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INTAGLIO PRINTS OF SCIENTIFIC AND TECHNOLOGICAL SUBJECTS: A JOINT PROJECT OF AN ARTIST AND A RESEARCH ENGINEER

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Abstract—*The authors, brothers, one an artist and the other a space research engineer, collaborated on the production of a series of intaglio prints dealing, as a conceptual whole, with new scientific and technological subjects and with their social implications. The goals of the project, the introspective reasoning of the collaborators, the content of the prints and the manner in which the content was treated are described.*

Their belief is that artworks treating scientific and technological subjects not only can give emotional satisfaction to individual viewers but can help them to bring about a better use of science and technology for the welfare of humanity.

I. INTRODUCTION

Although it is not unusual for family members, in our case two brothers, to combine their talents in a common effort, we consider our example rather unique. One of us (R.J.D.) is an artist, and the other (E.L.D.) is an engineer engaged in aerospace research. We have collaborated to produce a series of intaglio prints having subjects based on scientific discoveries and concepts and on technological developments. It is our hope that the following discussion will aid viewers of the prints not only to understand their intent but also to gain a perspective on relationships between visual fine art and contemporary science and technology. The striking results of recent scientific research provide new subjects for artistic expression. If recent advances can be interpreted effectively by artists, the trend toward interrelating science and art will undoubtedly continue.

Mythological subjects that were commonly treated in the past are still important subjects for 20th-century artists. Rembrandt, Titian, Picasso and many of their contemporaries dealt with their reactions to myths and to aspects of the Christian religion. These works were essentially based on life forms and behavioral patterns derived through experience and tradition. Space age and science fiction art project future hopes and fears, as pointed out by several authors in *Leonardo*.

We share the view of those who believe that artists should be encouraged to express in their artworks their reactions to the wealth of scientific and technical knowledge and to its impact on human life. Furthermore they should not hesitate to use new techniques, devices and materials offered by technology. We also concur with the sentiment expressed by François Le Lionnais: 'Science is not concerned with the discovery or creation of beauty; it seeks only the truth . . . .','. . . though science does not in any way aim to become an art, an art it inevitably is' [1]. Although the objectives of science and of art are different, we believe the process of creativity is common to them both. Other articles in *Leonardo* that have particularly captured our interest are those given in Refs. 2, 3 and 4.

A number of scientific discoveries and examples of extraterrestrial space exploration served as the subjects of our series of prints. One discovery was that of the DNA (deoxyribonucleic acid) molecule, which occurs in cell nuclei of many organisms and is a basic factor in heredity. E. Rabinowitch stated that the scientists who discovered the structure of the DNA molecule were 'obsessed with a search for meaning in nature, for truth's sake, with little thought of World prizes' [5]. We in our joint venture also sought 'meaning in nature' by analyses of certain basic scientific discoveries in order to interpret them imaginatively in artworks. For the first print, entitled 'The Building Block of Life' (Fig. 1, cf. color plate), we turned to James Watson's book *The Double Helix* [5]. The double-helix molecular structure for DNA is given symbolically in the picture, and the idea of cellular reproduction is conveyed with the intent to represent the beginning of life on Earth.

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A more recent print, 'The Mariner Path' (Fig. 2), deals with another realm of scientific research. Here the path of the Mariner Jupiter/Saturn spacecraft (launched as Voyager, in August 1977) is depicted. Important features of the Voyager mission will be observations of the planets Jupiter and Saturn and of some of their satellites. Finally, the spacecraft will escape from the solar system. At the lower right is depicted the Sun with its corona.

II. IDEAS OF LIFE

Interpretations of the meaning of life seem to us to be expressed best in terms of biological life cycles and by symbols of the Christian God and of humans as procreators. These ideas pervade the series. The short life span of individual humans makes it difficult for them to comprehend biological evolutionary changes. We have pondered the following question: Did living organisms evolve from primordial substances on the Earth or can the Biblical story of creation be taken as scientifically true? It was not necessary for us to pose an answer to this question in order to proceed with a selection of the subject matter for the prints.

