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Holography: Exploring a New Art Realm—Shaping Empty Space with Light

Rudie Berkhout

BACKGROUND

In 1973, I traveled extensively through the Far East (Hong Kong, Malaysia, Thailand and Indonesia). This trip was a turning point in my life. Instead of returning to my previous occupations in fashion design and stage lighting, I decided to look for new challenges and possibilities to express myself creatively. The social climate at that time in Holland, my home country, was not suitable for my new career search. New York City was a much more inspiring place. It was here in 1975, at the International Center of Photography, that I was first exposed to holography [1]. The combination of the scientific and the artistic realms intrigued me. The possibility of working with advanced technology outside a corporate structure and exploring it as an art medium appealed to me; I would be able to develop the technical processes involved and create images that reached into previously unknown visual areas.

I began to learn about the medium by taking a basic course at the New York School of Holography (NYSH). There I made several laser-viewable transmission holograms, but it was impossible for me to view the holograms away from the lab since I did not own a laser. I decided to rent the NYSH lab and make a commitment to learn the different techniques and, in particular, the intricacies of optics and holography.

THE FIRST EXPERIMENTS

My initial goal was to make a black-and-white transmission hologram that could be seen in white light. I first attempted to do this by using a large lens system, focusing the image on the holographic plate. This is best described as a white-light one-step process. It did produce a black-and-white image; however, the small depth of field and the color separation that occurred at the edges were problematic.

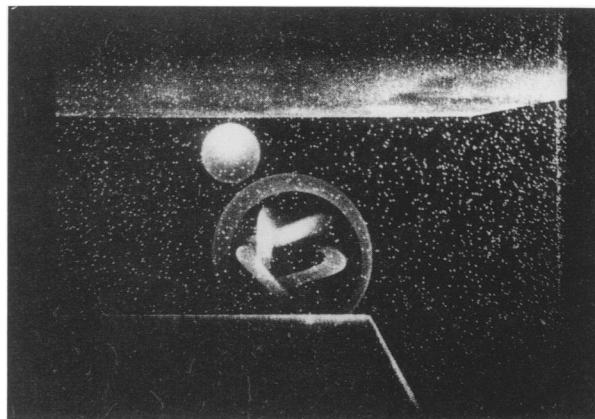
My next approach involved using the Benton white-light transmission technique plus an extra reference beam to arrange and line up the different colors that produce white. I called the first piece *Almost Black and White*. The image comprised three small light bulbs in three porcelain sockets, with wire connecting the electrical terminals—each element lent itself perfectly to this technique. I got amazingly 'real' results and enjoyed the paradox of one real light bulb activating three holographic ones. However, I was frustrated by the fact that diffraction made each color image a different

size; this meant that when the piece was viewed from different sides the colors separated, especially where the image extended in front of or behind the plate. Thus, limited depth of field and color misalignment made dealing with realistic imagery a cumbersome experience.

It was then that I stepped away from figurative work. In an experimental piece entitled *Pinching Mother Nature's Nipple*, I was able to take advantage of the technical limitations of the medium. I used a variety of geometric shapes that, when multiplied and overlapped, showed a surprising new palette and at the same time sidestepped the need for alignment.

In 1978, after 3 years of experimentation with different possibilities, I decided to concentrate on the creation of finished artwork. This resolution raised many questions: What to do with this beautiful medium? How to make sense of spectral color? Why make a hologram and not a photograph? Why did I want to go through this technological process? Challenged to find the answers, I rented a studio on 13th Street in Manhattan and installed a 10-mW laser to begin white-light transmission recording.

Fig. 1. *Future Memories*, white-light transmission hologram, 8 × 10 in, 1979. The beauty of optics is materialized in a simple ring shape holding in its center several smaller rings.



ABSTRACT

The artist outlines his work in holography from his introduction to the medium in 1975 to the present. His experiments with black-and-white and Benton white-light transmission holography are described. He writes about his pioneering use of Holographic Optical Elements (HOEs) in the image-making process that results in animated imagery and his transition from geometric abstracts to organically based compositions. The artist also discusses the improvisational techniques necessary to his involvement in this relatively new and evolving medium, and the technological and conceptual considerations of holographic art and high-tech art in general.

