Eric Renner

EDITION 4

PINHOLE PHOTOGRAPHY

From Historic Technique to Digital Application

Focal Press

Pinhole Photography

From Historic Technique to Digital Application

In memory
of my parents
Josie and Richie Renner

Another and more remarkable property of light is that when rays come from different, or even opposite, directions each produces its effect without disturbances from the other. Thus several observers are able, all at the same time, to look at different objects through one single opening; and two individuals can look into each other's eyes at the same instant.
Christiaan Huygens, *Traite de la lumiére*, 1690

and of my grandmother

© Eric Renner, *Grandma Becomes the Moon*, 20 × 16-inch pinhole photograph, 1976.

Pinhole Photography

From Historic Technique to Digital Application

Fourth Edition

Eric Renner

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CONTENTS

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ACKNOWLEDGMENTS

In 1984, I founded *Pinhole Resource*, a nonprofit photographic archive. Within the first year of receiving pinhole photographs internationally, I decided to publish *Pinhole Journal*. The first issue appeared in December 1985. There are now more than 4000 pinhole and zone plate images at the Pinhole Resource.

The first edition of this book appeared in 1995, having taken about 10 years to research and write. The book's success was due in large part to the huge interest that has evolved in pinhole photography. In just a few years time new material in both historic and contemporary terms, including use of the Internet, and changed photographic techniques have resulted in this updated edition with color throughout.

It continues to baffle me that the pinhole aperture's contribution to the history of art and science has remained so unrecognized. The contents of this book explain in generalities the pinhole's importance in both disciplines.

There are probably 3000 photographers working with pinhole throughout the world and a slightly lesser number of scientists using pinhole in high-energy studies. I am hesitant to try to list all of those artists who have generously shared their photographs for this book in all its editions or who have also given images to *Pinhole Resource*, for I am sure to leave too many people unmentioned. The photographs and text in the following chapters of this 4th edition name some of these people. Suffice it to say, a most sincere thanks to everyone who has contributed photographs and articles to *Pinhole Resource* or for consideration of inclusion in this book.

The generosity and help of artists and scientists has been well evidenced, particularly in contemporary imaging—whereas, much of the historic information took real effort to obtain. To give the reader an idea: How was I able to make the image in Figure 1.18 of Paolo Toscanelli's marble disc on the floor at the Duomo in Florence, when it is always covered with a bronze plate, and even in an off-limits area? Actually that one was easy. I arrived there coincidentally at the summer solstice, June 21, when it was being uncovered for its yearly inspection, because it was designed to receive a pinhole image of the sun at 12 noon that day. Furthermore, the astronomer Professor Alberto Righini was giving a public lecture "The Sun in the Church." I had not been aware beforehand that the marble disc was specifically designed for use on the summer solstice, although I went there specifically to see the meridian line. How fortunate was that! For those who are not familiar with the mathematician–astronomer Toscanelli, he enlightened Christopher Columbus, Mediterranean sailor and slave-trader turned ocean explorer, that sailing west he could find the east.

I sincerely thank the late Maurice Pirenne, who understood that the pinhole was a perspective imaging device used throughout the last six centuries in art; Kenneth A. Connors, for his efforts to communicate scientific information about pinhole and zone plates; Stanley R. Page, who collected all of the published articles on pinhole (since 1850); Father Joseph Metzler of *Archivio Segreto Vaticano*, who led Nancy Spencer and myself to see the pinhole in the Tower of Winds at the *Vatican* (astronomer John Stocke of the University of Colorado told us about it); Professor Caroline Bruzelius, Pina Pasquantonio, and Marina Lella of the *American Academy of Rome* where we did research for this book, who without their assistance we could not have gotten through the front door of many well-locked, well-guarded, and always "under restoration" esoteric places; Paolo and Christina Vampa of Rome, who led us to Paolo Gioli; Paolo and Christina Gioli; Dominique Stroobant of Carrara, who guided me with corrected information on the history of the noonmark at

the Basilica di San Petronio, Bologna, and also supplied information on astrolabes; Kitt Peak astronomer William Livingston, who first told us of noonmarks; Hans Knuchel, who generously allowed me to reproduce his pinhole and slit cameras, line drawings, and a slit image from his important out-of-print book *Camera Obscura*; Jim Moninger, who generously supplied the article "Pinhole Videography and the Digital Still" in Volume 18#2 of *Pinhole Journal*, which I used extensively in Chapter 8 on digital pinhole with spy cameras; Sarah Van Keuren, who wrote the text on digital imaging for nonsilver processes (also in Chapter 8); Sam Wang, whose help has been invaluable in making and using zone plates for digital photography; Jens Friis of Odense, Denmark, curator of the *Museet for Fotokunst* and editor-in-chief of *Katalog* magazine for the *camera obscura* image and written text by the late Pia Arke; John Caperton of the *Taken with Time* project created by *The Print Center* in Philadelphia, who allowed me access to the Vera Lutter *camera obscura* image from that exhibition; Anthony E. Nicholas of Lapis Press, who kindly permitted reproduction of the Jean-Francois Lyotard Diagramatic Cross Section of Marcel Duchamp's *Étant donnés* from their publication *Duchamp's Trans/formers*, translated by Ian McLeod, 1990; Tom Schweich and Dennis Slifer, who helped with images and information on Womb Rock in California; Shi Guorui, who invited and arranged for Nancy Spencer and me to exhibit, travel, and photograph in China, witnessing firsthand the observation tower he turned into a *camera obscura* on the Great Wall; Jerry Burchfield, who supplied detailed information on the *camera obscura* image *The Great Picture*; Jyl Kelley, who mentioned the availability of the pinhole photograph of the Trinity Site Atomic Bomb Test, and the Los Alamos National Laboratory/University of California, who allowed use of the image; Barbara Adams, director of the

© Eric Renner, *Nancy*, 16 × 20-inch pinhole photograph with photogram of Nancy's hair, 1996. From the collection of the photographer.

Petrie Museum in London at *University College*; Margaret Drower, also of London, who helped with the information on Flinders Petrie in Chapter 2 and who led us to Patricia Spencer of the *Egypt Exploration Society*; Jan-Erik Lundström of Sweden, who translated August Strindberg's writings on pinhole that appear in Chapter 2 (it was Sandra Moss and Jan-Erik Lundström who told me about Strindberg in the mid 1980s), *American-Scandinavian Foundation*, who awarded me a grant to study Strindberg's photographs in Stockholm; Gary Urton, who generously supplied information on Kogi temple pinholes in Chapter 3 (Sheila Pinkel of Pomona College told me of these temples).

Most of all, I thank artist Nancy Spencer for her immense help, ideas, and images. Without Nancy, this book would not exist. She co-wrote the "How To" chapter in the first edition and has supplied many ideas on content in future editions. Nancy directs Pinhole Resource and we co-edited *Pinhole Journal* until 2006 when it ceased publication after 20 years.

Lastly to Diane Hepner, Asma Palmeiro, Hayley Salter, David Albon, and Paul Gottehrer, my editors at Focal Press, who agreed with many of my requests.

I have made extensive use of quotes and written material from artists and scientists who have used the pinhole. Quoting their own words seemed the most direct way to communicate their ideas, intermixed with mine.

Artist viewing through a pinhole fixed eye point in a perspective machine. From Jacopo Barozzi di Vignola, *Le Due regole della prospettiva practica*, edited by Ignatio Danti, Rome, 1583.

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CHAPTER 1

Pinhole's History in the Exploration of Science and Ideology

The place of emergence is the womb of the earth.

—**BARBARA G. WALKER, *The Woman's Encyclopedia of Myths and Secrets*, 1983**

The eye is the window to the soul.

—**LEONARDO DA VINCI**

AND now, I said, let me show in a figure how far our nature is enlightened or unenlightened:—Behold! Human beings living in an underground den, which has a mouth open towards the light . . . .

—**PLATO, *The Republic*, Book VII**

Unable to resist my eager desire and wanting to see the great multitude of the various and strange shapes made by formative nature, and having wandered some distance among gloomy rocks, I came to the entrance of a great cavern, in front of which I stood some time, astonished and unaware of such a thing. Bending my back into an arch I rested my tired hand on my knee and held my right hand over my downcast and contracted eyebrows: often bending first one way and then the other, to see whether I could discover anything inside, and this being forbidden by the deep darkness within, and after having remained there some time, two contrary emotions arise in me, fear and desire—fear of the threatening dark cavern, desire to see whether there were any marvelous thing within it.

—**LEONARDO DA VINCI**

If in all ideology men and their circumstances appear upside down in a camera obscura, this phenomenon arises just as much from their historical life-process as the inversion of objects on the retina does from their physical life-process.

—**KARL MARX (with FRIEDRICH ENGELS) *The German Ideology***

THE PINHOLE ARCHETYPE—FROM THE DARKNESS OF CAVES AND HOLED STONES

Much of the visual imagery that we see is directly related to inborn unconscious ideas or patterns of thought. Science has labeled these patterns archetypes. Many of the pinhole images in this book and my conceptions about these images are reflective of this idea.

In the early 20th century, the psychologist Carl Jung was the first to call attention to these genetic artifacts. Understanding archetypes allows the viewer to comprehend the basis for his or her *instinctive* feelings, sometimes expressed as strong knee-jerk reactions—ones that are not necessarily constrained by logic—generated from seeing archetypal imagery.

Visual archetypes take many forms. An example of just one form of archetypal *evil brethren* imagery would be the planes hitting the World Trade Center Twin Towers followed by most Americans' knee-jerk feelings of nationalism and revenge—"They can't do that to us."

As Jung emphasized, archetypes connect to visual patterns that are universally present in every individual's psyche and, therefore, other cultures would have their own *evil brethren* motifs. Archetypes are constantly being updated by new imagery in the world around us—but that specific updated image always refers back to an ancient archetypal motif whose original form cannot be identified, as it goes far, far back into humankind's history.

The Pinhole Archetype

A *circular aperture* is an opening—a primary archetypal motif for birth and a place of transformation, symbolically feminine. It presents the viewer with feelings of wonder, mystery, and sublime questions about life.

Many ancient cultures have emergence legends designating a hole in the earth or a hole in the sky as the sacred place of origin where their forebears first appeared. Every cave, too, has mysterious energies connected to it. Leonardo's cave mentioned in his notebooks and Plato's cave in *The Republic* (book VII) are perfect examples of those eternal questions surrounding cave imagery: life, death, and transformation. A somewhat superficial analogue for this would be Pinhole Cave in Derbyshire, England, thus named due to Victorian ladies going into the cave and dropping their hat pins or hairpins into a puddle at the back of the cave. They did this for good luck, as the myth goes, so that once they have deposited their pin the first man they see they would marry (not exactly the best way to select a husband)—but a good example of a projected transformative experience. It is an irrational superstition and surrounded by mystery—but that is the point. It is hardly different from reading the astrology pages in your local newspaper.

A large stone placed vertically appeared as a structure rooted deeply in Mother Earth, and this same large stone, with a circular hole in it (Figure 1.1A), was used ritualistically to reenact the transformation of birth. A baby passed through the hole received regenerated birth energy. The East Indian definition for a holed stone was "gate of deliverance."

In the California's Providence Mountains in Wild Horse Canyon (near the Mojave Desert) is Womb Rock, also known as Rebirth Rock, a large outcrop with a natually shaped tunnel that opens toward the east (Figures 1.1B and 1.1C). The tunnel is large enough to crawl through. Its smoothly polished floor indicates that many people have done this—probably in conjunction with some ritual.[1] The archeologist E. C. Krupp wrote the following about this unusual site:

> Shamans may have passed through the birth canal of Womb Rock as part of a seasonal effort to renew the world. Youth on the edge of adulthood may have crossed the frontier with the passport of rebirth. Womb Rock may have also been a portal for the symbolic transformation of shamanic candidates into genuine dreamers. We can see what kind of power is transferred from these wombs of Mother Earth even if we can't be certain who were the beneficiaries.[2]

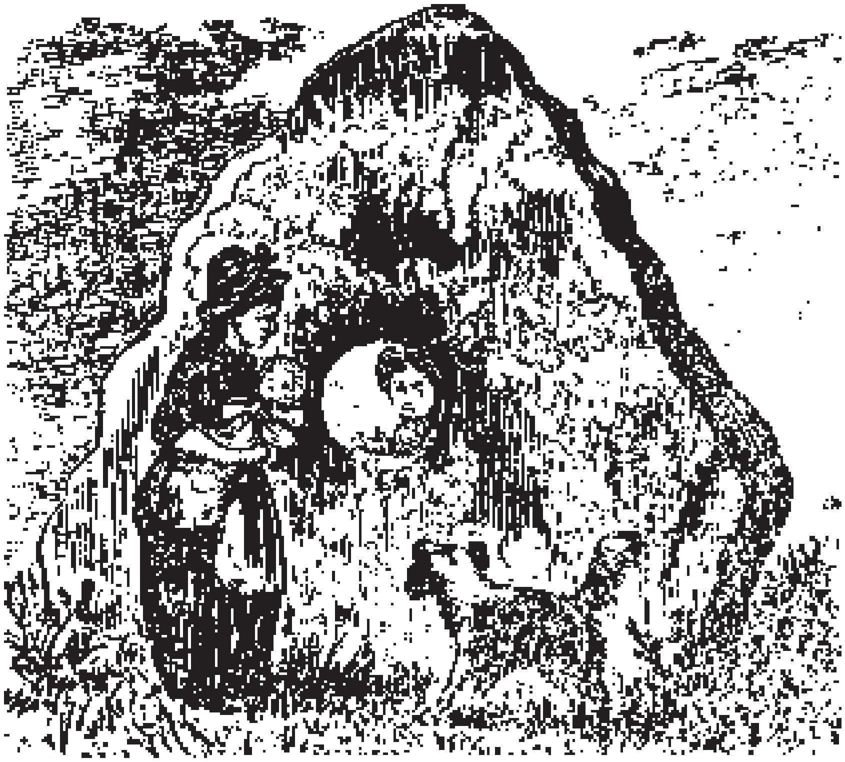

FIGURE 1.1A
Drawing, Joseph Blight, *The Tolvan Stone of Constantine*, 1873. One of the last places where pre-Christian rites of baptism survived. Babies were passed nine times through the hole in the stone and then laid to sleep on a grassy knoll. The stone, about 9 feet tall, is located in Cornwall.

FIGURE 1.1B
© Tom Schweich, *Womb Rock (Rebirth Rock)*, lens photograph, circa 2000.

The manmade circular hole in the capstone at Trevethy Quoit (Figure 1.1D) in Cornwall, England, is one of several that still exist. A quoit is the name for a burial chamber—upon burial the entire chamber was covered with dirt and became a burial mound. The circular hole in its capstone became that place of transformation—an opening for the person buried within.

Leonardo's quote "The eye is the window to the soul" reflects that same idea: that humans as natural structures have a window of transformation—*the eye*—that looks out upon the world. Thus, that same human window became a way for Leonardo to metaphorically see inward to discover the soul (the soul being a mysterious projected inner-being).

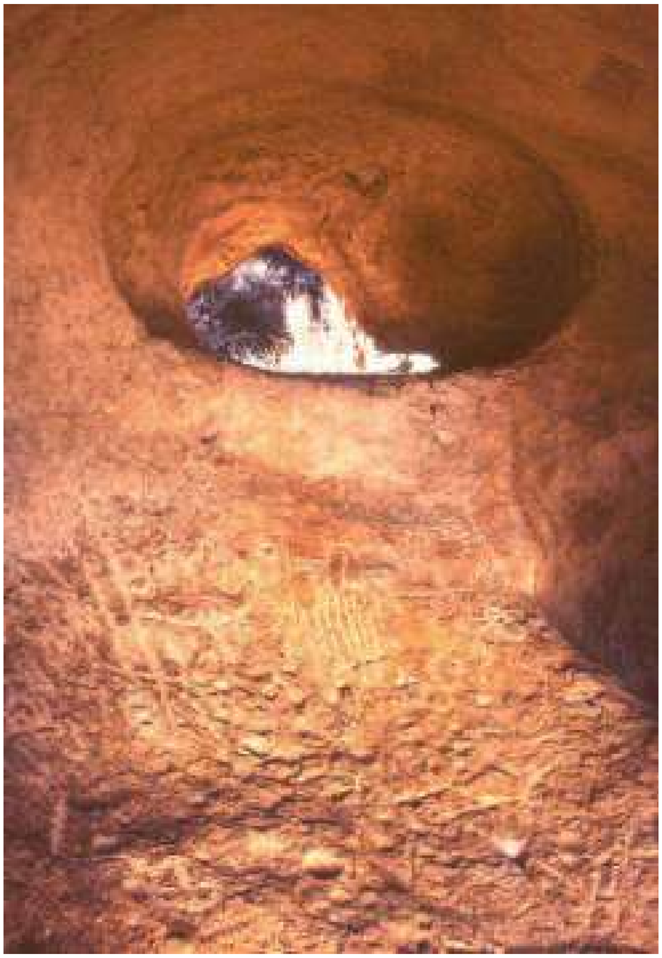

FIGURE 1.1C
© Dennis Slifer, *Inside Womb Rock (Rebirth Rock)*, lens photograph, circa 1998. From this side, looking through the hole toward the eastern horizon, there is a notch in the landscape profile. At the equinoxes the sun appears to rise in that notch.

FIGURE 1.1E
Mimbres black on white bowl, *Childbirth*, Swarts Ruin, 2½ inches high. Mimbres Valley, NM, circa 1000 A.D. Collection Peabody Museum, Harvard. The bowl is typical of burial pots of the ancient people who lived in the Mimbres Valley, NM. Upon burial, a hole was poked through the bottom of a utilitarian bowl. It was then laid over the person's head and become a place of transformation for the spirits.

FIGURE 1.1D
© Eric Renner, *Trevethy Quoit*, 6 × 9-inch pinhole photograph. This large stone quoit is situated in a field at St. Cleer in East Cornwall, England.

The human eye, therefore, is an ancient place of transformation. Much of the information in this book on pinhole photography, as well as many of the images within it, connects the pinhole as a direct ancestral link to the quote *the eye is a window to the soul*. As an analogue it could be said that the pinhole camera also is the window to the soul. But, as we will find, the pinhole camera—*as an extension to the eye*—supplies a sense of wonder that is different from what the eye with its lens sees.

EARLY PINHOLE OPTICS—ECLIPSES, TELLING TIME, ASTROLABES, AND OPTICAL PHENOMENA

Pinhole images are everywhere. Without a doubt, early humans were able to see pinhole images of the eclipsed sun on the ground under tree canopy—the sun is seen as a crescent. Every eclipse seen in the accompanying lens photograph (Figure 1.2) is actually a pinhole image of the sun. Thousands of pinholes images of the sun are created naturally by chinks in overlapped leaves from just about any large tree (Figure 1.3). When there is not an eclipse, these same leaves cast pinhole images of the full solar disc as easily recognizable circular spots onto the ground.

Many myths have been retold of ancient peoples seeing pinhole images inside tents, darkened rooms, and the like, so it would seem that a living knowledge of pinhole images has occurred for tens of thousands of years. An interesting primitive example comes from the book *Life Above the Jungle Floor* by Donald Perry. Perry describes his descent into the cavernous recesses of a 50-foot-tall hollow tree in the rain forest of Costa Rica. His ageless experience could have happened at any point in human history. Perry wrote:

> I climbed a few feet above the floor and turned off the light, again hoping to draw additional animals to the hollow. After several moments I became aware of slight changes in the natural light level within the cavern. For a moment I thought it was my eyes adjusting to the darkness, but I soon realized the phenomenon was due to an opening in the opposite wall. Very weak and

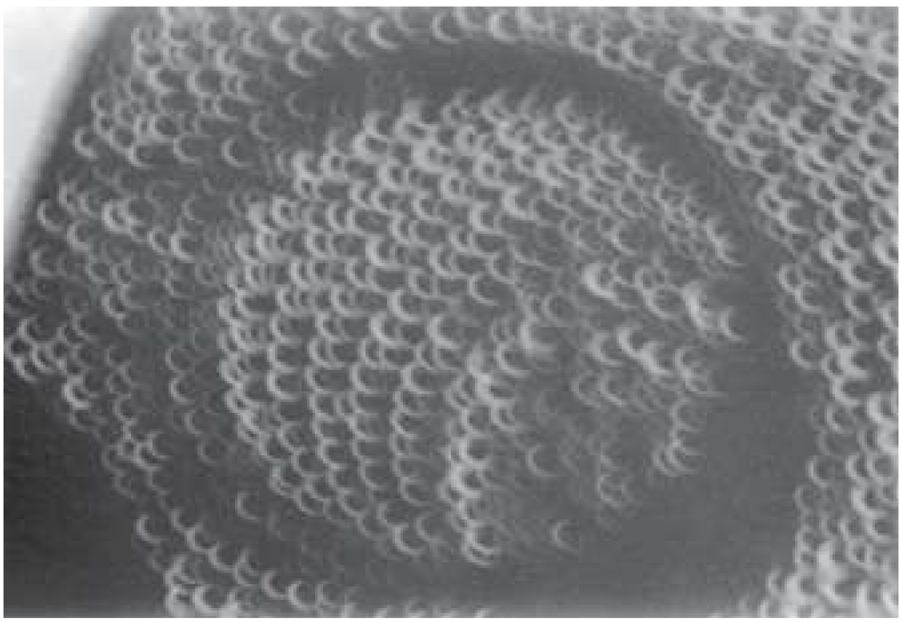

FIGURE 1.2
© Nancy Spencer and Eric Renner, *Pinhole Images of the Solar Eclipse*, May 10, 1994, lens photograph. Pinhole images of the solar eclipse have been projected through holes in a straw hat held about 3 feet above the ground. From the collection at Pinhole Resource.

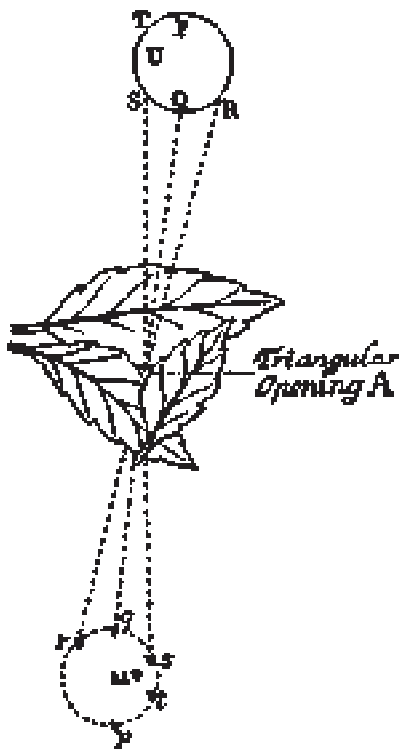

FIGURE 1.3
Drawing, sun's image projected through chinks in leaves. The upper circle represents the sun and the lower circle its pinhole image on the ground. Even though the pinhole is triangular, the image is round. By Sir William Bragg, from *The Universe of Light*, 1933.

> wavering light came through a small, cone-shaped hole three feet above the floor. In effect, the hole and near pitch black cavern constituted a crude optical device. The hole acted as a lens to cast a fuzzy image of the outside world onto a wall . . . . A weak upside down image of Doyly was projected onto the opposite wall . . . . I looked at my watch: five hours had passed, longer than it had seemed . . . . I screamed through the hole as loudly as possible to get Doyly's attention, but my cries were totally muted by the cavern. It was then that the extent of my isolation from the outside world became very real. The rope, my only connection to civilization rose to a very distant tiny exit, and I wondered what would happen if somehow it became untied.[3]

People have always needed to tell time. A straight stick known as a *gnomon*, placed vertically in the ground, will cast a shadow from the sun. Because the shadow is longer in winter and shorter in summer, the top of the shadow cast from the tip of the stick becomes a very basic solar clock, a sundial. Ancient cities and towns had gnomons in public places for telling time (Figure 1.4). Adding a metal disc pierced with a pinhole at the top of the stick gives a more precise measure, because a bright point is created on the ground above the shadow. This bright point is a pinhole image of the sun. The metal disc with a pinhole is known as a *shadow definer*; the entire instrument is known as a *pierced gnomon* (Figure 1.5). Since prehistory, some primitive tribes have used this early type of sundial, even into the 20th century. An elegant sundial with a pierced gnomon extends from a wall in Parma, Italy; the pierced metal disc was made into a sun (Figure 1.6).

In 1152, Eleanor of Aquitaine presented a sundial ring to her lover Henry II so that he would know when to meet for their trysts. Henry had his jewelers make a similar ring for Eleanor, inlaid with diamonds and engraved with the Latin words *carpe diem*, meaning seize the day

FIGURE 1.4
© Gnomon at St. Peter's, Rome, lens photograph by the author. The white line in the foreground is the noon mark placed in true north–south. As the sun's shadow crosses that line it is noon. The white disc at the end of the line represents the winter solstice. The gnomon was originally erected by Augustus of Alexandria.

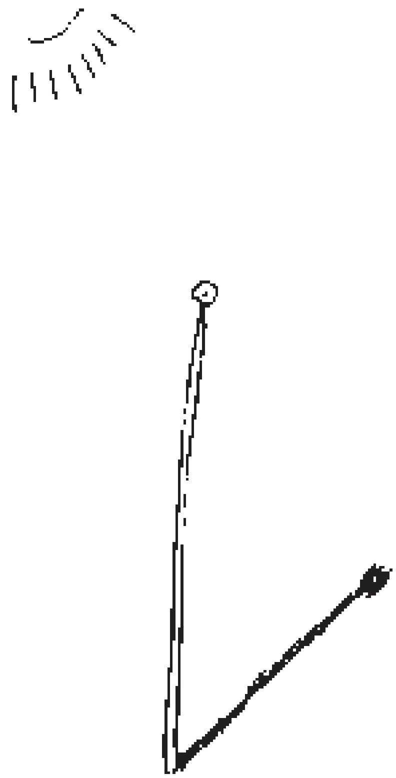

FIGURE 1.5
Pierced Gnomon, drawing by author after Rene R. J. Rohr, *Sundials*, 1965.

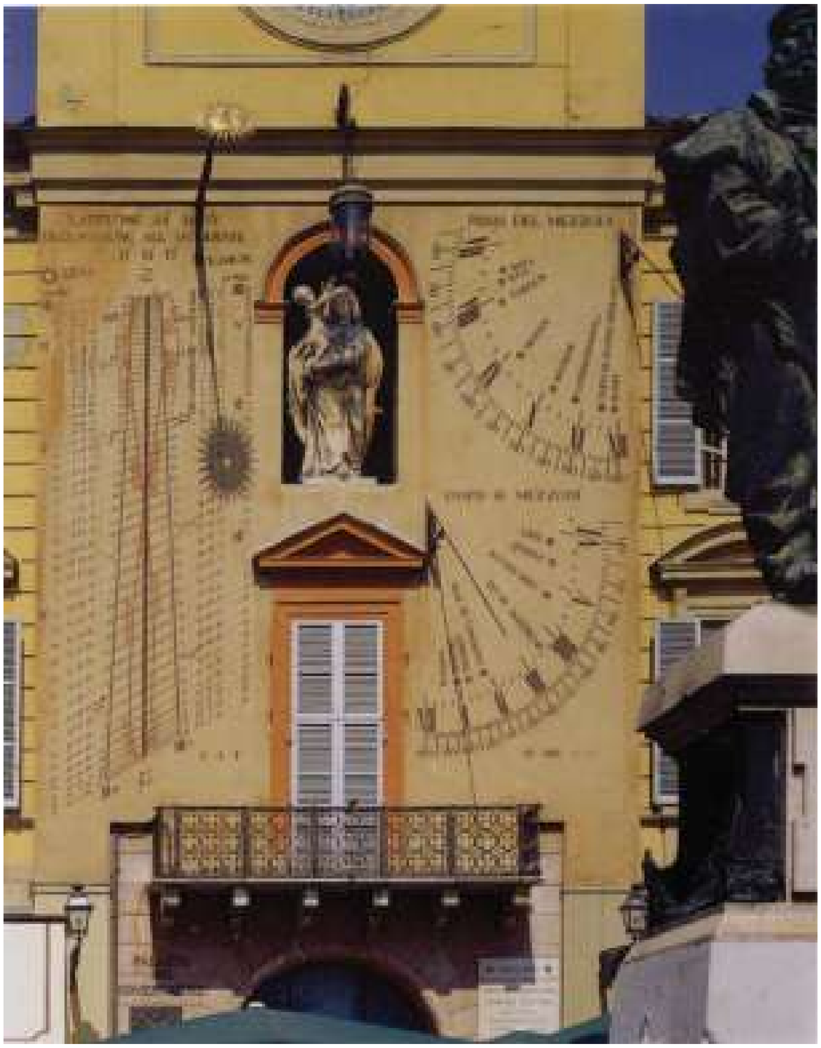

FIGURE 1.6
© Giacomo Medioli, Parma, Sundial, circa 1829, lens photograph, 1998. In the upper left the pierced sun disc extends from the wall, casting a shadow and solar pinhole image to tell time. From the collection at Pinhole Resource, image contributed by Dominique Stroobant.

(or to them: seize one another). The outer band of the miniature sundial was adjustable to place the pinhole in the right position for each month. Holding the ring upright on a sunny day a pinhole image of the sun appeared on the inner surface of the ring where the times of the day are engraved (Figure 1.7).

The ancient astrolabe (in Greek meaning star finder) is one of the oldest instruments, really a computer, that used pinholes for sighting. Hipparchus working in Alexandria and Rhodes in 150 B.C. developed the theory of stereographic projection—the most commonly used projection in the design of the planispheric astrolabe.[4] (Planispheric means that the surface of a sphere has been projected onto a flat surface.) For centuries the astrolabe was the most important tool for the astronomer, astrologer, and surveyor (Figure 1.8). Astrolabes used by mariners were more basic in their design, but still used pinholes or similar sighting mechanics.

The pinhole sights on an astrolabe were on a rotating bar, known as the alidade, on the back of the instrument (Figure 1.9). There were usually two holes: a small hole for use with the sun and a larger hole for stars.[5] Gemma Frisius (1508–1555), a mathematician at the University of Louvain, reinvented planispheric projection for use in astronomer's astrolabes, a design that began to be manufactured in various areas in Europe by the 1500s.[6]

FIGURE 1.7
© Nancy Spencer, *Eleanor of Aquitaine Sundial Ring,* (20th-century reproduction of the original ring), lens photograph, 2007.