Rembrandt was said to have drawn inspiration for his work from the daily life of the vigorous people of his native Netherlands and from the somewhat melancholy beauty of the country's landscape [6]. In a similar manner new developments in science and technology have been a source of inspiration to us. The major content of the prints reflects aspects of the universe that are the concern of those who work in the natural sciences. However, the prints were also influenced by our common Italian cultural heritage and by our Roman Catholic Church background.

III. THE PICTORIAL COMPOSITIONS

Before beginning the series, I (R.J.D.) had been making figurative and nonfigurative paintings, prints, collages and sculptures. My brother had expressed particular interest in several of the collages whose subject matter concerned the exploration of extraterrestial space by the U.S.A. and also in an engraving, aquatint and drypoint intaglio entitled 'Life Cycle of Man' (Fig. 3). In 1975, he asked me whether I would be interested in making a series of intaglio prints under the title 'A Commemoration of NASA Earth and Space Exploration for Evolution and Life, 1958–1978', whose scope is given above.

At first I did not respond to the idea with enthusiasm, because it posed a threat to the direction of my work at that time. But, after further discussion and reflection, I accepted his proposal as an artistic and intellectual challenge, and we proceeded to work together on the project. Over a period of several weeks, we prepared an outline of the subjects to be treated, with concise explanations of each of them gleaned from recent books and articles. I then prepared 20 preliminary photo-collage 'layouts'. On the basis of the 'layouts' I made many sketches wherein I worked out ways of introducing a sense of movement and rhythm, relationships between shapes and patterns, and

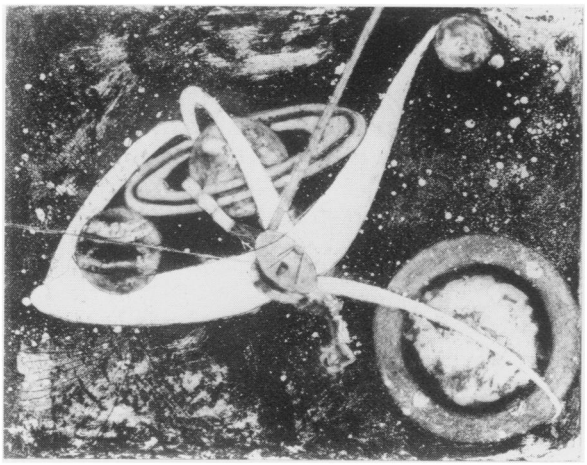

Fig. 2. 'Earth, A Planet in Exploration of the Solar System (The Mariner Path)', intaglio print, 28 × 35.5 cm, 1975.

