The Kinetichrome and Its Use of Polarized Light

Albert Friscia

Abstract—The invention of Polaroid in 1938 opened up new horizons for artists, giving them the opportunity of applying the fourth dimension of time to their work. The author traces the development of his work with Polaroid from his early experiments, using a handmade cardboard slide viewer with two Polaroid discs inserted, to his current Kinetichrome projections, which utilize computerized control to intensify color and movement as desired. Birefringent materials, the design for a slide worktable and the sequence used for the two polarizers are described.

I. INTRODUCTION

The injection of the element of time in the plastic arts presents enormous, still-unexplored possibilities. My own interest in visual movement goes back to 1937 when I designed and constructed a rudimentary kaleidoscope projector. A motor turned a cylinder containing pieces of colored glass and celluloid cut-outs. The designs were projected onto the white walls and ceilings of my New York studio. From a distance, an observer could 'freeze' the image by activating a switch that stopped the motor. However fascinating the non-repeatable designs were, I found the kaleidoscope more a spectacle than an art form, as the designs fell into place at random.

II. THOMAS WILFRED

About this time, during my many visits to the Grand Central Palace Theater in New York City, I had the opportunity to see the Lumia and Clavilux projections of the Danish-American artist Thomas Wilfred [1]. His first experiments were patented in 1905. His recitals of changing abstract color forms were indeed a contribution to modern art. They left me with an admiration for the highly poetic images produced by a complicated instrument. The Clavilux was somewhat like an organ that, by manipulating reflecting templates made from highly polished metals and transparent colored materials, created slowly changing abstract forms on a large screen. This was perhaps one of the first valid uses of the dimension of time in an art form.

Albert Friscia (painter, sculptor), Via delle Muratte 94, Rome 00187, Italy.

Manuscript solicited by Jan Zach.
Received 29 March 1986.

III. POLAROID

In September 1938, *Fortune* magazine published an article entitled "In the Light of Polaroid" which described a newly invented product called Polaroid [2]. This product was not only to modify our concept of light but to influence our approach to optical phenomena; it also influenced the future direction of my own work.

Scientists had been aware of the basic fundamentals of polarized light for over 250 years, and they had devised laboratory methods to resolve the theoretical aspects of the phenomenon. Indeed, in 1809 the French physicist Etienne Louis Malus noted the phenomenon of light polarization whilst peering through a calcite crystal. However, applying this knowledge to photography, automobile headlights, spectacles, three-dimensional X-rays and a multitude of other esoteric uses was more complex.

Technically, Polaroid, a flexible transparent sheet averaging 0.003 inch in thickness, is a colloidal suspension of needle-like crystals several thousand