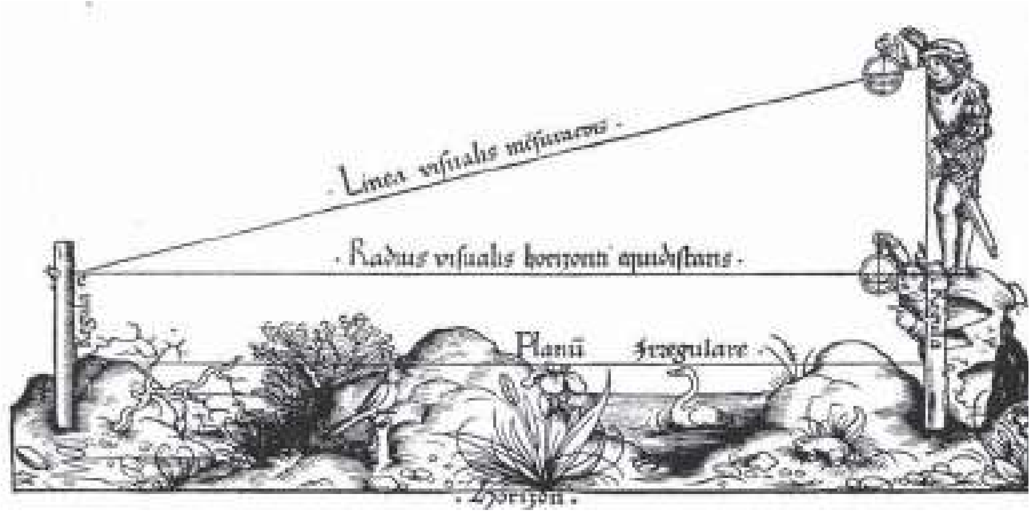

FIGURE 1.8
Drawing, using an astrolabe for surveying, Johann Stoffler, *Elucidatio Fabricae Ususque Astrolabii*, 1513.

Most likely the earliest recorded description of pinhole optics, although cryptic in nature, comes from Mo Ti in China, circa 400 B.C., which is translated as follows:

> CANON: The turning over of the shadow is because the crisscross has a point from which it is prolonged with the shadow.
>
> EXPLANATION: The light's entry into the curve is like the shooting of arrows from a bow. The entry of that which comes from below is upward, the entry of that which comes from high up is downward. The legs cover the light from below, and therefore form a shadow above; the head covers the light from above, and therefore forms a shadow below. This is because at a certain distance there is a point which coincides with the light; therefore the revolution of the shadow is on the inside.[7]

FIGURE 1.9
Astrolabe back showing alidade bar with hinged pinhole sight (lower right, sight is shown flat—in use, the two hinged sights at each end of the bar would be raised to the vertical position), made by Erasmus Habermel, Prague?, circa 1590, lens photograph, courtesy of Museum of the History of Science, University of Oxford, Inventory #38097, astrolabe presented by J. A. Billmeir in 1957.

In the West, the first recorded description of the pinhole comes much later, from Aristotle, circa 330 B.C., in *Problems XV*:

> #6: "Why is it when the sun passes through quadrilaterals, as for instance in wicker-work, it does not produce figures rectangular in shape but circular?

Here, too, is Aristotle's first recorded description of viewing an eclipse using a pinhole:

> #11: Why is it that in an eclipse of the sun, if one looks at it through a sieve or through leaves, such as a plane tree or other broad-leaved tree, or if one joins the fingers of one hand over the fingers of the other [Figure 1.10], the rays are crescent shaped when they reach the earth? Is it for the same reason as that when light shines through a rectangular peephole, it appears circular in the form of a cone?[8]

Aristotle's question in #6 became known in optics as Aristotle's problem. The problem was first solved by Franciscus Maurolycus (1494–1575) in *Photosmi de lumine et umbra* (1521).

An appreciation for the high degree of sophistication in understanding pinhole optics can be gained by studying Figure 1.11, a rarely published light-ray diagram constructed by Anthemius of Tralles in 555 A.D.

Anthemius wrote:

> Similarly, by the construction on the straight line ΔB, we shall show that the summer ray BΞ which falls on the plane mirror on MΞXO will be reflected to A along the straight

FIGURE 1.10
© David Stork, *Pinhole Images of Partially Eclipsed Sun*. Hands are held on top of one another so that pinholes occur between overlapping fingers; hands shown are actually a shadow on ground. From the collection at Pinhole Resource.

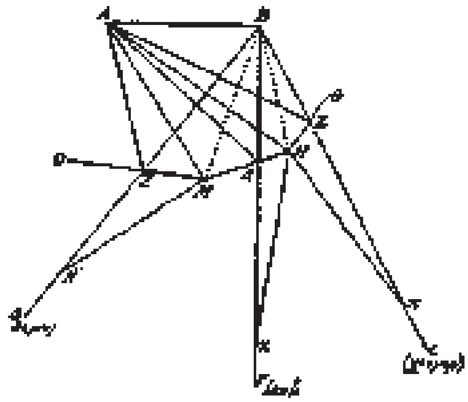

FIGURE 1.11
Anthemius of Tralles, light-ray diagram.

> line ΞA. If then we suppose a hole placed symmetrically about the point B as centre, all the rays falling through the hole, that is through the point B, upon the continuous mirrors already described will be reflected to A.[9]

One of the greatest optical scientists of all time, Ibn al-Haitham (965–1039 A.D.) of Egypt, known in the West as Alhazen, showed the pinhole to be an *instrument*—one that could be placed in the shutter of a darkened laboratory for use in examining solitary light rays. Alhazen's book, *Kitab al-Manazir* (Optical Thesaurus), was published around 1020 A.D. Alhazen says in Theorum 29:

> Light and colour penetrate transparent bodies separately: That lights and colours are not mixed in the air or in transparent bodies is shown by the following. When in one place several candles are put at various different points, all opposite an opening leading into a dark place (*locus obscuras*), with a wall or an opaque body opposite the opening, the lights (*luces*) of these candles appear on the body or that wall separately and corresponding in number to the candles. Each one of them appears opposite one candle on a line passing through the opening.[10]

Alhazen had also said: "The image of the sun at the time of the eclipse, unless it is total, demonstrates that when light passes through a narrow, round hole and is cast on a plane opposite to the hole it takes on the form of a moonsickle." (What a wonderful word: moonsickle.) In centuries to follow, optical scientists were inspired by Alhazen's use of the pinhole. For these scientists, the pinhole, too, became a starting point—*a primary tool for studying sunlight projected from a small aperture*. For instance, the scientists Theodoric of Freiberg (1250–1311) and Kamal al-Din al-Farisi (d.1320) from Persia analyzed sunlight coming from a small pinhole directed on a water-filled glass globe to explain the rainbow's complicated color principles (Figure 1.12A). Both scientists, although thousands of miles apart, worked simultaneously; both admired Alhazen's pinhole ideas. Some centuries later, this same experiment was rediscovered and reinvestigated independently by Antonio de Dominis (1564–1624), René Descartes (1596–1650) (Figure 1.12B), and Johannes Kepler (1571–1630) (Figure 1.12C).

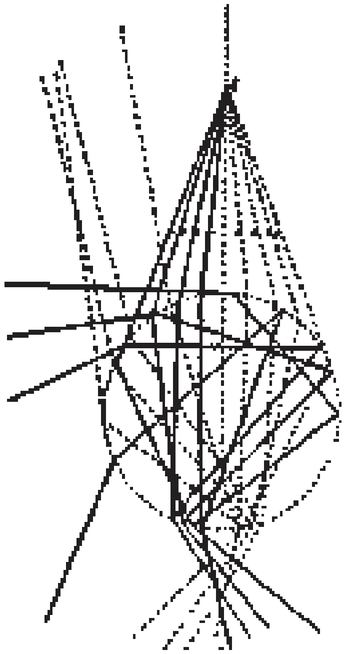

FIGURE 1.12A
Kamal al-Din al-Farisi, ray diagram. Sunlight refracted into a water-filled glass globe, which acts like a raindrop and is internally reflected back to the eye of the viewer. From *Tanquh al-Manazir*, 1310.

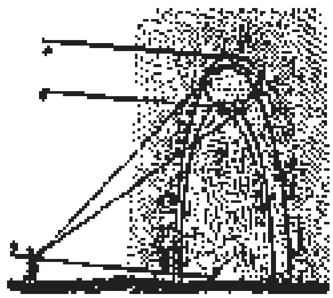

FIGURE 1.12B
René Descartes, ray diagram, showing formation of the rainbow. From *Les Meteores*, 1637.

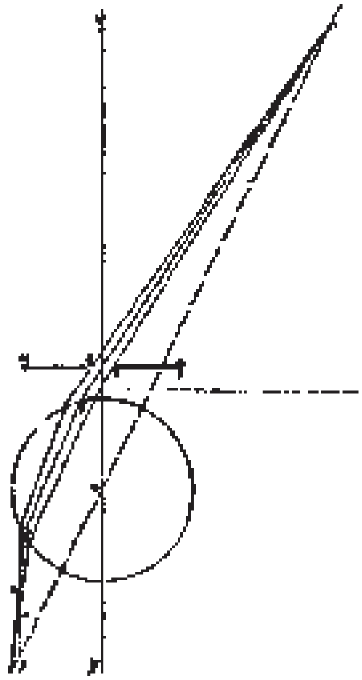

FIGURE 1.12C
Johannes Kepler, ray diagram, showing light from the pinhole point source entering a glass globe filled with water. From *Ad Vitellionem Paralipomena*, 1604.

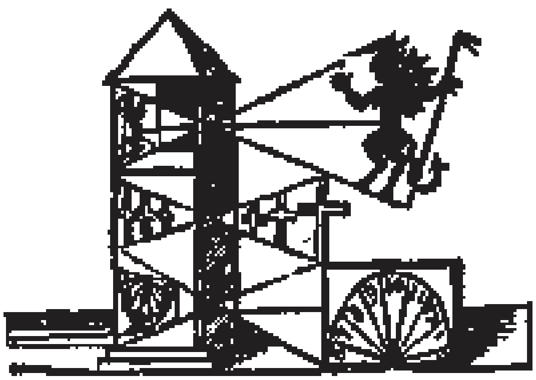

FIGURE 1.13
Roger Bacon, drawing, three-tiered pinhole camera obscura, circa 1300, from *Van Der Camera Obscura zum film*, Werner Nekes, 1992.

THE *CAMERA OBSCURA* AND HUMAN UNDERSTANDING

Certain optical scientists who studied pinhole images were also intrigued by the *camera obscura* (the room itself) where upside down images could be seen projected onto the walls, floor, and ceiling of a completely darkened room. As an archetype, the *camera obscura* is similar to Leonardo's and Plato's darkened cave. Medieval attitudes promoting devil-fear propagandism influenced the scientist–monk Roger Bacon (1219–1292) in his drawing (Figure 1.13) of a three-tiered pinhole *camera obscura* that demonstrated an integration of religious dogma and science. Bacon showed a *camera obscura* as a dark place wherein the devil can magically teleport—through the pinhole. For him the *camera obscura* image represented an evil illusion, dependent upon people's suspicions connected to darkness. When the three pinhole images are reversed inside the *camera obscura*, the devil is still the upper image; however, as reversed, the devil ends up below the crosses representing Christianity. Human intelligence, shown as numbers, reverses to be above the crosses. Historically, it is important to grasp that Bacon has identified human intelligence as something that also gets turned upside down in the *camera obscura*. The point Bacon makes is that a pinhole *camera obscura* in its magical reproduction of an image is a dark place of evil magic, a place where there is proof that the devil exists, therefore, human intelligence, that is, religion, is irrefutable.

Enlightened intellectual thought—even 200 years after Roger Bacon and even coming from those who participated to make the Italian Renaissance—still theoretically combined religious mystery–dogma with human understanding. Both were linked to the *camera obscura* as well as to the *eye*. The most well-known quotation in this regard is Leonardo da Vinci's 1500s "The eye is the window to the soul," mentioned earlier in the chapter.

Later, the English empiricist philosopher John Locke (1632–1704) compared pinhole *camera obscura* imagery to the gleaning of human understanding. In "An Essay Concerning Human Understanding," Locke stated:

> External and internal sensations are the only passages that I can find of knowledge to the understanding. These alone, as far as I can discover, are the windows by which light is let into this dark room. For, methinks, the understanding is not much unlike a closet wholly shut from light, with only some little opening left . . . . to let in external visible resemblances, or some idea of things without; would the pictures coming into such a dark room but stay there and lie so orderly as to be found upon occasion it would very much resemble the understanding of a man.[11]

Suspicions continued to be propagated about sinful illusions being seen within a darkened room, even a tiny darkened room known as the *peep show box* (Figure 1.14), which in itself was a brilliant artistic development that evolved from the pinhole *camera obscura*. (Artistic developments of the peep show box are shown in Chapter 2.)

By the 1700s almost all *cameras obscuras* had lenses rather than a pinhole for projecting an image. The philosopher Jean-Jacques Rousseau (1712–1778) compared the deceptive illusions that could be represented in a painting to the clarity of inner truth obtainable by the lens *camera obscura* likeness. Rousseau qualified the *camera obscura* metaphor as a means to confess all of his innermost thoughts, both "the good, the evil; and in the end everything"[12] as

> If I want to produce a work written with care, like the others, I won't paint myself, I'll paint over myself. This is my portrait, not a book. I shall be working, as it were, in a camera obscura. No art is needed beyond that of tracing exactly the features that I observe there. I am decided, then, upon the style as on the things . . . . I will speak each thing as I feel it, as I see it, without reflection, without embarrassment, without getting bogged down in fine points.[13]

Puritanical religious indoctrination toward illusionist *camera obscura* imagery continued (as it was well engrained in the public mindset), witnessed by a drawing in Johann Arndts's mid-1800s Bible *Wahren Christenthum*. Evil, guilt, sin, and the fall from grace were all reasons for instinctive fear when viewing a *camera obscura* image of the "mysterious" upside down

FIGURE 1.14
Nicolo Cantabella, traveling showman with peep-show box, copper-plate, Augsburg or Nuremburg, Germany, c. 1720. The various items shown at the frame of the image speak to a variety of "sinful practices" that might be seen within.

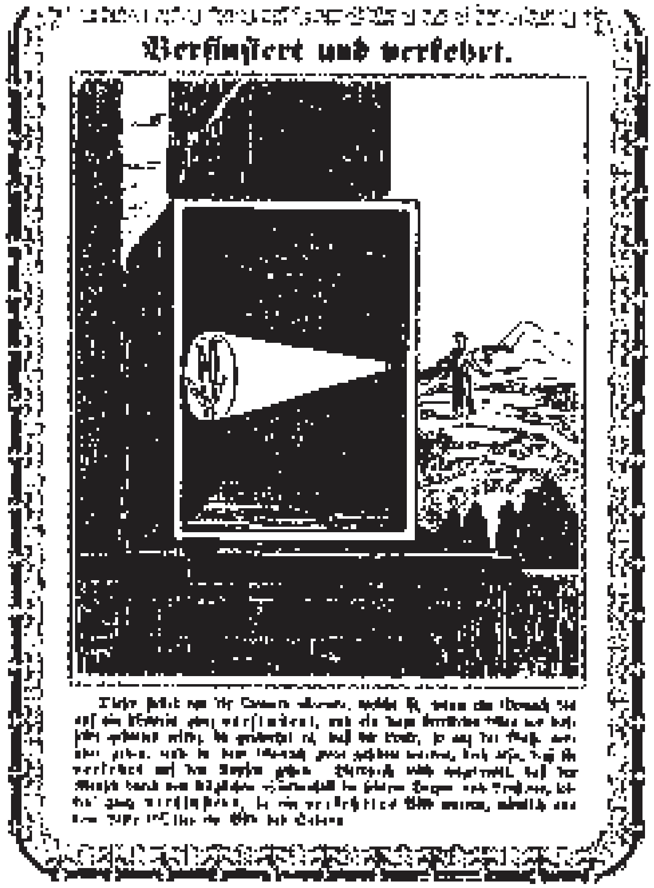

FIGURE 1.15
Etching, lens *camera obscura* and text, from Johann Arndts *Wahren Christenthum*, 1866, p. 23. From the collection at Pinhole Resource.

man. Parishioners reading the caption under what looks to be an ordinary drawing of a lens *camera obscura* (Figure 1.15) would read (as translated from old German) as follows:

> Darkened and Backwards
> This person stands before a camera obscura which is a chamber that has been darkened except for a little hole, and a prepared glass is held before it. Then it happens that the people who are walking past in the alley and can be seen in the chamber, but indeed upside down. Through this it is indicated that man because of his dark fall from grace in his heart and in his mind, unfortunately is lost! Totally dark, even backwards, and upside down. This is transforming an image of God into an image of Satan.[14]

Over all these centuries, from Roger Bacon's 1200s to the early 1800s, many of the illusionist optical devices brought us closer and closer to ***photography***—and then later to the moving image—the *cinema*. Laurent Mannoni in *Eyes, Lies and Illusions* speaks of the multitude of optical developments and their applications that have brought us to the present day. These he correctly labels as "deceptive art" because they fall under the umbrella of mechanisms working within the realm of archetypal darkness and mystery (the religious dogma still applies because these are archetypal motifs). Laurent Mannoni explains:

> The history of deceptive art is punctuated by complex scientific discoveries, by thousands of 'inventions' claimed by an extremely diverse range of personalities: scholars, artists, neurologists, politicians, scientists, Jesuits, technicians, merchants, mechanics, opticians, charlatans, the great and the small of this world. Like the majority of the other art forms, it is impossible to give the first appearance of deceptive art a precise date.[15]

Karl Marx (1818–1883) and Friedrich Engels (1820–1895) recognized the *camera obscura* as an ideal ***parallel*** for change—*a transformation of the balance of forces*. In writing in *The German Ideology* (1845, first published in 1932), Marx and Engels used the analogue of the upside down image in the *camera obscura* and also the upside down image in the human eye to correctly represent medieval superstition, darkness, illogical and irrational thought—all purposely manipulated to be "truth" by religious dogma—as a way to control the masses. This overt institutional control manifested itself through endless capitalism: *the rich over the poor* causing a cultural desperation; the poor are used, therefore abused. Marx and Engels stated that clarity, lightness, logical thought, and well-reasoned truth would come when the upside down image was no longer corrupted by the stranglehold of religion/capitalism. This *transformation of the balance of forces*—this reversal of the upside down image to right side up—would be egalitarian "sharing by all" communism. In this, their now infamous passage from *The German Ideology*, Karl Marx and Friedrich Engels stated:

> If in all ideology men and their circumstances appear upside down in a *camera obscura*, this phenomenon arises just as much from their historical life-process as the inversion of objects on the retina does from their physical life-process.[16]

Many philosophic minds have attempted to unravel the aforementioned Marx/Engels statement and continue to do so, well into the present day. (The quote is generally contributed to Marx.) In her very insightful *Camera Obscura: Of Ideology* (1973, translated into English in 1998) Sarah Kofman states that for Marx the *camera obscura*

> is the very symbol of the veil. Ideology, the camera obscura, here takes on all those connotations which hold true equally for unconscious and mythical thought. Ideology represents real relationships veiled, under cover. It functions, not as a transparent copy obeying laws of perspective, but, rather, as a simulacrum: it disguises, burlesques, blurs real relationships. To this, Marx opposes the values of clarity, light, transparency, truth, rationality. The camera obscura functions, not as a specific technical object whose effects is to present, in inverted form, real relationships, but, rather as an apparatus for occultation, which plunges consciousness into darkness, evil and error, which makes it become dizzy and lose its balance.[17]

Janne Seppanen in the Foreword to *Marja Pirilä—Camera Obscura: Interior Exterior* (2002) analyzed Kofman's explanation of the Marx passage as:

> Camera obscura has also regressed in a philosophical sense into what it always has been in the practices of the common people: a stage of fallacy and hoax. Religion is the crystallized form of ideology which, in the end, puts human destiny in the hands of God and bolsters capitalism by giving a false image of reality and naturalizing the prevailing mode of production and relations of production. In the final analysis, ideology works in such a way that it obscures the relationship between people's consciousness and their

> social existence. People believe that capitalism is an eternal and natural mode of production and, therefore, do not see its historical quality and possibilities for change. Other institutions of the superstructures of society work along the same lines: family, education, politics and the public sphere. Though for Marx, the turning of the image in camera obscura symbolizes the turning of consciousness, ultimately the device was for Marx—according to Kofman—a perfect, clearly seeing eye. In the production relations of capitalism, camera obscura only functioned as the upholder of the fallacy. The fault, therefore, was not in the device per se but in the society that made it the upholder of the fallacy. The situation would change through social activity, when the capitalist manner of production was overturned and the image in camera obscura was turned the right way up.[18]

Friedrich Neitzsche (1844–1900) denounced the use of the the term *camera obscura* for unconsciousness/consciousness versus darkness/lightness—using two opposites renders the *camera obscura* metaphor irrevelevant—therefore useless. He proclaimed in *Twilight of the Idols* (1888):

> *Moral for psychologists.* Not to go in for backstairs psychology. Never to observe in order to observe! That gives a false perspective, leads to squinting and something forced and exaggerated. Experience as the *wish* to experience does not succeed. One *must* not eye oneself while having an experience; else the eye becomes 'an evil eye.' A born psychologist guards instinctively against seeing in order to see; the same is true of the born painter. He never works 'from nature,' he leaves it to his instinct, to his *camera obscura*, to shift through and express the 'case,' 'nature,' that which is 'experienced' . . . . Nature, estimated artistically, is no model. It exaggerates, it distorts, it leaves gaps. Nature is *chance.* To study 'from nature,' seems to me to be a bad sign: it betrays submission, weakness, fatalism; this lying in the dust before *petits faits* is unworthy of a whole artist. To see *what is*—that is the mark of another kind of spirit, the anti-artistic, the factual. One must know *who* one is.[19]

Although Neitzsche stated that the *camera obscura* Marx metaphor was irrelevant, the ***camera*** as an object has remained an example of *deceptive* art. It is still an updated archetypal motif with its mysterious imaging capacity; its lens remains the *eye* that sees. The camera's usual color black on its outside continues to suggest darkness within. For what other reason would a camera be black on its outside? The proverbial "black box" has always presented questions. What might it do? If it makes a picture, does that picture take the person's soul away? Could a black box be used for mind control? Is it an *influencing machine*? In his article "The Art of Mind Control" published in the outsider art magazine *Raw Vision,* Mike Jay described a cautionary drawing by prisoner Friedrich Fent whose influencing machine looked much like a pinhole camera (Figure 1.16). Jay wrote:

> The former sign painter and decorator Friedrich Fent, for example, who was transferred to a mental hospital in 1910 while serving a prison term for sexual abuse of his stepdaughter created his oeuvre by taking the artwork from advertisements and book jackets and twisting it to reveal the influencing machines that were hidden within the image [Figure 1.16]. Thus a prancing devil from a newspaper ad for storage batteries is given a mysterious black box which transmits the disembodied voices that Fent is hearing in his head; and the cover of a popular book on hypnosis is customized to include a figure trapped in a hypnotic beam.[20]

If we make a quantum leap ahead, well into to the 20th century, when *camera obscura* was no longer a word in common usage because the word ***camera*** without the attached word *obscura* had obsolesced it, we arrive at Albert Einstein who said "It is not a long step from thinking of matter as an electronic ghost to thinking of it as the objectified image of thought."[21]

FIGURE 1.16
Friedrich Fent, *To the Devil with the Whole Lot of Auto-Suggestion*, ink and pencil on paper, 13 × 8 inch, 1910, courtesy of Prinzhorn Collection.

Examples of Einstein's conceptualized "objectified images of thought" might well be the controversial *thoughtographs* produced by Ted Serios in the early to mid-1960s, who was studied extensively by Jule Eisenbud, M.D., a trained psychiatrist of the paranormal as well as other scientists and doctors. Their two years of close observations could not disprove Serios' mental (and physical) ability to make an image appear on film. The camera of choice for Serios was a Polaroid 95 using type 47 (3000 ASA) film. Even with its lens system removed, or with the outer lens covered with tape—nor did Serios have to hold the camera to click the shutter (Figure 1.17)—he could make an image sometimes appear on the film. (He also made many nonimages the scientists called "blackies" and "whities".) When he did create an image, it usually had a soft, often blurred, mysterious dream-like quality, *quite similar to a pinhole image,* particularly when compared to a sharply focused lens image.

Because of this similarity, is it possible to say that *dream* imagery created in the mind, which everyone has, more or less, looks most like pinhole imagery?

Jule Eisenbud, M.D., was educated at Columbia College and Columbia College of Physicians and Surgeons where he received both the Doctor of Medicine and Doctor of Medical Science degrees. His "Ted Serios" research project was well documented and Eisenbud was certainly aware of the pitfalls of paranormal study. By 1966, Eisenbud published *The World of Ted*

FIGURE 1.17
Ted Serios, *Thoughtography*, 3½ × 4½-inch Polaroid type 47, 1966. Courtesy of The Photography Collections, University of Maryland, Baltimore County; © University of Maryland, Baltimore County 2007. In this image, Serios had no physical contact with the camera, which was held in turn by Dr. James A. Hurry and Dr. Jule Eisenbud.

Serios: "Thoughtographic" Studies of an Extraordinary Mind.[22] It is a 40-year-old book worth consideration.

If we are capable of accepting that psychic phenomena does exist, then there is no reason to believe that it could not be updated to include photography as one of its many outlets.

NOON-MARKS IN ITALIAN RENAISSANCE CATHEDRALS

A cathedral is a very large darkened room, generally absent of most daylight, thus supplying it with an aura of mystery. When a large pinhole is made in its ceiling or high on a vertical wall, the cathedral becomes an ideal *camera obscura*. In 1475, at the age of 78, the early Renaissance mathematician and astronomer Paolo Toscanelli placed a bronze plate with an approximate 1½-inch-diameter pinhole at the juncture of Filippo Brunelleschi's dome and lantern in the Duomo in Florence, Italy. On the floor he placed a round marble disc that designated noon at the summer solstice, June 21st (Figure 1.18). A *solar image* is projected through this large pinhole on sunny days and is visible more than 300 feet below on the floor of the cathedral. It was Toscanelli who enlightened Christopher Columbus, the Mediterranean sailor and slave trader-turned brutal explorer, that he could sail west to find the east (brutal because Columbus cut off a hand of those Caribbean native peoples who did not find him gold).

In 1756 a brass meridian line was meticulously inset into the floor of the Duomo, aimed and perfectly leveled in a true north–south direction. This line is known as a *noon-mark*. At noon, as the sun traverses the sky, a solar image bisects this meridian line. Technologically, the noon-mark in a darkened cathedral was an advancement over the open-air *pierced gnomon*—a more visible solar image could be studied and time calculated more precisely.

FIGURE 1.18
Small circular marble disc within larger circular marble disc, Duomo, Florence, lens photograph by the author. The smaller disc was placed by Paolo Toscanelli in 1472. The larger disc matches the true size of the solar image at the summer solstice; it was placed in 1510.

Toscanelli's pinhole is still used architecturally to see if the building and its massive dome have shifted. If you want to see the meridian line, it is uncovered at the summer solstice; the pinhole is available to see on Sundays when the curtains on the cupola are drawn back—at least those were the strict rules a decade ago when I was there.

The ceiling of the Basilica di San Petronio in Bologna contains a beautifully figured pinhole (Figure 1.19A) in the ceiling 120 feet above the marbled floor. It projects an image of the sun 12 inches in diameter onto the floor (Figure 1.19B). That solar image crosses a 90-foot-long noon-mark meridian line. Both the pinhole and the noon-mark were designed by Giandomenico Cassini in 1655. Because the sun is higher in the sky in the summer and lower in the winter, ecclesiastical holidays, shown as inscriptions along the meridian line, are lit by the solar disc on the correct days. William Livingston, a solar astronomer from Kitt Peak Observatory, Tucson, Arizona, studied the San Petronio solar image transiting the floor. He has calculated that the solar image moves its own diameter in 120 seconds, or one-tenth of an inch per second. It is actually feasible to set your watch—or, back then, your water-clock—to a 1-second accuracy![23]

The most historically important meridian line/pinhole is in Rome in the Tower of Winds at the Vatican (Figures 1.20A and 1.20B), situated in a room atop the Vatican Museum. The pinhole is clearly visible as a hole in the mouth of the God of the South Wind, painted almost at the top of *La Tempesta sedata* on the south wall. In 1580, using this pinhole image of the sun, Ignatio Danti and the papal astronomers showed Pope Gregory XIII that the spring equinox fell incorrectly on March 11th, rather than on March 21st. This was because the Julian calendar provided a year of 365 and 1/4 days, which is 11 minutes 14 seconds longer than the true solar year. This difference had led to a gradual change in the calendar date of the equinox, so that by 1580 the calendar date was 10 days earlier than the equinox. By 1582, after careful consideration, Gregory XIII corrected the Julian calendar by 10 days, thus creating his new Gregorian calendar. The Pope decreed that October 5 in the outmoded Julian calendar would become October 15 in the new Gregorian calendar so that the March equinox of 1583 fell on the correct day, March 21. Under the Julian calendar, a single day was gained in about 400 years. To correct this discrepancy, the Gregorian calendar omits the additional day in February in century years not divisible by 400. Thus 1600 was a leap year, but 1700, 1800, and 1900 were common years. The year 2000 was a leap year.

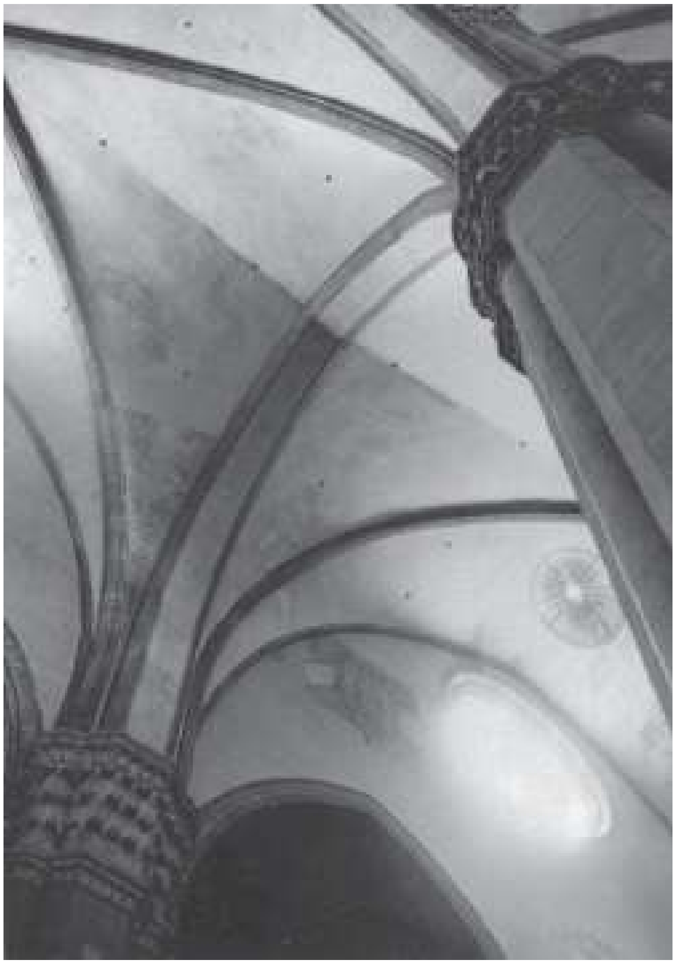

FIGURE 1.19A
© W. Livingston, *View Upward,* Basilica di San Petronio, Bologna, pinhole in ray figure, center right, lens photograph, courtesy of National Optical Astronomy Observatories, Tucson.