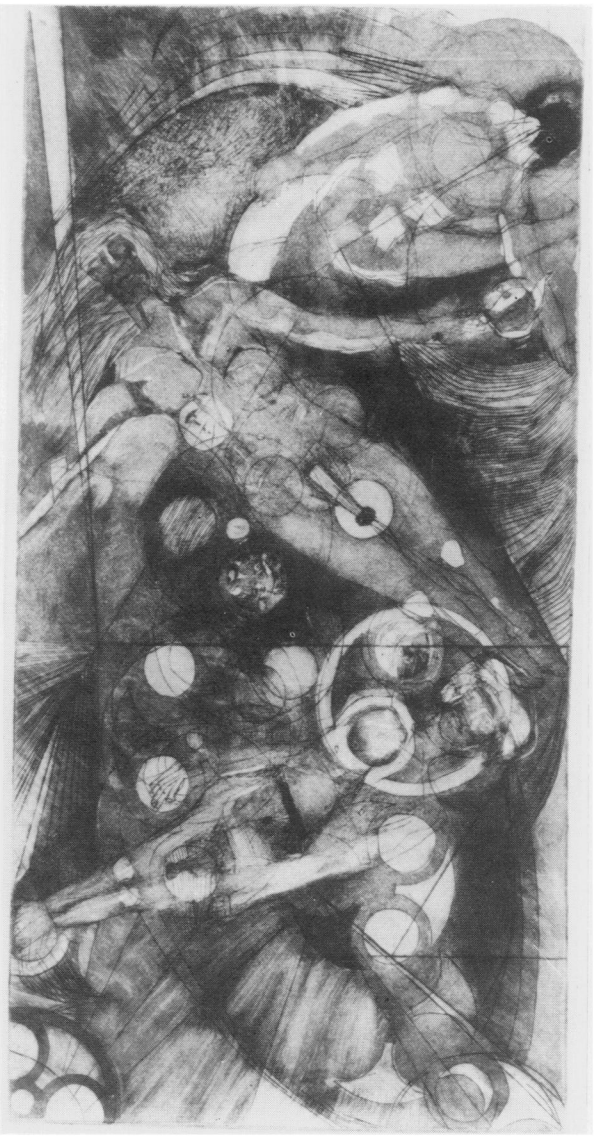

Fig. 3. 'Life Cycle of Man', engraving, aquatint and drypoint intaglio print, 74 × 37 cm, 1972.

surface textural qualities. The sketches took account of our plan to present the series as a conceptual whole.

I am unable to describe precisely what thoughts I had or how I made the many decisions during the period in which the sketches were prepared. In general, what I did can be described by a combination of the first and third hypotheses expressed by J. J. Trillat in a discussion of contemporary art: On the one hand, shapes and patterns observed in a domain of science are introduced in works by artists familiar with that domain; on the other hand, shapes and patterns are also introduced in artworks by artists unfamiliar with their occurrence in science, sometimes before they are observed in science [7].

My earlier intaglio print 'Life Cycle of Man' (Fig. 3) had a significant influence on my execution of the series. Underlying this picture is my particular interest in the brief life cycle of human beings. For the first part of the cycle I depicted in a symbolic manner youth confronted by the problems of physical survival; for the second part, a man in the prime of life and for the third and final part, man in death disappearing into space. I attempted to give the impression that the cycle occurred within a period of a few seconds.

Circular shapes, which I associate with infinity, recur throughout the composition. Beginning at the lower left side of the picture a helix spirals upward to encompass the three parts of the cycle. This interpretation of the 'Life Cycle of Man' arose from my imagination 'nourished, evidently, by reality', as described by J. Mandelbrojt [8].

IV. TECHNIQUE

In the print entitled 'Earth, A Planet in the Universe of Hydrogen (The Building Block of Life)' (Fig. 1), I represented the Earth by a circular shape slightly off-center to the right. To the right and partly superimposed on the depiction of the Earth is the double-helix structure of the DNA molecule. Below the DNA molecule is a circular area representing a chloroplast body containing cell organelles that are shown as pervading the Earth. At the left, there are depictions of photo-autotrophic plants, which need only carbon dioxide, water and light for the synthesis of organic material. Superimposed primarily over the depiction of the Earth are fine lines representing cosmic radiation interactions that may have been responsible for the origin of living matter on Earth. Tracks made in a hydrogen bubble chamber experiment were depicted in the print to represent these occurrences. By clustering the plant images at the left, I introduced a swirling effect in contrast to the very slow osmosis-like flow of nutrients into the Earth from a chloroplast body.

In order to produce, for example, only a faint trace for the tracks in the bubble chamber, I employed a photo-etching technique that I had originated. The technique involves exposing, washing and etching a zinc plate coated with a light-sensitive emulsion. I carry out all the steps in my studio except the initial coating of the plate and its exposure out-of-doors to sunlight. A commercial photo-engraver coats the plates uniformly with emulsion using a plate whirler.

For the exposure, I place the coated plate on a table and the *photo-positive halftone transparency* of the final drawing on top of the plate. Then I place a sheet of heavy plate glass on top of the transparency to assure good contact. The plate is exposed to direct sunlight for about an hour. Later the negative of the image is revealed after passing water over the plate for several minutes, washing away unexposed portions of the emulsion. The plate is then heated until the exposed emulsion showing the negative of the image turned dark brown in color, fixing it permanently to the plate. The final step is to etch the zinc plate by placing it face down in a very weak solution of nitric acid until the etch is sufficient to produce the desired detail and value contrast for printing.