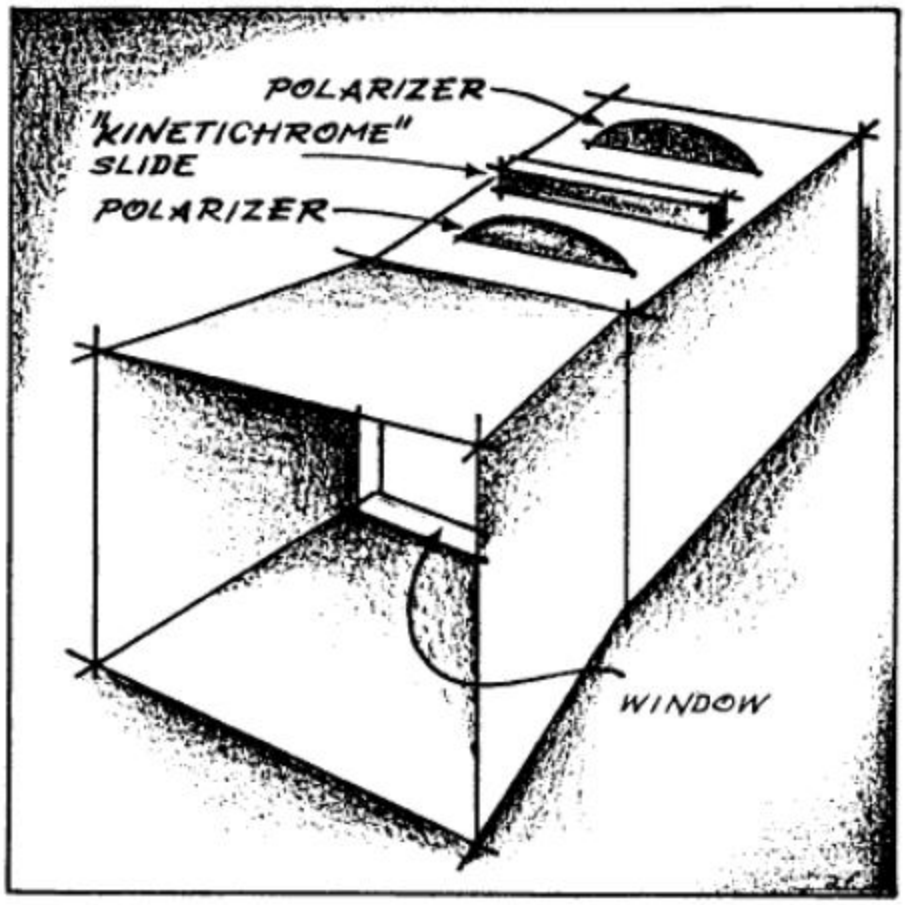

Fig. 1. Portable handmade cardboard slide viewer with slot for Kinetichrome slide and two Polaroid discs. Natural light is used.