FIGURE 1.19B
© W. Livingston, *Projected Solar Image,* Basilica di San Petronio, Bologna. Solar image is crossing the noon-mark on marbled floor; some distortion results from the camera angle. Lens photograph, courtesy of National Optical Astronomy Observatories, Tucson.

FIGURE 1.20A
© Father Carreira, recreation of the 1582 solar pinhole image for reformation of the Julian calendar. Reconstructed drawing in a photograph, Vatican.

Noon-marks with pinholes can be found in many cathedrals and scientific buildings throughout Europe. St. Sulpice in Paris has one, as does the castle El Escorial outside Madrid. One of the most beautiful and easy to visit is the still semifunctioning one in the cathedral S. Maria degli Angeli in Rome, a brief walk from the main train station. There are also ones in the Duomo in Milan, the Duomo in Acireale, Santa Maria Novella in Florence (the latter no longer in use), Catania, Padua, Parma, Siena, Venice, and Marseilles. With some luck, some of these can also be viewed.

Information about meridians and noon-marks can be gleaned from J. L. Heilbron's book *The Sun in the Church*. Heilbron mentions that "by decree of February 22 1836, the king of Belgium ordered that every principle town in his realm be furnished with an accurate *meridiana* in a cathedral, municipal building, or other public place."[24]

The astronomer Gemma Frisius (mentioned earlier for his design of astrolabes) used the pinhole in his darkened room to study the solar eclipse of 1544 (Figure 1.21). The room and

FIGURE 1.20B
© Vatican secret archives, *La Tempesta sedata*, on the south wall of the Tower of Winds; pinhole in the mouth of the God of the South Wind at top right.

eclipse are figured in *De Radio Astronomica et Geometrico* (1545); this is apparently the first published illustration of a pinhole *camera obscura*. The term *camera obscura* was coined by Johannes Kepler; that is, *camera* = room, *obscura* = dark. After about 1570, a *camera obscura* referred to a box, tent, or room with a lens aperture used by artists to draw the landscape. A lens made the image brighter than a pinhole and focused it to a specific distance. Many fascinating *camera obscuras* are shown in John Hammond's *The Camera Obscura: A Chronicle* (1981), Adam Hilger Ltd.

Gemma Frisius also used a *camera obscura* to study sunspots, small dark areas that appear from time to time on the sun. That Frisius could actually observe these sunspots by viewing the pinhole's projected solar image (Figure 1.22) was proven by the late 20th-century solar astronomer Ronald Giovanelli from Australia, who duplicated Frisius's apparatus and experiment.[25] The famous astronomer Tycho Brahe can be seen in his laboratory studying solar pinhole images that have transited the pinhole in the upper left-hand corner of Figure 1.23.

THE PINHOLE IN THE WAVE THEORY OF LIGHT

Optical scientists also investigated optical properties within the cone of light issuing from the pinhole. Over the centuries, these studies were to be paramount for proving the wave theory of light. What follows is a very brief chronological documentation of scientists' experiments with diffraction and interference phenomena inherent in wave theory.

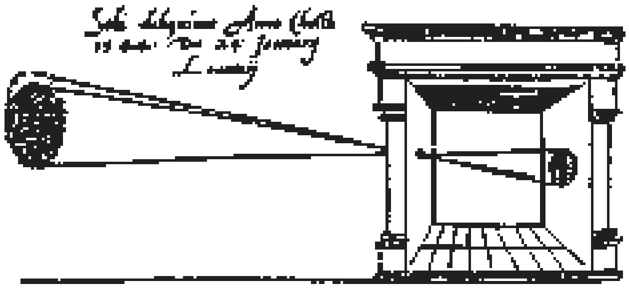

FIGURE 1.21
Gemma Frisius, observing the solar eclipse, January 24, 1544. From *De Radio Astronomica et Geometrico*, 1545.

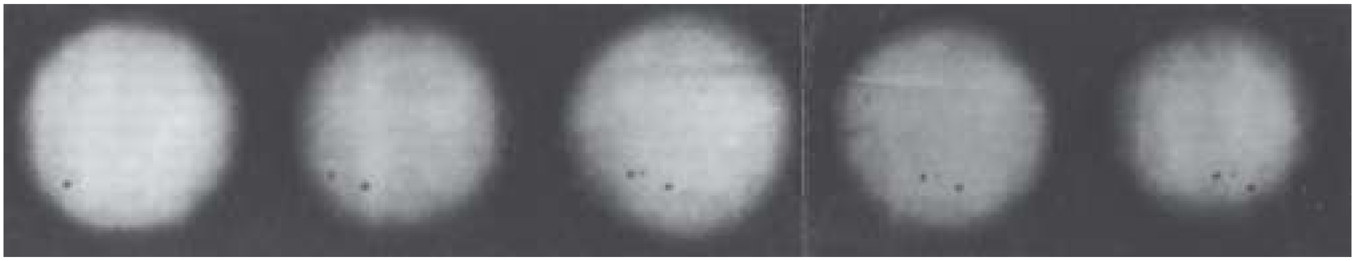

FIGURE 1.22
© Ronald Giovanelli, pinhole images of the sun showing a sunspot. From *Secrets of the Sun* (1984) by the late Ronald Giovanelli. Reproduced by permission, Cambridge University Press.

FIGURE 1.23
Etching, Tycho Brahe in his observatory, at age 40 in 1587. The pinhole is in the wall in the upper left-hand corner, and two virtual marks of the sun are shown on the mural quadrant at 75° and 20–25°. Collection of the British Museum, London.

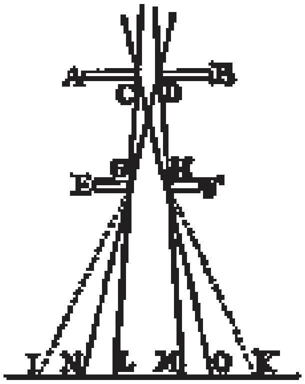

FIGURE 1.24
Francesco Grimaldi, diffraction of light by a pinhole. From *Physico-mathesis de lumine, coloribus, et iride, aliisque adnexis libri duo*, 1665.

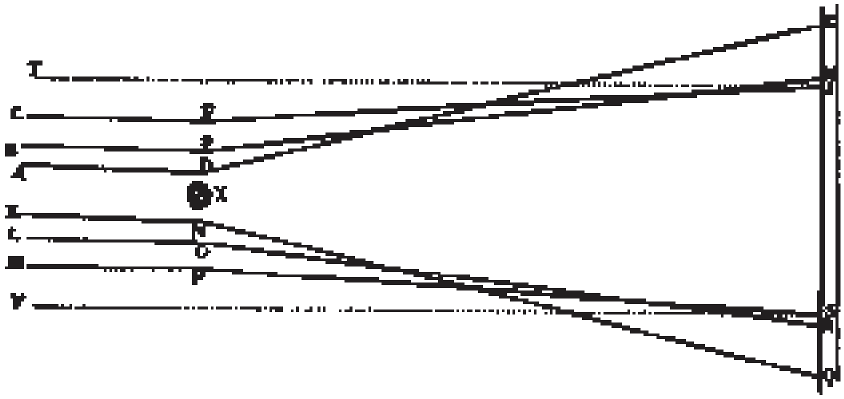

FIGURE 1.25
Isaac Newton, circle X represents the middle of the hair. From *Opticks* Part 1, Book 3, 1730.

Diffraction

The first accurate description of diffraction, where light actually bends after grazing an edge (Figure 1.24), comes from Francesco Grimaldi (1618–1663) in his *Physico-mathesis de lumine, coloribus, et iride*,[26] published in 1665. In Grimaldi's experiment, light from the sun entered his darkened laboratory through a very small pinhole (Figure 1.24, CD). Light from this pinhole had to pass through a second small pinhole (Figure 1.24, GH) placed in an opaque screen. Light having passed through both pinholes would then fall on a white screen (Figure 1.24, IK). If light propagation remained in straight lines after grazing an edge, light would be confined in area N to O. However, Grimaldi observed light in the areas beyond N and O, all the way out to IK. This proved diffraction occurs. Light is bent slightly after grazing the edge of an obstacle—in this case, two pinholes.

In another experiment, Grimaldi admitted light into his darkened room through two neighboring pinholes and received this light onto a white screen. Projected onto the screen were two circular pinhole images of the sun, each surrounded by a feebly illuminated ring. By placing the screen at a certain distance from the two pinholes, Grimaldi could overlap the edges of the outer rings so that the outer edge of one ring was tangent to the outer edge of the image on the other ring. Curiously, light in this overlapping portion was less brilliant than in other areas around the rings. This phenomenon would be known later as *interference*.

Isaac Newton (1642–1727) in *Opticks* (part 1 of the third book) wrote the following:

> Grimaldo [sic] has inform'd us, that if a beam of the Sun's Light be let into a dark Room through a very small hole, the Shadows of things in this Light will be larger than they ought to be if the Rays went on by the Bodies in straight lines and that these Shadows have three parallel Fringes, Bands or Ranks of color'd Light adjacent to them. But if the Hole be enlarged the Fringes grow broad and run into one another, so that they cannot be distinguish'd. These broad shadows and Fringes have been reckon'd by some to proceed from the ordinary refraction of the Air but without due examination of the Matter. For the circumstances of the Phænomenon, so far as I have observed them, are as follows.

> Observation: I made in a piece of Lead a small Hole with a Pin, whose breadth was the 42d part of an Inch. For 21 of those Pins laid together took up the breadth of half an Inch. Through this Hole I let into my darken'd Chamber a beam of the Sun's Light, and found that the Shadows of Hairs, Thred, Pins, Straws, and such like slender Substances placed in this beam of Light, were considerably broader than they ought to be, if the

> Rays of Light passed on by these Bodies in right Lines. And particularly a Hair of a Man's Head [Figure 1.25], whose breadth was but the 280th part of an Inch, being held in this Light, at the distance of about twelve Feet from the Hole, did cast a Shadow which at the distance of four Inches from the Hair was the sixtieth part of an Inch broad, that is, above four times broader than the Hair.[27]

Interference

More than a century after Newton's work, Thomas Young (1773–1839) modified Grimaldi's experiment and observed true interference of light. Young admitted sunlight through a pinhole and then received this diverging cone of sunlight onto two other pinholes placed in an opaque screen beyond the first pinhole (Figure 1.26). Each of these two pinholes also cast a diverging cone of light onto a screen. Where their cones of light overlapped on the screen, Young observed dark and light bands. In this experiment, the two pinholes lie on the wave front of the disturbances coming from the first pinhole, consequently they are in the same phase.[28] Thomas Young stated eloquently:

> It was in May, 1801, that I discovered, by reflecting on the beautiful experiments of Newton, a law which appears to me to account for a greater variety of interesting phenomena than any other optical principle that has yet been made known. I shall endeavor to explain this law by a comparison.
>
> Suppose a number of equal waves of water to move upon the surface of a stagnant lake, with a certain constant velosity [sic], and to enter a narrow channel leading out of the lake. Suppose then another similar cause to have excited another equal series of waves, which arrives at the same channel, with the same velosity, and at the same time with the first. Neither series of waves will destroy the other, but their effects will be combined: if they enter the channel in such a manner that the elevations of one series coincide with those of the other, they must together produce a series of greater joint elevations; but if the elevations of one series are so situated as to correspond to the depressions of the other, they must exactly fill up those depressions, and the surface of the water must remain smooth; at least I can discover no alternative, either from theory or experiment.
>
> Now I maintain that similar effects take place whenever two portions of light are thus mixed; and this I call the general law of the interference of light.[29]

The final "wave theory" comes from Augustin Fresnel (1788–1827), who concluded in the following in *Memoire sur de la defraction de la lumière*, 1819:

> Let AG be the aperture through which the light passes [Figure 1.27]. I shall at first suppose that it is sufficiently narrow for the dark bands of the first order to fall inside the

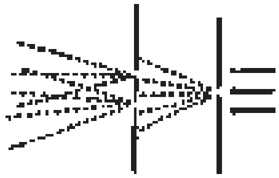

FIGURE 1.26
Robert W. Wood, the work of Thomas Young, sunlight projected through one pinhole onto two pinholes proves interference of light. From *Physical Optics*, 1934.

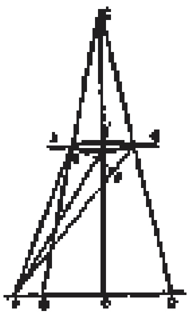

FIGURE 1.27
Augustin Fresnel, aperture through which light passes. From *Memoire sur la defraction de la lumière*, 1819.

geometrical shadow of the screen, and at the same time be fairly distant from the edges B and D. Let P be the darkest point in one of these two bands; it is then easily seen that this must correspond to a difference of one whole wavelength between the two extreme rays AP and GP. Let us now imagine another ray, PI, drawn in such a way that its length shall be a mean between the other two. Then, on account of its marked inclination to the arc AIG, the point I will fall almost exactly in the middle. We now have the arc divided into two parts, whose corresponding elements are almost exactly equal, and send to the point P vibrations in exactly opposite phases, so that these must annul each other.

By the same reasoning it is easily seen that the darkest points in the other dark bands also correspond to differences of an even number of half wave-lengths between the two rays which come from the edges of the aperture; and, in like manner, the brightest points of the bright bands correspond to differences of an uneven number of half wave-lengths—that is to say, their positions are exactly reversed as compared with those which are deduced from the interference of the limiting rays on the hypothesis that these alone are concerned in the production of fringes. This is true with the exception of the point at the middle, which, on either hypothesis, must be bright. The inference deduced from the theory that the fringes result from the super position of all the disturbances from all parts of the arc AG are verified by experiments, which at the same time disprove the theory which looks upon these bands as produced only by rays inflected and reflected at the edges of the diaphragm. These are precisely the phenomena which first led me to recognize the insufficiency of this hypothesis, and suggested the fundamental principle of the theory which I have just explained—namely, the principle of Huygens combined with the principle of interference.[30]

THE PINHOLE AND THE EYE

For decades, ophthalmologists have used an elegant, yet very simple pinhole instrument, known as an *occluder* (Figure 1.29), to determine whether decreased visual acuity can be

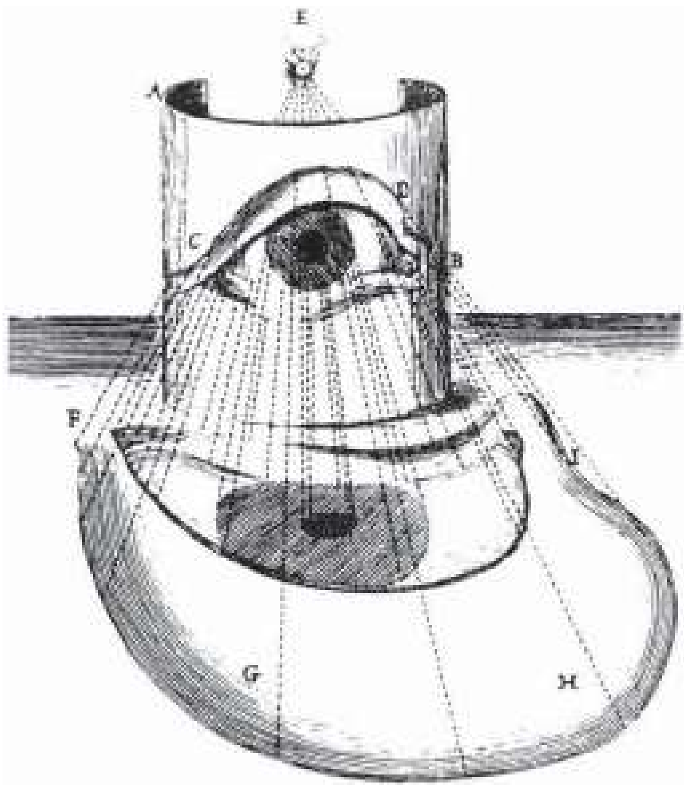

FIGURE 1.28
Mario Bettini, explanation for a cylindrical anamorph, 1642, from Jurgis Baltrusaitis, *Anamorfosi* (Milano: Adelphi Edizioni, 1990),184.

FIGURE 1.29
A multiple pinhole disc occluder manufactured by Western Optical. Reproduced by permission of Western Optical, Seattle.

helped by prescribing eyeglasses for the correction of a refractive error. The occluder is held closely in front of one eye while holding an opaque card over the other eye. If the patient can see clearly while looking through a pinhole in the occluder, eyeglasses can be prescribed; if not, a medical or surgical correction is necessary.

While looking through a pinhole in the occluder, a person's cone of vision is narrowed so that the image enters the viewer's eye only through the center of the lens. Projected onto the retina is a pinhole image. If a person's eyes can be corrected by glasses, then any distance, close or far, is in focus when an occluder is being used.

To try this, push a large-shafted needle through an opaque card. If you wear glasses, take them off. Place your homemade occluder up to your eye, making sure to hold your free hand in front of your other eye. You should be able to see clearly through the pinhole. Because the image you are seeing is a pinhole image, you will be able to see objects at close range. The pinhole can act as a magnifier! To try this, use the occluder while holding this page very close to your eye. Even if you don't wear glasses, you can magnify the type held at close range while looking through the occluder. After you remove the occluder, you will see that you have been viewing an area that is normally blurry.

Many centuries ago, Leonardo da Vinci (1452–1519) made use of this same principle. In *Manuscript D* following 5r, Leonardo writes:

> If you will make a hole as small as possible in a sheet of paper and then bring it as near as possible to the eye, and if then you look at a star through this hole, you are making use of only a small part of the pupil, which sees this star with a wide space of sky around it and sees it so small that hardly anything could be smaller. And if you make the hole near to the edge of the said paper, you will be able to see the same star with the other eye at the same time, and it will appear to you to be large, and thus in the same time with your two eyes you will see the one star twice, and once it will be very small and the other time very large.[31]

In a drawing by Cornelius Meyer (1689), it can be seen that pinholes were used in spectacles (Figure 1.30). Each lens was opaque and a pinhole was placed in the middle, offering the viewer who might have been nearsighted a sharper view. The Innuit have known of the advantages of pinhole glasses for many centuries, shown by the following text from *A Yellow Raft in Blue Water*, by the late Michael Dorris:

> In school I had been warned about snow blindness. I remember learning the Eskimos wore goggles made out of a seal's stomach. They stretched swatches of it across a frame and used a bone needle to punch pinholes to look through. Without protection people saw strange things, saw too much, too wide.[32]

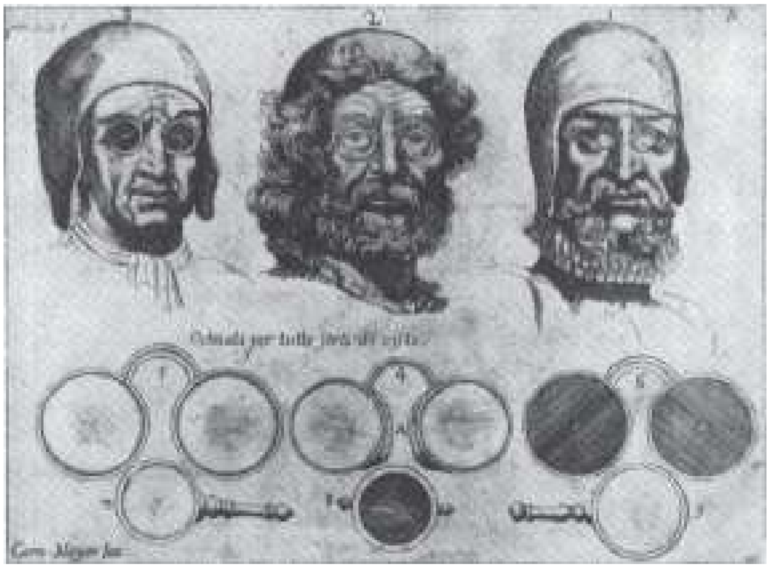

FIGURE 1.30
Cornelius Meyer, *Spectacles for all Manners of Sight,* drawing. Note that the man on the left is wearing pinhole glasses, shown in a detail on the lower right. From Gomar Wouters, 1689.

FIGURE 1.31
Contemporary pinhole glasses, lens photograph.

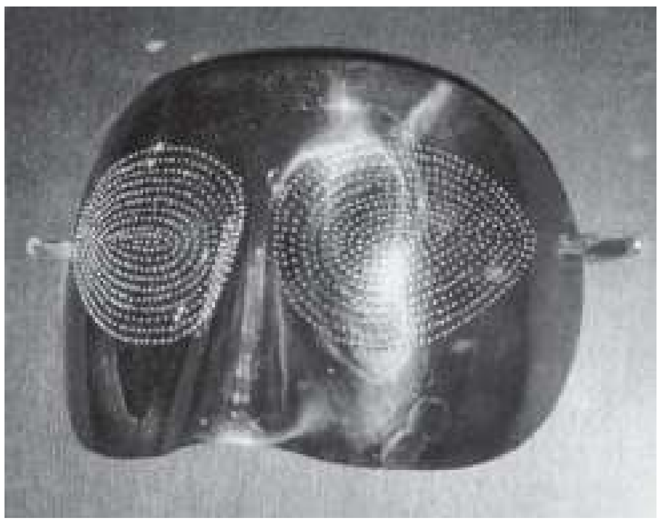

FIGURE 1.32
© Man Ray, *Pinhole Mask,* silver, approximately 7 inches wide. *Optic Topic* series, 1974. Lens photograph by Jorge Mònaco. From the collection at Pinhole Resource.

In the recent widely acclaimed Zacharias Kunuk film *The Fast Runner* (2002), slit coverings are worn by the Innuit to protect their eyes from snow blindness.

Updated 20th-century versions of pinhole glasses promoting strengthened eyesight (Figure 1.31) have been available commercially for several decades.

In 1974, in a playful combination of the techno/humor/science/art Man Ray (1890–1976) completed his series *Optic-Topic* when he was 84. Never has his complete series of devices been published fully in any book, and his *Pinhole Mask* (Figure 1.32) is little known. There were possibly 100 of these masks made in silver and gold (I was fortunate enough to see one in a exhibition in Buenos Aires; later I read of one available through a gallery in Paris). The mask is face sized and the pinholes can be used for viewing.

RESEARCH INTO OPTIMAL PINHOLES

There is some conjecture (undoubtedly in jest) that the first photograph by Niépce, an 8-hour exposure made in 1826, might just be pinhole.[33]

Historically, we do know that by 1857, Joseph Petzval was apparently the first to attempt to find, by mathematical formula, the *optimal pinhole diameter for the sharpest definition in a pinhole image*. The optimal formula was achieved about 30 years later in the 1880s by the Nobel Prize winner Lord Rayleigh (John William Strutt, 1842–1919). For 10 years, Rayleigh worked with pinhole formulas, hoping that pinhole apertures could be used appropriately in telescopes because large glass lenses were so expensive. His optimal pinhole formula is still used today. Rayleigh wrote of his work in *Nature*, 1891:

> What, then, is the best size of the aperture? That is the important question in dealing with pin-hole photography. It was first considered by Prof. Petzval of Vienna, and he arrived at the result indicated by the formula, $2r2 = fl$, where $2r$ is the diameter of the aperture, l the wavelength of light and f the focal length, or, rather simply the distance between the aperture and the screen upon which the image is formed.
>
> His reasoning, however, though ingenious, is not sound, regarded as an attempt at an accurate solution of the question. In fact, it is only lately that the mathematical problem of the diffraction of light by a circular hole has been sufficiently worked out to enable the question to be solved. The mathematician to whom we owe this achievement is Prof. Lommel. I have adopted his results to the problem of pin-hole photography. The general conclusion is that the hole may advantageously be enlarged beyond that given by Petzval's rule. A suitable radius is $r = fl$.
>
> I will not detain you further than just to show you one application of pin-hole photography on a different scale from the usual. The definition improves as the aperture increases; but in the absence of a lens the augmented aperture entails a greatly extended focal length. The limits of an ordinary portable camera are thus soon passed. The original of the transparency now to be thrown upon the screen was taken in an ordinary room, carefully darkened. The aperture (in the shutter) was 0.07 inch, and the distance of the 12×10 plate from the aperture was 7 feet. The resulting picture of a group of cedars [Figure 1.33] shows nearly as much detail as could be seen direct from the place in question.[34]

In 1889, Lord Rayleigh had shown that the optimal pinhole photographic image could "be at least as well defined as that received upon the retina."[35] This means the optimal pinhole, designed for a specific focal length, projects an image that equals the sharpness produced by the lens in each of our eyes. Even though the biconvex lens in each of our eyes accommodates (changes shape slightly for focusing at different distances), modern-day camera lenses will actually focus to a point sharper than our eyes can see. The accompanying pinhole photograph in Figure 1.34, by the late mathematician Roy Hines (1929–1981), is a sharp pinhole image as he was attempting to make it optimally sharp.

Anyone wishing to make an optimally sharp pinhole image should be using the thinnest metal and the cleanest-edged, optimally sized pinhole possible. The metal that edges the pinhole should be sanded with the finest emery paper to the point where the metal is as absolutely thin as practical. Just having the perfect pinhole is not enough. One should have a thorough knowledge of photography—film, developers, and printing techniques—and, most important, a knowledge of light and how the photographic materials selected will respond to the best lighting moment.

FIGURE 1.33
© Lord Rayleigh, *A Group of Cedars,* pinhole photograph, circa 1890. Printed by the author from a copy negative of the original print, courtesy of Hon. G. R. Strutt, John William Strutt archive.

FIGURE 1.34
© Roy Hines, *Gravestone of Lidian Emerson,* Sleepy Hollow Cemetery, Concord, MA, 8 × 10-inch flat-back camera, circa 1977. From the collection at Pinhole Resource.

TWENTIETH-CENTURY PINHOLE IMAGING IN HIGH-ENERGY PHYSICS

Figure 1.35 of the Trinity site atomic bomb test is not an image using X-ray film to photograph high-energy particles as they explode—it is probably the first pinhole image of the atomic bomb mushroom cloud in New Mexico, undoubtedly made with a view-camera with a pinhole attached to its lens board rather than a lens. Who knows why it was a pinhole image?

With the advent of nuclear energy in the 1940s, pinhole cameras began to find their way into nuclear physics to image high-energy particles because it was discovered that a photographic lens *absorbs* rather than projects high-energy X-rays or gamma rays, whereas a pinhole will produce an image.

The idea of imaging high-energy X-rays and gamma rays from the sun, black holes, and exploding stars using pinhole cameras placed on space vehicles began in the late 1950s. The first soft X-ray pinhole photograph of the sun was achieved on April 19, 1960, when a set of pinhole cameras was flown on an Aerobee-Hi Rocket. Richard Blake, one of the designers of the pinhole cameras, explained the flight, cameras (Figure 1.36A), and resulting photograph (Figure 1.36B) as follows:

> Duration of exposure was 286 seconds. Peak altitude was 220KM. The camera was kept pointed at the sun within one minute of arc by biaxial pointing control . . . . There were actually eight cameras in the block, four of which survived the flight and impact (the recovery parachute did not function properly). Two of the four were designed to produce photographs with a resolution of one-fifth solar diameter, the other two with one-tenth solar diameter. The camera producing the best picture utilized a pinhole which was 0.005 inch in diameter and was placed 6 inches from the film. In order to adapt pinhole photography for use in the x-ray region, it is necessary to prevent visible and ultraviolet light from striking the film. The pinhole was covered with a thin film of Parlodion (a type of nitro-cellulose). The Parlodion, in turn, supported an evaporated film of aluminum.[36]

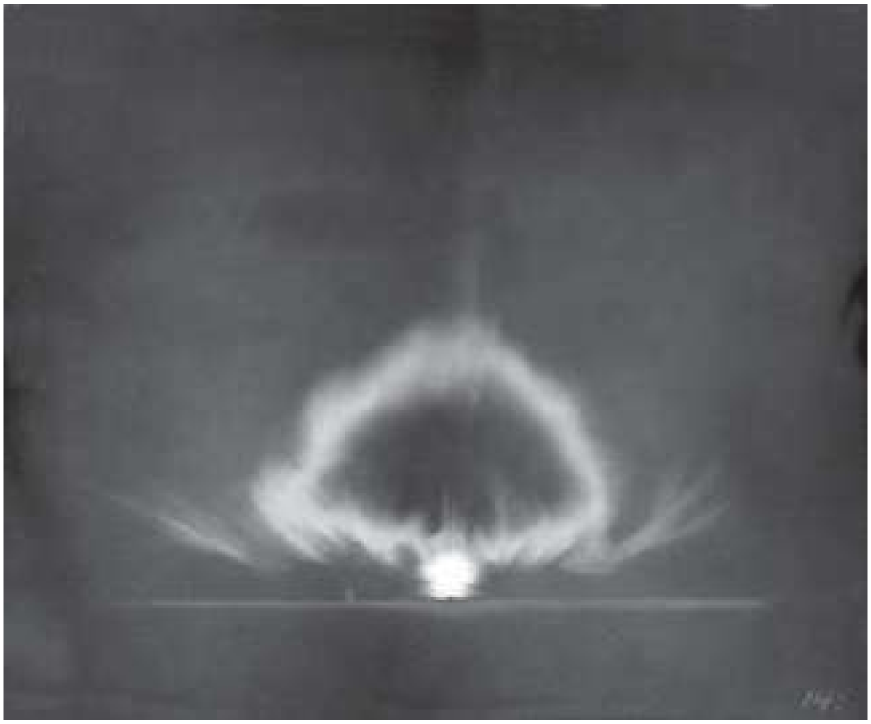

FIGURE 1.35
Julian Mack, *Trinity Site Atomic Bomb Test*, pinhole photograph, 1945, courtesy of Los Alamos National Laboratories.

