waterfalls flowing among granite boulders;
- a winding road through a forest of tall trees covered with leaves;

- a flowering meadow in the spring, with a contrasting pattern of rocks and grass;

- a heavily wooded area of towering trees and overgrown vines.

Below: An idyllic wooded scene, in which the eye can continue on in an imaginary journey. (Photographs on this page are by G. Hertlein, from Lower and Upper Bidwell Park, Chico, California.)

Above: Details from a basalt-rock streen field, with remnants of prior growth contrasting with new spring flowers. Below: Wild grape festoons a drapery canopy in a grove of ancient oaks, the site of the film "Robin Hood".

Why does it happen that computer art so far has not achieved a considerable success in art and in popular recognition?

I think there are a number of reasons, and I shall discuss some of them.

FLAT DESIGN INSTEAD OF SOLID PERSPECTIVE

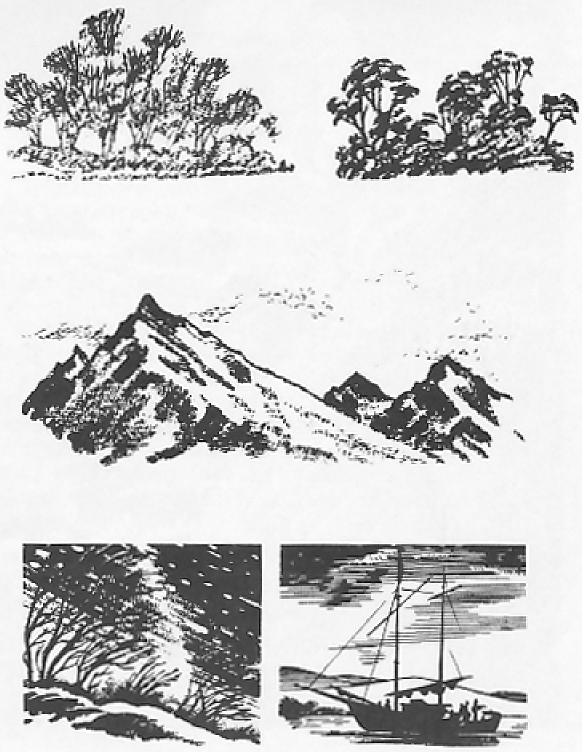
Computer art is often so flat as to be two-dimensional in space, instead of appearing solid, using three dimensions and perspective. After a person has looked at designs made up of many crossing lines, arrangements of curves, and random collections of various geometric figures of random sizes and random shapes, he feels he has seen a great deal of computer art, and he becomes bored. This kind of computer art is much like the designs of a child in the kindergarten; only the doting parent and the fond teacher find them "delightful", while the ordinary person says "What is so wonderful about that?"

I would like to see much more use of perspective, much more depiction of solid forms. The planet earth, the world of man, and everything in them possess a great deal of solidity.

NON-REPRESENTATIONAL INSTEAD OF REPRESENTATIONAL

For all human beings the world is full of common objects and scenes: trees, hills, rocks, waves, oceans, houses, people, faces, and far more -- together with an orientation that is vertical and horizontal. Who would enjoy seeing a human face upside down -- or a sandy beach on its side?

Below: The world of nature can be an endless source of inspiration for the computer artist. The sketches shown are from *Drawing Scenery: Landscapes and Seascapes* by Jack Hamm, published by Grosset and Dunlap, New York City, 1972. Although mathematics and science are viable subjects for computer art, so is the world of nature.



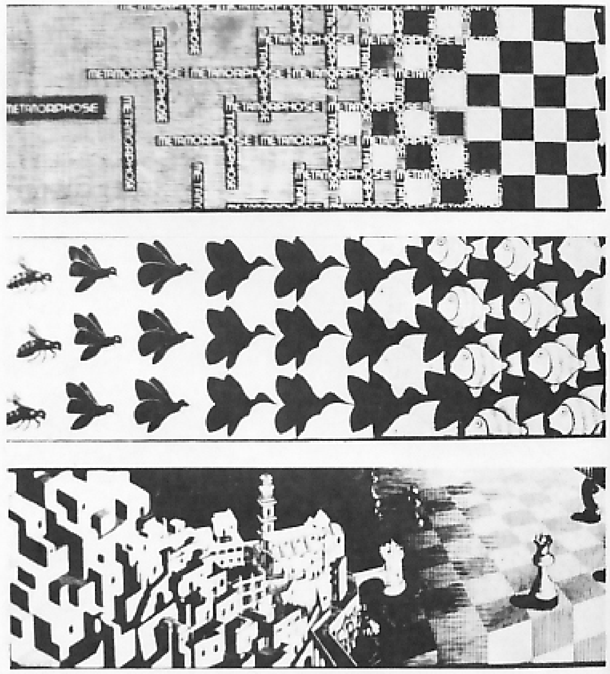
Art regularly intends to give a message to the beholder, and it is very inefficient to split the viewer's attention, one part paying attention to the message, and the other part trying to adjust (rotate) an unfamiliar orientation. It is also inefficient to have one on top of the other of several scenes or objects, such as a mountain, an ocean, and a house, penetrating each other, equally represented. Any artistic message becomes so cluttered that most viewers will turn away in confusion.

It seems to me that great art is of necessity representational. It represents some kind of familiar object or scene together with a representation of some kind of mood or emotion or feeling or coloring (metamorphorically) or way of viewing the object or scene, so that a message comes through to the beholder: for example, "This is a rock, and this is the way I once saw it, transfigured."

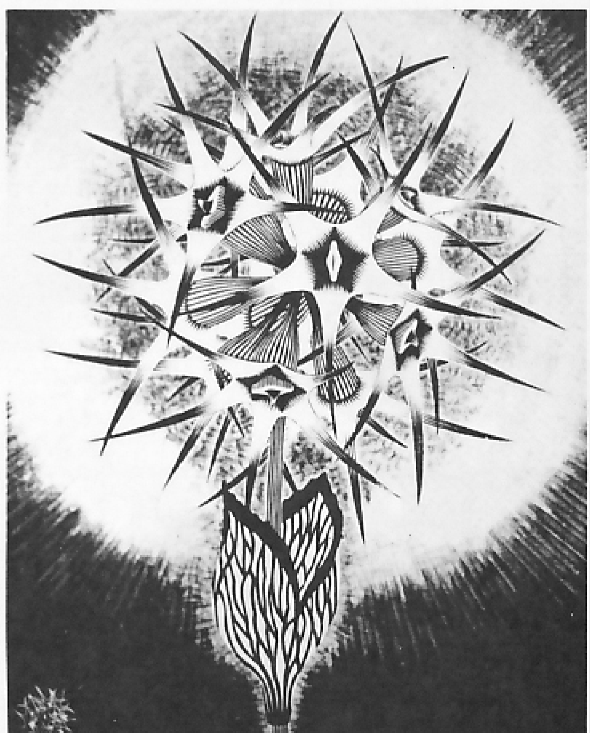
Over and over again computer art is abstract. A little is all right. A steady diet is objectionable to me. Almost nothing in the ordinary world corresponds to the abstractions. Such art is like the picture of some totally unfamiliar machine. It has no message, except "I don't understand it" to the ordinary viewer. People turn away from it. "It does not appeal to me", they will say. More precisely the beholder could say "It does not speak to my condition", or if he is familiar with the language of the communication experts, he will say "There is so much noise in that message that I can find no worthwhile information in it."

