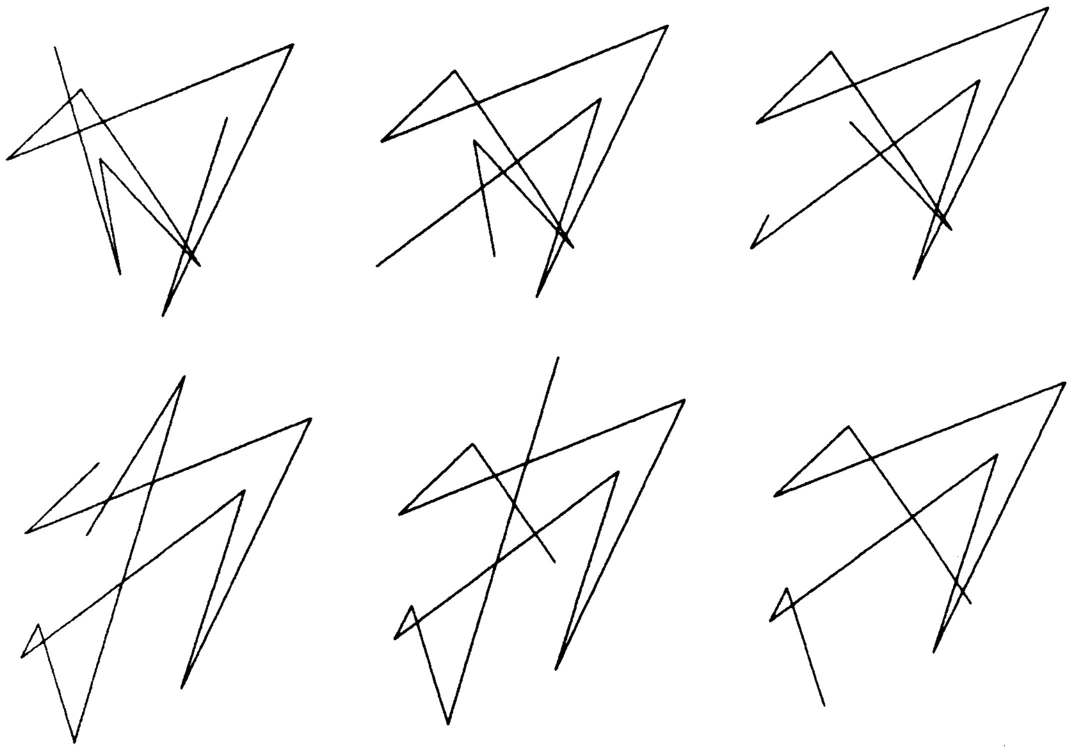


Six sucessive steps in the evolution of a kinetic sequence produced by the program PATHS: read clockwise from the upper left.

SOME EXPERIENCES WITH COMPUTER GRAPHICS

Charles J. Fritchie, of the Tulane University Department of Chemistry, has been developing techniques of cybernetic art. He has held exhibitions at the International Sculpture Conference (New Orleans, 1976), The Contemporary Arts Center (New Orleans, 1977), and the Huntsville Museum of Art (Huntsville, Alabama, 1978). We reproduce here several of his recent works, along with his discussion of the techniques, philosophy and potential of computer-assisted art.

Writing this article has been a bit difficult. The editors, having seen some of my computer art programs at work, asked for an article describing some aspect of the field. I easily accepted, feeling the discipline would clarify my own ideas and let me answer some criticisms and doubts about computer art in general. Planning the article soon filled me with stage fright. Other people have worked in computer art for fifteen years or more and have exhibited at places like the Museum of Modern Art; my background is in chemistry and I began art almost by accident 2½ years ago. My direction is insecure, although I am pleased with some initial efforts. On the other hand, I am not the authority for a general survey, and I do not think it would be as interesting in this context as a personal account would. Therefore, my plan is to outline the field generally and follow this with my reaction toward some work produced at Tulane. It must be stated at the outset that the work shown here is attributable to a collaboration between Professor Robert Morriss and myself, and it is a truly joint effort. The views offered, however, are my own.