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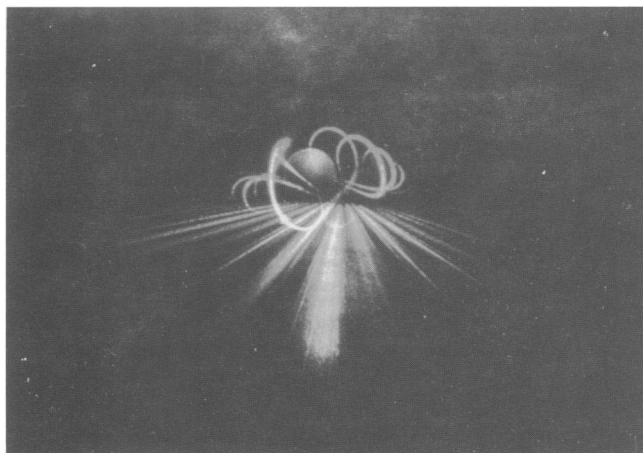


Fig. 2. *Event Horizon*, white-light transmission hologram, 8 × 10 in, 1980. A breakthrough occurred while I was working on this piece: I was able to draw with light for the first time.

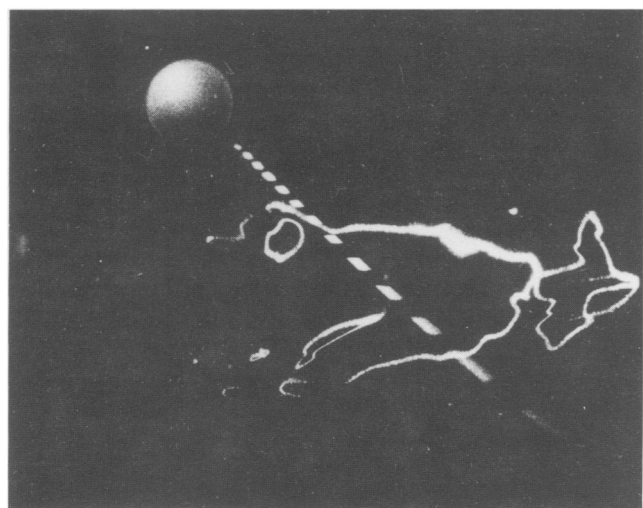


Fig. 3. *Transfer 137*, white-light transmission hologram, 8 × 10 in, 1980. I used a distortion medium to warp two lines to create the effect of a reflection on water.

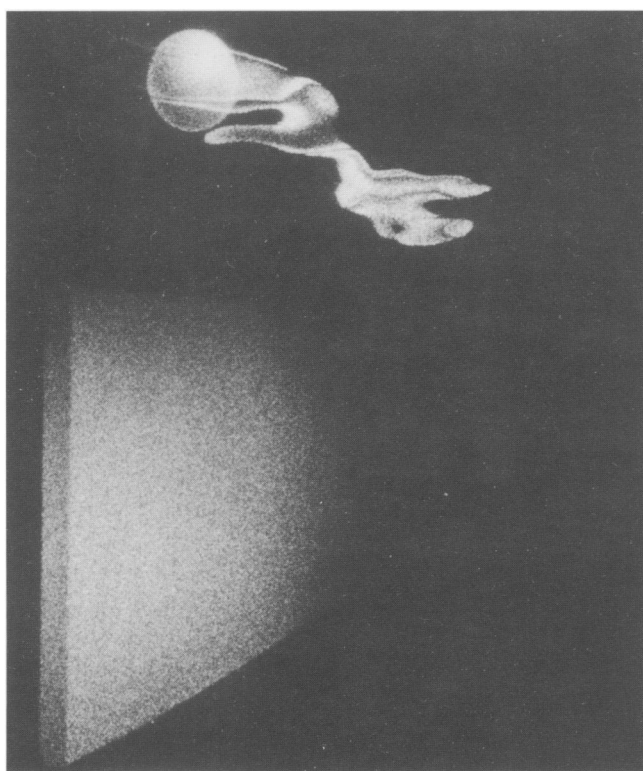


Fig. 4. *Kuan Yin*, white-light transmission hologram, 12 × 16 in, 1981. This piece is named after the Chinese goddess of mercy and joy.