The photo-etching technique was employed to obtain only the Earth depiction with the superimposed depiction of bubble chamber tracks, the DNA molecule and the chloroplast body. The remaining areas of the plate were executed in a different way. I applied a thin, acid-resistant, hard wax coating (etcher's ground) to a heated zinc plate. I transferred a drawing of the photo-autotrophic plants and cell organelles to the wax ground by tracing the drawing through carbon paper. Then I scratched the transferred depictions into the wax with an etching needle. The plate was again placed in the nitric acid for about 10 minutes to etch the linear details.

Aquatint was the intaglio technique that I employed to add desired tone and textural qualities. Powdered rosin was dusted with a cloth bag sieve on to the cleaned, wax-free plate in areas where the effects were desired and then the plate was heated until the rosin particles fused to it. The plate was placed in nitric acid for several minutes to cause slight etching for the production of lighter tones. Areas then were *stopped-out* with an acid resistant varnish and the plate was immersed again for further etching to give darker tones. Finally, the rosin and varnish were removed with denatured alcohol.

The plate was inked with stiff black etcher's ink and hand-wiped for the desired tones with tarlatan (an open-weave, heavily sized cotton). Printing was done on an etching press. The paper (Rives B.F.K. printing paper) was prepared by soaking in a tray of cold water to dissolve out some of the glue size. This treatment made the paper more receptive to ink and responsive to press pressure. The excess surface water on the paper was absorbed by blotting paper and it was then placed over the inked plate on the bed of the press. Finally, the plate and paper were covered with blotting paper and printing felts or wool blankets and the plate was rolled through the press to pull the print. In the process the paper became embossed. It was then carefully removed

from the plate and taped securely to a sheet of Masonite to dry.

Several artist's proofs were pulled in black and in color in preparation for the first edition of 25 prints. To make color proofs, I began by inking the plate with black ink and wiping it very dry and clean. This was followed by the application of the *à la poupée* method, which involves inking and wiping each color area individually on the plate. This method is desirable, since the plate had to be run only once through the press to produce a multi-colored etching.

V. INTERPRETATION OF OUR JOINT EFFORT

We agree with H. W. Janson's statement that artistic expression 'stresses the artist's emotional attitude toward himself and the world' [9]. In our instance, aspects of science and technology were introduced into artworks. We believe our cooperative effort was possible because of the three motivations that, according to M. J. Moravcsik are the urge to create, the enjoyment of beauty and the desire to contribute to the welfare of humanity [10]. Our urge to create was perhaps the stronger because of our brother relationship and because of the character of our joint artistic venture.

In 'Earth, A Planet in the Universe of Hydrogen (The Building Block of Life)' (Fig. 1), we tried to communicate the basic importance of the origins of the life process by giving it a dramatic aura. Symbols, such as the representation of the double-helix structure of the DNA molecule, were included to remind viewers of the scientific contributions towards a knowledge of this process. Each of us, engineer and artist, has been stimulated to better understand what is known about such basic questions, in the sense described by M. A. Coler in Ref. [11].

In making 'Earth, A Planet of a Magneto-Dynamic Core (Progenitor of Life)' (Fig. 4), our intent was to involve viewers in a whirlpool-like visual experience, such that contemplation of it would lead them to conceive of the apparently chaotic character of some natural processes. We did not wish to depict the physical characteristics of whirlpool-like motion. Instead an unbalance was given to the composition so as to draw the attention of viewers first to the black center where magnetic waves are depicted and then to the surrounding light area, which is a photo-etching of a fusion reactor. We imagined a magneto-dynamic labyrinth at the center of the Earth that is capable of generating a force field that is visible and difficult to escape. The space vehicle was included (Fig. 4) to symbolize discoveries made by its use concerning the Earth's magneto-dynamic core. It is shown receiving signals directly from the Earth's core. While we were engaged in this work, we, like L. Pešek, placed ourselves in a mood that we were 'creating not a fanciful landscape but one that really exists' [12].