Below: *Castrovalva* by Maurice Escher, a lithograph, signed and dated in 1930. On this page other illustrations of Escher's works are shown as examples of the principles discussed in this article. His art is timeless, of the past, yet filled with futuristic qualities and ideas, including the concept of metamorphosis and transformation, so popular in computer art today. Here art transcends technique.

Below: *Detail of Metamorphosis II, 1939-40,* by Maurice Escher. One form is transformed into another, featuring the world of nature and man as a unified entity. The viewer never tires of this quality of art, and repeated studies of this work only reveal new insights and ideas. Although the work is representational, it does not copy nature.



Below: *Prickly Flower, 1936,* a wood engraving by Maurice Escher. Although nature is the source, the artist has stylized and made more minimal, the flower design, and rotated the form.



INSTANTANEOUS MOMENT INSTEAD OF HISTORICAL EXISTENCE

Computer art so far appears to express an instantaneous moment only. But a good picture regularly represents not just one instant of time or one momentary event, but many historical events or happenings. It shows the way an object or a scene has grown or decayed, began, flourished, and collapsed.

The pattern of pine needles under a pine tree can show pine needs that have just fallen, and underneath them the needles that fell a year ago, and underneath them those that fell two years ago, and so on. Their color changes, their texture changes, the amount of decay increases. Further down the pine needles decompose into humus. If there is a wagon track or a horse's hoofprint, its edges will show a historical sequence. A good picture can show or indicate all this, the dimension of time and history.

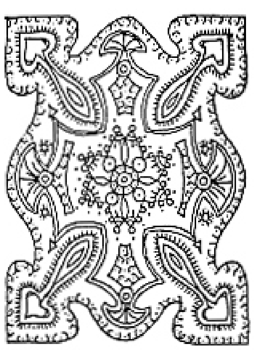
The same is true for rocks in a roaring stream, where there is a hard basalt dike cutting through much softer sedimentary rock layers. Some of the rocks will erode swiftly, some will erode slowly. A good picture can reveal history.

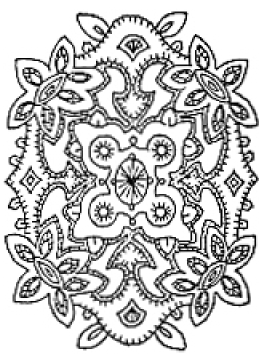
A good artist thoroughly knows the detailed characteristics and historical events that he is reporting on. And he can make these real and vivid to the beholder. And then he can add his expression of mood and feeling and atmosphere, etc., to what he is depicting.

People understand more and enjoy art more when they can look at all the scene shown and find interesting and challenging things to observe. The artist Arthur Rackham made a reputation for himself by drawing trees with knotholes that seemed to look, and little figures of animals, fairies, and elves nearly hidden, in his illustrations for children's books. Another example is the extensive body of lithographs and woodcuts by the famous artist, Maurice Escher, and the viewer never tires of finding new ideas in his works. A great artist is likely to show many relatively hidden yet interesting details in his representation of past events in his pictures.

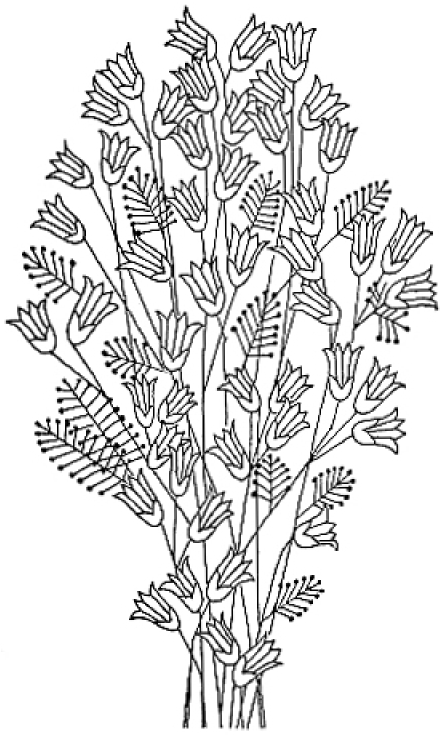
....

Below: *Medium-Size Persian Medallions,* by Gregory Mirow, from his book, *A Treasury of Design for Artists and Craftsmen,* published by Dover, New York, 1969. Why not write a computer program to make medallions like these? One quadrant is programmed, and the other three quadrants are mirrored. The design may be digitized initially, or put through a curve-fit routine. Excessive emphasis on angularity in art becomes boring.





Above: *Chinese Bronzes - Bird,* from the Chang and Chou periods, 1st millennium B.C. is an example of curved, decorative forms found throughout man's art. Computer art is excessively angular, due to point to point programming of X/Y coordinates. I would like to see more curved art, as featured on these pages. Below: *Bouquet* by Gregory Mirow.



Why not a computer program to make a floral cluster like this? The above designs are readily programmed.

....

STIMULATION OF THE BEHOLDER

I think the basic quality of great pictures, great photographs, and great designs is that one can look at them repeatedly for a long time, and discover more and more and more of interest and delight and "beauty".

Is beauty in the eye of the beholder? Certainly, if chimpanzees were establishing standards of beauty in a chimpanzee culture, the beauty of some chimpanzee faces would be "obvious" to chimpanzees, and similarly beauty in some human faces is "obvious" to human beings. Yet the type of beauty of a human face is clearly dependent upon culture of a particular society of a particular time.

It seems to me, that for a beholder, interest and delight in art depends on recognition of objects and scenes, and richness of detail, all suffused with a way or manner or technique of conveying emotion or feeling or mood. In this way, messages both intellectual and emotional, are conveyed to the beholder, and he is greatly stimulated by "beauty".

DESIGN TECHNIQUES AND ART MATERIALS IN COMPUTER ART

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INTRODUCTION

The programmatic aspects of computer art are highly developed at this time. Fifteen years of practicing computer art have allowed artists to explore a range of approaches. These are programmatically very personal, creative, and they are sophisticated technically. Dissemination of routines from one campus to another is at least moderate. There is still, however, a tendency to behave like gourmet cooks, and many computer artists are reluctant to share their inner secrets with another, in fear of being surpassed by the recipient of the "recipe".

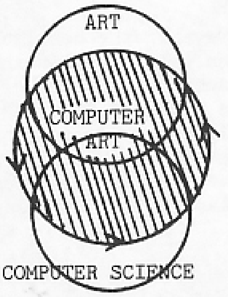
Today, a computer computer artist can often tell how a given work was programmed, and in addition, the artist can generate the algorithm to reproduce the technical aspects of the original. Many thousands of persons have studied computer art since the early sixties, and specific methods to achieve varied effects are a known foundation in this new discipline.