Pergamon Press plc.
Printed in Great Britain.
0024-094X/88 $3.00+0.00

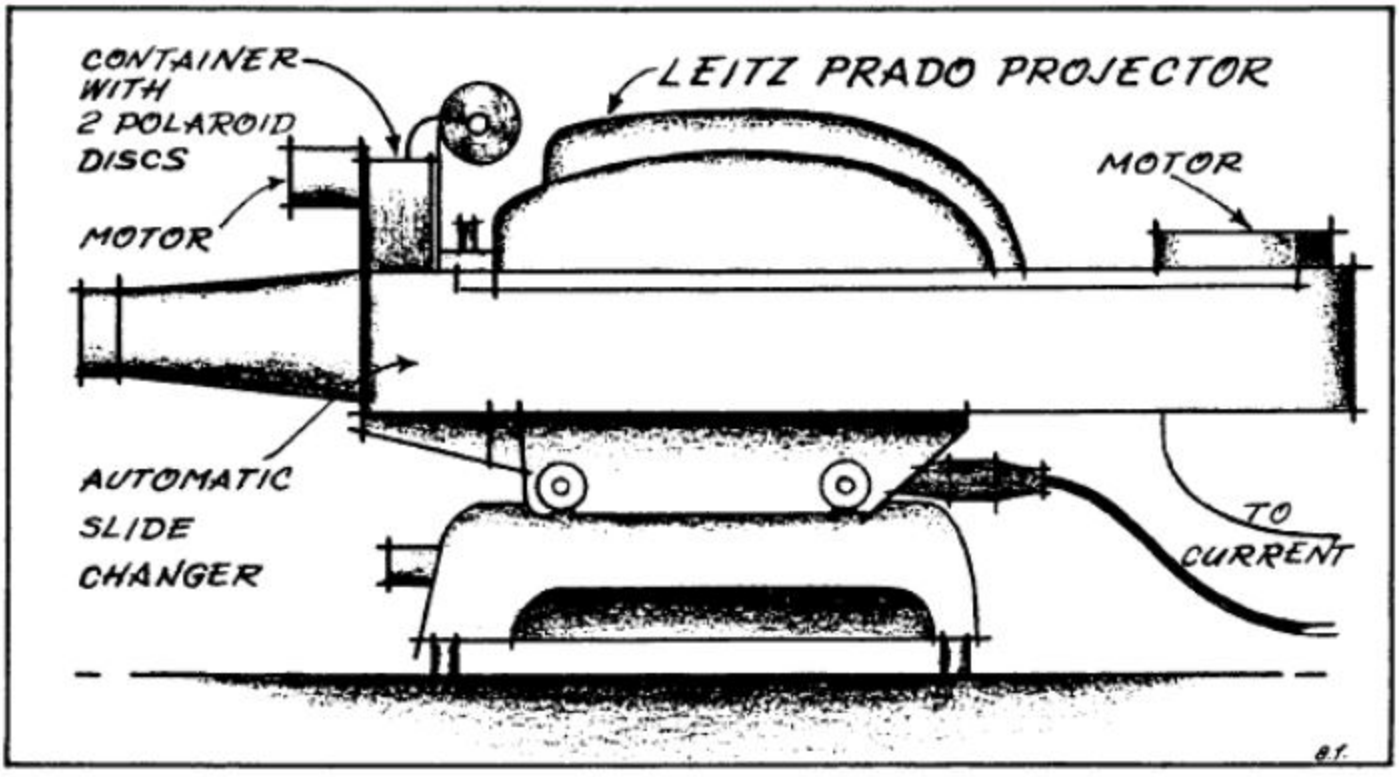

Fig. 2. The Kinetichrome projector is a modified Leitz Prado projector with geared Polaroid assembly and an individual motor run on a 1.5V battery mounted near the lens.

billion to the square inch and all lying parallel. The crystals are so tiny that the structure can be seen only through a polarized microscope, enlarged 1100 times. The manufacturing process, which is quite simple, starts with a large transparent sheet of easily stretched and chemically reactive plastic, usually polyvinyl alcohol. The sheet is warmed and then quickly stretched to many times its original length. During this operation, most of the long polymeric molecules become turned in the same direction as the stretching force, producing an order that gives the material certain crystalline properties. The name 'Polaroid' is derived from the fact that the needle-like crystals are aligned in a definite direction and, in this sense, are polarized.

Often in nature polarized light is only partly polarized. Bees orient themselves in accordance with polarized light. Light rays from the sun excite transverse electric vibration in air molecules, which then scatter polarized light in directions perpendicular to the vibrations. Light reflected at an angle from a nonmetallic surface, such as glass or water, is partly polarized.

Light is defined broadly as radiant energy in the form of electromagnetic radiation [3]. It comes to the eye chaotically from all directions. Polaroid gives light rays a definite course, eliminating glare and intensifying color. A ray of light is similar to a round bar; but when it passes through a polarized sheet, it becomes flattened like a ribbon. In other words, Polaroid conditions light by giving it a special direction and eliminating the chaotic rays.

IV. THE BIRTH OF AN ART FORM

If two polarizers (one to be called the 'polarizer', the other the 'analyzer') are placed one in front of the other with the

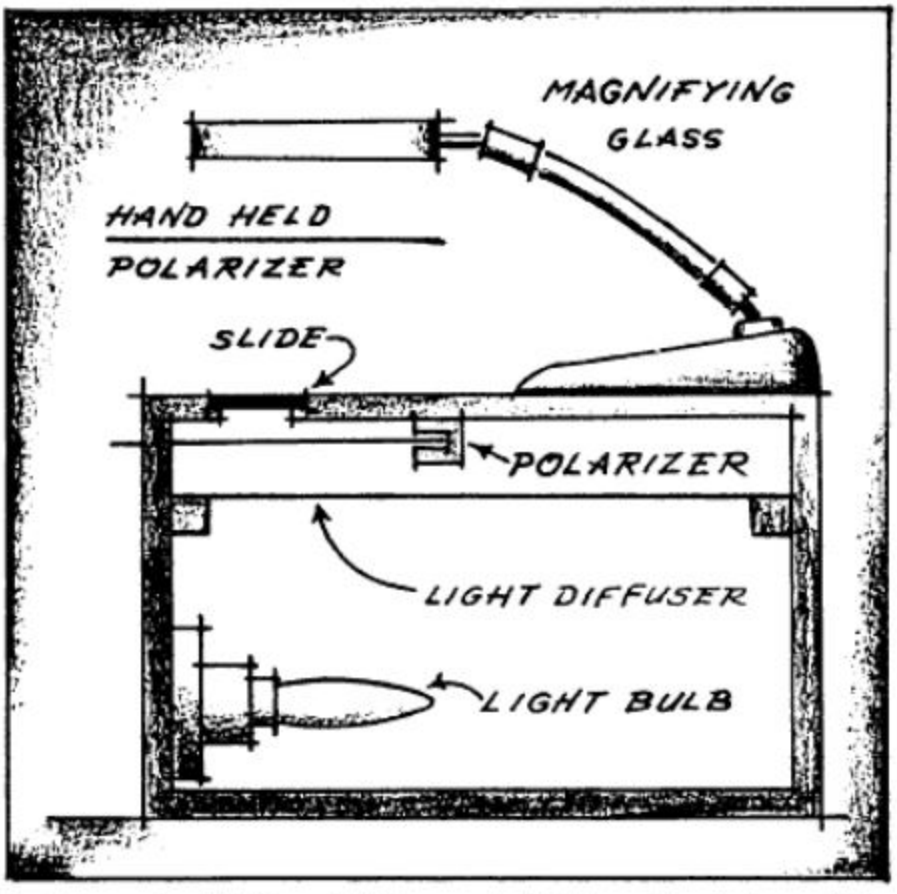

Fig. 3. Cross section of light box worktable for composing Kinetichrome slides, showing magnifying glass, slide holder, two polarizers, light diffuser and light source.