A preliminary drawing with a photographic insert and a final print 'Earth, A Planet of Animals and Plants (Evolution of Life)' are shown in Figs. 5 and 6. The composition is intended to depict the gradual process of biological evolution from the most primitive forms of life to presently existing forms, shown symbolically in a series of stages from the upper right corner of the print downward in a sweeping curve. Two items of particular interest are the transparent image of the Earth at the center of the print and the Earth Resources Technology Spacecraft (ERTS) at the lower left. The Earth, shown as covered by water, is superimposed over a larger field depicting evolution that can also be considered as a sector of the Earth's surface. Within the depiction of the Earth, three aquanauts are shown actively engaged in explorations that may yield information that will contribute to a better

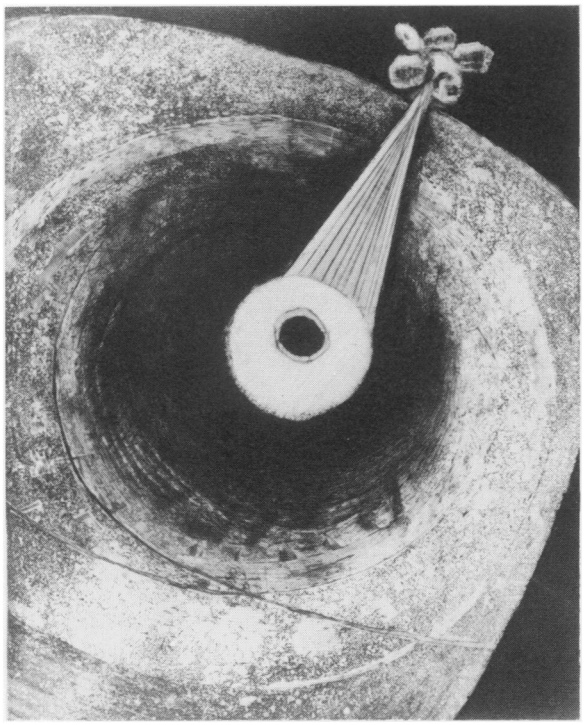

Fig. 4. 'Earth, A Planet of a Magneto-Dynamic Core (Progenitor of Life)', intaglio print, 28 × 35.5 cm, 1975.

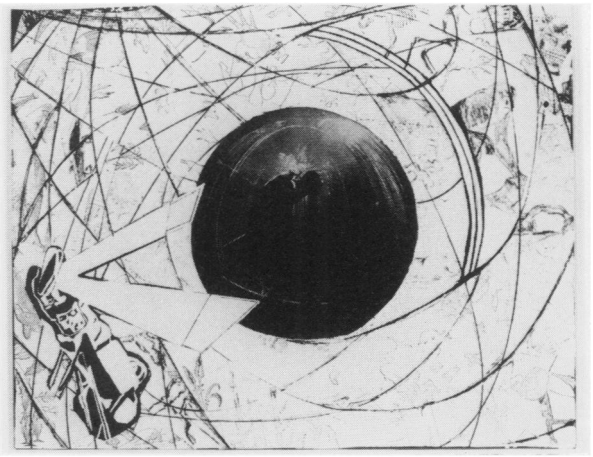

Fig. 5. Preliminary Sketch for 'Earth, A Planet of Animals and Plants (Evolution of Life)' (see Fig. 6).

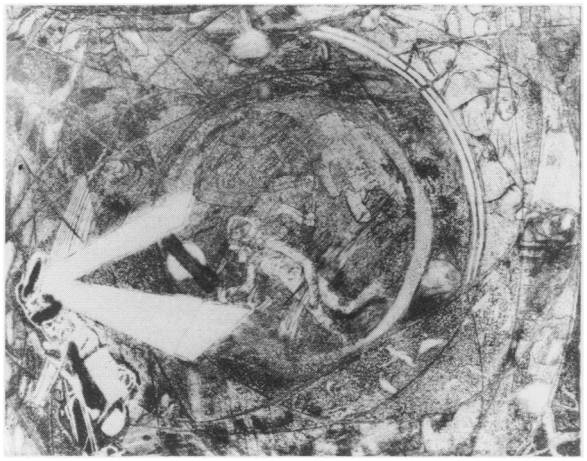

Fig. 6. 'Earth, A Planet of Animals and Plants (Evolution of Life)', intaglio print, 28 × 35.5 cm, 1976.