It is becoming academically fashionable to introduce courses in computer art -- and this presents difficulties, because it represents materials from computer science and art. Courses on this topic tend to emphasize one aspect of the subject more than the other, and this is a natural tendency.

The "ideal" course in computer art is a balance between the technical, and the artistic. The field itself may be represented as a continuum:

ART <-----------------------> COMPUTER SCIENCE

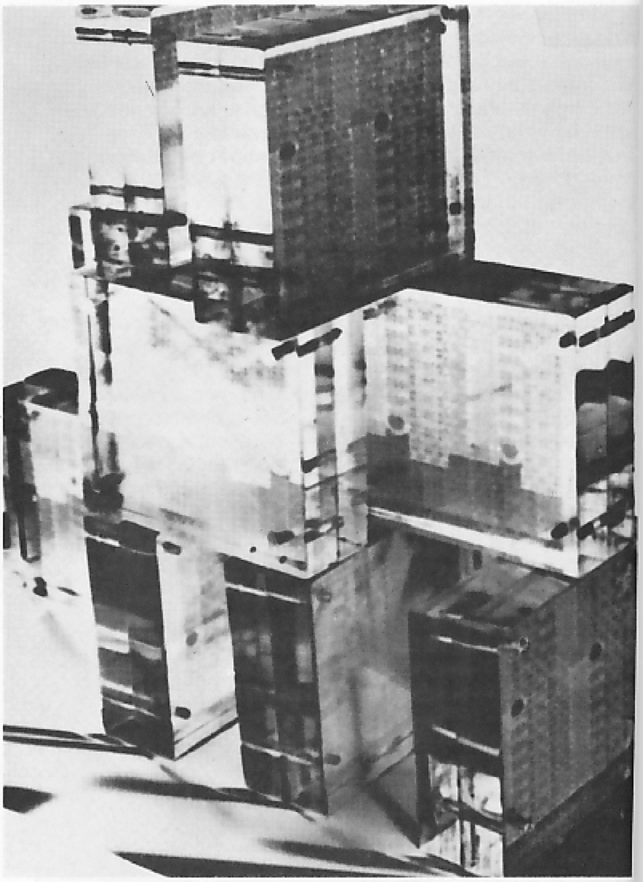
The continuum may be expressed more adequately in the form of a circle, eliminating the either/or attitude of the above diagram:



The implications of computer art and art techniques have been discussed by this writer since 1970-1972. In looking back at this early writing, although the implications of the importance of art were definitively reviewed and analyzed, it was not until 1973, that the author departed from a marked tendency to exploit art materials from the plotter. This occurred as a result of using a microfilm plotter, with film output. /1/ It may be that most of us are hardware (and software) dependent in our approaches to creativity, and that when a new system is available, renewed creative experiences naturally occur.

The purpose of this article is to share class-tested design techniques to achieve personal modules that are then manipulated in computer art. In addition, this article reviews varied art materials (including photography) for final works of computer art. Although programmatic techniques are abundant and well disseminated, the equally important aspects of art techniques are almost non-existent, and little has been published on this topic.

BELOW: A portion of the sculpture, *City Series*, consisting of 20 modules, executed in 1970, by the author.



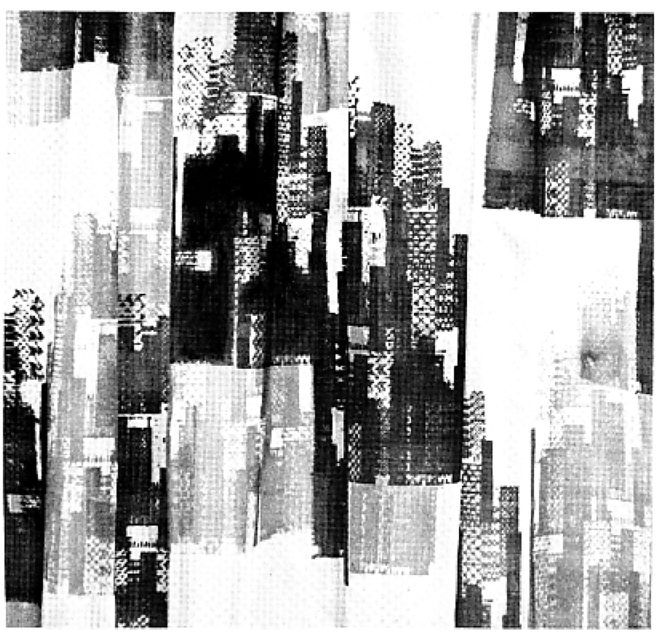
PROGRAMMING - THE FOUNDATION OF COMPUTER ART

In this article, there are brief references to the programming aspects of computer art. While it is an interdependent, significant aspect of the subject, it is not the purpose of this paper. For those who are interested in observing how art is integrated with programming, two recent papers are cited: (1) COMPUTER ART FOR GENERAL EDUCATION /2/ and (2) COMPUTER ART FOR COMPUTER PEOPLE - A SYLLABUS /3/.

Transportable libraries of subroutines to achieve and vary computer art have become more common. User-oriented art systems have been developed for non-computer scientists to achieve both static and interactive art forms. Computer scientists engaging in computer art have become sensitized to art, and artists have become adept at programming. The "Bible" of graphics practitioners, Newman and Sproull's Principles of Interactive Graphics, /4/ has allowed researchers and students to become far more knowledgeable about the programmatic aspects of computer graphics. The superior bibliography of this text has been augmented by other reference sources available to graphics people. Examples of these sources are the Visual Arts Bibliographies published each spring by Computers and the Humanities magazine; /5/ the interdisciplinary graphics bibliography of Jackie Potts; /6/ and the detailed bibliography of the author, /7/ gathered for the California State University System.

In addition, graphics system libraries are highly developed at many institutions. Technical reports by these development centers are readily available, at little or no cost. There is a marked tendency to plan transportable systems and to disseminate libraries, as opposed to the previous cottage industry approach, of each installation simultaneous re-inventing the graphics wheel.

BELOW: *Computer-Designed Textile*, from a grouping of textiles executed by the author in 1976. The design is from the *City Series*.



Examples of these graphics/art systems are: Jerusalem, Israel, /8/ by Vladimir Bonačić; another at the University of Munich, Germany, /9/ by Reiner Schneeberger; a mathematics/art system at Georgia State University, Atlanta, /10/ by Jean Bevis; an art system shared by the California State University and College System, /11/ developed by the author; SPLAT by John Skelton and his colleagues /12/ at the University of Denver, Colorado; and ART I by Katherine Nash and Richard Williams /13/ at the University of Minnesota in Minneapolis.

These are but a few of the many varied and highly developed art systems burgeoning throughout the world.