First, I should say a few words about the origin and nature of computer art. It can refer to any art forms such as sculpture which incorporate a computer as working element, controlling evolution of the work or providing response to the environment. However, because of the newness of the field and problems of reliability which arise with mechanical objects, computer art's greatest early growth has been in the field of graphics, and primarily in static graphics or in movies produced over a long time period, frame by frame. As costs have fallen, kinetic computer graphics have arisen and even now computer generated graphic sequences appear in television advertisements. It is this fairly widely available, but still expensive, static or kinetic graphic art which I shall describe here.

Two of the first exhibits giving serious artistic attention to computer graphics (and electronic art in general) were "Cybernetic Serendipity," held at the Institute of Contemporary Arts in London in 1968, and "Machine," held at the Museum of Modern Art in New York the same year.

In 1968, the only standardized equipment which could be used for "end product" art was the high speed line printer, which is grid oriented, essentially a fast typewriter. Except in a process or conceptual sense, the line printer is highly limited as a means of artistic expression. A very few laboratories about this time had experimental access to digital plotters, devices which can move a pen over a piece of paper in a full plane under computer command. The digital plotter is the first piece of computer equipment or hardware suited to a wide range of graphics. In principle it can produce any graphic work which can be executed with uniform pen pressure. Solid areas result from closely spaced lines, or can be filled by hand. Many of these devices do produce stair-step lines rather than smooth curves, because of the mechanical design. A serious limitation with these plotters is the time required for any plot, a limit not so serious for a human artist who has continual control over his work, but one which is highly limiting in computer art because of the need to experiment with many drawings while developing programs or sets of computer instructions with reasonable graphic capabilities. Other real limits with these mechanical devices are the need to use special paper or pens, which often have inferior aesthetic qualities, and a tendency to tear the paper during execution of involved drawings.

The computer controlled television screen or cathode ray tube (CRT) was the next major advance in computer graphic technology. One form of this is closely analogous to the digital plotter: the electron beam of the CRT can be directed smoothly from any point on the two dimensional surface to any other, drawing a line as it goes. The speed and accuracy of this device erase most of the limitations of the digital plotter while keeping all of its advantages, except the possibility of substituting pens or paper. Permanent or "hard copy" output from the CRT is by video recorder, photography, or a sort of electronic Xerox process onto specially treated paper. It is such a computor controlled CRT which is used at Tulane by Robert Morriss and myself for production of computer graphics.

Before leaving this review of computer output devices, I should mention another popular form of CRT - the video or raster scan CRT. As the random vector CRT is analogous to pen or pencil drawing, the video CRT is analogous to painting. The electronic beam which can work in black and white or in color, regularly scans the entire screen in horizontal lines just as in commercial television. It displays at each position on the screen whatever color or brightness is stored in the computer memory corresponding to that location. The complexity of the picture to be drawn is limited principally by the amount of memory available. If, for example, each of the typical 512 scan lines is divided horizontally into 512 pieces, then 512 x 512, or about 250,000 memory cells are required for total control of the picture. Typically, the random vector CRT can reach many more points; for an 18" screen, an array of about 4000 by 3000 points is easily obtainable. Thus, the random vector CRT can draw lines more accurately, but has more difficulty with surfaces and cannot work in color.

Relatively cheap, low resolution video CRT's are available to the hobbyist today, for as little as $2,000 to $3,000, including the computer. In these displays, resolution or addressability is perhaps 40 x 30 to 200 x 150 points, meaning that in the former case the screen of an 18" CRT can be painted with rectangles of color or brightness which are about one-half inch in size. In the raster CRT, computer technology has come full circle to the electronic analog of the grid oriented line printer.