understanding of the origins and evolution of humans. We imagine aquanauts of the future having surgically implanted gill-like under-water breathing devices located under the rib cage. The ghost-like aquanaut at the right is shown exploring the depths of the underwater world. These ideas are artistic fantasies, but then such fantasies are known to have stimulated fruitful thought.

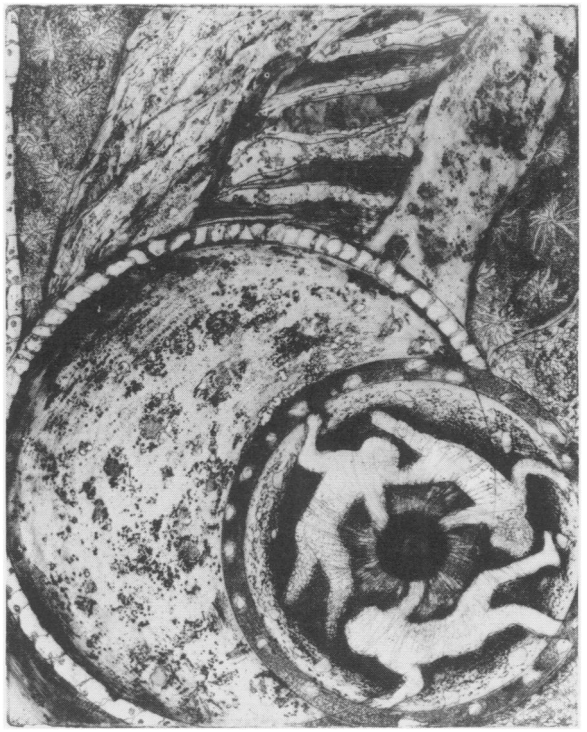

Fig. 7. 'Earth, A Planet of Life in Water (Base of Life)', intaglio print, 28 × 35.5 cm, 1976.

VI. COMMENTS ON THE ARTIST'S TASKS

Although our venture was a cooperative effort, I (R.J.D.) feel that my task to express artistically aspects of science and technology was the more difficult. My brother expended much time checking the sketches for adequacy in depicting scientific concepts. Our conversations expedited progress in the work. Criticisms and rough sketches were duly recorded for reference. This approach requires close cooperation, if meaningful and understandable artistic ideas are to be presented.

As I learned more and more about the subjects of the series, I became instilled with a sense of urgency for the achievement of our objectives. I sensed what C. R. Holty so aptly expressed in his memoir, 'a growth and change within ourselves', when he sought additional information on the subject of his concern [13]. Study in a library of the topics of our interest greatly stimulated me. I found that on comprehending a subject more adequately I reached such a pitch of emotional excitement that I was anxious to return to my sketching. Of course, I often became perplexed and I sought help from my brother or returned to the library to resolve any queries. Evidence of the results of this pursuit of information may be seen in the print 'Earth, A Planet of Life in Water (Base of Life)' (Fig. 7), where, in microscopic detail, there are depictions of plankton, algae and amoebae.

James Seawright wrote, 'Art is, after all, only a record of people in a time, and this is the time of technology' [14]. We are convinced that artists can interpret artistically scientific knowledge and thereby aid in finding a more meaningful way of life in the future. We feel, concerning visual fine art reflecting science and technology, that, in the words of F. J. Malina, in 'addition to providing individuals with deep emotional satisfaction, it will help societies to make better use of science and technology for the welfare of humanity everywhere' [15]. With this objective we have undertaken a joint project of an initial set of 20 intaglio prints. We shall continue to make others after this series is completed.