Emphasis on Programming - A study of these systems, and an analysis of the voluminous references cited before, reveals a very heavy emphasis on programming, with far less information on techniques of design and art material presentation. There is a change occurring, as the fashion of programming dominance gives way to a focus on the product, which is a computer program that produces works of art. The final work of art is inadequately developed if the output relies on industrial papers. A recent editorial by the author /15/ delineates the marked trend of taking computer art back into art.

Final Products - Based on the evidence of innumerable final products of computer art displayed at national and international exhibitions, a critical observer of art can readily surmise that the art aspects of computer art are unknown, undeveloped, and inadequately presented to students.

There is still a tendency to overemphasize the program, perhaps indicating a desire to be "scientific" and intellectual, wherein the idea (program) is everything. Protagonists of programming vs. art are unaware of the supposed unity of art and science that is part and parcel of this new medium. European computer artists appear to be more sensitive to art materials than those in the United States. This topic has been discussed eloquently by Herbert Franke in many of his writings. /16,17,18,19/

In summary, the viewer judges a work of art by the work of art. Computer art is not a programming competition, and the work of art is not the program, although the program is an essential and significant part of this medium.

A NEW TREND

The exhibition, "Cybernetic Serendipity", will go down in the history of computer art as that important "first". The potential of the union of art and technology discussed in this exhibition (and text) /20/ has become more than mere promise. A marked trend is visible in computer art: computer art in the varied arts. An example of this trend was the ICCH/2 Exhibition, organized by the author for the Second International Conference of Computers and the Humanities, /21/ held in Los Angeles at the University of Southern California in April of 1975. The exhibition of 150 international invited works was shown at other conferences and universities, including a special Eastern showing in New York City at NCC '76. /22/ This showing of international art is on indefinite loan to ACM, New York City.

In this particular exhibition, very few final works were printer/plotter/CRT output. The few examples of direct computer output were deliberately shown to illustrate the role of the computer as a designing agent or colleague. Computer art has become an intermediate step in the process and final presentation of art. (See the detailed charts in reference #15.) Computer art has output in many diverse forms: painting, sculpture, photography, serigraphy, lithography, etchings, rug and textile design, weaving, etc.

Last year's NCC Art Exhibition consisted of 364 works /23/, and in many cases, art techniques were highly developed. (150 of the 364 works were ICCH/2 art.) In that large exhibition, it was obvious that only novices still worked with white industrial papers (and printer output) as the final presentation form. In meeting with conference attendees at NCC '76, there appeared a need for discussion and dissemination of techniques regarding design development and art material presentations.

Earlier the interdependency of art and computer science was reviewed, and it is recalled at this point deliberately. Many NCC attendees wanted the "old kind" of computer art - innumerable interference patterns, dependency upon mathematically designed designs, and lack of material development. Hundreds of people did not like the computer-designed serigraphs (silkscreens) from the Systems Dimensions Limited Collection. (For illustrations and comments by the artists, see the May, 1976 issue of CG&A /23/.)

LACK OF EXPOSURE AND STUDY OF NEW TRENDS

One very important reason for lack of exposure and study of new trends is the absence of definitive literature on this topic. In a great proportion of conferences, recommended page lengths of papers are far too short to afford anything but the "sizzle of the steak", and therefore, definitive details from the author are required. This can become a burden for prolific authors, and for years, correspondence is received on the same topic. Another example is this: "Please send me everything you have on computer art". (This is generally a query from overseas correspondents!)

In addition to lack of information on design and art material development in computer art, many artists continue to explore design techniques and sources that have surfeited computer publications for the past twelve to fifteen years! (They must not read.) For a brief period of time, there appeared the philosophy, "It was created with the aid of a computer -- therefore, it is a more perfect art". The computer field, in its newness, has naively fallen in love with itself.

In my work that often includes arranging national and international computer art exhibitions and editing of articles and periodicals on this subject, hundreds of works are reviewed from all over the world. This is a continuing process. Repeatedly, entries are submitted that compare programmatically and artistically with the exercises executed by my students during their first few weeks of exposure to computer art. (In the case of students, the work is kindly but respectfully returned for further development.) This is not possible outside the classroom. It is a known fact that artists and writers do not want constructive criticism--merely acceptance and praise.

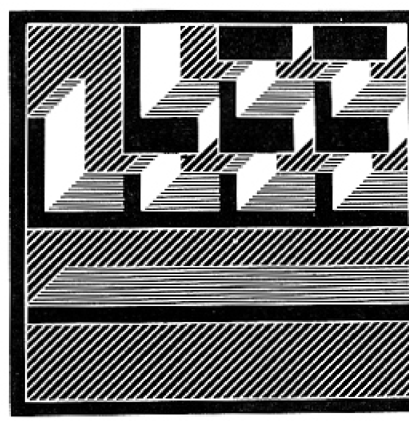
What are reasons for such lack of development? One important reason is that many practicing computer artists are not able to travel and to see large national and international exhibitions. Many exhibitions cannot afford to produce catalogs, and the latter are in black and white, to reduce cost. Dissemination of these publications is very limited.

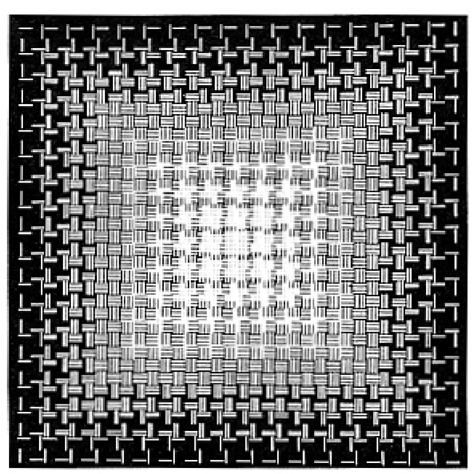
In the study of art, it is important to physically see actual works, and to respond to color, size, mood, etc. This is true of fine art and of computer art.

However, computer art exhibitions are put up very briefly, and taken down at the end of conferences. The limited exhibitions featured in university galleries do not have sufficient funding for extensive, diversified international collections. Computer art exhibitions should be mounted by computer firms, and toured for modest rentals for the benefit of computer people and graphic artists. Sharing and rental of superior exhibitions could make computer art possible for more people.

In summary, exposure to the best of the computer arts would result in an upgrading of the state of computer art now seen in current periodicals and exhibitions.

BELOW: A few examples from the Systems Dimensions Limited Collection. *The Cube: Theme and Variation Series,* by E. Zajec. BOTTOM ILLUSTRATION: *Segrid* by John Roy. Both are serigraphs of computer art.