The holograms I wanted to create required 8-×-10-in glass plates—a major investment for me at the time. To save on expenses I cut the plates into 1.5-×-10-in strips. The use of glass—as opposed to acetate or mylar—was necessary to achieve the quality I wanted. I also found that using glass in creating the master eliminated the ‘wobble’ seen in my previous experiments and made the positioning of the master more flexible.

I decided to start my new transmission experiments on a basic level by exploring a space defined by lines and dots. I created the lines by illuminating the sanded edges of plate glass and the dots by making air bubbles in three water-filled tanks measuring 14 ft × 14 in × 1 in. The three tanks were separated by several inches to create a spatial effect. The bubbles acted like little lenses, and their random distribution gave the field an organic appearance.

In recording the transfer, I combined several master holograms in one composition and placed different masters in different locations relative to the transfer to create multicolored images. In this manner, I made a series of transfers, which I called *Photon Studies #1* through *#10*. Later, I selected two pieces from this series and made a small edition of each—my first finished art pieces.

SPECTRAL HARMONICS

During this first production I discovered the beauty that results from using several different colors that are visible simultaneously. In synthesized music, one note can sound cold, but several notes can create a chord with many harmonics, causing a richer and more beautiful sound; the same happens with spectral colors. A monochromatic image looks artificial and cold, but through the use of two or more different spectral colors, all visible at the same time, the work starts to beam ‘harmonics’. For me, it is important first to make sure that the imagery can handle spectral color. A familiar object, with its natural subtlety of mixed colors, is often disappointing in monochromatic light. The dots and lines in my first *Photon Studies* were conducive to spectral color, and at the same time created an unfamiliar space—prerequisites for good holographic harmonics.

THE 12 MW BOOGIE: BUILDING CASTLES WITH COLORED BLOCKS

Also during 1978, I re-examined the image and color multiplication techniques that I had developed at Brown University in 1976 [2]. This time I began with one cube and two spheres, which were recorded in three master holograms. With the help of a holographic optical element (HOE) that I designed especially for this task, I made many cubes and spheres from the original masters. The HOE I developed was basically a lens containing many focal points arranged in a three-dimensional grid through which I multiplied the masters. I recorded this as the *12 mW Boogie* (Color Plate A No. 4). This piece represents the colored blocks that a child plays with when trying to build castles. The colors were varied and vibrant, and the transition of cubes into spheres constituted my first animation.

The sale of several pieces during 1978 encouraged me to make a further commitment to my work: I decided to build my own lab. In December 1978, I located a 600-square-foot basement, stopped my commercial holographic work and built 'Dream Lab #1'.

The original space was just large enough to hold two 12-x-4-ft tables: steel plates glued to a concrete slab that rested on innertubes were the ideal solution for me at the time. One table was for the master-making and the other was for the transfer process. Two tables made it possible to operate two optical systems; thus, after making a master I could immediately see how the image would fit in the transfer set-up. Dream Lab #1 was completed in 3 months.

HOE, HOE, HOE

Intrigued by the results achieved through the use of HOEs in my previous work, I set out to explore the possibilities further. Two pieces, *Echo Chamber* and *Interchange*, exemplify the use of two different image multiplication techniques. In *Echo Chamber* I used the HOE in the transfer, while in *Interchange* I used the HOE in the master making.

Future Memories (Fig. 1) was made from three masters. One was of a sphere, another of the field and lines, and the third an 'inside-out' animation. This element was a revelation to me; the