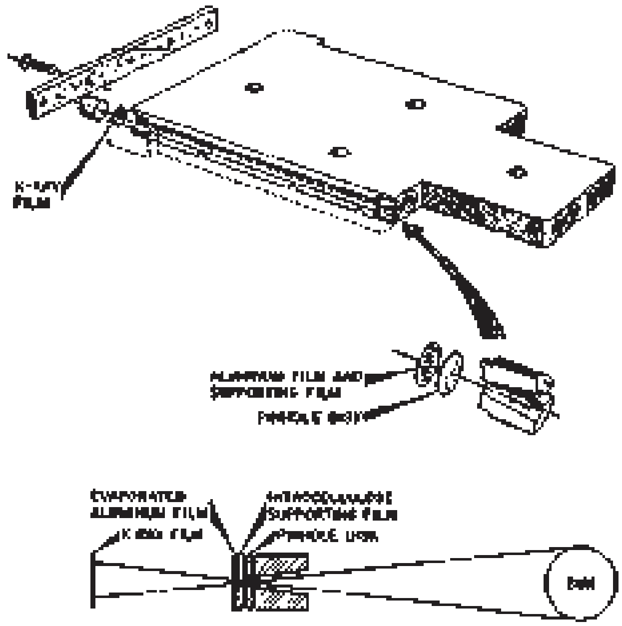

FIGURE 1.36A
© Richard Blake et al., pinhole camera used to obtain the first soft X-ray pinhole photograph of the sun, 1960. From the collection at Pinhole Resource.

FIGURE 1.36B
© Richard Blake et al., first soft X-ray photograph of the sun, 1960. From the collection at Pinhole Resource.

After many years of theoretical groundwork in pinhole imaging for astronomy, present-day pinhole cameras flown on space vehicles use multiple pinhole optics (Figure 1.37) known as *coded-aperture imaging* to photograph high-energy X-rays and gamma rays from extreme energy sources such as black holes and exploding stars. One astrophysicist working with pinhole optics, Thomas A. Prince, described the first gamma-ray image of a supernova (exploding star) as follows:

> The Caltech imaging gamma-ray telescope was launched from Alice Springs, Northern Territory in Australia on November 18 [1987]. It observed the supernova for approximately two and one-half hours starting at 14 hrs. 30 min. U.T. The telescope used a technique called coded-aperture imaging to produce images in a wavelength where mirrors and lenses are not feasible. A coded-aperture imager functions like a multiple-pinhole camera. In such a camera, multiple holes [Figure 1.38A] cast overlapping images on a position sensitive electronic detector. The individual, overlapping images are unscrambled using a computer and superimposed to yield the final image of a gamma-ray source.
>
> Using the coded aperture technique, the Caltech telescope produced an accompanying slide image of Supernova 1987A [Figure 1.38B]. This is the first such image of the supernova at gamma-ray energies. Indeed, it is one of the first few images at gamma-ray energies (100keV to 10MeV) of any astronomical object. The hard x-rays and gamma-rays which make up this image are thought to be direct and scattered photons from the decay of radioactive cobalt 56, newly produced in the explosion of the supernova. The field of view shown in the slide is 12 degrees across and the supernova itself is unresolved. The background in the supernova field is produced by statistical fluctuations in the diffuse hard x-ray and gamma-ray background and does not necessarily represent real structure.[37]

In 1999, in a playful reenactment of astronomical imaging, vis-à-vis art, Dianne Bos of Canada took many of the 20th-century's greatest star-cluster images made by astrophysicists and humorously reinvented them to pinhole studies. To accomplish this astronomical feat,

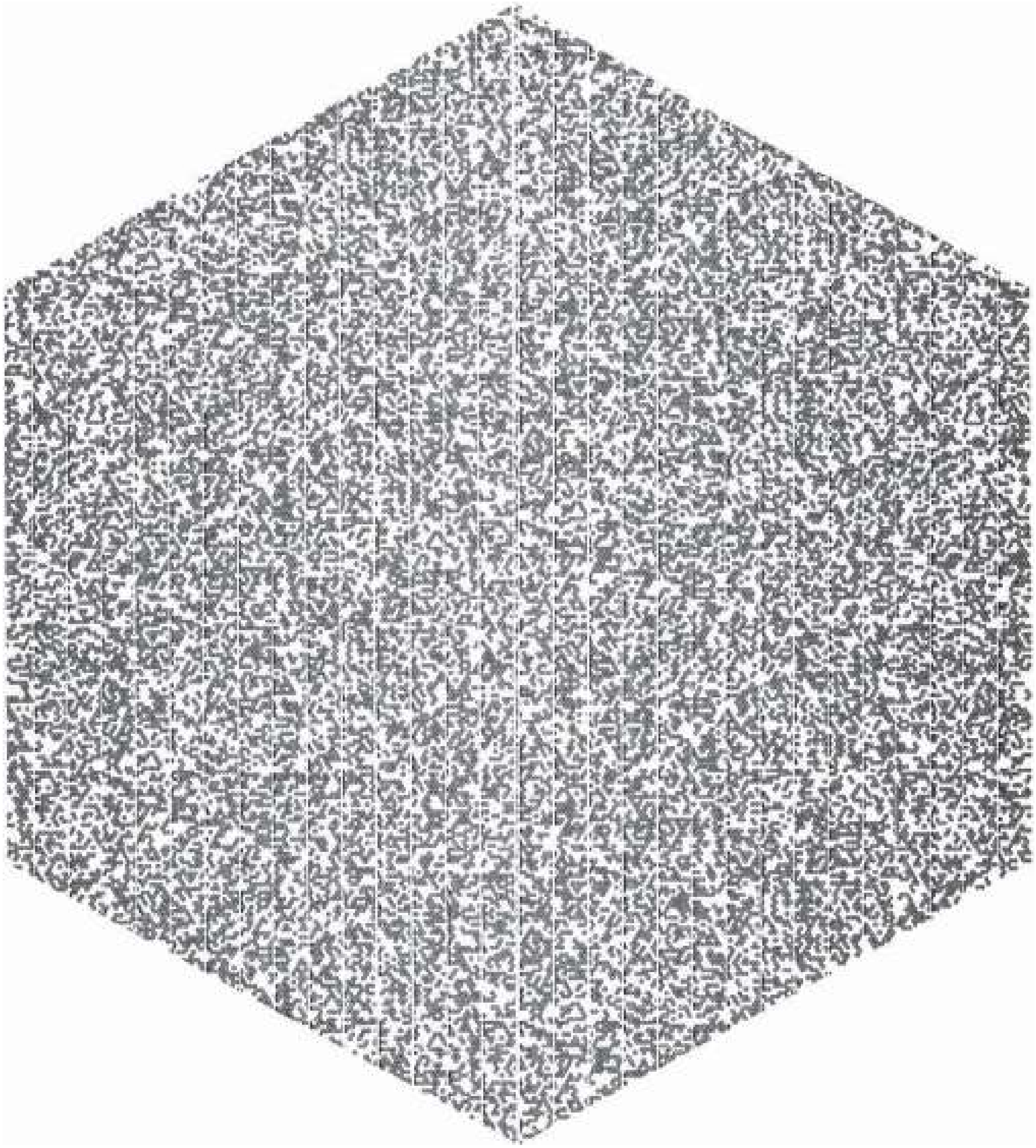

FIGURE 1.37
© E. E. Fenimore, a 26,232 pinhole uniformly redundant array aperture study plate, 12 × 13 inch, 1985, courtesy of Los Alamos National Laboratories. From the collection at Pinhole Resource.

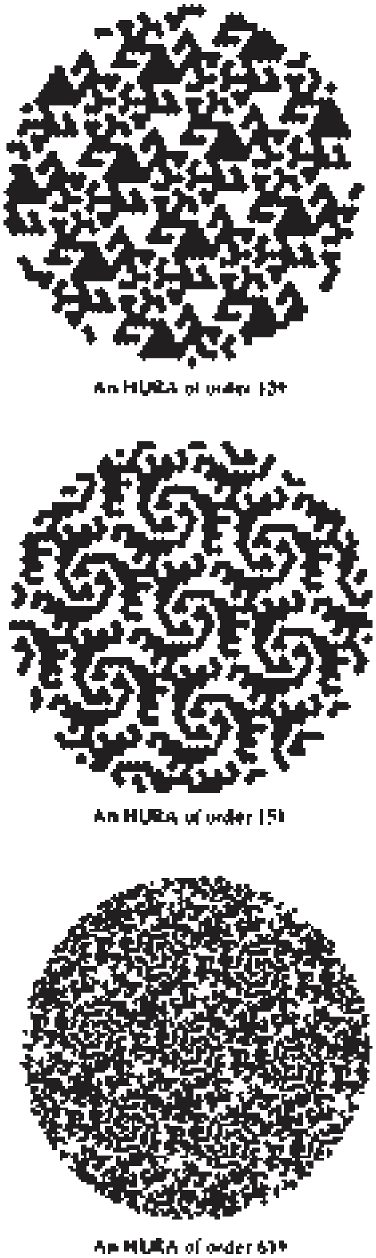

FIGURE 1.38A
© Thomas A. Prince, three hexagonal uniformly redundant arrays of order 139, 151, and 619. Courtesy of the California Institute of Technology, George W. Downs Laboratory of Physics, Pasadena.

FIGURE 1.38B
© Thomas A. Prince, first gamma-ray image of supernova 1987A. Coded aperture pinhole image, November 18, 1987. Courtesy of the California Institute of Technology, George W. Downs Laboratory of Physics, Pasadena.

Bos created pinhole aperture plates and subsequent images that resembled the famous galaxies, such as *M81 by Candlelight* (Figure 1.39A). Of her work she explained:

> I've had an interest in astronomy since I was a child. While working on my fine arts degree I took astronomy and that proved to be the most inspiring class creatively. My interest has continued over the years and exploration of the furthest reaches of space and time by the Hubble telescope are fascinating and humbling.

FIGURE 1.39A
© Dianne Bos, *M51 by Candlelight,* from series *Galaxy*, 20 × 16-inch pinhole photograph, 1999. From the collection at Pinhole Resource.

FIGURE 1.39B
© Dianne Bos, aperture plate for stars visible to the naked eye, from series *Galaxy*, 2002. Lens photograph. From the collection of the photographer.

I've been experimenting for some time on how I could explore these ideas with a pinhole camera. I couldn't get into space so I had to invent my own pinhole camera that could recreate what the source of these pinpricks of light might be. This wasn't an easy task but eventually I arrived with an image that at a glance looked just like photographs of outer space and then at closer inspection made you laugh. In fact these are the most conceptual photographs I've ever produced. Images for a new folk cosmology mythologizing the nature of light itself.

This series began with a candle. It seemed the most poetic and spiritual of 'original' light sources. If we look far enough into space, what do we see? A million candles dotting the night sky. But it is only one candle appearing as many. Each view slightly different depending on the size of the pinhole and the location on the pinhole plane. I tried to follow the star charts quite accurately when creating these galaxy images. The location and size of each pinhole corresponds to a real star [Figure 1.39B]. The brighter the star, the bigger the pinhole and consequently the brighter and more obscure the image taken with that pinhole. There are a couple images where I placed my hand behind the candle. My ghostly hand protecting the light from blowing out only appears with some of the brighter candle images. I've also used the moon, light bulbs and TV sets as light sources. One of my favorite images is Galaxy M51 made up of hundreds of tiny E = MC2, taken from a TV show on Einstein.

To get back to travel—I guess space travel is the final frontier. We are itching to see what's out there. That's why we send expensive little camera units to Mars and get real disappointed when they crash. It's the potential for surprise waiting beyond the next hill that keeps us going.[38]

FIGURE 1.40A
© Peggy Ann Jones, 99781217 black hole camera, 1993–1994. From the collection of the photographer.

FIGURE 1.40B
© Peggy Ann Jones, *99781217*, 13½ × 16-inch pinhole photograph, 1993–1994. From the collection of the photographer.

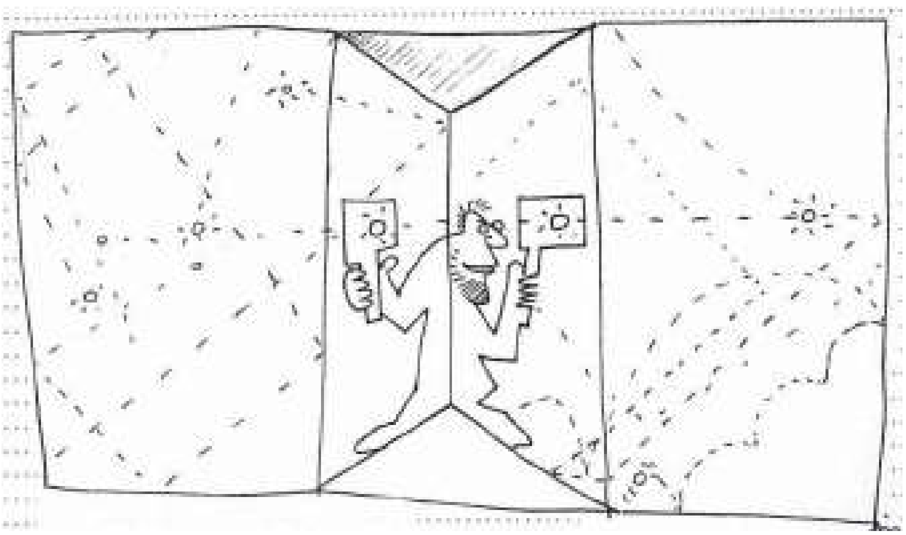

FIGURE 1.41
Jack Neff, *The Sorting Demon*, drawing, 1986 (see footnote 20).

In a similar concept, Peggy Ann Jones of California used intentional light leaks to create point sources of light as random constellations, as well as an iconographic 1950s upside-down colander to recreate an UFO. She explained the 99781217 black hole camera and its image (Figures 1.40A and 1.40B):

> This piece represents a series of sculptural cameras that were intentionally designed to have light leaks. Each camera was made from styrofoam packing material used to protect electronic equipment. When I found that the styrofoam back was leaking light from many small points, I was elated. The direction to take was clear; I would make Astro-Photography in my studio. I recall that a Black Hole is not really a hole in space at all.[39]

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CHAPTER 2

Pinhole's History in the Exploration of Art

I used to tell my friends that the inventor of painting, according to the poets, was Narcissus, who was turned into a flower; for as painting is the flower of all the arts, so the tale of Narcissus fits our purposes perfectly. What is painting but the act of embracing by means of art the surface of the pool?

LEON BATTISTA ALBERTI, *On Painting and on Sculpture*, 1435

Perspective is a Latin word meaning Seeing-Through.

ALBRECHT DÜRER, *Book of Measurements*, 1525

BRUNELLESCHI'S PINHOLE PERSPECTIVE DEVICE

> Lippo de ser Brunelleschi of Florence founded the procedure of working out this method [of perspective] in which there was truly something ingenious, subtle, and beautiful; by rational procedures he constructed what you see when you look in a mirror.[1]

The Western world's concept of space would radically begin to change at the end of the first quarter of the 15th century because of one singular device that used a small aperture (Figure 2.1). Certainly this is not something we were taught in school. We are fortunate to be able to read about it firsthand, because Filippo Brunelleschi's small apertured perspective device was explained to us by his "Anonymous Biographer"—someone who apparently worked with Brunelleschi, yet never has been fully identified (although thought to be Antonio Manetti).

In a paper by the Anonymous Biographer, written in approximately 1482, we find the following:

> About this matter of perspective, the first thing in which he displayed it was a small panel about half a braccio square on which he made a picture showing the exterior of the church of S. Giovanni in Florence. And he depicted in it all that could be seen in a single view; to paint it he took up a position about three braccia inside the middle door of S. Maria del Fiore. The work was done with such care and accuracy and the colours of the black and white marble were so faithfully reproduced that no miniaturist ever excelled him. In the picture he included everything that the eye could take in, from the Misericordia as far as the corner and the Canto de'Pecori on one side to the column commemorating the miracles of St. Zepotius as far as the Canto alla Paglia and all that could be seen beyond it on the other. And for what he had to show of the sky, that is

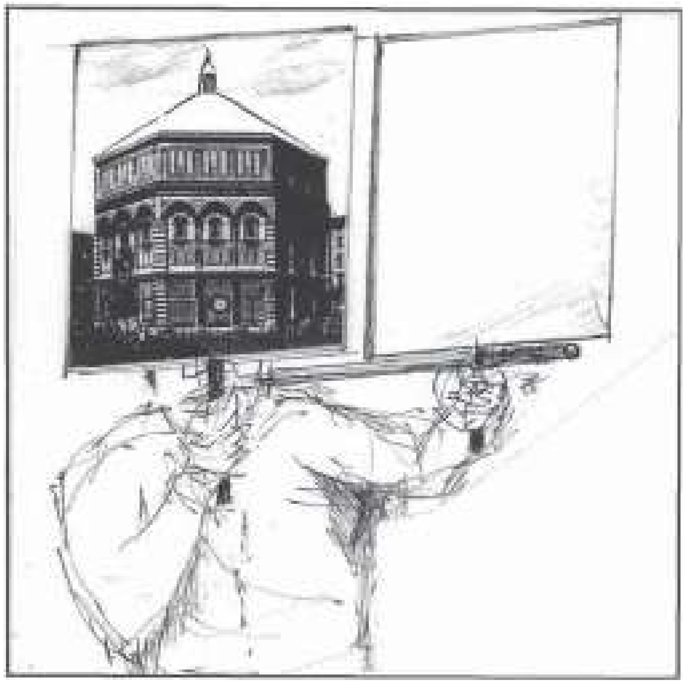


FIGURE 2.1
Filippo Brunelleschi's small-apertured perspective device. Brunelleschi stands before the Baptistery in Florence. He uses one eye to look through a lentil-sized hole made through the back of his painting. In his left hand he holds a mirror that reflects the painting. He moves backward or forward to find the correct viewing distance. When the angle of view of the real Baptistery matches the edge of the mirrored image in the painting, Brunelleschi can lower the mirror and have a duplicate of his painting. Circa 1420s, drawing by the author, 1998.

> where the walls in the painting stand out against the open air, he used burnished silver so that the actual air and sky would be reflected in it and the clouds also, which were thus seen moving on the silver when the wind blew. Now, the painter had to select a single point from which his picture was to be viewed, a point precisely determined as regards height and depth, sideways extension and distance, in order to obviate any distortion in looking at it (because a change in the observer's position would change what his eye saw). Brunelleschi therefore made a hole in the panel on which the picture was painted; and this hole was in fact exactly at the spot on the painting where the eye would strike on the church of S. Giovanni if one stood inside the middle door of S. Maria del Fiore, in the place where Brunelleschi had stood in order to paint the picture. On the picture side of the panel the hole was as small as a bean, but on the back it was enlarged in a conical shape, like a woman's straw hat, to the diameter of a ducat or slightly more. Now Brunelleschi's intention was that the viewer, holding the panel close to his eye in one hand, should look from the back, where the hole was wider. In the other hand he should hold a flat mirror directly opposite the painting in such a manner as to see the painting reflected in it. The distance between the mirror and the other hand was such that, counting small braccia for real braccia, it was exactly equivalent to the distance between the church of S. Giovanni and the place where Brunelleschi was assumed to be standing when he painted it. Looking at it with all the circumstances exactly as described above—the burnished silver, the representation of the piazza, the precise point of observation—it seemed as though one were seeing the real building. And I have had it in my hand and looked at it many times in my days and can testify to it.[2]

Filippo Brunelleschi (1377?–1446), the brilliant Renaissance architect and engineer, invented the small-apertured perspective device in 1425 when he was 47 years old. The Anonymous Biographer tells us the diameter of the hole was "as small as a bean" (lentil-sized, which is about 3/16 inch in diameter). The hole enlarged in the back of the painting "to the diameter of a ducat or slightly more" would have been approximately 1 inch in diameter. Fred Leeman in his book *Hidden Images* simplifies this description as follows:

> This picture had to be observed in a particular way: One had to stand exactly where the artist had stood when he painted his subject—that is, almost six feet inside the entrance of the church. A peephole had been cut in the center of the picture, and the viewer had to look through it from the back of the picture. Gazing through the hole, he would see the cathedral square and the Baptistery just as Brunelleschi had painted them. Then, holding up a mirror, he could look through the peephole and this time see the front of the painting, which coincided exactly with the actual view of the square. In order to enhance the effect, the sky was not painted in on the panel; instead, a layer of silver reflected the real sky. "And so," as Manetti writes, "the clouds that one saw in the silver moved with the wind when it blew."[3]

Brunelleschi used two of the most basic optical devices: the small aperture and the mirror. He wanted to create a theory for perspective pertaining to the eye, which sees objects in three dimensions, and then places those objects into two dimensions, as in drawings and paintings. Equally important, he wanted to know how is the eye similar to the *camera obscura*?

In his experiment, Brunelleschi was able to demonstrate there was a *vanishing point* in three-dimensional space, where specific lines of *perspective* converged on a point farthest from the eye (like looking down two railroad tracks, which converge to a point). There also was a vanishing point at one eye where specific *lines of light* converged on the eye. Brunelleschi was able to represent perfectly the reality of three dimensions by looking through the lentil-sized aperture drilled into the two-dimensional painting. The painting was reflected back toward him in the mirror. When he removed the mirror, he had a duplicate of the painting in three dimensions. To accomplish this, he had to be standing exactly at the correct distance in front of the real building, and his eye behind the hole had to remain stationary. This stationary place became known as the ***fixed eye point***.

This seemingly simple experiment profoundly changed humanity's concept of space. Brunelleschi's theory became known as the "theory of one point perspective." It was the first scientific proof of how three dimensions could *precisely* become two dimensions.

With Brunelleschi's device, a *point* and a *small aperture* (a pinhole) become interchangeable as long as they remain a *fixed eye point*. To thoroughly understand their interchangeability, we must be able to comprehend that any point in space can be replaced by a pinhole that will project an image made from multiple points of light passing through it. Any point in space consequently can become an image in our eye. These points of light are seen by our eye as a *complete* three-dimensional picture. Each of these points forms a straight line of light passing through the aperture. The image in our eye is usually comprehended mentally as a complete image in three dimensions in front of us; it seems difficult for most people to grasp that the image of what is in front of us is really a small, retina-sized image in our eye that our brain reverses. This image is similar to a three-dimensional image projected into a *camera obscura* and seen in two dimensions on a flat white sheet held either perpendicular to the pinhole or angled (known later as an *anamorph*). All this works perfectly well in the 15th-century view of straight line geometric optics. Brunelleschi's profound device ushered in the Renaissance.

Brunelleschi's small-apertured device demonstrated the following in one point perspective with use of the *fixed eye point:*

- How straight-line geometric optics works in both the eye and the *camera obscura*.
- How to arrive at a "normal" perspective view of a building—in other words, the distance from a building at which the angled perspective feels "normal" to the eye, not too wide angled.
- How a three-dimensional scene, whether it is a building exterior or interior, can be transformed into two dimensions.

- How a vanishing point connects us to distance.

Many art historians have written about Brunelleschi's small-apertured perspective device. The historians have failed to realize one crucial element: Brunelleschi's device was operating on the geometric principles of the enlarged pinhole. By failing to recognize this, they fail to realize that Brunelleschi was also theoretically demonstrating the workings of a small-apertured *camera obscura* as well as the workings of the eye. Historians never mention pinhole optics; some have even gone so far as to duplicate Brunelleschi's experiment by using a refractive-lens camera.

ALBERTI'S FIRST DIFFRACTION CAMERA

Brunelleschi's mirror and small aperture had captured three-dimensional space and scientifically placed it into two dimensions. Why couldn't someone capture three-dimensional space and scientifically place it into three dimensions? This can be accomplished by moving the *fixed eye point*, where Brunelleschi's eye had been behind the hole in the painting, and placing it as a *small aperture* in the wall of the darkened room. This produces a *camera obscura*. The projected image can be viewed in two dimensions on a screen or it can be viewed in three dimensions on the walls, floor, and ceiling.

The early artist scientist "Renaissance man" certainly knew of the "hole in the shutter" optical principle; it was used by researchers in light from Alhazen (1020 A.D.) onward. With an aperture of the correct diameter, the projected image would be well defined on the walls, floor, and ceiling. The only theoretically correct way to see the projected image again was to look through the aperture. Because one's head would naturally block the light coming into the darkened room, the projected image had to be painted. This, of course, preserved the image. When you put your eye at the aperture, you could actually see the painted image, precisely as it looked outside. (Of course the image was painted upside down and light had to be added inside.)

How profound! Theoretically, everything was geometrically correct! The first *diffraction camera* was brilliantly created and made by Leon Battista Alberti (1404–1472), a friend of Filippo Brunelleschi. An anonymous biography of Alberti published in Muratori's *Rerum Italicarum Scriptores* (xxv296), quoted by Vasari, states:

> Alberti painted wonderful pictures, which were exhibited in some sort of small closed box, viewed through a very small aperture. The pictures showed marvelous verisimilitude; one picture was nocturnal, showing the moon and stars, the other diurnal, showing a day scene.[4]

Undoubtedly, this was a *camera obscura*, because it stated that the paintings were "viewed through a very small aperture." Unfortunately, these boxes were lost. A present-day room-sized *camera obscura* is shown in Figures 2.2A through 2.2D.

Alberti would have probably made his day scene of a well-known landmark so that the scene could have been viewed outside the box in its well-known three-dimensional reality or through the aperture in the box in its newly created three-dimensional reality. How would Alberti have painted this scene? To be theoretically consistent with Brunelleschi, he would have probably made a rectangular or square box with the top removed and a small aperture in one side aimed toward the landmark. Alberti could have draped a thick black cloth over himself and the box to exclude all extraneous light from entering the box, except for the image through the small aperture. The image of the landmark would have been upside down on the inside of the box. Alberti could have duplicated the image with paint or in pencil on the entire inside of the box. It would not have been easy to bend over and paint or draw the upside-down image, but if my understanding is right about the milieu of those early Renaissance times, this kind of craziness would have been just perfect.

FIGURE 2.2A
To convert an ordinary room into a camera obscura, select a room with a window overlooking a spacious view. To avoid direct sunlight, choose a window facing north. From *How to Convert an Ordinary Room into a Camera Obscura* © Robert Rosinsky, 1987.

FIGURE 2.2B
With an opaque material block out the selected window and all other windows. Black plastic, available at most hardware stores, is quite effective. Plastic is rather inexpensive and attaches easily with gaffer's tape or pushpins. © Robert Rosinsky, 1987.

FIGURE 2.2C
Make a hole about the size of a penny in the center of the selected window. A larger hole will render a brighter but fuzzier image, whereas a smaller hole will show a fainter but sharper image. © Robert Rosinsky, 1987.

FIGURE 2.2D
Close any door allowing light into the room and turn off all artificial lights. An inverted and reversed image of the outside view will appear on the walls and ceiling. © Robert Rosinsky, 1987.

After the picture was painted, Alberti would have attached a painted top to the box, turned it over so it was right-side up, and let people view it through the very small aperture. The painting would not have been lit by the aperture; it could have been lit by an opening in the top or side of the box or the painting could have been translucent and lit from an opening in the back of the box. The painting in its truthful representation of three-dimensional reality would have seemed miraculous. What a wonderful sense of humor Alberti's boxes must have had!

Are there any other cameras where you view the image through the aperture? There are. Boxes like Alberti's, with a painting in three dimensions inside is viewed through a peephole, became known as *peepshow boxes* or *perspective cabinets*. Unfortunately, art historians never refer to them as any type of *camera obscura*. Less than a dozen have survived. The best preserved peepshow box (Figure 2.3), by Samuel Van Hoogstraaten (1627–1678), resides in the National Gallery in London. For light, one of its sides is glass. There are two apertures or they could be called *fixed eye points.* Each is placed in the side near the glass, three-fourths of

FIGURE 2.3
Samuel Van Hoogstraaten, peepshow box. Size of interior: 21½ inches high, 31½ inches wide, 21 inches deep, circa 1660, courtesy of National Gallery, London. The box consists of three sides, a top, and a bottom. The fourth side is clear, covered with glass. About three-quarters up each side, adjoining the glass, is a peephole. These two peepholes are approximately 3/4 inches in diameter and are near the glass front. Viewed in person, the painted interior has a beautiful light and looks real. The anamorph painted on top of the peepshow box is shown in Figure 2.13.

the way up the side. Van Hoogstraaten had to invent two different illusionist pictures for the inside of the box. Each is viewed through a separate large aperture. The main problem Van Hoogstraaten faced is that each picture had to blend perfectly with the other in the middle of the box—a complex three-dimensional challenge.

Van Hoogstraaten was a contemporary of Jan Vermeer. Vermeer's use of optical aids such as the lens *camera obscura* is well documented, particularly in *Vermeer's Camera* by Philip Steadman, (Oxford University Press, 2001). Although partially destroyed, a six-sided peepshow box by Van Hoogstraaten is on display at the Detroit Institute of Art. The side containing the small aperture has been removed! Because you don't look at the scene through the aperture, the idea is lost, and the scene simply looks distorted. Several other peepshow boxes can be found in The Netherlands and Denmark.

The peepshow box, a painting in three dimensions, remained only a curiosity—one seldom realized by artists over the centuries to follow. With that said, probably the most important 20th-century peepshow box is Marcel Duchamp's *Étant donnés* (in English it translates as *Given*) constructed in secret over two decades (1946–1966). *Étant donnés* employs the use of *two* peepholes placed at eye level in an antiquated wooden door (Figure 2.4). The viewer is an important part in *Étant donnés*.

The viewer looks through these two peepholes and cannot make much sense of the *picture plane*. Seeing a photographic image of *Étant donnés* does not explain it visually, nor should

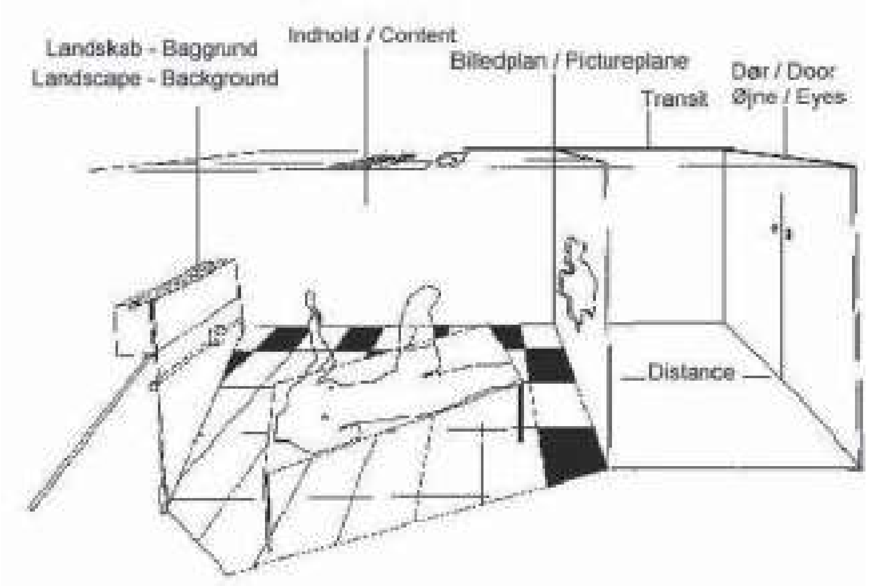


FIGURE 2.4
Jean-Francois Lyotard, diagramatic cross section of *Étant donnés*, reproduction of diagram, the cross section of the peepshow construction of *Étant donnés*: 1° la chute d'eau/2° le gas d'éclairage, 1946–1966, courtesy of Lapis Press. From *Duchamp's Trans/formers*, translated by Ian McLeod (Venice, CA: Lapis Press, 1990).