I - TEACHING COMPUTER ART AND THE DEVELOPMENT OF TESTED TECHNIQUES

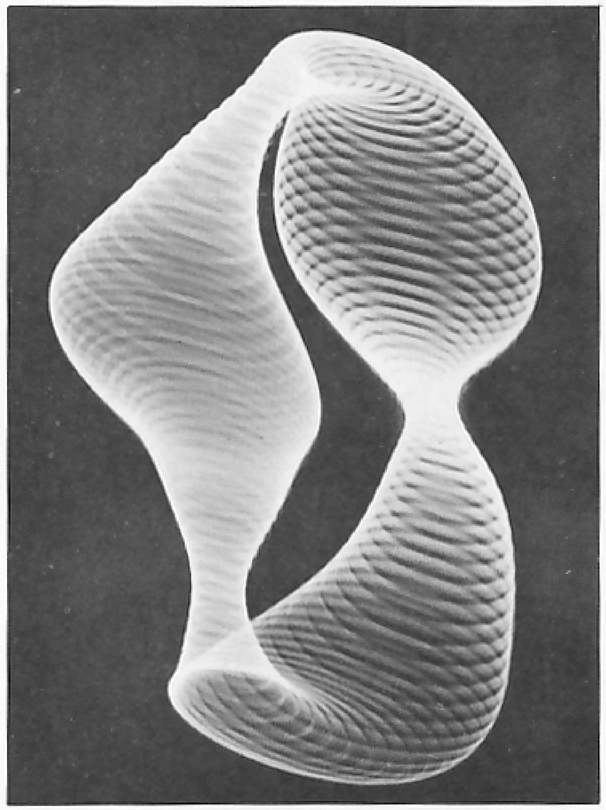
During the past seven years, the writer has generally taught three courses per semester of varied approaches to computer art. At times the offerings have been enriched by senior/graduate seminars in graphics software development. Several approaches have been researched and tested:

1. Introduction to Computer Art - We have tested many versions of an introductory course, and have retained a Freshman/Sophomore orientation for General Education students. This course is not intended for computer science majors and minors. Canned programs and subroutines are used. At the present time two very different versions of user-oriented routines are being tested, to greatly simplify the programmatic aspects of this course. A recent paper /24/ discusses this course in great detail.

2. Computer Art for Artists - A course was developed for the School of Art and Art History at the University of Iowa, Iowa City, in 1973 and 1974 and tested there. Changes and adaptations have occurred since, with emphasis on the applied arts. After teaching several very different versions of this course, it is believed that a modular approach of specific topics is perhaps better suited to artists. A recent paper by Joan Truckenbrod from the 3rd International Conference of Computers and the Humanities /25/ introduces computer use as one element in a Beginning Design class. The paper by Kingsley Wu and Victoria Willis /26/ in this issue also uses the computer as one element in an Interior Design course. At the present time the author is drafting a paper on modular approaches to computer art, to be published in the winter of 1977.

3. Computer Art for Computer Scientists - A special technically-oriented syllabus has been class-tested for intermediate to advanced computer scientists. It includes design material emphases, yet deliberately focuses on technical aspects of benefit to computer science majors and minors: software development techniques, and research in computer graphics interdisciplinary applications. /27/ This course includes a generous exposure to art materials, including photographic manipulations and serigraphy.

Summary - In the teaching of computer art for different types of students, many specific techniques and exercises have been class-tested and retained over a period of seven years. This has represented a search for beginning principles of computer art, and enduring techniques. It has been aided by the help of hundreds of enthusiastic and artistic students from many disciplines. We have found repeatedly, that the work of one-semester students can result in professional-looking, very personal computer art that includes art papers from plotters, photographic manipulations, and varied final presentations of computer art.



ABOVE: *Raumband mit Drei Knoten* by Dr. Herbert W. Franke, is an example of a mathematically-based computer art, photographed from a cathode ray tube. CRT graphics are aesthetically effective, because of the luminosity of the light areas of pattern. (A reversal print of the same graphic, in which the pattern is black, is not as attractive, in that the excessive black pattern connotes a nervosity, because of the number of lines.) In addition, this graphic has been manipulated photographically, by use of a coarse-grained photographic screen, as used in the applied arts. It is an example of "opposites", in which the fine lines have been altered to achieve a fuzzy effect.

It is not possible within the confines of a single paper to discuss every aspect of teaching these courses in computer art. As an appendix to this paper, an abstract of references #24 and #27 is included-- as information for people who are in process of introducing courses in computer art.

II - *DESIGN AND MATERIAL TECHNIQUES*

A. Initial Sessions - A very brief discussion on beginning programming and designing is given first, to emphasize the need to begin designing and using a graphics system immediately. Students begin Phase I of designing and programming by sketching something during the first class period and actually programming that design the first day. (Examples of beginning designs and programming are given as illustrations.)

Here are typical beginning assignments:

WEEK 1: Program a well-developed continuous line design, and decrement (decrease) it towards a specific origin an assigned number of times.

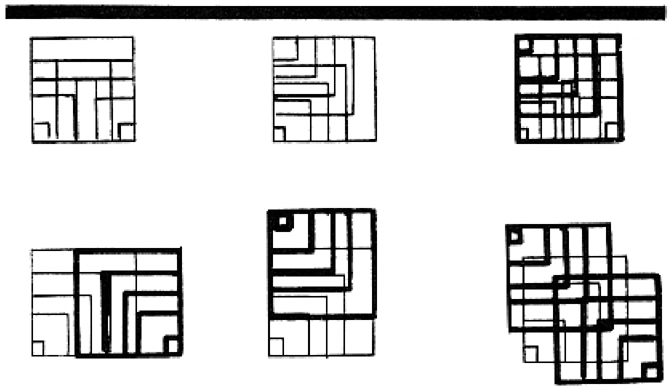
WEEK 2: Begin sketching for Phase II (more personal designs) and continue with Phase I designs. Add to or subtract from the first continuous line design, decrementing it as before. Restore the values and decrement the design towards a second origin.

WEEK 3: Explore innumerable derivations of Phase II designing (Design Derivation Exercises), and simultaneously take the first (continuous line) design through a curve-fitting subroutine from the graphics library. Compare and/or combine curvilinear vs. rectilinear versions.

WEEK 4: Take Phase II designs (more personal than the original continuous line design, and repeat the exercises of weeks 1-3. (The student here is using known programmatic techniques and merely supplying new data, making the change very readily.) In addition, take the first designs, and manipulate them with a canned 3-D routine from the graphics library. Analyze all four versions, and begin to note on paper a personal direction, using the STYLISTIC ANALYSIS OF COMPUTER ART as a guideline. (Included as an Appendix.)

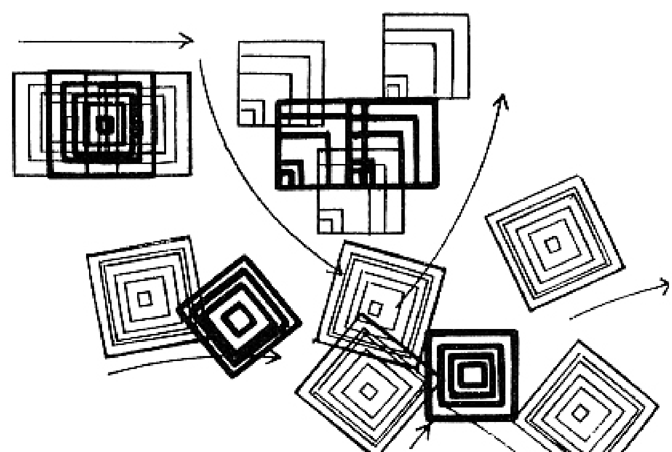
Summary - By the end of week four students have at least a moderate idea of a personal approach to computer art. They also receive a brief exposure to art materials during this time. Beginning artists work on industrial papers for weeks 2 and 3, then switch during weeks 3 and 4 to art papers and an introduction to photographic manipulation. (See the brief glossary of unique terms used in teaching, at the end of this paper.) In all approaches, designing, materials and programming are integrated, each facet important and interdependent.