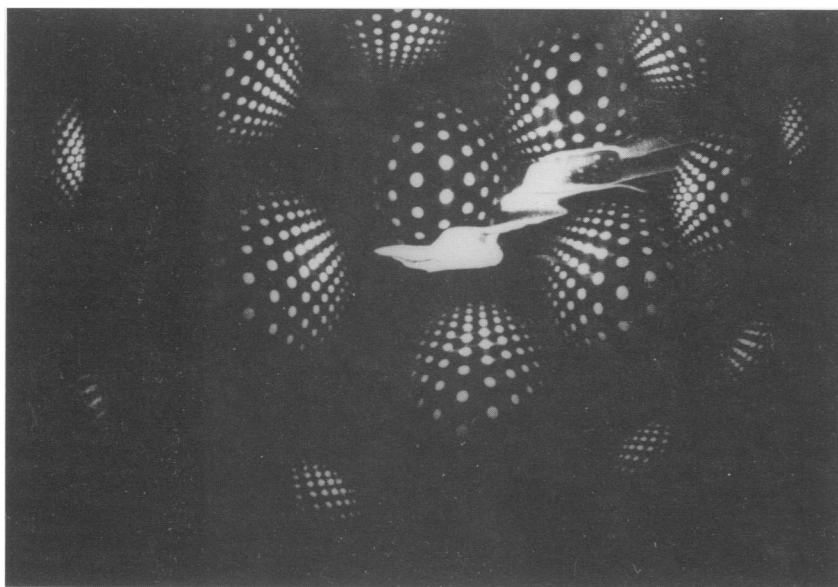


Fig. 5. *Vasarely Space*, white-light transmission hologram, 12 x 16 in, 1981. This work was inspired by the artist Victor Vasarely, who used similar optical effects in a two-dimensional format.

beauty of optics materialized in this simple ring shape that held in its center several smaller rings. By moving from side to side, the viewer perceives one of the smaller rings as it expands to become the outside ring while the outside ring collapses into the center. I constructed this image by using a ring-shaped object, a large collimating lens full of aberrations, and several HOEs to repeat the sequence. For *Particle Fields I* and *Planet Claire*, I used a similar setup. My excitement about this kind of holographic image-making lies in the fact that it is the result of pure optical processing, which is not possible in any other medium, and the results seem related to atomic interactions.

At the end of 1979 I exhibited this work in a spacious display, with carefully balanced ambient light [3]. I played recorded music in the background to help the viewer step 'into' the work. When I exhibit, I like to have as little apparatus as possible so as not to distract from the artwork. The tripod display, which I still use today, grew out of my desire to show the work simply and elegantly. For me, part of the uniqueness of holography is that the image is simultaneously there and not there, depending on the viewer's position. Being able to see the work from the sides and from behind allows the viewer to examine and consider all angles of the image.

Event Horizon, *Transfer 137* and *Kyoto* were made in 1980; each was created using a different approach to the holographic animation process. In *Event*

Horizon (Fig. 2), I was able to generate an image element totally by optical means. This was a breakthrough for me; for the first time I was able to 'draw' with light. Starting with a point of laser light, I stretched, multiplied and curved the wavefront into an animated coil-like structure that I placed over a sphere (from a second master) in the final transfer. The third master used in this piece was of a forced-perspective field made of receding lines.

For *Transfer 137* (Fig. 3), I used a distortion medium to warp two lines to create the illusion that they were being reflected from a water surface. A dotted line pointing straight at the viewer and a sphere were captured in two other masters. The spherical object that I often use in my work provides a 'resting point', and the field or dotted line draws the viewer into the holographic space. In *Kyoto*, I placed two similar cloud-like animations on top of one another in the transfer to produce a color mixture. The color line-up was not critical in this case, and the overlapping provided three colors. *Kyoto* is also the product of the first 12-x-16-in transfer plate I made and the first example of a piece created with the 2-x-20-in master plates (instead of 1.5-x-10-in) I now use to expand the viewing angle from side to side.

Keeping the compositions simple is a difficult but important objective I set for myself, as is leaving enough space to invite viewers to wander in and contemplate 'unfamiliar realms'. *Kuan Yin* (Fig. 4) and *Ukiyo* were completed in

1981 and clearly express my Zen-like approach of that year. In the piece *Vasarely Space* (Fig. 5), I played with the three-dimensional possibilities of the optical effects that the artist Vasarely had used in a two-dimensional format.

THE TECHNIQUE SUGGESTS

In 1982 I made the viewfinder that I now use as part of the master-making process. This is basically a hologram of a dotted rectangular outline that represents the transfer plate in the image space of the master. This helps during the process of composing the image and colors of the finished plate. This viewfinder hologram by itself looked so good that it inspired *Deltawerk*, *Delta II* and *Delta IV*. These three works incorporated dotted outlines of curved surfaces that interact with each other.