Étant donnés be shown photographed because the inherent perspective of a camera destroys what Duchamp was attempting to do, which was to destroy the picture plane, because a camera acts as a *fixed eye point* and therefore automatically puts *Étant donnés* into one point perspective with a vanishing point. The two peepholes, a rough cutout in an obscured dark brick wall and a steeply angled (*foreshortened*) view of a reclining explicitly nude woman placed at the extreme left side of the view, all act together to remove the scene from the comprehensible perfected reality created by the *normal view* picture plane. Most of all, the kitchy waterfall on the right seems to be too distant for the entire picture to achieve one point perspective coherence.

Étant donnés resides in the Duchamp Room in the Philadelphia Museum of Art. It remains an important statement about art, artifice, and artificiality. It also serves as a visual and theatrical response to philosophical constructs about the *camera obscura* metaphor mentioned in Chapter 1: lightness/darkness; consciousness/unconsciousness in a life composed of desire versus reality.

On the deconstruction that *Étant donnés* represents Pia Høy wrote:

> Unlike many Duchamp researchers, I consider *Étant donnés* to be Duchamp's masterpiece . . . . It is one of the most challenging works of art that exists anywhere, and in my own words: 'the most thrilling work of art' . . . . For in *Étant donnés*, Duchamp successfully produces a work that is not a work of 'art', but rather, what would seem to be Duchamp's lifelong project finally reaching perfection in this work. This paradoxical project would seem to consist of producing a picture without a picture plane, or a painting without a canvas, which is precisely the opposite of what Duchamp's contemporary artists were busy doing . . . . When I call *Étant donnés* a deconstructed painting, it is a reference to the construction, *Étant donnés*, with the aid of which Duchamp deconstructs another construction, most clearly traditional perspective painting. In such a painting, the layers or levels are laid on top of each other, so that they 'melt' into one level that materializes itself with the aid of the picture plane. When one looks at such a perspective painting, one experiences at a more illusionistic level that the picture stretches out behind the plane, behind "Alberti's window", and exposes—if not always a realistic picture of reality. At least something which has a fairly convincing stamp of realism. The abstract painting cannot be deconstructed in the same literal way as the perspective painting. The spatiality which the abstract painting often postulates, despite its strive for flatness, is of a more spiritual or invisible nature.[5]

ALBERTI'S INTERSECTOR

Brunelleschi's small-apertured perspective device was transformed by Alberti in another way. He used it as a device for two-dimensional drawings and paintings, known as the *intersector* or the *veil*. This was of great assistance to the artist, particularly in foreshortening, and was widely used over many centuries. In *De Pictura*, Alberti says:

> I believe nothing more convenient can be found than the veil, which among my friends I call the intersection, and whose usage I was the first to discover. It is like this: a veil loosely woven of fine thread, dyed whatever color you please, divided up by thicker threads into as many parallel square sections as you like, and stretched on a frame. I set this up between the eye and the object to be represented, so that the visual pyramid passes through the loose weave of the veil. This intersection of the veil has many advantages, first of all because it always presents the same surfaces unchanged, for once you have the fixed positions of the outlines, you can immediately find the apex of the pyramid you started with, which is extremely difficult to do without the intersection . . . . A further advantage is that the position of the outlines and the boundaries of the surfaces can easily be established accurately on the painting panel; for just as you see the forehead in one parallel, the nose in the next, the cheeks in another, the chin in one below, and everything else in its particular place, so you can situate all the features on the panel or wall which you have similarly divided into appropriate parallels. Lastly, this veil affords the greatest assistance in executing your picture, since you can see any object that is round and in relief, represented on the flat surface of the veil.[6]

While the intersector is being used, the artist's eye had to remain stationary at the ***fixed eye point***; consequently, some of the early devices had a small aperture placed at eye level. Many preliminary drawings from the Italian Renaissance show horizontal and vertical grid lines associated with the intersector's use. Some finished paintings even retain sparse patches of these lines.

Brunelleschi's gifted friend Masaccio (1401–1428) used the intersector for *The Trinity* (Figure 2.5), apparently the first painting in one point perspective. The woman standing on the left has grid lines across her figure and finer grid lines across her face. It must have been extraordinary to view the superb realism of this painting in 1428. Many consider *The Trinity* to be as powerful a painting in two dimensions as Brunelleschi's dome on the Duomo, several blocks away, is in three dimensions. Another friend of Brunelleschi, Donatello (1386–1466), apparently was the first to use one-point perspective in sculpture.

The Flemish painter Jan van Eyck (1390–1441) contemporaneously achieved one-point perspective in his masterpiece *The Marriage of Giovanni Arnolfini and Giovanni Cenami*, although his theories and experiments on one-point perspective have not been documented historically. It is known that Flemish painters were in artistic contact with the Italian Renaissance and that van Eyck had even been urged by King Alfonso to emigrate to Naples to decorate his new palace. Flemish artists were known to have painted directly onto the reflection in a mirror to depict interiors, which is another way of achieving one-point perspective (as long as the painter's eye remained stationary). The contemporary painter/*camera lucida* media-hound David Hockney, in his admiration of van Eyck's masterpiece, has reached that same conclusion. He states:

> There is the convex mirror again. If you were to reverse the silvering, and turn it around, this would be all the optical equipment you would need for the meticulous and natural-looking detail in the picture.[7]

LEONARDO DA VINCI

Andrea Mantegna's allegorical *Oculus in the Ceiling* is a perfect example of a *fixed eye point*—as the viewer is forced to be standing below the painted oculus, looking up at the very foreshortened angels (Figure 2.6).

FIGURE 2.5
Masaccio, *The Trinity,* 21 feet 10-1/2 inches × 10 feet 4-7/8 inches, S. Maria Novella, Florence. The painting was intended to be viewed at exactly 20 feet 1 inch, circa 1428.

One-point perspective, the intersector, and the *fixed eye point* as a painter's aid were refined to their highest point by Piero della Francesca (1420–1492) in his book *De prospectiva pingendi*, published in 1480. For a view of many Renaissance intersector devices, see Martin Kemp, *The Science of Art* (New Haven, CT: Yale University Press, 1990).

Leonardo da Vinci (1452–1519) explained his use of the *fixed eye point* (Figure 2.7) as:

> You should have a pane of glass as large as a royal half folio, and fix it firmly before your eyes, that is, between your eye and the thing you wish to depict, and then you take up a position with the eye at 2/3 *braccio* from the glass, fix your head with some device so you cannot move it, shut or cover one eye, and with the brush or pencil or chalk draw on the glass what you see beyond it, and then polish it down with sandpaper and dust it over good paper and paint it as you wish.[8]

FIGURE 2.6
Andrea Mantegna, oculus in the ceiling, 270 cm diameter, *Camera degli Sposi*, Palazzo Ducale, Mantua, Italy, circa 1474.

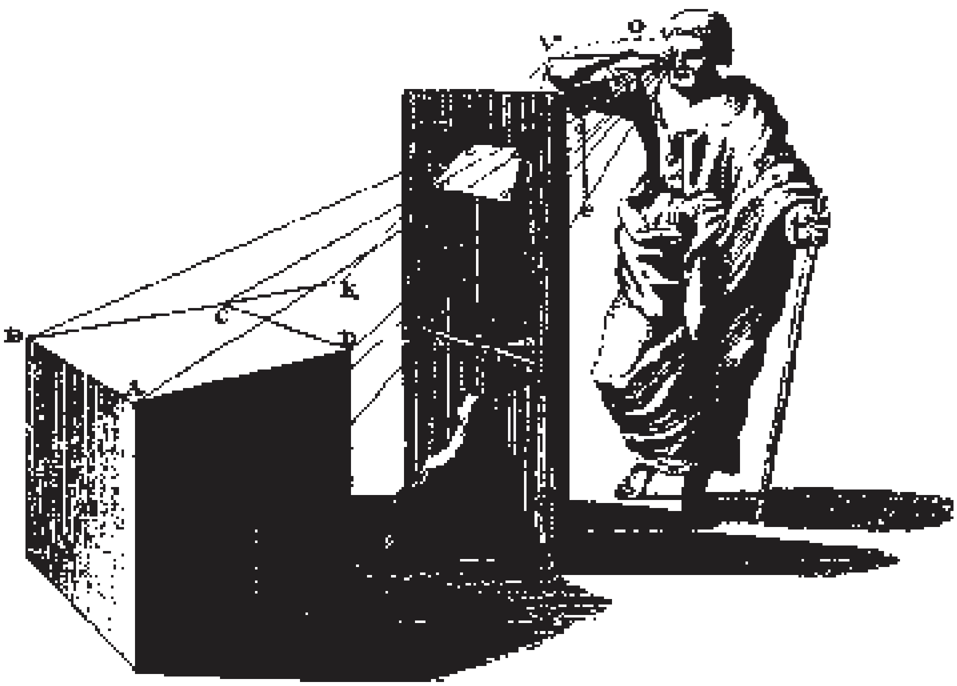


FIGURE 2.7
Brook Taylor, principle of the Leonardo window. One eye is being used to view the top of the cube ABCD and place it in projection abcd within the Leonardo window, which is the surface of intersection FGHI, from *New Principles of Linear Perspective*, 1811.

Undoubtedly the best-known painting in one-point perspective is da Vinci's *Last Supper*—the vanishing point goes to Christ's right eye. Leonardo mentions the use of a small aperture in at least 20 places in his manuscripts.[9] Some of his more notable quotations on the subject are as follows.

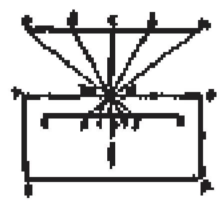
> If you transmit the rays of the sun through a hole in the shape of a star you will see a beautiful effect of perspective in the spot where the sun's rays pass.
>
> LEONARDO [C.7a (9b)]

> Only one line of the image, of all those that reach the visual power, has no intersection; and this has no sensible dimensions because it is a mathematical line which originates from a mathematical point, which has no dimensions. According to my adversary, necessity requires that the central line of every image that enters by small and narrow openings into a dark chamber shall be turned upside down, together with the images of the bodies that surround it.
>
> LEONARDO [W. 19152a]

> That I must first show the distance of the sun from the earth; and, by means of a ray passing through a small hole into a dark chamber, detect its real size; and besides this, by means of the aqueous sphere calculate the size of the globe.
>
> LEONARDO [Leic. Ia]

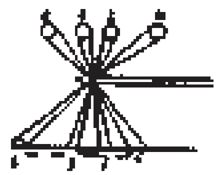
> A method of seeing the sun eclipsed without pain to the eye. Take a piece of paper and pierce holes in it with a needle, and look at the sun through these holes.
>
> LEONARDO [Trib. 6b]

> The edges of a color transmitted through a small hole are more conspicuous than the central portions.
>
> LEONARDO [C. A. 190a]



> An experiment, showing how objects transmit their images or picture, intersecting within the eye in the crystalline humour. This is shown when the images of illuminated objects penetrate into a very dark chamber by some small round hole. Then, you will receive these images on a white paper placed within this dark room and rather near to the hole, and you will see all the objects on this paper in their proper forms and colors, but much smaller . . . And let the little perforation be made in a very thin plate of iron.
>
> LEONARDO [D. 80]

> What difference is there in the way in which images pass through narrow openings and through large openings, or in those which pass by the sides of shaded bodies? By moving the edges of the opening through which the images are admitted, the images of immovable objects are made to move.
>
> LEONARDO [W. 19149a]



Having been published many times, Leonardo's well-known statement on the pinhole *camera obscura* reads:

> I say that the front of a building—or any open piazza or field—which is illuminated by the sun has a dwelling opposite to it, and if, in the front which does not face the sun, you make a small round hole, all the illuminated objects will project their images through that hole and be visible inside the dwelling on the opposite wall which should be made white; and there, in fact, they will be upside down, and if you make similar openings in several places in the same wall you will have the same result from each. Hence the images of the illuminated objects are all everywhere on this wall and all in each minutest part of it. The reason, as we clearly know, is that this hole must admit some light to the said dwelling, and the light admitted by it is derived from one or many luminous bodies. If these bodies are of various colors and shapes the rays forming the images are of various colors and shapes, and so will the representations be on the wall.
>
> LEONARDO [C. A. 135b]

Two drawings by Leonardo (Figure 2.8), without written explanation, show light rays entering a human eye and light rays entering a glass globe placed behind the aperture of a small *camera obscura*. These drawings would award Leonardo priority for the first refractive camera (containing a lens); however, historians of science overlook these drawings, choosing instead to credit Daniele Barbaro (1513–1570). Leon Battista Alberti's diffraction camera is not even in the running. Science historians must think a camera has to have a conventional lens, otherwise it's not a real camera! As soon as a lens was placed in a *camera obscura*, artists no longer needed to use the pinhole *camera obscura*. When the lens *camera obscura* became portable, by about the late 1600s, it made Alberti's intersector somewhat obsolete. This would have happened around the time of Vermeer (1632–1675). For a scholarly discussion on the *camera obscura*, see M. S. Hammond, *The Camera Obscura: A Chapter in the Pre-History of Photography*, Dissertation Abs. Int. 47(10) (doctoral dissertation, Ohio State University, 1987).

Albrecht Dürer (1471–1528) was responsible for transporting concepts of the Italian Renaissance to Germany. He learned the use of one-point perspective, the intersector, the small aperture, and the fixed point while traveling in Italy. Dürer, the great draftsman, had gone there specifically "to learn the secrets of the art of perspective from a man who is willing to teach me."[10] It is thought Dürer learned perspective through personal instruction from Leonardo or from Luca Pacioli (1450?–1520?), the author of *The Divine Proportion*. It is known that Dürer read Piero della Francesca's *De prospectiva pingendi*, published in 1480, because in 1525, Dürer wrote della Francesca's five rules of perspective in his own *Book of Measurements*:

> Perspective is a Latin word meaning "Seeing-Through," [seeing through the small aperture]. To this same "seeing through" belongs five things.
>
> 1. The first is the eye that sees.
> 2. The second is the object seen.
> 3. The third is the distance between (eye and object).
> 4. The fourth; one sees everything by means of straight lines, that is to say the shortest lines.
> 5. The fifth is the dividing from one another of the things seen.[11]

Included in Dürer's *Book of Measurements* were drawings (Figure 2.9A through 2.9D) of many tools for the artist to use in creating one-point perspective by using the *fixed eye point*. Somewhat similar perspective devices were beautifully recreated for use in the French film *Artemisia* (1997), a fantasized recreation about the only known woman painter from the Italian Renaissance, Artemisia Gentileschi.

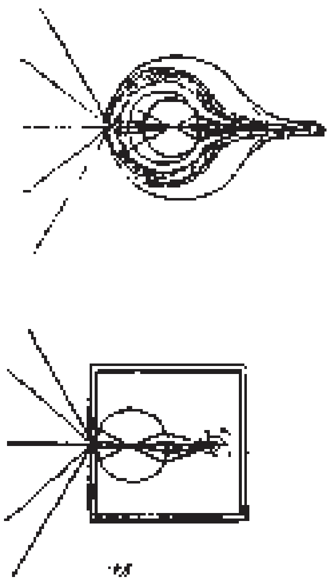


FIGURE 2.8
Leonardo da Vinci, light rays entering the eye and light rays entering the glass globe placed inside a small *camera obscura*, from *Codex Atlanticus* fol. 337 r., circa 1500.

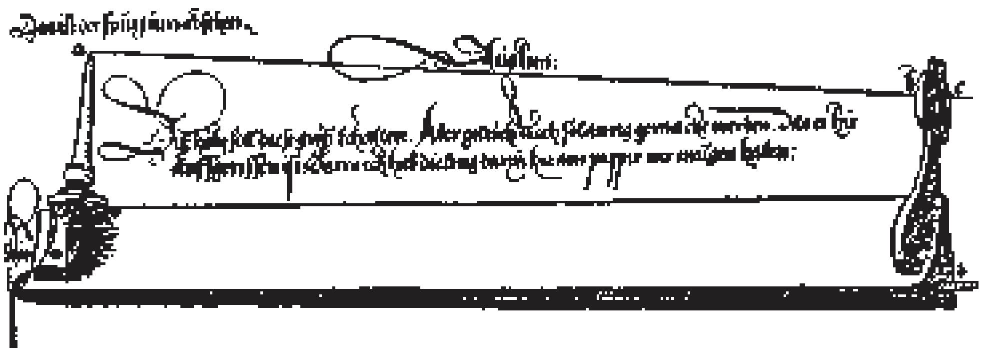


FIGURE 2.9A
Albrecht Dürer, perspective instrument, from *Book of Measurements*, circa 1525. Artist views the scene through the *fixed eye point* small aperture in the upright, sighting past the top of the pointed column.

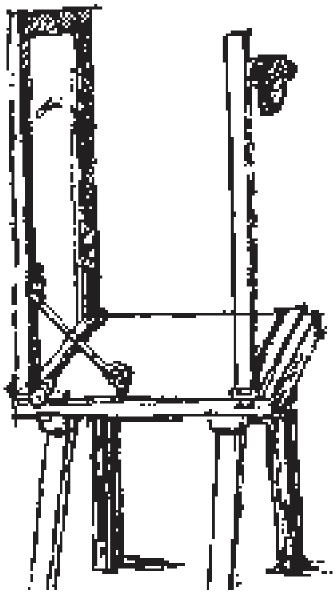


FIGURE 2.9B
Albrecht Dürer, perspective apparatus, from *Book of Measurements*, circa 1525.

FIGURE 2.9C
Albrecht Dürer, perspective instrument, from *Book of Measurements*, circa 1525. Artist is viewing through a tube, which is attached to a back wall.

FIGURE 2.9D
Albrecht Dürer, the intersector, from *Book of Measurements*, circa 1525. Note the column, which replaces the *fixed eye point*.

This final quote from Leonardo discoursing the point in space and the divine comes from *Codex Atlanticus*. It gives an idea of Leonardo's exuberance toward the miraculous and "divine things." He exclaimed

> Who would believe that so small a space could contain the image of all the universe? O mighty process! What talent can avail to penetrate a nature such as these? What tongue will it be that can unfold so great a wonder? Verily, none! This it is that guides the human discourse to the considering of divine things. Here the figures, here the colors, here all the images of every part of the universe are contracted to a point. O what a point is so marvelous!

It is interesting to compare the artist Leonardo's animated view of the pinhole as a divine point in space "O what a point is so marvelous!" to the philosopher John Locke's highly analytical view toward the pinhole "with only some little opening left" mentioned in the last chapter.

The importance of Leonardo's exuberance toward both the point in space and the one-point perspective as technological tools was explained dramatically in the mid-1990s PBS television program *The Day the Universe Changed*. In that program, Samuel Y. Edgerton brilliantly explained the profound contributions and monumental significance of the vanishing point continuum of the pinhole—a continuum that began on the day Brunelleschi made his pinhole perspective device. Edgerton chronologically traced western civilization's important historical events that directly connected to Brunelleschi's pinhole and vanishing point; to Leonardo da Vinci and, at the same time, to Paolo Toscanelli's advising Columbus to sail west to find a distant point in the east; to present-day airplanes departing toward distant landing points; and to recent "smart" missiles being fired at distant targets.

Before this television documentary, Edgerton had grasped another immense implication that confirms an unusual aspect and sociological contribution of the pinhole. It answers the question of "why" the one-point perspective was investigated so thoroughly during the Italian Renaissance. Edgerton's insight is profound. In the epilogue of his book *The Heritage of Giotto's Geometry* (Cornell University Press, 1991), Edgerton perceptively explained:

> Geometric linear perspective was quickly accepted in western Europe after the fifteenth century because Christians wanted to believe that when they beheld such an image in art, they were perceiving a replica of the same essential, underlying structure of reality that God had conceived at the moment of Creation. By the seventeenth century, as "natural philosophers" (such as Kepler, Galileo, Descartes, and Newton) came more and more to realize that linear perspective does in fact conform to the actual optical and physiological process of human vision, not only was perspective's Christian imprimatur upheld, but it now served to reinforce Western science's increasingly optimistic and democratic belief that God's conceptual process had at least penetrated, and that knowledge (and control) of nature lay potentially within the grasp of any living human being.[12]

Simply put, Edgerton is saying: Through the use of optical instruments such as Brunelleschi's pinhole perspective device and Alberti's intersector, the Popes and the Church of Rome realized that the one-point perspective in artists' paintings made the Christian miracles look completely real and therefore completely believable. The one-point perspective was therefore worthy of promotion. Religious, that is, "miracle," paintings received the Pope's stamp of approval. Because Christianity has always believed in representing humanistic iconographic miracles, painters' art was of great propagandist value. Even paintings of secular subjects had a miraculous appeal as a consequence of the continuum of one-point perspective. It was even better when Johannes Kepler's book on lenses, *Dioptrics*, was published in 1605 because Brunelleschi's optical theory was proven to be correct scientifically.

The Church was quite pleased with their patronized representations of miracles, but it could not comprehend that Galileo's Earth was no longer flat. This most monumental concept that the Earth was round, proven earlier by the one-point perspective and the vanishing point, had unfortunate consequences—Columbus's discovery of the new world—which, with colonization, emphasized a human destruction like none other the world had ever witnessed. Little known is the fact that the loss of native peoples in North and South America would prove to be the largest of all holocausts. This is well documented in David Stannard's book *American Holocaust* (Oxford University Press, 1992). In Albert Einstein's words:

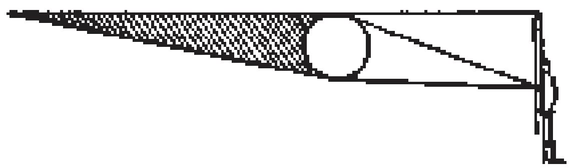
> The world that we have made as a result of the level of thinking that we have done so far, has created problems we cannot solve at the level of thinking at which we created them . . . . We shall require a substantially new manner of thinking if humankind is to survive.[13]

ANAMORPH—THE DECEPTION OF THE EYE

By the 16th and 17th centuries, many artists became aware of another use of miraculous superrealism, obtainable by using the fixed point for casting a picture onto a curved surface or angled wall. To achieve this heightened realism, the finished picture had to be viewed from that same *fixed eye point* from where the image was cast. A new school of art, known as *trompe l'oeil*, which translates "to deceive the eye," evolved around this concept. Possibly the highest achievement of *trompe l'oeil* is to be found in the curved vault in the church of St. Ignazio in Rome, in the painting *Entrance of Saint Ignatius into Paradise* (Figure 2.10A) by Fra Andrea Pozzo (1642–1709). To show the viewer the position of the *fixed eye point*, the famed perspectivist Pozzo placed a brass disc on the floor below the curved vault. When viewers stand on this disc and look upward, their eyes match the artist's *fixed eye point*, and the entire painting snaps into place. The multitude of painted figures on the vault look as if they are truly floating in space above the viewer. No two-dimensional reproduction of this painting can portray the beauty of this three-dimensional illusion. It has to be seen in person.

To create this painting, Pozzo placed grid lines across the surface of his flat preliminary drawing. Next he placed a giant net (Figure 2.10B) enlarged in scale from the same grid horizontally across the bottom of the vault. Pozzo then ran a set of strings from the *fixed eye point* through each intersection in the net. He then marked where each string held taut touched the vaulted ceiling. This showed him how to place the original grid onto the curved ceiling, thereby enabling the flat painting to then be reproduced onto the curved surface.

Pozzo's painting is an *anamorph*, directly descended from Brunelleschi's small-aperture perspective device, Alberti's intersector, and Leonardo's anamorphic pinhole projections. In an anamorph, an image is projected and then drawn onto a surface that is angled away from the *fixed eye point*. Leonardo wrote the following about creating anamorphic projection:



> If you want to represent a figure on a wall, the wall being foreshortened, while the figure is to appear in its proper form, and as standing free from the wall, you must proceed thus: have a thin plate of iron and make a small hole in the center; this hole must be round. Set a light close to it in such a position that it shines through the central hole, then place any object or figure you please so close to the wall that it touches it and draw the outline of the shadow on the wall; then fill in the shade and add the lights; place the person who is to see it so that he looks through that same hole where at first the light was; and you will never be able to persuade yourself that the image is not detached from the wall.
>
> LEONARDO [A. 42b]

Leonardo's drawing of a child's face is the first known anamorphic drawing (Figure 2.11). Viewed frontally, the child's face is very wide and almost unrecognizable; viewed on edge, the face becomes recognizable. It is best to view Leonardo's drawing by holding one hand over one eye and viewing the drawing from the right edge. In the same drawing is another anamorph, an eye, able to be viewed from the right edge.

The anamorphic pinhole view, which da Vinci is credited with discovering, results in the following:

- A distorted view of reality (what a person sees when viewing the anamorph from the normal frontal position).
- An undistorted view of reality (the true picture). This view can be found only if you know where the pinhole or small aperture was situated to make the painting or drawing. Usually, the pinhole was on one side. A number of historic anamorphs are shown in *Perspective*, by Pierre Descartes (New York: Harry N. Abrams, 1977), and in *Hidden Images*, by Fred Leeman (New York: Harry N. Abrams, 1976).

FIGURE 2.10A
Fra Andrea Pozzo, *Entrance of St. Ignatio into Paradise,* Church of St. Ignatio Di Loyola, Rome, circa 1685–1694. Everything above the dark vaulted windows is painted onto an upper curved vault. Even the columns seem to be projecting upward into deep space.

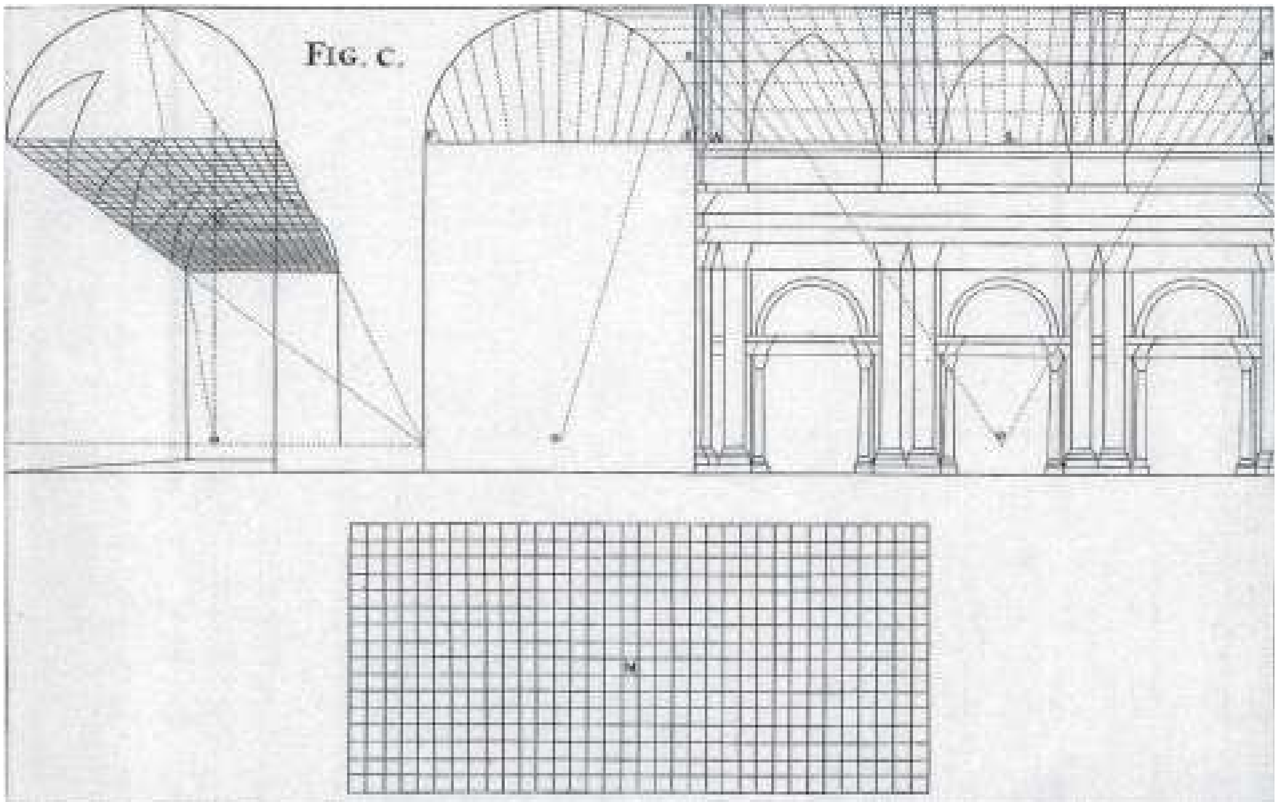


FIGURE 2.10B
Fra Andrea Pozzo. The method of drawing the net or lattice work on vaults (the 100th figure) from *Perpectiva Pictorum et Architectorum*, 1693. The fixed eye point is shown as an o in the elevation drawings. Angled dotted lines are stretched through the net intersections onto the vault.

FIGURE 2.11
Leonardo da Vinci, child's face and an eye, anamorphic drawing, from Codex Atlanticus, Fol. 35 verso a, circa 1485.