BELOW: *Illustrations from Homage to the Square Derivations,* from lecture notes by the author, used to illustrate simple concepts of variations of a decrementation of the square. Darker lines illustrate use of two colors, in art material use.

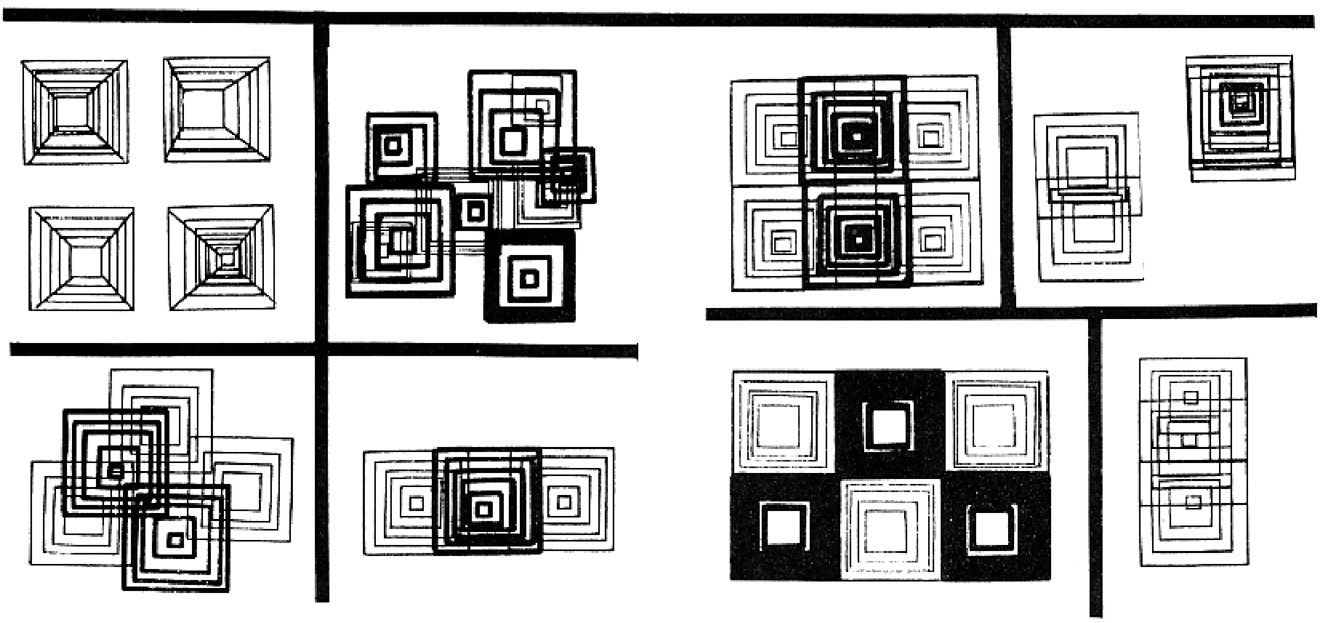


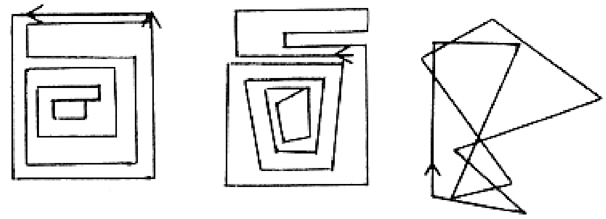
ABOVE: *Examples of Static, Symmetrical Design,* from the author's lecture notes.

BELOW: *Departing from the Symmetrical,* from the author's notes. BOTTOM ILLUSTRATION: *Focus on Symmetry, with Dark and Light Areas.*



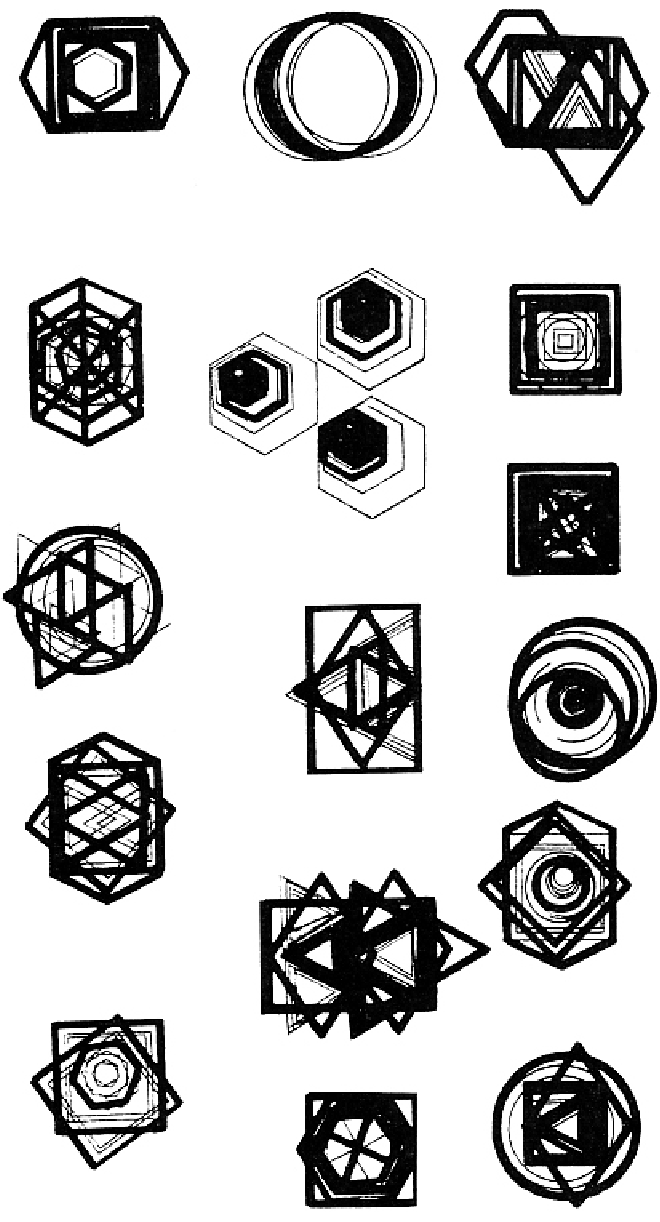
NOTE: The illustrations shown are template drawn, and are used as overhead transparency visualizations in lectures.