crystals aligned in the same direction, light comes through unchanged; but if one polarizer is given a quarter turn, almost no light will penetrate [4]. A sheet of folded cellophane or Mylar viewed between two polarizers will produce a brilliant pattern of precise complementary colors. Here was the basis for utilizing polarized light as an art medium. Not only static color compositions but also changing color images could be created, thereby adding the dimension of time to the work.

But the term 'painting' could not be used to refer to this particular method of composing images, as neither paint nor pigment is involved. I was composing with light, using colorless transparent materials. I thus coined the term 'Kinetichrome', since my compositions involved both movement and color.

Since time immemorial humankind has attempted to interpret or imitate the colors created by light, using colored clays and chemically colored pigments to document and interpret human life, experience, environment and all the psychological factors involved. With Polaroid, however, light itself could be used as a means of expression.

Fig. 4. ***Transfiguration*****, Kinetichrome, 23 × 23 × 5 in, 1975. This work is representative of a formal-informal approach. It stresses movement in the forms of composition, combined with the movement of the Kinetichrome color changes. The superimposed portrait of the artist is the static element around which the movement occurs.**

V. EXPERIMENTATION AND RESEARCH

From 1947 to 1950, I painted and worked on my Kinetichrome experiments [5]. First, I built a small cardboard viewer into which I could insert a slide composition and two Polaroid discs (Fig. 1). Then, I purchased a manual Polaroid projector, built a slide holder with two calibrated discs and showed my Kinetichrome projections to an enthusiastic audience in Rome. This was considered an innovative type of manifestation, the word 'kinetic' having not yet been used in reference to a work of art. Later, I modified a Leitz Prado projector (Fig. 2), inserting two Polaroid discs which were turned by a motor run on a 1.5V battery mounted near the lens. To automate the slide changes, I designed a sort of monorail, which carried the slides around the lamp housing of the projector, and activated it with another motor, making the performance completely automatic. The changing Kinetichrome compositions each remained on the screen for 1 minute, the time necessary to complete the sequence of color changes. The performance was accompanied by taped electronic background sound composed by Paul Ketoff, an electronics engineer working in Rome [6].

VI. BIREFRINGENT MATERIAL

How does cellophane or Mylar give us color when interposed with Polaroid? Perhaps this can be explained simply, without going into mathematical equations. Cellophane, during the manufacturing process, is pulled taut through rollers, causing a rearrangement of its molecular structure, which renders it birefringent [7]. It then is capable of refracting a ray of light obliquely into two slightly different angles, which propagate through the material at different wavelengths; this gives rise to interference, which produces colors under a polarizer.

VII. THE KINETICHROME SLIDES

Besides cellophane and Mylar, one can use mica, liquid crystals, or an assortment of different minerals and chemicals. I avoid using transparent adhesive tape, which is also birefringent, as it is not clean enough for slide production, though it need not be excluded. Maximum freedom is essential, as one should try to enrich the quality of effects produced and not confine the process within certain limits. However, one should avoid applying nitric acid or sulphuric acid to cellophane; I have found neither to be useful, and their side effects can be harmful.

Composing for slides is a delicate operation. Since the forms are so small, one has to compose under a magnifying glass. At the same time, one needs to turn the two polarizers until an interesting composition has been achieved. One should build a light box with an artificial light source inside (Fig. 3). It should include space for working on the slide, two Polaroid discs and a place for a magnifying glass. The forms can be cut from cellophane or Mylar, superimposed one over the other. By slightly heating cellophane between two sheets of metal on a gas flame, one can develop interesting patterns; these then can serve as a basis for developing other pieces that can then be juxtaposed. While composing, one should keep in mind the element of time, for the images should be interesting during the entire cycle as the discs are rotated.