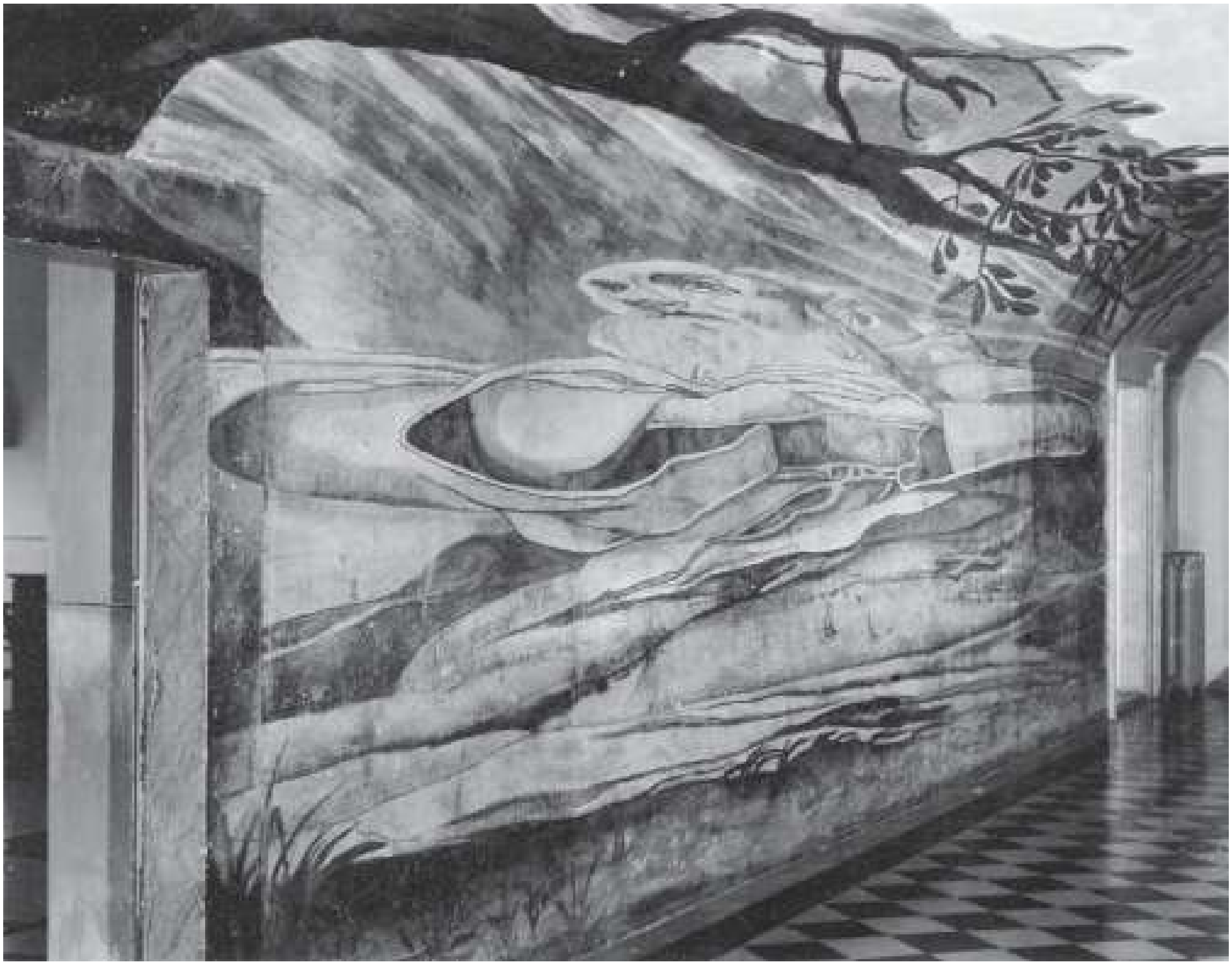


FIGURE 2.12
Emmanuel Maignan, *St. Frances of Paola*, a 60-foot-long anamorphic painting in the monastery of Church of Trinitá dei Monte, Rome, circa 1646. This painting, the only extant large anamorph, is open to the public for one-half hour each week.

The only large anamorph still in existence that dates from the Italian Renaissance is *St. Francis of Paolo*, by painter Emmanuel Maignan and optical scientist Jean-Françoise Niceron (1613–1646). It is in the Monastery at Church of Trinitá dei Monte in Rome and was painted in 1642–1646. This remarkable 60-foot-long painting (Figure 2.12) lines a hallway. Entering from the far end of the hallway, one sees St. Francis in prayer kneeling on his cloak under a tree and floating over the Straits of Messina—one of his miraculous deeds. Standing directly in front of the painting, one sees that the robes become a lake with several boats and small villages dotting a mountainous terrain. Maignan and Niceron, both monks in the Order of the Minims, made this anamorph using a tubular, *fixed eye point* and a hinged, two-dimensional, miniature gridded painting. Strings were stretched from the *fixed eye point* through the hinged miniature to arrive at distant placement points on the long wall. Jean-Françoise Niceron wrote the influential book *Thaumaturgus Opticus*, published posthumously in 1648. The book's title refers to St. Francis as a "performer of optical miracles." Both Maignan and Niceron were friends with well-known Renaissance scientist–philosopher René Descartes, who lived nearby at that time. Niceron made many circular anamorphs that could be viewed with a mirrored tube.

FIGURE 2.13
Samuel Van Hoogstraaten, top of peepshow box, circa 1660 (painted about 15 years after Maignan and Niceron), courtesy of National Gallery, London.

Samuel Van Hoogstraaten's peepshow box, shown earlier in the chapter, has a remarkable anamorph painted onto its top (Figure 2.13). A thorough history of anamorphs can be found in *Anamorfosi* by Jurgis Baltrusaitis (Adelphi Edizioni, Milano, 1990).

THE FIRST PINHOLE PHOTOGRAPHS IN ART

Except for a few peepshow boxes and a limited number of anamorphs, the pinhole lay relatively dormant from about 1653–1850. This was changed by the invention of photography. Sir David Brewster, the well-known English scientist, was one of the first to make pinhole photographs. In his 1856 book, *The Stereoscope*, Brewster coined the word *pin-hole* and it stuck. Other names have been suggested or even urged as a replacement. Examples include

- *spiraculo* by Leonardo da Vinci circa 1500
- *natural camera* by Joseph Petzval in 1859
- *stenopeic* photography by Dehors and Deslandres, late 1880s
- *natural camera* by George Davison in 1889
- *lensless* by Alfred Maskell in 1890
- *rectographic* by J. B. Thomson in 1901
- *needle-hole* by Gray in 1907[14]
- *spiracolografie* by Ando Gilardi in 1978

As inappropriate as it might seem, because the pinhole is almost always made with a needle or drill, the term pinhole has its own particular charm and historical appropriateness. Here is Brewster's observation and new word, *pin-hole*:

> Pictures thus taken are accurate representations of the object, whether it be lineal, superficial, or solid, as seen from or through the hole; and if we throw sufficient light upon the object, or make the material which receives the image very sensitive, we should require no other camera for giving us photographs of all sizes. The only source of error which we can conceive, is that which may arise from the inflexion of light, but we believe that it would exercise a small influence, if any, and it is only by experiment that its effect can be ascertained. The Rev. Mr. Egerton and I have obtained photographs of a bust, in the course of ten minutes, with a very faint sun, and through an aperture less than a hundredth of an inch; and I have no doubt that when chemistry has furnished us with a material more sensitive to light, a camera without lenses, and with only a pin-hole, will be the favorite instrument of the photographer. At present, no sitter could preserve his composure and expression during the number of minutes which are required to complete the picture.[15]

Sir William Crookes (1832–1919), John Spiller, and William de Wiveleslie Abney, all from England, were also some of the first photographers to try pinhole. Probably the earliest extant group of pinhole photographs were made by the Englishman Flinders Petrie (1853–1942), the "father of archaeology," during his second excavation in Egypt (Figure 2.14) in 1881 at Gizeh. Petrie's biscuit-tin camera is described by Margaret Drower, in her 1985 biography *Flinders Petrie*. She wrote:

> [Flinders] never having owned or used a camera in his life, he set to work to design one. It was essentially a box of japanned tin about the size and shape of a biscuit tin; the lens had two apertures, drilled in a sheet of tin, and the drop-shutter was also of tin, strengthened by a slip of wood; there was a sleeve of opaque material into which he could insert his hand to remove and replace successive plates, exposed and unexposed plates being separated by a slip of cardboard.[16]

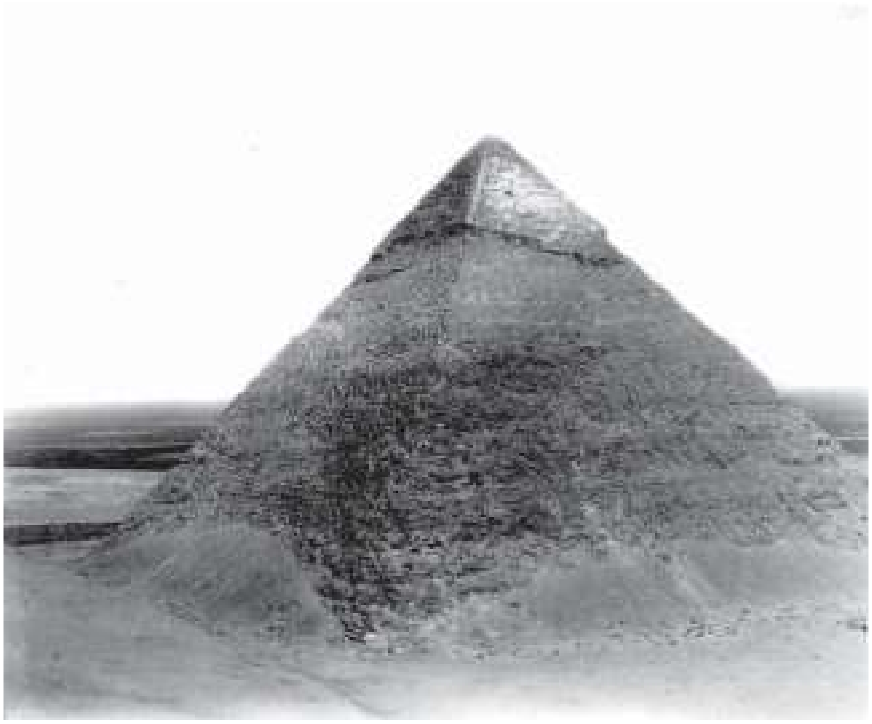


FIGURE 2.14
Flinders Petrie, *Khaefre Pyramid,* pinhole photograph made from a 3 × 4-inch original glass negative, 1881–1882, courtesy of Petrie Museum, University College, London.

Petrie's pinhole camera is lost. However, from the aforementioned description and from his suggestions in *Methods and Aims in Archaeology* (1904), it is possible to reconstruct his camera. It had some sort of simple lens, stopped down with two pinholes, one at *f*/100 and the other at f/200. If one of these pinholes had been of optimum diameter, Petrie's camera would have produced true pinhole images while that pinhole was in use. Maurice Pirenne in *Optics, Painting, and Photography* states: "Indeed for a pinhole of the optimal size it is not possible to improve the accuracy of the image by placing a lens in front of the pinhole."[17] Petrie was not afraid to take a nonconformist position in camera technologies; he achieved exactly what he wanted in the most basic, direct way. Petrie wrote:

> Small stops can be made out of a strip of tin plate or blackened card; and the hand camera [placed on a tripod] can be stopped down with a pinhole stop stuck in front of the lens so as to work at almost any nearness and scale with exposures of 1/2 or 1 minute in full sunshine. The instantaneous shutter is a useless article for all fixed objects. It is far better to work with a small stop which gives plenty of depth of focus, and exposed 2 to 20 seconds, which is long enough for *f* /100 on slow plates in Egypt. For direct enlargement of objects a stop of *f*/200 is excellent, and only needs 30 seconds exposure. If a shutter is wanted a simple drop can easily be extemporised.[18]

In his diary, dated September 20, 1881, Petrie wrote: "finished off camera and trying plates of newspapers as tests of definition. Got a line of 1600 inch wide on the plate."[19] A scrapbook of Petrie's pinhole photographs resides at the Egypt Exploration Society, London. Another pleasantly insightful observation on Petrie's photographic eccentricities comes from M. V. Seton-Williams in *The Road to El-Aguezin*:

> He took all his photographs on the site. The objects and pottery were arranged on shelves draped with a black backcloth against the sides of the hut. Then the stand camera would be set up . . . . the exposures could take anything up to half an hour, but the film, speed 40 H & D, was made specially for him by Kodak, that it did not matter if the whole expedition passed between the camera and the objects, as they sometimes did because the camera was set up in the only passageway into the mess room.[20]

It is surprising to see this clever, yet folksy, pinhole camera from 1885 (Figure 2.15A), made by Dr. Jno Van Sant, from San Francisco, California. Its aesthetic is in juxtaposition to what

FIGURE 2.15A
Dr. Jno Van Sant, diffraction camera, pinhole aperture 1000 inch, 1885, lens photograph. Courtesy of Smithsonian Institute, History of Photography Collection.

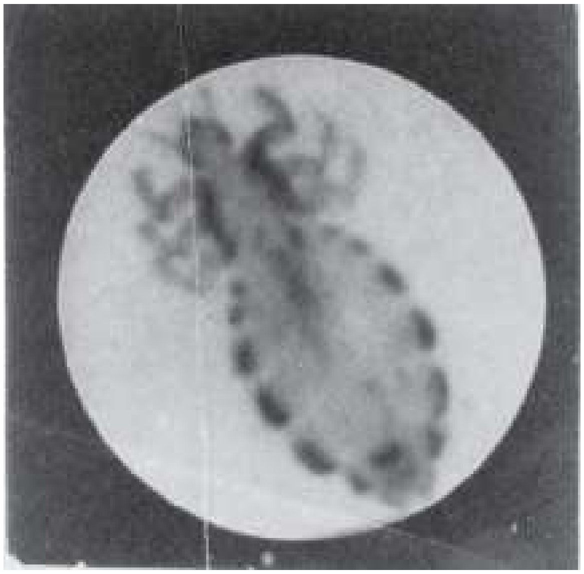


FIGURE 2.15B
Dr. Jno Van Sant, *Head Louse,* with pinhole aperture 1000 inch, July 19, 1885, pinhole photograph. On the reverse of the photograph it reads: "Pediculus capitus (Head louse) About 15 diameters, Aperture 1000. Light coal oil lamp July 19, 85. Dr. Jno Van Sant." Courtesy of Smithsonian Institute, History of Photography Collection.

we normally think a homemade pinhole camera of that era might look like. Equally surprising is his magnified diffraction image of a head louse (Figure 2.15b), because it was made with this camera.

PINHOLE'S POPULARITY IN EARLY PICTORIALISM: GEORGE DAVISON

By the late 1880s, the Impressionist movement in painting influenced a few of the more daring "art" photographers. For the first time, a sharply focused image was not deemed paramount by some; it was opportune to experiment with the pinhole technique. This aroused intellectual antagonism. On one side were those from the old school, who believed in the sharpest focus and achieved it with highest quality lenses. On the other side were those from the new school, who admired atmospheric qualities, otherwise derided as fuzziness. Fuzziness later became known as *pictorialism*. There were factions within each group that reflected differences of opinion about the extent of sharpness or just how much fuzziness was desirable. In England, the most outspoken proponent for fuzziness was George Davison. At that time photography was not considered art. In 1889, in the new magazine *Photography*, Davison wrote:

> It need hardly be said that nearly all beginners and many old stagers simply go straight for the smallest stop they dare use in order to make sure of getting all sharp. If the object is what we may call scientific, well and good, but if there be anything worthy of artistic representation in the picture selected, such a procedure will certainly tend to lose, suppress, or distract attention from it. Some of those who are fond of chewing the word "fuzziness" say that they quite see all this, and they express approval of many pictures shown them with soft out of focus backgrounds, and also of pinhole landscapes, but still they persist, apparently out of personal partisanship, in taking up a hostile position towards those who venture to call this artistic focus, and who point to the necessity for such treatment in every pictorial subject. Now, in regard to ninety-nine hundredths of the photographs turned out, it does not matter in the main how they are treated in this respect; they would be almost equally feeble however focused, but given a subject with really strong and poetic possibilities in it, sharpness and detail will go a long way to render it commonplace.[21]

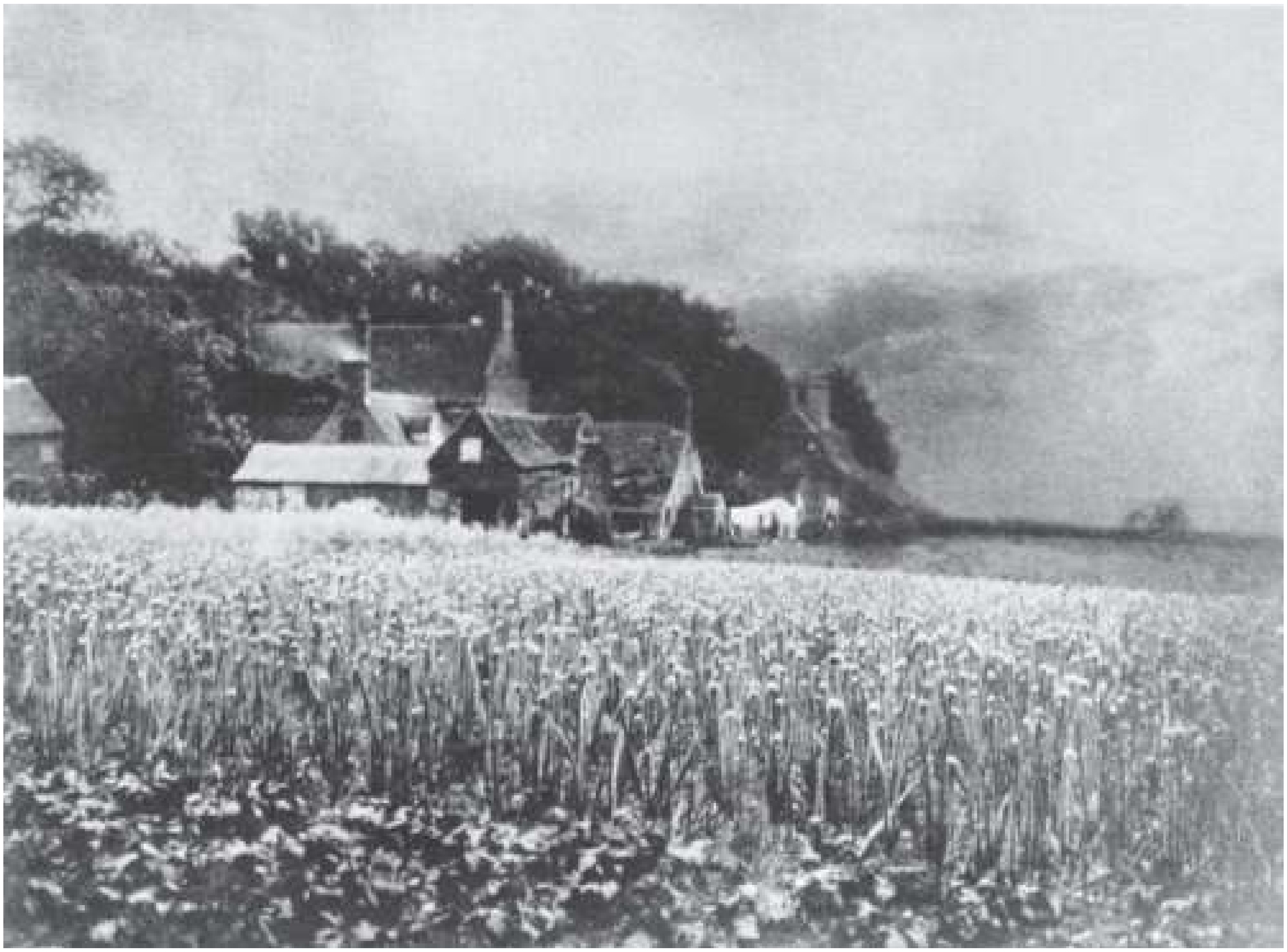


FIGURE 2.16
George Davison, *The Onion Field*, 1890. Courtesy of John and Elizabeth Fergus-Jean.

A month earlier, Davison had described his technique as follows:

> Our own apparatus is a thin flat piece of brass with a succession of holes of sizes 1/20 in. to 1/80 in., about 1/2 in. apart, countersunk in it. This bar of brass slides across a hole in a special front to the camera, through slots made in a simple telescopic lens tube, which tube serves as a sky shade . . . . It will certainly do most photographers good to produce a few pinhole pictures. If they are not warped by prejudice, or blinded by ignorance, they cannot fail to feel the advantage that frequently is gained by such diffusion of focus.[22]

A year later, Davison's pinhole photograph An *Old Farmstead* (Figure 2.16) won the highest award at the annual exhibition of the Photographic Society of London. (Davison later changed the title to *The Onion Field*.) Davison received praise; the pinhole received the following criticism:

> It is certainly a satire on the labours of the optician that after the resources of science have been exhausted to produce a perfect lens, the best work can be produced with no more elaborate optical instrument than a bit of sheet metal with a hole pierced in it.[23]

This award, and criticism, was the beginning of the schism in the Royal Photographic Society that resulted in the formation of the Linked Ring—a group of art photographers dedicated to the ideal of pictorialism. George Davison was 1 of the original 12 founders. International exhibitions of art photography were presented by the group. Later pictorial photography was substituted for art photography.

By 1888, photographic enthusiasts in Europe, Japan, and the United States were purchasing varied types of commercial pinhole equipment. In London in 1892, 4000 pinhole cameras known as Photomnibuses were sold. (Oddly enough, not one of these cameras can be found in any historic collection.)

Several years earlier, in 1889, an American company invented the Ready Fotographer (Figure 2.17)—a camera a century ahead of its time, for it was the first disposable camera, and it was a pinhole camera. It contained one dry-glass plate, a pinhole in tinfoil, and a folding bellows (the entire camera folded flat). Possibly the first commercial pinhole camera came from France, designed by Dehors and Deslandres in 1887 (Figure 2.18). It, too, was unusual, having a rotating pinhole disc with six pinholes (three pairs of similar sizes), used singly or in stereoscopic pairs. The American company Anthony Eureka produced a medium-format, bellows-extension pinhole camera that used 3–5/8 × 4–5/8-inch glass plates. The camera came with a four-pinhole brass turret in 1888 (Figure 2.19). The pinhole sizes were 0.5, 0.75, 1.25 mm, with a viewing pinhole of 2 mm. Another American company sold the Glen Pinhole Camera, which included six dry plates (each 2–1/2 inches square), chemicals, trays, print frame, and ruby paper for a safelight. As if this were not enough, several companies sold rotating pinhole discs (Figure 2.20), which could be placed directly into a lens board (after the lens had been removed). All of these pinhole cameras and attachments are extremely rare today.[24]

FIGURE 2.17
Ready Fotografer pinhole camera, circa 1890. Courtesy of Smithsonian Institute, History of Photography Collection.

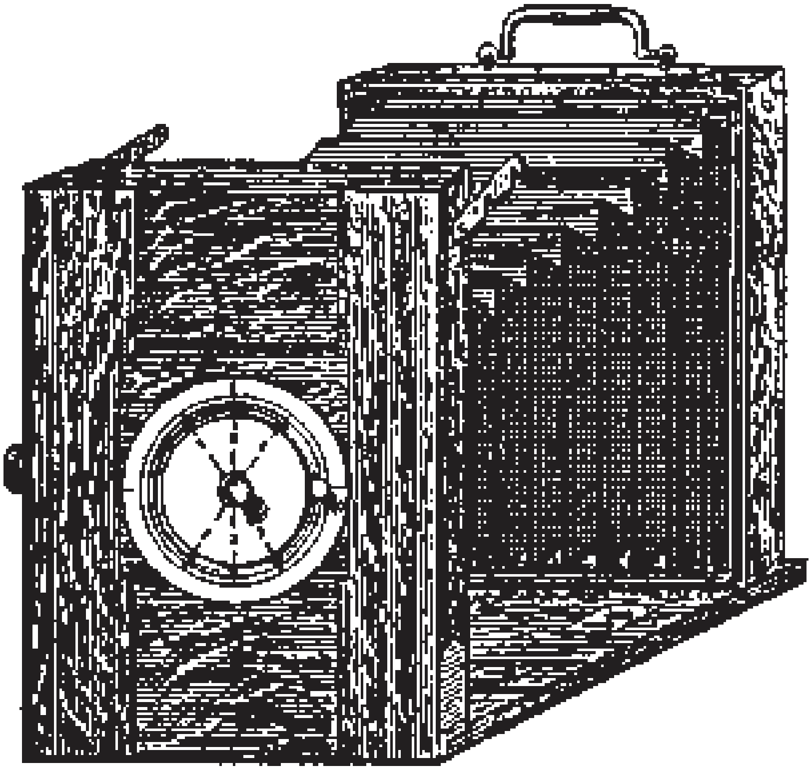


FIGURE 2.18
Messrs. Dehors and Deslandres' pinhole camera and pinhole disc. From *Anthony's Photographic Bulletin* in "Photography Without a Lens," Vol. 18 #19, October 8, 1887, pp. 599–601.

FIGURE 2.19
Anthony Eureka pinhole turret camera, 1888, made by Greenpoint Optical for Anthony Camera. The pinhole turret is composed of three sheets of brass; the first and third layers are the same shape and thickness. They are attached to the camera by three outside screws. The pinhole turret that turns inside these two layers is held in place by a pin rivet, visible at the left of the pinhole. The exposed brass in the upper left corner of the turret has small notches to accommodate one's fingernail to spin the turret. From the collection at Pinhole Resource.

FIGURE 2.20
Watkins Universal pinhole lens, circa 1905. Courtesy of Allen Sipprell.

AUGUST STRINDBERG

In 1892, the renowned Swedish dramatist August Strindberg (1849–1912) began experimenting with pinhole cameras. In his study of science and art, Strindberg became the creator of his own exotic branch of metaphysics, much of which was away from the "Christian imprimatur." He distrusted lenses. Unfortunately, his pinhole psychological portraits from this period are lost.

Strindberg's search within the photographic form had many nonconventional approaches, one of which was to create images without a camera. These were not photograms. For instance, Strindberg made celestiographs by holding photographic paper in his hand pointed toward the galaxy or planet he was photographing (Figure 2.21). Strindberg's manuscripts at the Royal Library in Stockholm give evidence that he often completed 15 pages of mathematical calculations to arrive at how and when to aim the photographic paper (I was fortunate to be able to study his manuscripts and notes in 1985). Strindberg's celestiographs are reflective of his rare personality and brilliant mind, observed partially by reading his *Occult Diary*. (I wonder what he would have thought of Ted Serios's 1960s thoughtographs?) Had Strindberg not been an internationally known dramatist, his photographs, particularly the celestiographs, may well have never been preserved or recognized.

Photo historians are just beginning to accept Strindberg's place in the history of photography. Although his photographic work spanned 40 years, only around 100 images exist today. Of these images, just three might be pinhole; of these, two unusual ones are in his *Occult Diary* (Figures 2.22A and 2.22B). Practically the only recognizable parts of these images are the doors, which connect to a place of transformation. The other is his photographic verification of Fraunhoefer diffraction. An additional two pinhole images were published in Frieda Uhl's book on Strindberg and are listed as being "made with a camera without a lens," although these seem questionable. In making portraits, Strindberg was the first to say: "Put your soul through the hole." Despite the dearth of surviving images, we are fortunate indeed, for preserved in some of Strindberg's writings are explanations and investigations, although they are written with his cryptic, searching humor. Translated by Jan-Erik Lundström, a

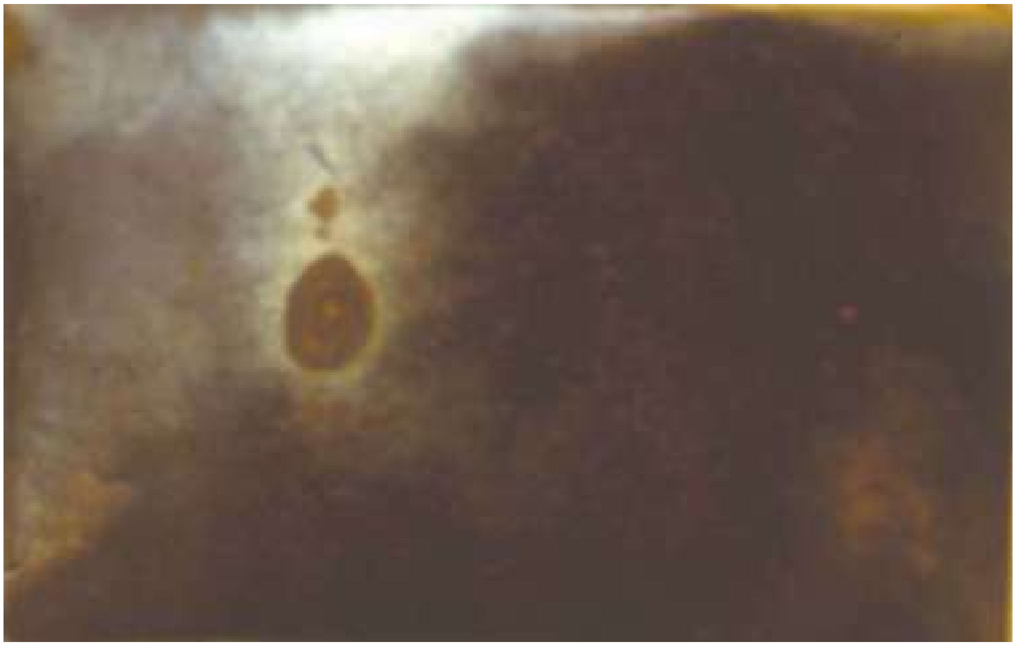


FIGURE 2.21
August Strindberg, *Celestiograph*, approximately 3½ × 4½ inch, 1894, Courtesy of Royal Library, Stockholm.

FIGURE 2.22A
August Strindberg, untitled pinhole photograph, 1 × 2 inches, in August Strindberg, *Occult Diary*, circa 1910. These two pinhole photographs are far from the pictorialist imaging of that era. Courtesy of Royal Library, Stockholm.