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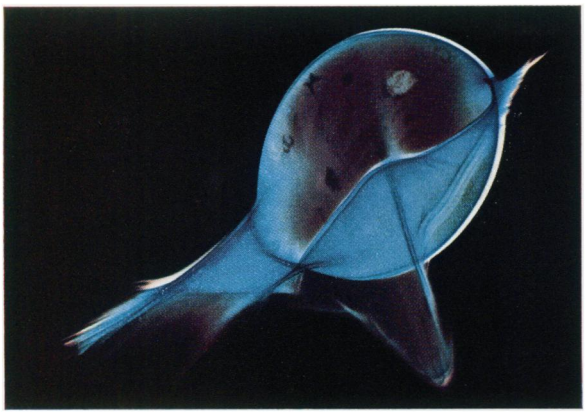

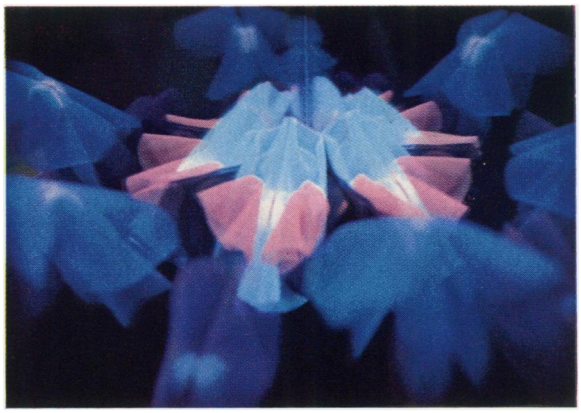

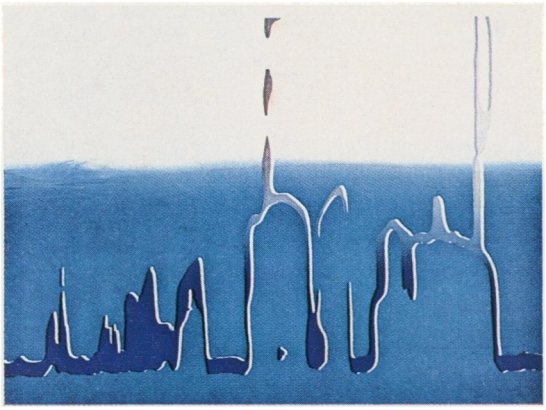

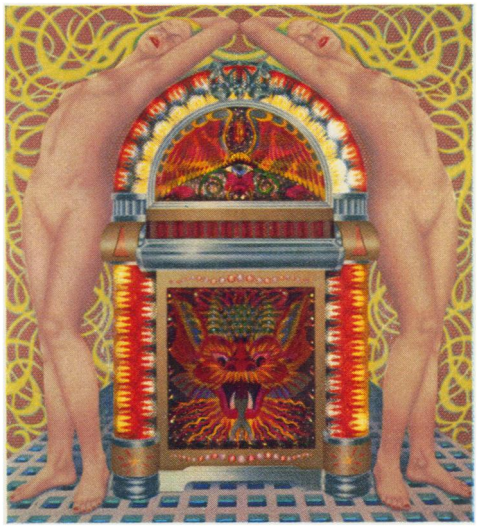

Top left: *Alan W. Bernheimer. Untitled, color reflectograph,* 19 × 24 cm, 1966. (Fig. 4, cf. page 178)

Top right: *James F. Watkins. View of a floating image produced by the kaleido-sculpture device,* 1976 (Fig. 1, cf. page 219)

Centre: *Aage Justesen. 'Pictonom Fr* 1 *Sv, Anneliese Rothenberger', silkscreen print,* 42 × 55 cm, 1976. (Fig. 1, cf. page 206)

Bottom left: *Robert J. Divita. 'Earth, A Planet in the Universe of Hydrogen (The Building Block of Life)', intaglio print,* 28 × 35.5 cm, 1975. (Fig. 1, cf. page 181)

Bottom right: *Dale E. Mills. 'Ménage à trois', acrylic paint, Glass Stain, glass plate, miniature electric light bulbs, reflective beads,* 125 × 115 × 18 cm, 1977. (Fig. 3, cf. page 189)

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