ABOVE: *Typical Continuous Line Designs,* drawn and programmed by students during the first laboratory period. These same designs may be put through a curve-fit routine, to achieve a curvilinear form, and manipulated by referencing subroutines on the graphics library. The initial patterns may also be manipulated through an easy 3-D routine.

BELOW: *Computer Science Template Sketches*, samples of initial modules from the IBM template, from the author's lecture notes.



B. <u>The Search for a Personal Direction</u> - A mathematician may choose mathematics as a basis for a personal direction. The manual artist can achieve stylistic analysis exercises of manual fine art and emerge with a continued development of previous work. Here it is important that some sense of continuity is attained by the artist, relating computer art to known methods of working.

Yet how does a computer scientist, or a person from Geology, Sociology, Education, etc. choose a "personal direction" in computer art? The system we use takes a person where they are design-wise, programmatically, and helps them to achieve a new plateau. We use several approaches:

1. Exposure to art slides of computer art;

2. Analysis of actual samples of art;

3. Analysis of computer art examples from exhibition catalogs, and texts;

4. Lectures on the analysis of manual and computer art;

5. Use of the checksheets for the analysis of art;

6. Design derivation exercises from varied sources;

7. Material explorations of a diverse nature.

C. <u>Verbal Analysis and Personal Responses to Art</u>

In using a computer in the humanities, there is a necessity to analyze what is to be accomplished, with specific objectives and sequences of steps in mind before doing the work. The execution of art is solving of a problem. In order to accomplish this analysis, it is necessary to become more verbal and analytical about art. In addition to being aware of personal responses to art, there is a necessity for identifying <u>why</u> one has a specific reaction. Further, it is necessary to identify whether the reaction is an objective or subjective one.

This verbalization and analysis is integrated with the approaches listed above. Here is a brief breakdown of how this is accomplished:

1. SLIDES - During a first session, 100-150 slides are shown. Individuals respond to work, and begin to analyze what they like <u>and</u> what they do not like. (Identification of a negative reaction, as well as a positive one, offers many clues in this search for self-expression.)

2. SAMPLES OF COMPUTER ART - 50-100 works of varied computer art are brought to class. Students examine them, touch, feel, and respond to the works, beginning to take notes on personal preferences. They identify positive and negative reactions, and begin to verbalize reasons for these responses. Checksheets may be used to note a beginning sense of direction. Very often, strong personal preferences are noted at this early period.

(Note: See the November CG&A for the Checksheet, along with examples of varied types of art.)

3. CATALOGS, ILLUSTRATIONS OF COMPUTER ART - New international catalogs, and recent special issues of periodicals featuring computer art /28/ are studied. Often black and white slides of these works are shown, and a definitive analysis is made of how each work was achieved. This includes the techniques of programming, types of routines used to vary the module, and an analysis of final material development that makes each work unique.

4. LECTURES ON THE ANALYSIS OF ART - Illustrated lecture/discussion periods follow, to enable students to discern the many forms of personal choices that may co-exist within a group. Non-artists often experience an initial block in choosing a "personal direction," whereas artists may be caught up in the "mystique" of being an artist, often confusing self-expression with excellence. Again, analysis of art begins with the verbalization of the whys of preferences, going beyond subjective, non-verbal responses. (There are many individuals who feel that art cannot be analyzed, and that it is not measurable -- therefore, anything goes!) But there are many specific, measurable elements of art, and some of these are explore in the foregoing discussions.

5. CHECKSHEETS FOR THE ANALYSIS OF ART - Over a period of years, categories of forms, approaches, programming, sources, and material developments were noted by the author and published in 1974. An examination of the appendix - Stylistic Analysis of Computer Art, allows the student to more readily identify the work under study. It is a form of artistic taxonomy. This does not imply that the artistic-scientific experience is 100% notable, but rather, it represents an attempt to continually grow in such an analysis.

People using the checksheets are readily able to chart and perceive a beginning direction, and periodically to note changes in preferences by dating the sheets, and color-coding each dated response. Many people experience definite changes in personal preferences, merely from the experience of creating computer art. Many forms of notation may be used: plus or minus; a stanine grading system; a letter grade; checks or other symbols. The important idea is to identify personal choices, reasons for these choices, and to get beyond the nebulosity of non-verbal attitudes about art and ideas. For what is experienced by a human being can be known, identified, and moderately verbalized.

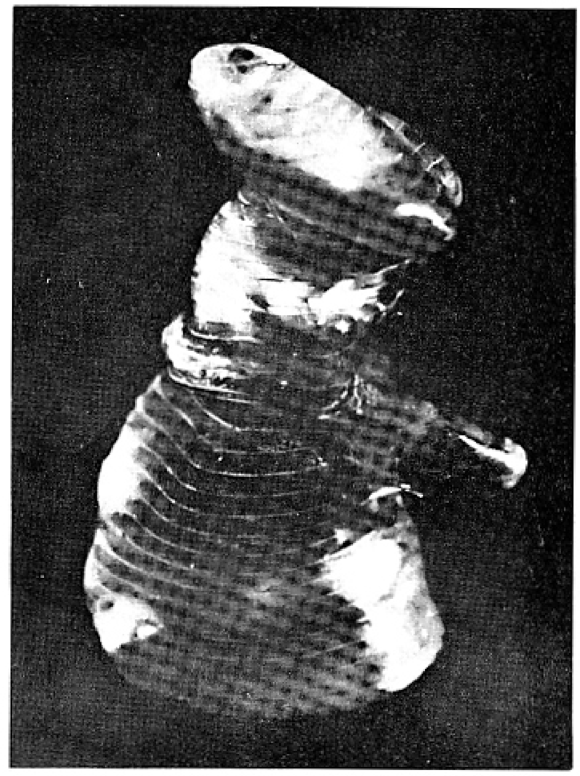
III - APPROACHES TO DESIGN

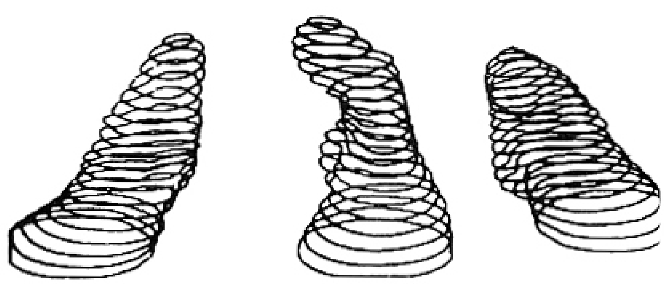
Verbal analysis affords one path to knowledge of self-expression, but it is insufficient. We need to personally explore, discover, and grow by doing. Here are some initial approaches to design.

1. MINIMALIZATION - an idea is expressed in complex form and pattern, and reduced gradually by stages into a minimal or "essence form". /29/ Black and white slides of patterns throughout the ages are shown, with analysis of each form and the period in which it arose. How much can one take away from a form, and still have the form recognizable?