Here again, I speak in the computer graphic context, but analogous reasoning applies to computer art in general. The serious question has been raised whether any machine can "create art." This argument is ultimately similar to that which asks whether machines can "think." Original thought and aesthetic creativity are products of the subconscious, intuitive or holistic side of the human mind. Computer models of pseudorandom generation, followed by logical analysis, can mimic this process, but in a linear rather than holistic way. Analog computation can respond holistically, but in a limited form, to its environment. Even if computers are someday produced which emulate intuitive thought, aesthetic generation would involve knowledge of the capabilities of the human mind and its responses to aesthetic stimuli. This knowledge is certainly incomplete today. It is a proper subject for experimentation, however, and several computer artists are doing just that.

Thus, computer art today depends more or less on one or more human artists for its creation. I think it is fruitful to separate computer art into three classes: (l) art in which the computer is used as an immediate tool or transcription medium; (2) art which is produced by a collaboration between a human artist and a preprogrammed computer; and (3) art which involves a computer and which, once created, functions independently of any human artist. For convenience these classes can be called computer assisted art, collaborative computer art, and pure computer art.

In the first category I would place art produced when an artist draws on an electronic tablet that translates his hand movements into a television or digital plotter image. Here I would also place those television portraits produced on computer printouts for tourists (although creation of the program and equipment which produces them belongs in the third category). The quality of these works depends explicitly on the judgement of the artist using the equipment, and they make minimal use of the computer's cybernetic ability.

The second category, collaborative computer art, is currently and may always remain the largest. Here are works such as the images reproduced with this article, in which a human artist produces or selects specific art objects, kinetic or static, using a fixed computer program. The program's composer defines its range of capacities or aesthetic space, but extraction of specific objects from that space depends on further work by a human artist. In essence, the program author, who may or may not be an artist, has created raw material with a wide latitude for good or poor aesthetic use. The computer's participation, to separate collaborative art from computer assisted art, must include extensive use of its cybernetic ability in form generation, composition, or some other aspect of the aesthetic act.

Finally, as I see the scale of man - machine artistic relationship, "pure" computer art results when the human artist has implanted enough of his aesthetic judgement into the computer for it to function free of intervention. The work may consist of a combination of program plus computer plus display device which yields a static or dynamic display upon request from an observer. It may be simply a program which can function on any of a variety of machines and displays devices. It may even operate independently of any observer.

One of the striking things about computer art is the extent to which computer artists work in collaboration with one another as well as with the machine. This collaboration is produced by the expense and the complexity of the tools involved. Mastery of computer programming calls for a backgound in mathematics or logic; an acute aesthetic sense requires involvement in judging or creating art outside of the limited context of computer art; if the final work is objective rather than conceptual, certain ability and skill in electronics or video or photography or printmaking or whatever are needed. Today, at least, it is rare for a single individual to possess this range of talent and expertise. Thus, although this article expresses only my personal views and feelings toward computer art, my involvement in it and the work displayed here, are greatly indebted to a number of people. In addition to Robert Morriss, I must acknowledge Hal Carney, Chet Kasnowski, Renee Magnanti, Jim Steg, and a number of students in Professor Carney's drawing classes over the last two years. These people have provided technical expertise, enthusiasm doubt, ideas, and challenge. Tulane's Video Access Center and particularly Mike Saag have contributed toward ideas in kinetic art recorded through video.