VIII. THE KINETICHROME SYSTEM

The experimentation and research that I have pursued for many years exploits

the entire gamut of the visible spectrum and its many nuances of intermediate color values. This is based on the rotation of the polarizer at 2 RPM and of the analyzer at ½ RPM in the same direction. The birefringent slide material is placed between the two polarizers and remains static. This system is unique and differs widely from the system outlined in the article "In the Light of Polaroid" which had first evoked my interest. I have observed Polaroid manifestations that were 'flat' in color and exceedingly limited in color changes because the method was limited. If one has the entire spectrum and its interlaying variations of color, I believe one should use them. Much can be communicated by simply using black and white, but this does not require polarized light. In composing Kinetichromes, I am able to control, limit and simplify the colors, which I have often done, but this is an intellectual procedure and is not a restriction imposed by the limitations of our technical knowledge.

IX. THE KINETICHROME LIGHT BOXES

I build my light boxes, the Kinetichromes, to hang on a wall. They measure 23 × 23 × 5 inches. The light source consists of two 15 watt fluorescent tubes with an opaque Plexiglas light diffuser. The Kinetichromes contain a transparent composition sandwiched between two pieces of clear plexiglass. A motor is geared to turn two polarizers, 19 inches in size, at the ratio previously mentioned. Unfortunately the Kinetichrome illustrations reproduced here can show only 'frozen' images isolated from the changing sequence.

The opening of the light box has a shape that is between a circle and a square. This shape is called a super-ellipse by the Danish poet-scientist Piet Hein who resolved the mathematical equation from which it is derived [8].

I exhibited my first Kinetichrome light

Fig. 5. *Sundance*, Kinetichrome, mica, heated cellophane Mylar, 23 × 23 × 5 in, 1980.

boxes in 1967 [9]. The image in *Ceres* (Color Plate B No. 2) displays a formal-informal approach [10]. Through this image, I sought to create the impression of an activity that would pertain to a distant asteroid. In *Transfiguration* (Fig. 4), which is also representative of my formal–informal approach, I stressed the movement in the forms of the composition combined with the movement of the Kinetichrome color changes. The superimposed portrait of the artist is the static element around which the movement occurs. In *Sundance* (Fig. 5) I was seeking to achieve the impression of dancing figures or forms in cosmic space.

I am presently preparing two automatic computerized projectors in order to have a 'lap dissolve' from the image of one slide composition to another. Seeing one image superimposed over another while the color mutation and slide change take place produces a pleasing sensation.

Another method I have been using to project Kinetichrome images is the 35mm strip film. This strip film, which passes horizontally through a film sprocket, is turned by a very slow motor and is inserted between two polarizers. The birefringent material is sandwiched between two clear strip films in a 'loop' that can be of any desired length. An advantage to using the strip film is that it produces a continuous performance; a disadvantage is that to compose such a strip film is an almost endless task.

X. CONCLUSION

In addition to my work with Kinetichrome light boxes, I model wax sculpture for bronze casting and execute airbrush images made with cut-outs similar to those used in the Kinetichromes. I also render geometrical paintings in oil on canvas. Despite the various media I use, my work shows a consistency in its form and the interrelationship of subject matter, even though I have gradually modified my approach from informal to formal. For me there is little difference in working with two, three or four dimensions, as I do not feel a great division between these expressions [11].

It is my ambition to build a Kinetichrome that measures about 8 × 8 feet, in collaboration with the Polaroid Corporation. Although the maximum width of a Polaroid sheet is 19 inches, larger dimensions can be achieved by butt-joining five sheets together and then laminating between plexiglass.

One application of Kinetichrome projections is in the realm of dancing, for the changing image can be projected onto a semi-circular screen at the back of the stage, creating a kind of backdrop that incorporates the dancers as well. Or the image can be projected from behind the stage onto a semi-transparent screen, which becomes an animated but secondary backdrop for the dancers. These backstage projections can also create a desired mood for theater by utilizing a design appropriate to the subject.

All in all, my fascination with the Kinetichrome as a means of expression is consistent. I feel there is still much to be discovered through composing works of art with polarized light.