FIGURE 2.22B
August Strindberg, untitled pinhole photograph, 1 × 2 inches, in August Strindberg, *Occult Diary*, circa 1910. Courtesy of Royal Library, Stockholm.

contemporary European photo critic, is the following excerpt from Strindberg's "On the Action of Light in Photography—Reflection on the Occasion of the X-Rays:"

> But: First speculate, then experiment! And I speculated as follows: Coming from the next room, the sound from an instrument touches my ear more forcefully if the door is open, than if it is closed. Analogy: The light ought to work more directly in the camera, if it doesn't have to pass through a solid medium, such as glass.
>
> This was true and false at the same time; because sound is more easily transmitted in solid bodies than in the air. And yet, when I open the door, I can hear better!
>
> And I do see clearer through glass lenses than through air!—Here I stopped, amazed at the changeability of the unchangeable laws of nature, their capriciousness, their self-contradictions, and their looseness. But I then continued. Took away the lens from the camera, and inserted a diaphragm, drilled through with a sewing needle. I photographed a person, and received a result which in all aspects was more successful than in photographing with a good lens.
>
> Against all rules, I had placed the man against a window—behind which was a landscape with fir trees in the foreground, and lakes and forests in the background.
>
> The man appeared in clear detail; and so did the trees, in perspective all the way out to the distance.
>
> Test with a lens and the same pose. The man now appeared flat, no detail, and of the trees not a trace—the whole landscape only a bright white background.
>
> But my diaphragm gave me yet another advantage. The man's coat was white with blue stripes. These blue stripes should normally turn out white, but here they remained greyish, outlining themselves against the white coat. And this fact, that blue retained its value, became for me the starting point for further experiments with colour photography.
>
> My speculation was correct when I took away the glass-lens, and allowed the light to work directly without passing through a medium.[25]

Elaborating on Strindberg's ideas about pinhole photography, Jan Erik Lundström wrote:

> Human vision is an artifact. Just like our understanding of nature is nothing but models that we construct, which are more or less feasible in our dealings with the world. And as a consequence the realism of the camera or photography cannot be easily trusted.
>
> These are of course ideas that have many reverberations in contemporary cultural discourse—that realism is relative, that language constructs a world rather than reflecting one—in the heydays of deconstructivism, and a postmodernism that has given up the possibility of a sensory world, a world of direct physical experience. Strindberg's turn to pinhole photography might then be viewed as a counterpoint—a search for an unmediated world, an absolute realism.

> Such was also his mode of photography—seldom expressionist or window-on-the-world realism, but rather conceptual, analytical, symbolic, metaphysical. The camera was an instrument with many ends. Photography a medium with endless applications.[26]

A reverse of Strindberg's celestiographs (and Ted Serios' thoughtographs) is the interesting concept about "existence" that Nicole Krauss invented using pinhole photography in her book *The History of Love* (New York: W. W. Norton & Company, 2005), where the person being photographed *knows* the camera will *not* make an image (I think I have witnessed this in some of my own attempts to make portraits once or twice—that the person apparently did not want an image to appear, so it didn't). Here is what Nicole Krauss wrote:

> He was an amateur photographer and one day he showed me how to make a pinhole camera. This was the spring of 1947. I sat in the back of his shop watching him fix the photographic paper inside the box. He told me to sit, and shone a lamp on my face. Then he removed the cover over the pinhole. I sat so still I was hardly breathing. When it was finished we went into the darkroom and dropped it in the developing pan. We waited. Nothing. Where I should have been there was only a scratchy greyness. My cousin insisted we do it again, so we did it again, and again nothing. Three times he tried to take a picture of me with the pinhole camera, and three times I failed to appear. My cousin couldn't understand it. He cursed the man who sold him the paper, thinking he'd been given a bad batch. But I knew he hadn't. I knew that was the way others had lost an leg or an arm, I'd lost whatever the thing is that makes people indelible. I told my cousin to

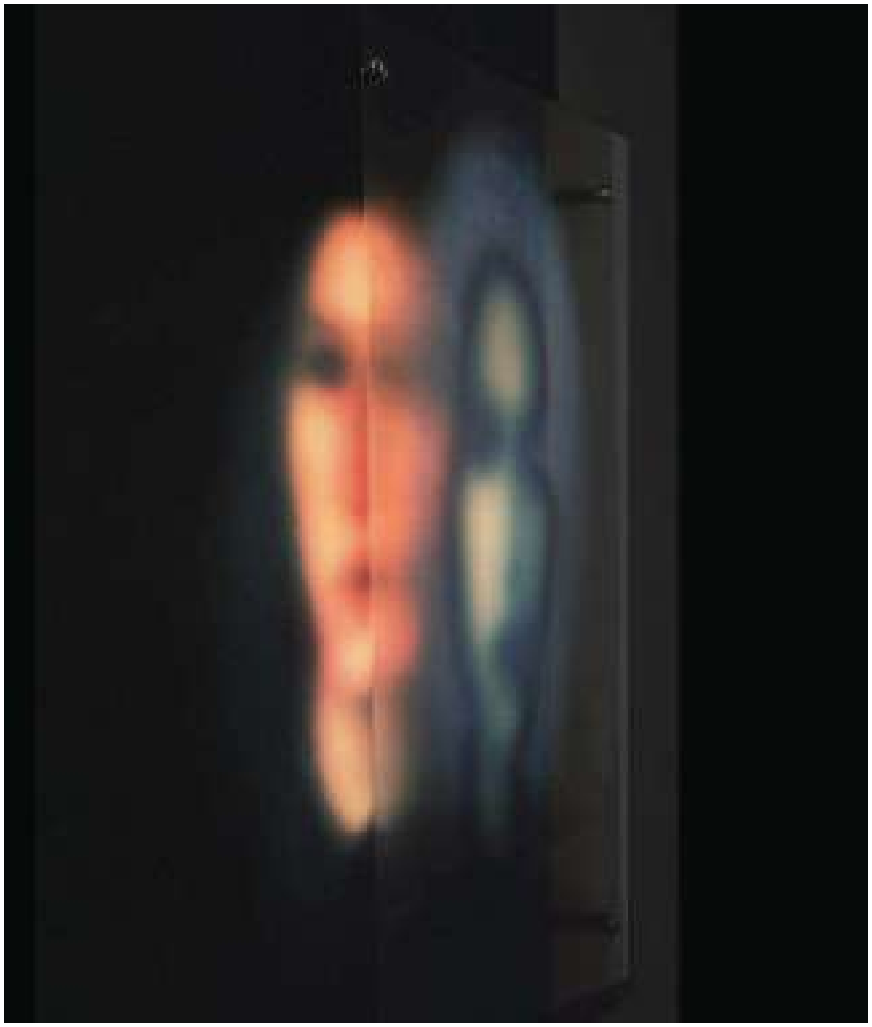


FIGURE 2.23
© Katarzyna Majak, *Self-portrait with Aura*, 50 × 40-cm zone plate photograph. From the collection at Pinhole Resource.

sit in the chair. He was reluctant, but finally he agreed. I took a photograph of him, and as we watched the paper in the developing pan his face appeared. He laughed. And I laughed, too. It was me who'd taken the picture, and it was proof of his existence, it was also proof of my own. He let me keep it. Whenever I took it out of my wallet and looked at him, I knew it was really looking at me.[27]

In 2004, with a unique sense of 20th-century technology, Katarzyna Majak from Poland used a computer screen (for light as you would do with an enlarger) and a negative zone plate image to create an *aura* image (Figure 2.23). (Strindberg would have approved of her *turning of consciousness*.) Majak explained her process:

In 1835 Daguerre claimed that he managed to discover a way to let the image—be it a portrait or a landscape—*leave* its *trace* . . . .The image in a daguerreotype was unique and unrepeatable. The mysterious character of it was enhanced by a possibility to see the result only from a certain angle. I am challenging a contemporary viewer in a similar way. My images exist as a combination of a zone plate photograph and its "emanation" (or 'projection')—unique 'aura' on the film.

The negative of a zone plate photograph was scanned and through a direct contact between a computer screen and a sensitive material exposed onto the film. After a few days the film became overexposed to make the development needless. A unique colour is characteristic of a sensitive material and the image becomes visible when watched from an angle, not from the front. The illuminated 'veil' (or 'mask') reveals the positive of the face.[28]

PINHOLE'S DEMISE IN THE EARLY 20TH CENTURY

By the 20th century, the pinhole was pigeonholed and labeled impressionistic. The technique could find only limited use by later pictorialists (Figure 2.24). World War I intervened, newer media such as silent film with its cataclysmic speed of imagery, and inexpensive, mass-produced lens cameras with their sensibilities of sharper realism left pinhole far, far behind. Because the sensibilities of the pinhole had been so linked to impressionism, it became passe'. Even the Bauhaus art movement did not seem interested in the pinhole technique.

By the Depression era of the 1930s, the pinhole was barely remembered. At best, in the photographic art world, it became only a teaching tool. Frederick Brehm, in the late 1930s, at a college that would later become Rochester Institute of Technology, was possibly the first professor to emphasize the educational side of pinhole technique. Brehm also designed Kodak's only commercial pinhole camera (Figure 2.25)—the *Kodak Pinhole Camera* (circa 1940s). This kit offered the first build-it-yourself commercial pinhole camera. Brehm unknowingly may have damaged the reputation of the pinhole; by the 1950s many people thought of the pinhole as only the simplest of cameras, useful mostly because it could be made from a kit—for student-like (or boy scout) attempts—but hardly as important as a real image made by a lens camera.

It has been a popular misconception that the well-known British art photographer Bill Brandt (1904–1983) used a pinhole for his wide-angle nude studies. Jim Barrow, who later owned the camera Brandt used for this series, stated that the camera was definitely not pinhole. I hope Barrow's letter, included here, will correct photographic history. Barrow wrote:

Here is the "story." Bill Brandt had two whole plate (6-1/2 × 81/2 inches) cameras made by Kodak in England (or made for them). The design would have made them useful to general purpose commercial photographers doing day, architectural or industrial work; it has been said that it was a popular camera with the police force, maybe so, but it has been described as a police camera and this is nonsense. It was non focusing, rigid construction, but a focusing bellows attachment was available as an extra. Basically

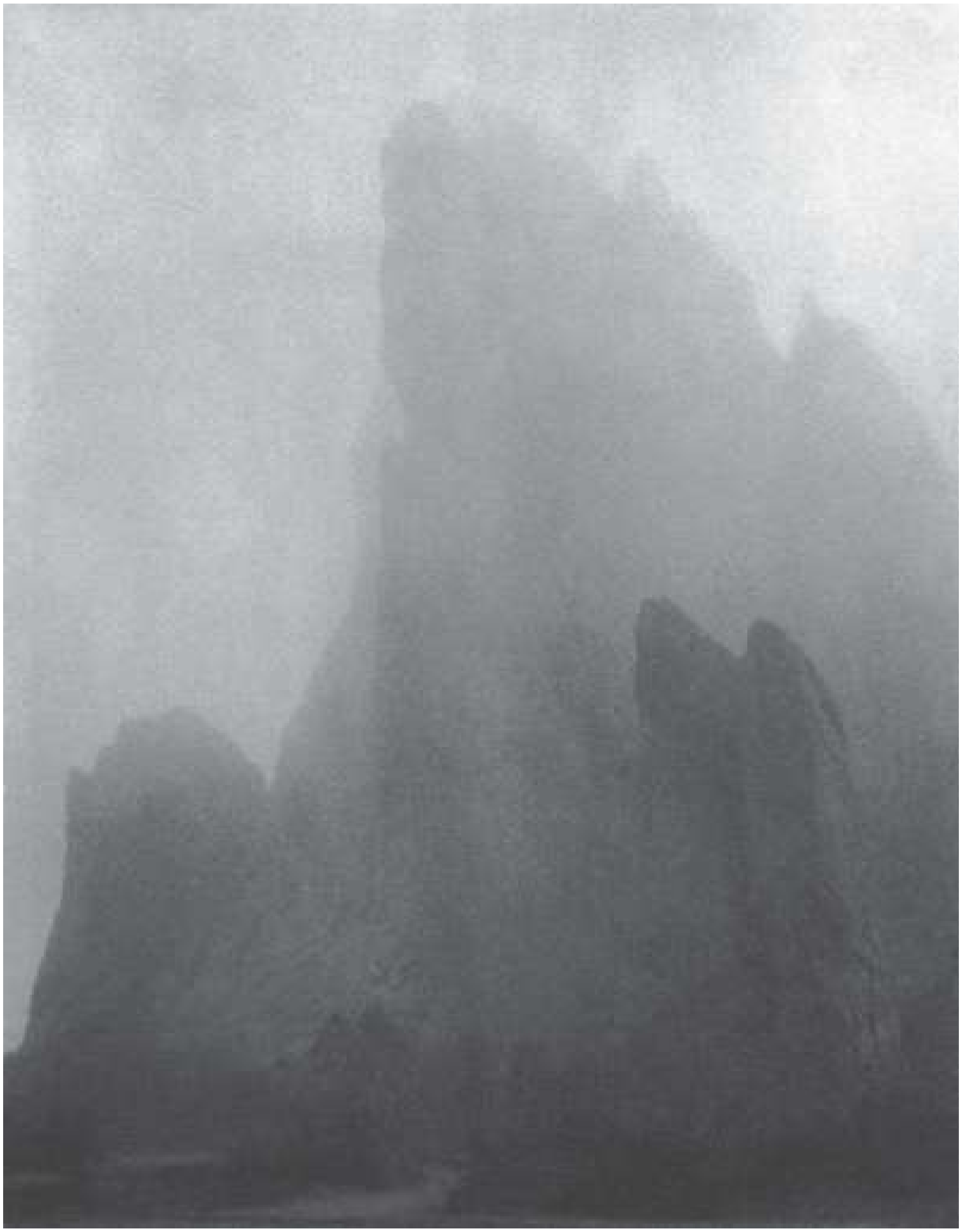


FIGURE 2.24
Laura Gilpin, *Ghost Rock,* Garden of the Gods, Colorado, 10 × 8-inch platinum print, P1979.95.66. © Amon Carter Museum, Laura Gilpin Collection, Fort Worth, Texas. Used by permission.

> it was designed around the Zeiss W. A. Protar series maximum aperture f18 stopping down to f45—the focal length of mine was 8.5 cm—but he had others. The provenance of my camera, which I recently sold, was Brandt's widow. I am enclosing a picture of the camera identical to the one he used [Figure 2.26].[29]

By the end of the 1950s, the few articles published about pinhole trivialized the medium. A new awareness was needed.

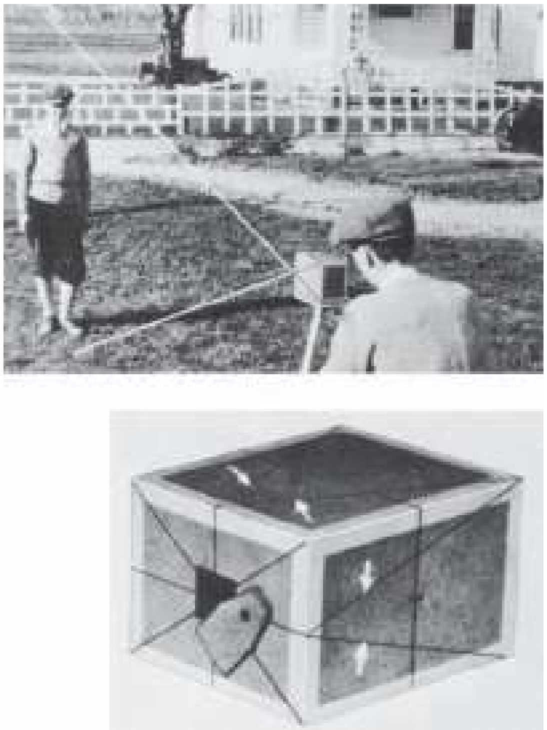


FIGURE 2.25
Frederick Brehm, two details from instructions for building Kodak's pinhole camera, circa 1940. Gift of Richard Zakia, from the collection at Pinhole Resource.

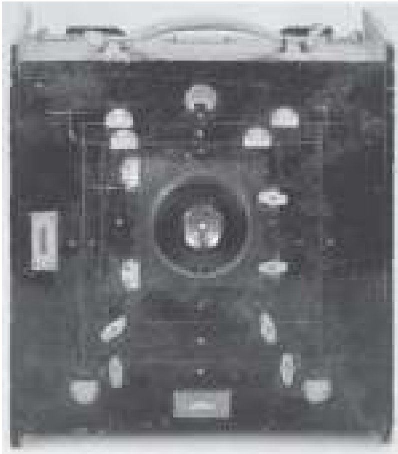


FIGURE 2.26
© Jim Barrow, whole plate camera similar to Bill Brandt's, lens photo. From the collection at Pinhole Resource.

Notes

1. Filarete (1400–1469), in Eugenio Battista, *Brunelleschi* (NY: Rizzoli International, 1981), 110. Art historins have longed to find perfect evidence that would result in conclusive agreement on the birth of perspective. For further study, read Samuel Y. Edgerton Jr., *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca, NY: Cornell University Press, 1993) and Martin Kemp, *The Science of Art* (New Haven, CT: Yale University Press, 1990).
2. Filarete, (1400–1469), in Eugenio Battista, *Brunelleschi* (NY: Rizzoli International, 1981), 102–113.
3. Fred Leeman, *Hidden Images* (NY: Harry N. Abrams, 1976), 21–22.
4. James Waterhouse, "Camera Obscura," in *Encyclopædia Britanica* (NY: Encyclopædia Britanica Company, 1910), 102. There has even been conjecture by Professor Nicholas Allen of the Port Elizabeth Technikon, South Africa (1993) that a *camera obscura* with a quartz lens and some type of light-sensitive photographic material were used in the 1300s to create the Shroud of Turin.
5. Pia Høy, *Marcel Duchamp–Étant donnés: The Deconstructed Painting*, translated by John Irons, *tout-fait*, Issue 3, 2000, www.toutfait.com/duchamp, unpaginated.
6. Leon Battista Alberti, *On Painting and on Sculpture* (1435; reprint ed. by Cecil Grayson, London: Phaidon Press, 1972), 69.
7. David Hockney, *Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters* (New York: Viking Studio, 2001), 82.
8. Battista, *Brunelleschi*, 110.
9. Leonardo da Vinci, *The Notebooks of Leonardo da Vinci*, ed. Jean Paul Richter (NY: Dover Publications, 1970). Leonardo's contributions to pinhole optics are in the following Manuscripts: D. 8a; A. 64b; Br. M. 174b; W. 19152a and b; D. 5r; A. 9b; C. A. 190a; A. 9b; W. 19150b; A. 42b; C. A. 135b; W. 19149a; B. N. 2038. 20b; Triv. 6b; F. 5a; C. 6a; Leic. 1a; C. 7a (9b); W. 19148b; C. A. 204b.
10. William Martin Conway, *The Writings of Albrecht Dürer* (NY: Philosophical Library, 1958), 208.
11. William Martin Conway, *The Writings of Albrecht Dürer* (NY: Philosophical Library, 1958), 208.
12. Samuel Y. Edgerton Jr., *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca, NY: Cornell University Press, 1993), 289. A contemporary demonstration where one can witness the beauty of light and how it interacts with one point perspective is Walter De Maria's *Lightning Field* situated near Quemado, New Mexico.

13. The Society for General Systems Research, *Yearbook of the Society for General Systems Research* (Palo Alto, CA: The Society for General Systems Research, 1956), 24.
14. Stanley R. Page, "The Golden Age of Pinhole Photography 1885–1919," *Pinhole Journal*, Vol. 2#3 (1986): 29. A very complete description of pinhole photography during the 1890s.
15. Sir David Brewster, *The Stereoscope: Its History, Theory, and Construction* (London: J. Murray, 1856), 136–137.
16. Margaret Drower, *Flinders Petrie* (London: Victor Gollanca Ltd., 1985), 48.
17. M. H. Pirenne, *Optics, Painting, and Photography* (New York: Cambridge University Press, 1970), 23.
18. Flinders Petrie, *Methods and Aims in Archeology* (New York: Macmillan, 1904), 74–75.
19. Flinders Petrie, *Diary*, dated 20 September 1881, 1882, Petrie Museum, London, unpublished.
20. M. V. Seton-Williams, *The Road to El-Aguezin* (London: Kegan Paul Int., 1988), 3.
21. George Davison, "Softness in Photographs and Means of Obtaining It," *Photography* 1 (12 December 1889): 684–686.
22. G. Davison, "Softness in Photographs," *Photography* 1 (14 November 1889): 634–635.
23. "Exhibition of the Photographic Society," *Times* (London), 29 September 1890, p. 4.
24. Stanley R. Page, "The Golden Age of Pinhole Photography 1885–1919," *Pinhole Journal*, Vol. 2#3 (1986): 21–25.
25. August Strindberg, ""On the Action of Light in Photography—Reflection on the Occasion of the X-rays," translated by Jan-Erik Lundström," *Pinhole Journal*, Vol. 4#1 (1988): 19. Strindberg's entire article was written circa 1894 and appeared in *Strindberg's Collected Works*, Vol. 26, ed. John Landquist (Stockholm: Bonniers 1912–1920).
26. Jan-Erik Lundström, "Notes on 'On the Action of Light in Photography . . .'" *Pinhole Journal,* 4#1 (1986): 21.
27. Nicole Krauss, *The History of Lov* (New York: W. W. Norton & Company, 2005), 81–82.
28. Katarzyna Majak, Artist's Statement, *Pinhole Journal,* 20#3 (2004): 3.
29. Jim Barrow, personal communication to the author, 6 September 1998.

CHAPTER 3

Pinhole's Revival

Much work is yet to be done and what is needed is earnest workers.

H. D'ARCY POWER, "Advanced Pinhole Photography,"
***Photo-Miniature*, July, 1905**

Stenopeic from the Greek Stenos: narrow and the stem Op of Orao: to see.

PAOLO GIOLI, 1986

The pinhole camera techniques seem to function better when used to produce a type of image which is not concerned with commonplace reality but instead focuses on the world of dreams and fantasy.

FRANCO SALMOIRAGHI, 1968 MFA thesis, Ohio University

REBIRTH (1960–1990)

In the late 1960s, a few artists whose training was not necessarily photographic chose to explore pinhole photography. None of them was aware that others were working in pinhole. Chronologically, who was first does not seem important—what sets all these people apart is that they chose to experiment in pinhole photography without instruction from others: Paolo Gioli in Italy; Gottfried Jäger in West Germany; and David Lebe, Franco Salmoiraghi, Wiley Sanderson, and me in the United States.

Why were these artists working in pinhole if pinhole photography had died a decade or two before? The reason is because a changing reality in the air prompted investigation of alternatives. Something as universally accepted as lens sharpness, the singular image, and the mass-produced conventional camera needed to be reexamined.

Paolo Gioli, who began working in *stenopeic* (pinhole) photography in 1969, wrote:

> There is in the history of writing, of graphics, a mark that continues to fascinate me: the dot. It's always amazing to see a dot made by a pencil and then the dot immediately become a pinhole. The eye of a needle is probably the most provocative design in the history of art. Most of my work goes through the eye of a needle, basically with a great variety of camera obscuras, not a 35mm camera. I have taken the stenopeic slit as an ideological as well as a plastic 'point of view.'
>
> The photostenopeic image came to me because I didn't have a camera. I am fascinated by the purity of the action of shooting 'poor' and the equally pure image that one gets back [Figure 3.1A]. Mine is not a brief scholastic experiment, but a definite way of understanding space specifically through a point in space which, as we know, penetrated into caves with alarming rays, or, reflected on the walls perturbing the first Arab thinkers—and my sensitized papers.[1]

FIGURE 3.1A
© Paolo Gioli, *La Mia Finestra* (My Window), 3½ × 5-inch pinhole photograph, 1969. From the collection of the photographer.

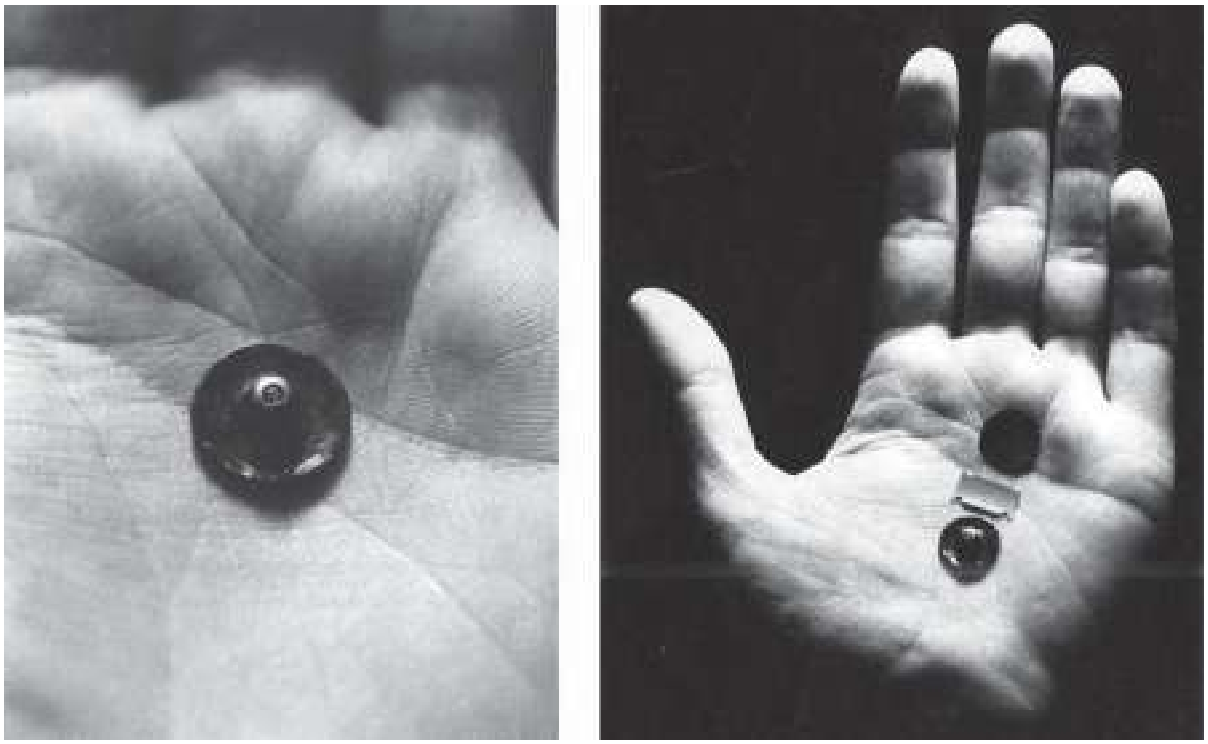


FIGURE 3.1B
© Paolo Gioli, snap, cut film, backing, and snap in the palm of Paolo Gioli's hand, circa 1970s. From the collection at Pinhole Resource.

By 1972 Paolo Gioli had begun working on his series of gestural "snapshot" images (a play on the word snapshot at the time). These he titled *spiracolografie*, named after Leonardo da Vinci's name for the hole in the wall, *spiraculo*. Gioli's pinhole snapshots were more primal, visceral, and humanistic than the instantaneous snapshot era that surrounded him.

FIGURE 3.1C
© Paolo Gioli, *Il mio viso umido e calotipico* (spiracolgrafia microstenopeica), 40 × 30 cm, 1975. From the collection of the photographer.

To accomplish this he used a simple metal snap with its customary hole already provided (Figure 3.1B). To explain Gioli's photographic procedure, Ando Gilardi wrote:

> He presses the button [the snap] against the thumb with the index and ring finger; a tiny bit of standard film is placed between the thumb fingertip and the button. The middle finger of the same hand closes the "spiraculo" [pinhole] on the bump, then moves and acts like a shutter. Gioli works in the dark with one lamp only, or even with a small flash, whose light blow is enough to fix the forming image, with no more than 3 mm diameter. He then obtains a negative film which he enlarges [Figure 3.1C] . . . . This one—of Gioli—is a gesture that is photographically pure.[2]

David Lebe, a senior at the Philadelphia College of Art in 1969, stated:

> Reality moves so fast that everything is either an expectation or a memory. . . . We experience many fragmented and concurrent images and perceptions which flow together instantly, creating a picture [Figure 3.2] and a feeling of a scene. It is this flow of images and this sense of time that I want in my work.[3]

For myself, life is a paradox and a jigsaw puzzle to be completed. I enjoy looking at it from the inside; metaphorically the camera is never outside of me. What I attempt to give back to the world is my pinhole imagery (Figures 3.3A and 3.3B). My images are conceived within my own needs and have never been done as a way to earn money. I first learned about pinhole photography while studying product design as a sophomore in 1960; everyone in the class designed pinhole cameras (although it was not a photography class). By 1968, while teaching three-dimensional design for State University of New York, and involved in the first wave of antiwar and environmental sentiment—in one unique moment, very special to my lifetime, when I was simply walking down the street, I said to myself, or something said to me: "Why don't you make a camera that takes a whole environment into view?"[4] I have been attempting to do that ever since with a variety of cameras, ideas, and social concerns.

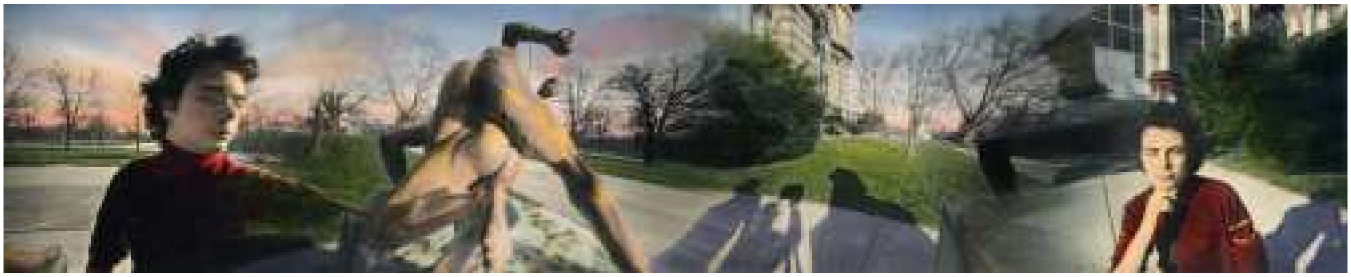


FIGURE 3.2
© David Lebe, *Self,* Memorial Hall, Philadelphia, 1974, 3½ × 17½-inch Epson pigment ink on archival mat paper, edition of 20 (2006 print from 1974 negative). From the collection of the photographer.

FIGURE 3.3A
© Eric Renner, pinhole camera, approximately 20 inches in diameter to accommodate a 9 × 29-inch piece of outdated aerial film, 1968. Film wraps around the inner cylinder. From the collection of the photographer.

FIGURE 3.3B
© Eric Renner, *Ticul Schoolyard,* 9 × 25-inch five pinhole photograph, 1969. This, my favorite image from the series *Ticul, Yucatan*, is actually only five overlapping pinhole images, because I accidentally chopped off the sixth overlapping part of the negative in the dark prior to developing. In 1971, the *Life Library of Photography* series published this image in *The Art of Photography*. It seems to have spoken to many readers (that series of photo books was quite popular internationally), as over the years quite a surprising number of pinhole photographers have mentioned how it inspired them to do pinhole photography. From the collection of the photographer.

In recent years I see visual imagery as archetypes, further described in my book *American Disguise* (San Lorenzo, NM: Flying Monkey Press, 2007).