A dozen or more programs have been written by now in our exploring of computer graphics. My direction at first was to use the computer as a steadier and more flexible hand than my own, using it to refine specific visual ideas, usually geometric. I expect to return to this kind of work, but after exploring other approaches which now seem better. The first serious attempt to use the computer for generation of nongeometric forms was the program GRAFIC, written in 1976. (Incidentally, all programs described are written in FORTRAN, a computer language available on almost every large computer.) By following arcs or chords of pseudorandomly generated tangential circles, GRAFIC composes free form lines in a wide variety of characters or styles. Eleven basic styles have been built into the program; others can be added randomly or deliberatley whenever the program is run. Lines can be thickened or repeated in one or two directions to give ribbons or L-beam shapes apparently flowing in three dimensional space. The program GROWTH evolved from GRAFIC as an attempt to give the artist more control over form. The programming problems began to appear severe, so this idea has also been temporarily suspended short of completion. POLYPLOT, also from 1976, generates solid forms rather than lines. The forms are defined on two sides by second order polynomials and on two sides by parallel straight lines. The solids are blackening. The fair success of POLYPLOT led me to write RANSOL, which uses a vocabulary of more linear forms. It is limited to rectangles, parallelepipeds, triangles, and X-shaped triangle pairs. Shading is similar to POLYPLOT and if shading of a triangle is incomplete, it appears to be a trapezoid.

These programs were all composed with no thought to composition. They were simply attempts to define wide vocabularies or conceptual spaces onto which rules of balance and proportion could later be built. The single exception to this statement is POLYPLOT. As a result of my experience with another program, LYRIC, which produces kinetic rather than static images, and which was conceived as a visual analog of music or poetry, the program POLYPLOT incorporates the element of repetition with variation. Once a form is generated, it may be repeated horizontally or vertically, with changes of scale and with small perturbations on its shape. Another program under active development at this time is PATHS. PATHS is also kinetic and generates a multisided angular form that wanders at various speeds around the CRT screen.

Four static works are reproduced here; the fifth figure shows six consecutive steps in the evolution of a PATHS image. I view all of the programs described as ultimately to become works of "pure" computer art, if their evolution proceeds satisfactorily. At the present stage, however, our *modus operandi* has been for Morriss and me to choose specific images from their repertoire and to present these as final works. The images chosen may have been produced independently by the program, or by a collaboration between it and us. One or both of us, nonetheless, must be held responsible for the aesthetic choice involved. The images shown here are some to which I respond. I should also point out that the space in which these images exist is ambiguous just now. Except for POLYPLOT 2 (Division), final forms for presentation have not been fixed. They exist as 35 mm slides; Kodalith transparencies have an appeal. Transfer to low relief metal or glass sculpture is possible, or to classical forms of photography or printmaking.

POLYPLOT 3 (Cry, for Clarence) is dedicated (without his knowledge but I hope acceptably) to Clarence John Laughlin, whose work I immensely respect and who finds human imagery everywhere. Beyond the obvious face I like a number of graphic details in this image, such as the calligraphic marks near the top and the vertical divisions on the left. The bowl-like form at the bottom is architectural in scale, and the small white form before the face is a horse image reminiscent of Marini. This unplanned generation of significant image and form is a feature I particularly like in these programs. In this sense the computer is like a magic spaceship which can bring one to a desert or a forest, a seacoast or a cracked pavement--anywhere that image is found. Primarily because of the nature of the programs, the current images are highly abstract.

I react to the transparent GRAFIC 5 (Homage to Henri) in a similar fashion. The busty female dominating this image reminds me of the Parisian fashions depicted by Lautrec. With little effort, one can find on the left a parrot's head and beak, and just to the right of that, a dancing figure. The figure is so energetic and graceful that one overlooks the missing head. Searching further, one sees a heart form and a crescent moon, a symbol of Venus, superimposed on the woman. I do not mean to say that these specific images make the work worthwhile, or that one should play a game of finding recognizable forms within it. I mean only to show that, like good artistic work in any medium, it is potentially rich in imagery at various levels of consciousness. Mostly when I see this image, I feel the woman behind a blowing breeze of horizontals.

The ambiguous depth of field in both the above works, as well as the ambiguous scale in the former--somewhere between lifesize and hundreds of meters--is another feature I like about much of this computer imagery. (Parenthetically, I feel free to describe these works in a very detached way, since Morriss and I did not in a very real sense "create" them. They are products of the computer acting almost on its own, which I happen to like.)