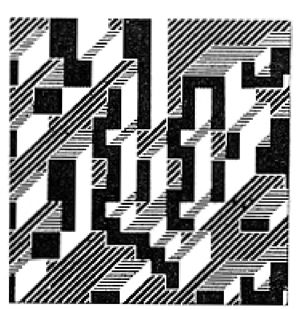
Students are asked to guess the origins of forms, the given culture, of varied periods from this definitive text on ornamental design.

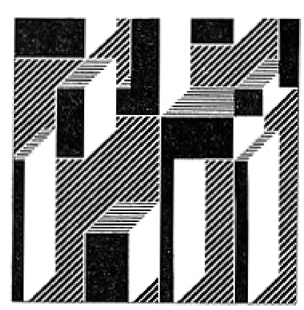
BELOW: *Untitled Sculpture* by Jose Alexanco of Madrid. The sculpture is one of many variations designed by the computer, and executed by the artist. The source of design is prehistoric cave art, dating from c. 15,000-10,000 B.C., from the Magdeleine Cave in France. Below also are *Plotter Sketches for Sculpture* by Jose Alexanco.





BOTTOM ILLUSTRATION: *Variations on the Cube Series* by E. Zajec, from the ICCH/2 Exhibition, a derivation from early Bauhaus art, minimal structural direction.





Black and white slides of Mondrian's life work are shown and studied, going from representational forms, to less recognizable patterns, to highly abstract designs that are markedly computer-like! A specific follow-up assignment takes a source design and proceeds to explore more minimal versions of the exercise, and more complex variations of the original source design.

2. EXPLORATION OF OPPOSITES - An object or artistic work is studied and sketched. If the source is very complex, it is observed in increa singly more minimal forms. If minimal, the form is enhanced, until it becomes more complex. If the object is curvilinear, it is changed to an angular form and vice versa. Combinations of curved and angular forms are encouraged. If the source is open, it is explored less open, until portions are closed. If the forms are closed, they are opened up. A follow-up assignment requires a search for alternatives, and facile execution of these alternatives. This develops a creative facility that literally affords a generative series of works from first sources.

3. ADDITION VS. SUBTRACTION - All patterns are added to and subtracted from their original forms. The student attempts to discern a personal sense of "rightness" in manipulating designs. Yet in an attempt to grow beyond present ideas, artists are urged to note and deliberately explore the opposite of the comfortable idea. As an example, a student may note a strong personal preference for natural sources -- and a preference for simple forms. As work proceeds during the semester, the artist is required to execute graphics where he or she has added to, or subtracted from the preferred designs and methods of working. Often, by trying the opposite of simplicity, the artist finds genuine delight in the new approach. Very frequently, students will prefer a very minimal design, that is undeveloped in form. When required, as a free experiment, to explore additions to the design, they experience marked preferences for the augmented versions of design, and are embarrassed regarding earlier preferences.

4. POSITIVE VS. NEGATIVE SPACE - Works of art are studied for spatial balance. Computer art tends to exploit innumerable interference patterns, and to negate the spatial elements found in manual art. Artists are encouraged to become more sensitive to negative space, and to allow areas of rest as a balance for areas of occupied design. They may exploit the negative area as a foil for the positive design elements.

There is almost a tradition in computer art, of emphasizing complexity of pattern, with exploitation of the computer's capacities to draw innumerable fine lines very precisely according to the artist's requirements. Many computer artists have become programmed to believe in this complexity of line pattern. The space is equally as valuable as the pattern itself. An example is a tree: the open areas between branches contributes to the beauty of design. The open areas in computer art contribute to enjoyment of the total composition. This is true in music, where pauses refresh the mind, and the silences in poetry, where no words strengthen the words.

5. SYMMETRY VS. ASYMMETRY - Illustrations are given and studied, which which symmetry changes markedly to become asymmetry. (See page 30.)

Each person is asked to take source designs and to explore specific gradations of symmetry or asymmetry, with resultant analysis of preferences. The verbal and written comments regarding preferences in this area are illuminating to the student, and the group. While students are encouraged to attempt the "opposite" of a choice of symmetry, they evidence marked rigidity in this area, as though the first choices are sacred to their psyches. The flexibility to explore alternatives without fear is a valuable lesson in creativity.

6. SUBJECTIVE VS. OBJECTIVE REACTIONS - Fashions in the arts dictate specific explorations, and they become dogmas, and "seeming" facts. In computer art, we abandon such notions, and symmetry is equally as acceptable as asymmetry; complexity is as aesthetic as minimal experimentation. In studying and using the art checksheets, students are more able to objectively identify their preferences and directions. For example, the Analysis of Component Forms reveals a breakdown of types of design sources. The student objectively finds specific categories that are preferable, yet is aware that each family of forms is equally acceptable as a source. The mathematical is one source. Science is another. Nature and the environment are objectively viable sources for derivation.

Subjectively, the choice of forms is made by the student. Subjectively, or personally, the student chooses from a menu of subroutines which will vary and alter the design source. Personal, emotive, subjective reasons dictate these choices.

SUMMARY - From these exercises, artists get to understand more fully what is going on in their heads. They learn to take original ideas and go beyond them, and to freely, flexibly explore alternatives. And from these exercises, they are able to identify, verbalize, and know more fully what they are doing artistically.

TO BE CONCLUDED IN THE NOVEMBER ISSUE. Included in Part II are the following topics:

- Derivation Art Exercises - Definitions, and examples of the techniques, illustrations;
- Sources for Personal Art - Nature, the environment, manual art, etc.;
- Beginning Art Material Experiments - How to use varied art materials in computer art;
- Photographic Development - How to use varied photographic techniques in computer art;
- Definitive References;
- Abstracts of Syllabi for Teaching Computer Art;
- Glossary of Unique Terms in Computer Art;
- Appendices - Checksheets for Computer Art, Etc.
- Additional illustrations of the above.

IT'S RENEWAL TIME - CG&A GOES INTO VOLUME TWO

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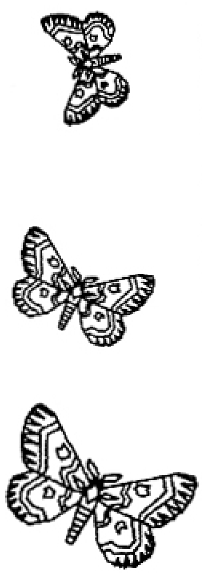
by Charles J. Fritchie and Robert H. Morriss, Tulane University, New Orleans, Louisiana
Illustrations and photographic techniques used to achieve graphics from a storage tube CRT.

An Investigation of Criteria for Evaluating Computer Art
by Thomas E. Linehan, Ohio State University, Columbus, Ohio
The new aesthetic of computer art requires a departure from the previous, formalist-traditionalist doctrines for evaluating art.



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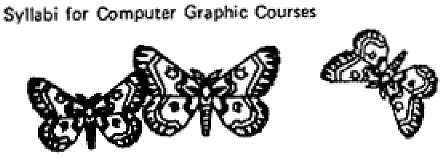

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