In 1983 I underwent many personal changes. I depicted my general state of affairs at that time in *Wavering*: a self-portrait positioned on a precariously balanced tripod that is balanced as if it could fall over at any minute. A still profile was combined with two profiles that go through major animated distortions, and all three are positioned on a field with two vanishing points.

1984: DREAM LAB #2

After working for 5 years in Dream Lab #1, I lost the lease at the end of 1983. Fortunately, I found a better and larger space—my present lab and studio. I then decided to design and build an optical system with more flexibility and larger dimensions to accommodate finished work measuring 24 × 36 in. My goal was to make the image-making process more organic, immediate and direct, so that I could express more personal thoughts and take the hard edge out of the high-tech. The optical table in 'Dream Lab #2' is made of a concrete slab that rests on innertubes; it is L-shaped with one arm covered 12 in deep in sand and the other held in place with ¼-in steel magnetic mounts. The sand is used in the master-making process, providing flexibility as well as stability in the positioning of the mod-

els. An overhead reference beam leaves the imaging space free from obstructions.

The first masters I made on the system were of the sand itself, to check the stability of the table. Those masters turned out so well that I have been using sand in my compositions ever since. The grains of sand complement the graininess of the laser speckle, and the immediate, hands-on modeling possibilities of the sand are wonderfully low-tech in contrast with the high-tech methods of the recording process.

The New Territories (reproduced in Peter Zec's article in this issue of *Leonardo*), the first finished work I created in the new lab, depicts an abstract landscape with a background color field. The image was slightly enlarged to compensate for the lack of a large collimator in the transfer setup; the landscape ranges from 5 ft in front of to 5 ft behind the plate. This was achieved by the careful placement of the line drawing in the sand to fit the final hologram format of 12 × 16 in. Two plates were framed together to form a diptych, thus adding to the feeling of space.

Since then I have made many abstract landscapes that explore different ways of using sand and create a feeling of expansiveness while suggesting brushstrokes floating in mid-air with no connections to a surface. I like the work to oscillate between landscape and abstract painting, challenging the viewers and jolting their usual perception of the world.

In 1988, I started using multiple reference beams once again, to mix the pure spectral colors of the work and create a more subtle palette. Each new piece has been an adventure into unexpected color mixes and space constructs. That year I decided to work on individual pieces, instead of producing my work in limited editions of nine, thus freeing myself from the problems of making perfect editions.

REFLECTIONS AND PROJECTIONS

A lot of my work happens by coincidence. I play with the medium, learning what it can do. Usually, I do not have

any specific imagery in mind. I experiment with simple forms and shapes to see how the medium responds. After observing the results, I select the elements that seem to be in harmony and that reflect some of my feelings about the world we live in. I like to share my sense of wonder and awe, love and joy, trust and faith. To me the physical world is a most miraculous holographic creation that is all too often taken for granted.

Creating the imagery can be a tedious process, mentally as well as physically. I have come to realize that gaining an understanding of the creative process is just as challenging as mastering the technical skills of the medium. Sometimes an artwork materializes smoothly, almost effortlessly, and at other times it is a struggle. In December 1988 I celebrated the first 10 years of supporting myself solely through the sales and exhibits of my artwork [4]. One of my dreams is to build a lab in the countryside to bring high technology into nature and nature into the lab. Working in the woods through all four seasons, I would like to use natural shapes and forms, recording elusive details. This lab would also be a place to experiment further with light sculptures and outdoor installations using laser light and sunlight.

Working with light itself and using it as a painter's palette is no easy task, because I am creating the palette as well as the paint. However, the process is exciting, and as I master the medium, I expand the territory in which I explore what I want to say. My hope is to reach the subtler levels of perception, holding up mirrors for thoughts, reflecting the magic we live in.

References and Notes

1. This exhibition of holography at the International Center of Photography was organized by Rosemary Jackson and Jody Burns.
2. H. J. Gerritsen sponsored my work at the laboratory at Brown University.
3. Future Memories, my first one-man show, was held at the Museum of Holography in New York in 1970.
4. During the next 10 years, I hope to obtain more support from foundations, corporations, museums and collectors. I have been encouraged in this direction by receiving a generous financial award from the Shearwater Foundation.