POLYPLOT 2 (Division) is probably my favorite work to date. It satisfies a feel for abstraction and sculptural imagery and at the same time forcefully presents the philosophical concept of division and identity. It stands for a prototype of all divisions: black and white, heavy and light, large and small, self and nonself.

Snowflower is a name attached to GROWTH 1 with some difficulty. The other associations have arisen naturally. This image I chose because of a gentle, lyric feel to it. Again, the space is ambiguous, but nearly flat. This is not a real flower, but a living form against the translucence of a snowbank.

The final figure is from a new and developing program, PATHS. Art created with a computer, especially that displayed on a CRT, is intrinsically kinetic. Each of the four images just described was constructed in about a minute or less. The program POLYPLOT, especially, produces work one might describe as conceptual or ephemeral: forms are thrown on the screen almost instantly, and images may begin to evolve among the solid shapes only to be destroyed by submersion. This kinetic existence can only be seen in the "pure" computer art work--the combination of computer, CRT, and program. Given the expense of a computing system, another medium of presentation is necessary to retain some of this vitality. Movie film or video are two possibilities. To convey a sense of this kinetic, six consecutive movements during an execution of the program PATHS are shown as the first figure. For me, at its best this program conveys an illusion of spacially evolving cubist forms. It points the way toward "scored" or choreographed kinetic visual art, possibly the most fertile domain of this new art form.

I hope this survey will help to allay some fears about the "mechanical" nature and lack of profundity in computer art. Whatever the value of our own work, it should be clear that a very rich domain lies here, and mining it is worthwhile.

Artist and Computer, Ruth Leavitt, Ed.; New York, Harmony Books, 1976.

Computer Graphics Computer Art, Herbert W. Franke; New York, Phaidon, 1971.

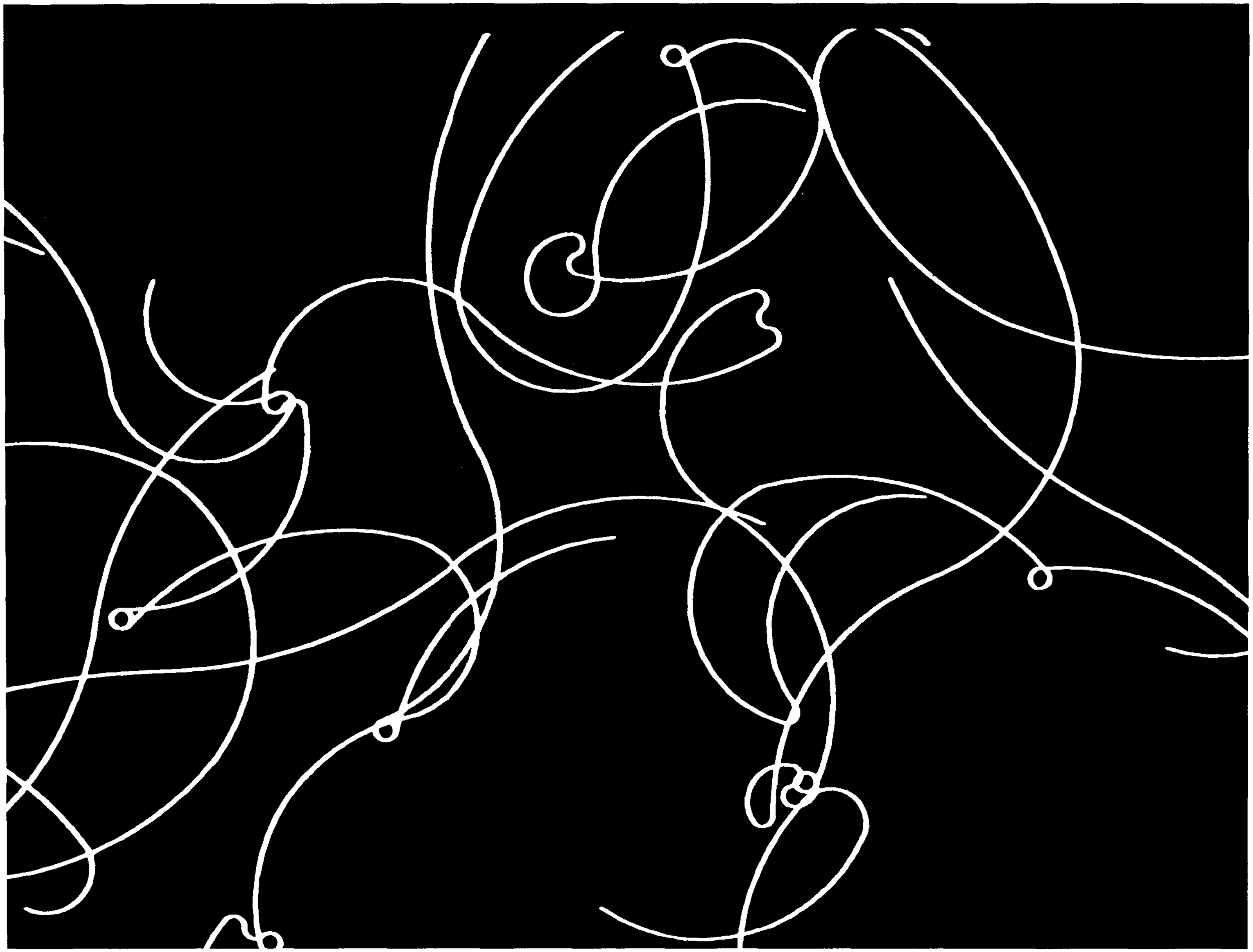
"Computer Graphics and Art," (quarterly), Grace C. Hertlein, Ed.; Newtonville, Mass., Berkely Enterprises, Inc.