REFERENCES AND NOTES

1. T. Wilfred, "Composing in the Light of Lumia", *J. Aesth. Art Criticism* **7**, 70 (1948).
2. "In the Light of Polaroid", *Fortune* (September 1938). While still a student at Harvard University, the 20-year-old Edwin H. Land had been discussing his ideas on light polarization with his physics instructor George Weelwright III. Without waiting to graduate, Land left Harvard and set up a company to manufacture Polaroid, which he patented in 1929. Weelwright left Harvard to become vice-president of the Polaroid Corp.

   For further information on polarized light, see William Suncliff and Stanley Ballard, *Polarized Light* (Princeton, NJ: Van Nostrand, 1964); and "Polarized Light", a publication of the Polaroid Corporation (February 1967).
3. Clarence Rainwater, *Light and Color* (New York: Golden Press, 1971) p. 8.
4. For more detailed discussion of polarizers, see Nik Semenoff, "Photographic Images and Optical Effects Using Birefringent Materials", *Leonardo* **17**, No. 3, 180–184 (1984).
5. During these four years, a grant from the G.I. Bill gave me the opportunity to travel to Mexico, France and Italy.
6. Paul Ketoff is the inventor of the "Synket", a portable sound synthesizer.
7. See S.J. Edwards and A.J. Langley, "On Producing Colours Using Birefringence Property of Transparent, Colourless Stretched Cellophane", *Leonardo* **14**, No. 3, 187–190 (1981). Referring to the property of birefringence, Edwards and Langley state: "This quality is possessed by a number of crystals, including calcite, quartz and tourmaline, and also by certain organic polymeric materials having a crystalline character such as transparent, colourless cellophane sheet . . . ."
8. J. Hicks, "Poet with a Slide Rule", *Life* **61** (14 October 1966) p. 55.
9. My first Kinetichromes were exhibited in the 1967 international show on kinetic art entitled "Light", held at the Galleria dell'Obelisco in Rome. Since then, my Kinetichromes and Kinetichrome projections have been exhibited at the Galleria D'Arte Moderna in Rome and have accompanied illustrated lectures entitled "Origins of Movement in Kinetic Art".
10. Formal: geometric forms with linear contours. Informal: biological forms that have irregular contours.
11. Although I use the fourth dimension, time, in my Kinetichromes, it is usually only one of three dimensions (height, width and time). However, I have created a Kinetichrome sculpture (1981) which does have four dimensions.

Editor's Note—For additional reading on the use of polarized light in art see the following articles from *Leonardo*: C. Martinoya and N. Joel, "The 'Chromatic Abstractoscope': An Application of Polarized Light", *Leonardo* **1**, No. 2, 171–174 (1981); J.A. Burns and J.K. Burns, "Kinetic Art: A Mural of Variably Stressed Photoelastic Material with Light Polarizers", *Leonardo* **6**, No. 4, 325–328 (1973); R.A. Brown, "Figurative 'Polarized Light Painting': Static and Kinetic Types", *Leonardo* **10**, No. 3, 213–214 (1977); K. Muscutt, "Projected Kinetic Displays and Photomicrographs Based on the Use of Polarized Light", *Leonardo* **11**, No. 2, 97–102 (1978).

APPENDIX

There are many types of Polaroid. The Polaroid sheet that I have always used is HN 38. The KN 36 or KN 42 polarizer is useful for higher temperatures as it can resist up to 175°F. The size of the sheet is 19 × 50 inches.

HN 38 linear polarizer and KN 36 linear polarizer can be obtained from Polaroid Corporation, Polarizer Division 1, Upland Road, Norwood, MA 02062, U.S.A.

Du Pont Mylar type D polyester film can be obtained from Du Pont Nemours International, S.A., 50–52 Route des Aracias, CH 1211, Geneva 24, Switzerland.

B

No. 1. Top left. Rita Deanin Abbey, *Exit Glacier, A-34*, porcelain enamel fired on steel, 24 × 24 in, 1986. Organic shapes and the contrast of color and texture allude to the energy of movement and sound.

No. 2. Top right. Albert Friscia, *Ceres*, Kinetichrome, 23 × 23 × 5 in, 1967. This work, which displays a formal-informal approach, was based on impressions pertaining to a distant asteroid.

No. 3. Bottom. Janet Saad-Cook, *Alembic*, sunlight, mirrored stainless steel, dielectrically coated glass, 8 × 3 ft, 1986. The materials that reflect sunlight to create this Sun Drawing are in the patch of sunlight at the lower right.