"Computers and People," formerly "Computers and Automation," (monthly), Edmund C. Berkeley, Ed.; Newtonville, Mass., Berkeley Enterprises, Inc. August issues are devoted to computer art.

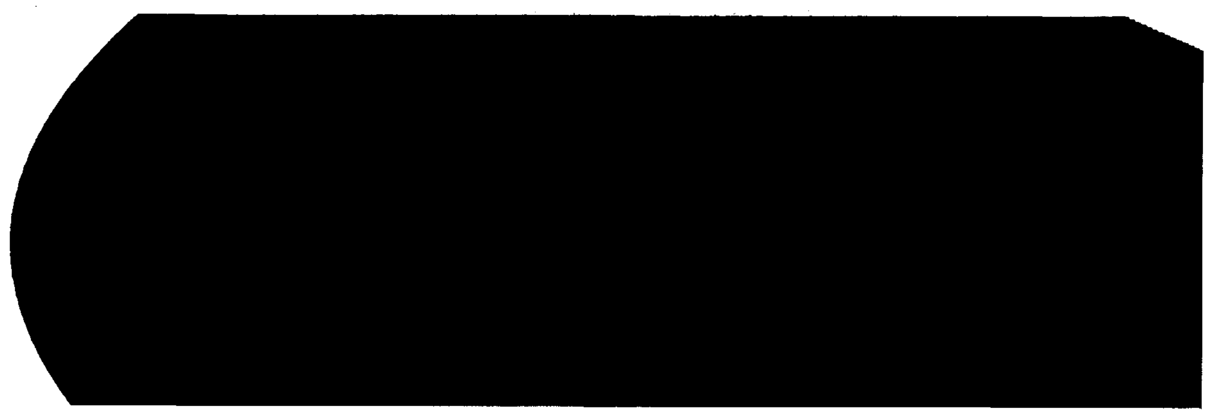
Cybernetic Serendipity, Jasia Reichardt, Ed.; New York, Praeger, 1969.

Science and Technology in Art Today, Jonathan Benthall; New York, Praeger, 1972.

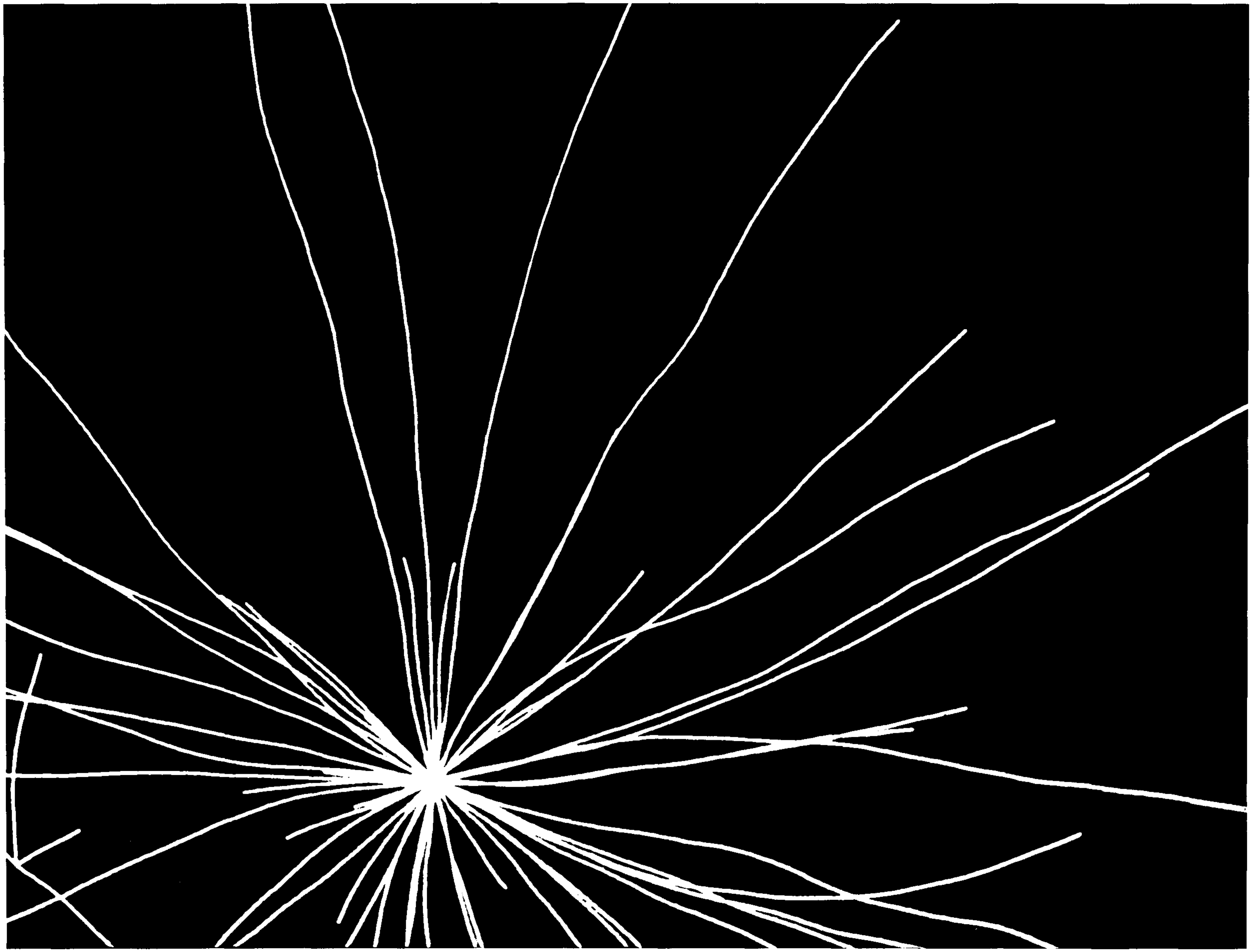
POLYPLOT 3 (Cry, for Clarence).



GRAFIC 5 (Homage to Henri).



POLYPLOT 2 (Division).



GROWTH 1 (Snowflower).