Two scientists were also working with pinhole, for the dual purpose of art and science: Maurice Pirenne (1912–1978) in England and Kenneth A. Connors in the United States.

Maurice Pirenne was a physiologist and optical scientist who wrote widely. He had spent a lifetime studying the history of art, particularly painter's use of perspective. For decades he explored the complexities of viewing two-dimensional paintings using both eyes (as in ordinary binocular vision) and with one eye (as in the *fixed eye point* required for Renaissance one point perspective). He wanted an overview—one that explained how people have viewed two-dimensional paintings over past centuries. He also attempted to know "why" certain artists, ones who used Brunelleschi's *fixed eye point* with Alberti's intersector for highly foreshortened imagery, often altered the perspective view slightly so that it did not look distorted in the area beyond the eye's range of normal. His book *Optics, Painting, and Photography*, Cambridge University Press (1970) is his synthesis. Within it are 22 pinhole photographs; most are couplets with varied angles of view or slightly shifted perspective, an important book for anyone seriously interested in pinhole photography. Pirenne prefaced his work by stating:

> In a sense, the present work constitutes a commentary on Leonardo. Instead of merely relying on texts, however, it deals on an experimental basis with problems which confronted Leonardo. . . . The book also deals with relevant aspects of the history of optics, from Euclid to Einstein.[5]

Pirenne also explained the pinhole camera as:

> Whereas each luminous point sends divergent rays into its surroundings [Figure 3.4A], the pinhole camera does select certain cones of rays [Figure 3.4B] from among all the rays which fill the whole of space, so that the main rays of these cones do now converge toward the centre of the pinhole. [These main rays are shown in Figure 3.4A as the lines AH, BH and CH.]
>
> The fact that image-forming systems so select certain cones of rays in each of which the rays diverge from its object point, while the cones themselves all converge towards the image-forming system, is the crux of the matter with regard to the formation of 'real' optical images.
>
> The situation is essentially the same for the eye—except that inside the eye, as well as inside the lens camera, the rays of each cone are made to converge, whereas inside the

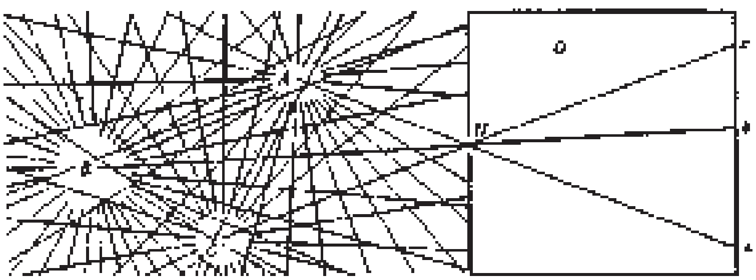


FIGURE 3.4A
© Maurice Pirenne, luminous points of light sending divergent rays, from *Optics, Painting, and Photography*. Courtesy of Cambridge University Press, London, 1970.

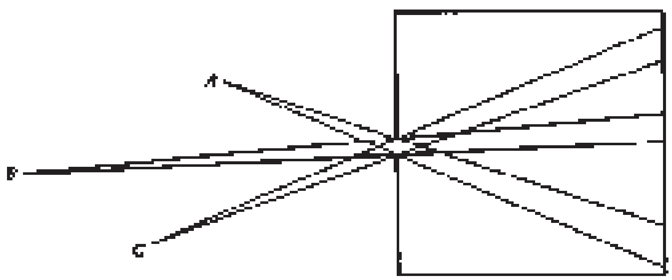


FIGURE 3.4B
© Maurice Pirenne, pinhole camera selecting certain cones of rays, from *Optics, Painting, and Photography*. Courtesy of Cambridge University Press, London, 1970.

> pinhole camera they remain divergent. Outside the eye, the narrow divergent cones of rays coming from the different object points all converge towards the pupil. The main rays of all these individual cones thus form a visual pyramid or a pyramid of sight which geometrically diverges from the eye, even though physically the light goes towards the eye.[6]

Pirenne's "visual pyramid" in the aforementioned quote refers to the pinhole perspective devices of Brunelleschi and Alberti, placed into a 20th-century context. Pirenne has examined some of the intricate visual conceptualizations Leonardo questioned; Pirenne's answers beget more questions.

Kenneth A. Connors, while professor of pharmacy at the University of Wisconsin, worked imaginatively and scientifically with pinhole and zone-plate photography, sharing his fascination and research with both mediums in his generously self-published magazine *Interest* (1972–1980). Connors stated:

> The pinhole is a 'phase-selector,' a recombination element that selects only waves that are (very nearly) in phase. In order to do so, of course, it must reject most of the light, so that image intensity is very low. The process of optimizing pinhole diameter for a given focal length consists of applying a criterion that specifies the range of phase differences that is acceptable in the admitted wave-front.[7]

In 1972, the painter Willie Anne Wright of Richmond, Virginia, began working with pinhole cameras. By the early 1980s she was one of the first to use large sheets of Cibachrome direct-positive photographic paper (presently named Ilfochrome Classic) directly in her pinhole camera and filtered for daylight. Of her work (Figure 3.5) Willie Anne Wright looked toward the pinhole archetype as:

> Plato's image of a world of shadows inhabited by prisoners has, for me, layers of meaning concerning the nature of reality and has a direct relation to the concept of the *camera obscura*. . . . To me if you vaguely compared the den to a *camera obscura*—the sun would be the fire and the people would sit (inside) facing the back of the camera (making room for the pinhole, of course) and would watch the figures thrown on the back (inside) of the camera. Now going a step further this could be considered a

FIGURE 3.5
© Willie Anne Wright, *Nancy at the Ocean,* 8 × 10-inch Ilfochrome Classic pinhole photograph, 1983. Private collection.

metaphor for life in this world—where appearances are not always true and we see as through 'a mirror darkly' truth to be revealed in its entirety perhaps in another world. It's probably better not to try literally to interpret the simile, but to grasp it intuitively.[8]

In 1974, Carlos Jurado's book on pinhole photography, *The Art of Capturing Images and the Unicorn*, was published by the National University of Mexico. From 1970 onward Jurado worked in relative obscurity, mostly unknown outside of Mexico until recently. Of his pinhole imagery (Figure 3.6), Carlos Jurado stated:

I consider photography as a magical process in which alchemy is more important than technology. . . . I don't use pre-made materials like oat boxes or any other boxes. I build my own cameras according to my needs of expression. . . . It is like a way of "reinventing" photography. I feel the inventors of photography are true heroes of humanity. Today this process is basic to human life. . . . I modestly try to follow their steps and I am sure that my images have some of their influence.[9]

In 1973, Phil Simkin in Boston created a "displacement project" with the Boston Institute of Contemporary Art in which 20,000 hand-assembled, preloaded pinhole cameras (Figure 3.7A) were stacked in tractor-trailers and taken to drop-off points around the city where residents would pick up (displace) a camera and then make a photograph. Two years later the project was "redisplaced" at the Philadelphia Museum of Art. Fifteen thousand cameras were stacked in the foyer (Figure 3.7B). People could come into the museum and take (displace) a camera out of the huge stack of cameras and make an exposure at home, preferably in their living space. A public darkroom was built in the museum, where, with the help of museum assistants, each person who photographed would develop and print their image. During the month-long duration of this project, images were continuously exhibited. Each camera was made from dye-cut cardboard with a taped-in brass shim pinhole; 3 × 10-inch Ilford photo paper was used as a negative. The entire project received much publicity when *Popular Photography* published the article "Pinholes for the People," June 1975. Simkin's camera was never sold commercially nor has its unique design received the acclaim it deserves.

FIGURE 3.6
© Carlos Jurado, *Viejo Autorretrato*, 4½-inch-diameter pinhole photograph, 1973. From the collection at Pinhole Resource.

FIGURE 3.7A
© Phil Simkin, displacement pinhole camera, 1973, lens photo by Phil Simkin. From the collection at Pinhole Resource.

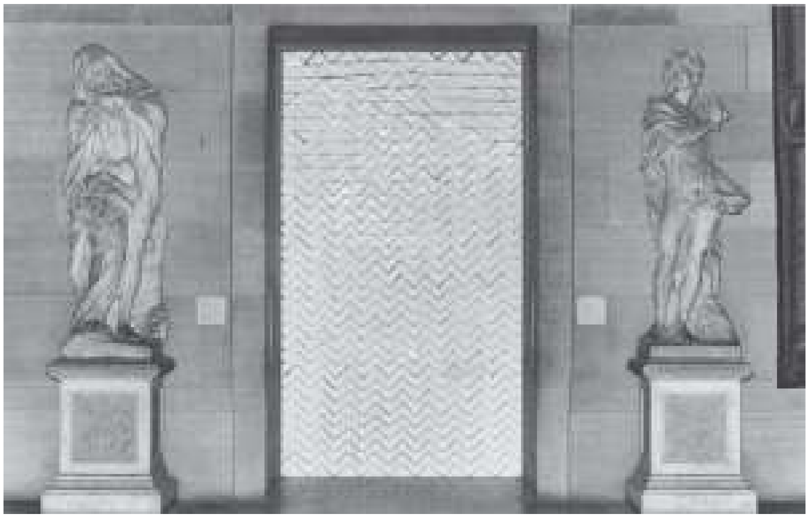


FIGURE 3.7B
© Phil Simkin, front layer of 15,000 displacement pinhole cameras stacked in the foyer at Philadelphia Museum of Art, 1973, lens photo by Patrick Radebaugh. From the collection at Pinhole Resource.

FIGURE 3.8
© Ruth Thorne-Thomsen, *Head and Plane,* Chicago, 4½ × 5¾-inch pinhole photograph, from series *Expeditions*, artist's proof, 1979. From the collection at Pinhole Resource.

In 1976 Ruth Thorne-Thomsen, while working toward her MFA at The School of The Art Institute of Chicago, began her now well-known series *Expeditions* (Figure 3.8). Of Thorne-Thomsen's early work, Denise Miller-Clark in *Within This Garden* (NY: Aperture Foundation Inc., 1993) wrote:

> The first images were of lands of heat, mystery, and romance. The sand castles, pyramids, and palm trees in her photographs hint at exotic places just beyond the frontiers of civilization, even though the miniature landscapes were made on the heavily populated beaches of California and Mexico. The series title, a metaphor for those passions instilled by her maternal grandmother, also suggests adventure.[10]

Ruth Thorne-Thomsen wrote about the *Expeditions* series:

> The photographs in 'Expeditions' are what I call 'environmental collages,' consisting of small props and photographic cut-outs . . . assembled in the environment, and photographed with a pinhole camera and paper negatives. I attempt to create photographically convincing realms.[11]

FIGURE 3.9A
© Peggy Ann Jones, Copernicus pinhole camera, 7 × 3½ × 3-inch cast lead nonfunctioning pinhole camera, 1984. Lens photograph by Peggy Ann Jones. From the collection of the photographer.

FIGURE 3.9B
© Peggy Ann Jones, *One Thing Lead to Another*, camera case of seven lead camera-like sculptures, weight 44 pounds, 7 × 21 × 14 inches. Lens photograph by Peggy Ann Jones, 1984. From the collection of the photographer.

> My work is an effort to combine elements found in the real world or even borrowed from other works of art to produce a separate and different reality.[12]

In a sociological context concerning excess, the sculptor–photographer Peggy Ann Jones of California may have been the first artist to make pinhole cameras that purposely did not function (Figure 3.9A). In 1977 she playfully placed a group of seven cast-lead nonfunctioning cameras into a photographer's carrying case (Figure 3.9B). The case weighed 44 pounds

Pinhole camera kit. This was the first commercial pinhole camera available from 1982 to 1995. It was a foldable, cardboard three-part box for 4 × 5 film or paper, featuring an acid-etched pinhole surrounded by the archetypal eye. © Jerry Stratton and Bob Witanowski of Ohio; 3000 were sold. Lens photograph by Mark Erickson. From the collection at Pinhole Resource.

and was titled *One Thing Lead to Another*! Obviously Jones was playing on the idea that most photographers think they need an overabundance of equipment. By the time their carrying case is full, it's just too much—a metaphor for her view of a technoindustrialized society's expectation for overabundance. Her work has continued to the present, almost always having sociotheoretical concerns.

Dominique Stroobant, of Belgian descent, lives in the marble-quarrying and sculpture-producing center of Miseglia de Carrara in Italy. He is a stone sculptor and pinhole photographer. Beginning in the late 1970s, he has been instrumental in fabricating time/sequencing precision cameras that produce highly evocative imagery. Stroobant spoke philosophically:

> I got trapped by pinhole photography, once I discovered how obvious and pleasant it was to realize everything from the start. My tools could not be ready-made. Why try to conceive of anything more sophisticated than the cameras presently in use: there is more enjoyment to go the other way. Since Niépce in photography nothing else has been done but reduce space and time to smaller fragments at each step . . . Once I showed people what I could realize with these clumsy, heavy, but still handsome devices of mine, they thought it was sorcery. However, I believe, all they are accustomed to use is real sorcery! Just try to dismantle any camera of today. We live in an age where many peasants do not even know how to grow a salad, or anything else, without

FIGURE 3.10A
© Dominique Stroobant, *January 8, 1978,* 1-day exposure, 7 × 9-inch pinhole photograph from camera H2-R. From the collection of the photographer.

very specific chemicals. There is no trick to what is shown here. I see it as my duty, however, (or rather my pleasure) to dissolve the boundaries of consciousness [Figures 3.10A and 3.10B], wherever people think they should be fixed. The first photographers did what real painters did and are still doing: they tried to fix not just what they saw, but in order that they could see it. Since one sees only what one thinks one sees, there is no way of seeing things the way they are. Not only do we see 99% with our memory but even whatever we use to visualize what we see or feel, is almost entirely programmed by some preconceived idea of what we should see. One can also build devices to visualize things one cannot see, which one can only imagine in an indirect way. It took me time to see—not just understand as an abstraction—how the sun affects us. Most people understand things by rationalization, through spatial geometry for example, but they still do not 'see' . . . Many things are not obvious. Most ready-made images give us a fragmented view of things. This fits easily into the field our eyes can embrace at once. Perhaps part of Alberti's perspective system, and many existing prejudices about what is a deformed or non-deformed image in photography, are due to accepting as a norm the limitations encountered in human optical perception.[13]

By 1979 Paolo Gioli was possibly the *first* pinhole photographer to experiment with Polaroid transfer (Figure 3.11). Simultaneously, Gioli was continuing a decades-long search for objects with holes that could naturally function as pinhole cameras. Eventually he used a multitude

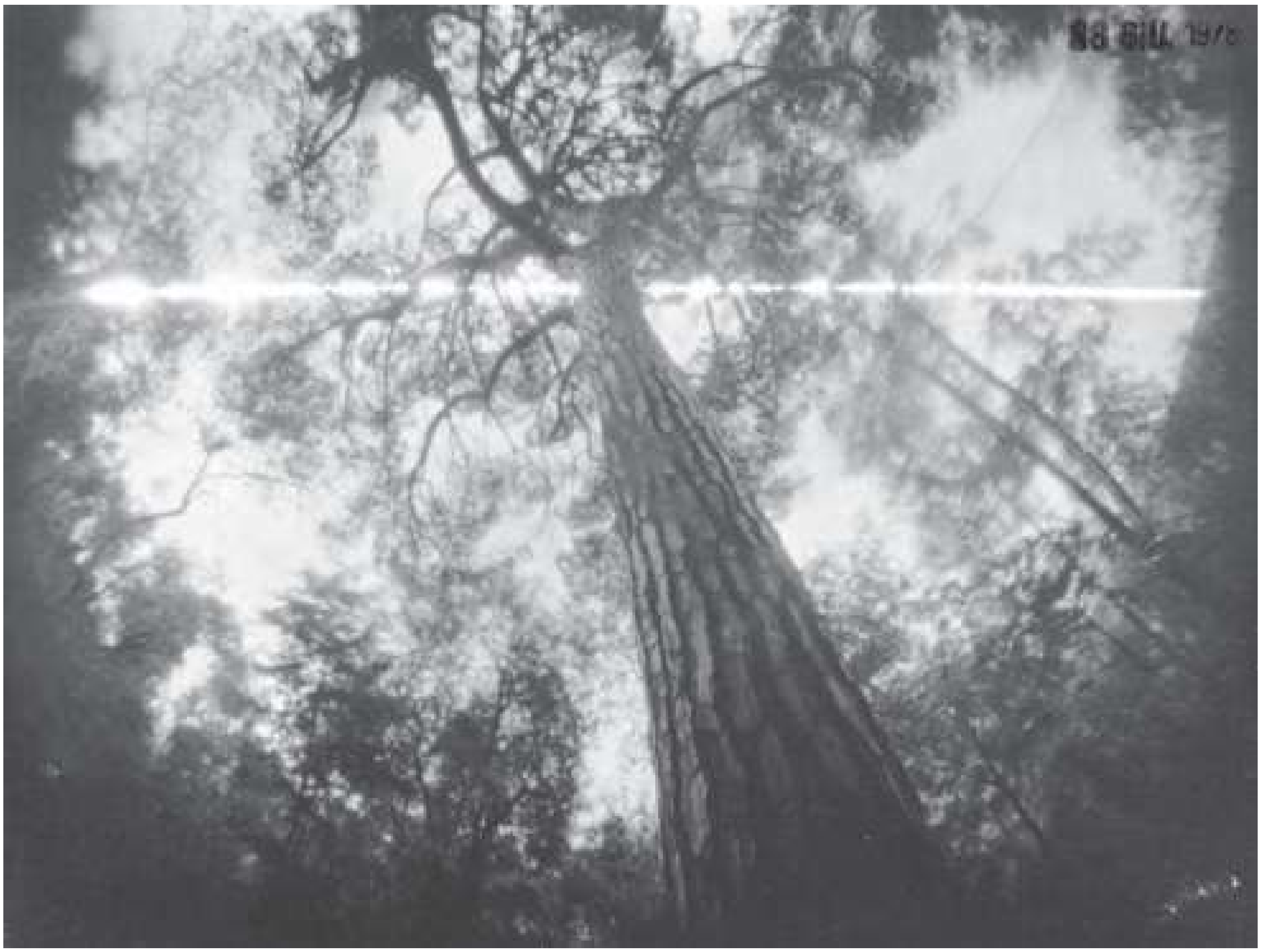


FIGURE 3.10B
© Dominique Stroobant, *June 28, 1978,* 1-day exposure, 7 × 9-inch pinhole photograph from camera H2-R. From the collection of the photographer.

FIGURE 3.11
Paolo Gioli, *Torso di Sebastino*, 1993. Polaroid Polacolor 60 × 50-cm *ottica e matita, transerto su carta da disegno cm 100 × 80*. Private collection.

FIGURE 3.12
© Paolo Gioli, *Mestola Forata Stenopeica*, lens photograph, 1980. Note that every hole in the ladle has been filled with an opaque sheet, each with a pinhole. From the collection of the photographer.

FIGURE 3.13
© Paolo Gioli, *Novantasei Fori Forati*, 5–inch square pinhole photograph, 1980. From the collection of the photographer. If viewed closely you can see a multitude of side views of Paolo Gioli.

of diverse objects: crackers, shells, buttons, traffic cones, nuts, needle eyes, graters, pepper shakers, ladles (Figure 3.12), and ant holes to name only a few of his unique pinhole cameras.

One of the first artists to find Duchampian ready-made objects, turning them into pinhole *pop art*, was Julie Schachter of Washington State. Her inventive series, which started in the early 1980s, has continued for over 25 years. It intertwined culturally functional pinhole cameras made from everyday household items with product-specific, culturally sensual pinhole imagery. For her *Bather* series (Figure 3.14B), Schachter used her *powder obscura*, made from a powder puff container into a light-tight pinhole camera (Figure 3.14A). The puff became the shutter. In another set, Schachter placed a Boraxo camera (Figure 3.14C) in the sands of Death Valley, harking back to the old television commercial for Borax soap, sponsor of TV's "Death Valley Days," which starred Ronald Reagan. Her photograph biographically portrayed then President Reagan in an appropriate Boraxo/desert/"Star Wars" landscape for a revealing portrait of the man and his gun (Figure 3.14D).

The first Schachter pinhole camera to specifically define her tongue-in-cheek area of expertise was the *Campbell's Soup Camera* (Figure 3.14E) with the defiantly titled image *The Soup Can's Revenge, 100 Andies* (Figure 3.14F). Of her imaginative satires, Julie Schachter stated:

> It seemed poetic justice for a Chicken Noodle Soup can to take a shot at Andy Warhol and produce the multiple pinhole portrait of its prime PR man. Thus began my enlistment of common objects into the service of photographic exposé.[14]

Other Schachter cameras, such as the *Tinkertoy Pieces and Box camera* (Figure 3.14G), combined tripod, pinhole camera, and photographic image of her son Marlon (Figure 3.14H) into one.

The final image in this book (Figure 9.19) is a more recent Julie Schachter from 1993. It is titled *Lunambulist*—in many ways it is quite Duchampian. In my mind, she is expressing that the real picture is beyond the one that I see in her image. Much like Duchamp, she has removed the construction of the picture plane; she has placed it into the viewer's mind.

FIGURE 3.14A
© Julie Schachter, *Powder Obscura*, 1980s, lens photograph. From the collection of the photographer.

FIGURE 3.14B
© Julie Schachter, *Bather* series, 16 × 20-inch type C pinhole photograph from powder obscura cameras, 1980s. From the collection of the photographer.

FIGURE 3.14C
© Julie Schachter, Boraxo pinhole camera, 1980s, lens photograph. From the collection at Pinhole Resource.

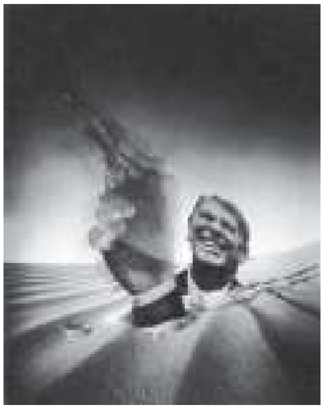


FIGURE 3.14D
© Julie Schachter, *Ronald Reagan,* 4-¼ × 3-¼-inch pinhole photograph from Boraxo pinhole cameras, 1980s. From the collection at Pinhole Resource.

FIGURE 3.14E
© Julie Schachter, Campbell's soup can camera, 1980s, lens photograph. From the collection of the photographer.

FIGURE 3.14F
© Julie Schachter, *The Soup Can's Revenge, One Hundred Andies,* 30 × 24-inch pinhole photograph, made from Campbell's soup can camera, 1980s. From the collection of the photographer.

FIGURE 3.14G
© Julie Schachter, tinkertoy pieces and box camera with wood cardboard and string pod, 1986, lens photograph. From the collection at Pinhole Resource.

FIGURE 3.14H
© Julie Schachter, *Self-Portrait with Marlon,* 7 × 5-½-inch pinhole photograph made with a Tinkertoy camera, 1986. From the collection at Pinhole Resource.

Portraying self in a new way was invented by Jeff Fletcher of Austin, Texas. Much like the holed-stone megaliths used to transform ancient birth energy, as well as the mystery of caves, his photographic series *Bromide Eggs* invited us to enter a dozen aspects of his extremely private world. Fletcher imaged his pictographs onto the inner surface of opened egg shells (Figures 3.15A and B). With an superb sense of fantasy, his photographs are miniaturized cave paintings. The viewer must become a reduced-in-size Alice in Wonderland to truly view them. Of these wonderful anamorphs, which took extreme perseverance to make, Fletcher wrote:

> The whole idea of eggs—a symbol of new life, the human figure, life/death cycles, regeneration, etc., just seemed to me the perfect conceptual match. With a little thought the emulsion of choice became "Liquid Light" which comes in a bottle and can be applied to almost any surface. The camera was easy. Built out of an aluminum pepper shaker, it has a pinhole in what was the bottom and the holes that made the "P" on the lid have been blocked. Because each shell has a different size and/or shape, there is a piece of felt used to hold the shell firmly in place. It seemed I was all but done. All that remained was to start eating a lot of eggs.
>
> Unlike the gelatin on normal film and papers, Liquid Light is a soft gelatin. To use it, one heats the bottle until the emulsion melts, applies it to the desired surface, allows it to cool and set, makes an exposure, then develops the image in the same manner as conventional photographic papers. This technique may work well in most cases but proved to be a disaster when used the way I had in mind. The temperature inside a camera, in direct sunlight, gets quite high. The first image or two I tried just oozed out of the shell into the developer. A treatment in a weak formaldehyde solution solved that problem and eliminated a rather disgusting sight.
>
> So that's it, or almost it. Somewhere along the line a problem with chemical fogging developed. After more than a year of tinkering with the variables—chemistry, egg sources, etc., I came to the conclusion that the egg shells themselves vary—not from shell to shell, but from season to season. It seems that only late spring, early summer eggs will work well. I have no idea as to why. Kodak has been in the poultry business for over a hundred years. Perhaps it's true, 'You are what you eat.'[15]

FIGURE 3.15A
© Jeff Fletcher, pepper shaker pinhole camera with eggs, 1990, lens photograph. From the collection of the photographer. The holes in the letter P are not used as apertures; the pinhole is in the bottom end of the shaker.

FIGURE 3.15B
© Jeff Fletcher, *Self-Portraits, Bromide Eggs,* 1989, pinhole photographs in eggs. From the collection of the photographer.

In Miseglia de Carrara, in the clearing of a hillside woods, Terrence Dinnan of Vermont and Dominique Stroobant dug a 4–foot-diameter circular hole, shaped like a half-globe (Figure 3.16A), and covered it with black plastic and an entry bag (Figure 3.16B) for loading and unloading photographic paper. In the middle of the cover was a pinhole (Figure 3.16C). Dinnan crawled into the hole to line the interior with 80 sheets of unexposed photographic paper. After crawling out, an exposure was made (Figure 3.16D). The whole became an *Earth Camera*. Their process was reminiscent of the first astronauts leaving their space capsule to make a photograph; however, Dinnan–Stroobant inverted their procedure to take place on Mother Earth. Their final image has the look of an environmentally conscious stellar composite.

FIGURE 3.16A
© Terrence Dinnan and Dominique Stroobant, pinhole earth camera while digging, 1980, Miseglia de Carrara, Italy, lens photograph, Terrence Dinnan in front. From the collection at Pinhole Resource.

FIGURE 3.16B
© Terrence Dinnan and Dominique Stroobant, setting of black plastic on pinhole earth camera, 1980, lens photograph. From the collection at Pinhole Resource.

FIGURE 3.16C
© Terrence Dinnan and Dominique Stroobant, pinhole earth camera on exposure, 1980, lens photograph. From the collection at Pinhole Resource.

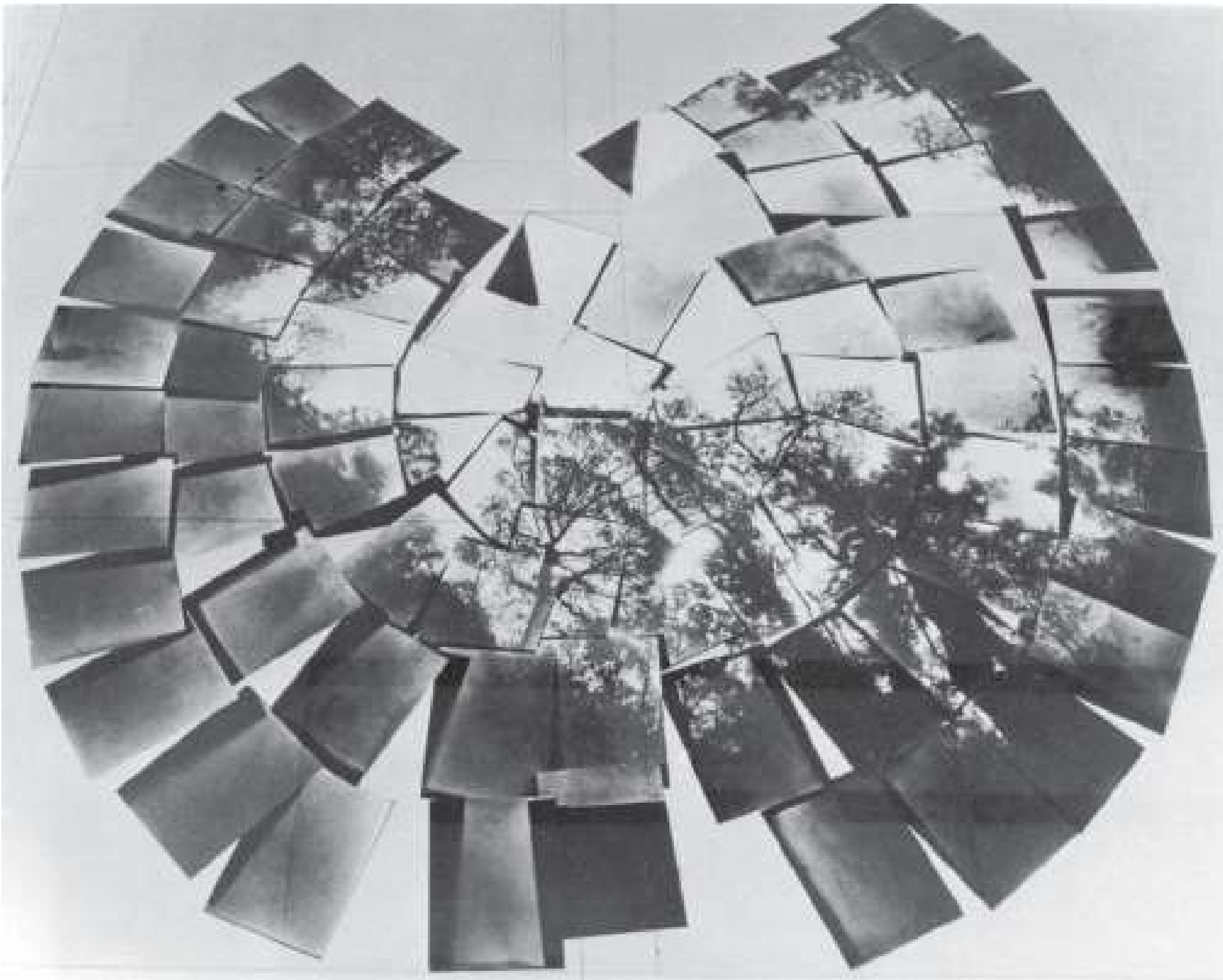


FIGURE 3.16D
© Terrence Dinnan and Dominique Stroobant, earth camera pinhole photographs, ICC, Antwerp, 1980, lens photograph. From the collection of the photographers.

During the 1980s, Dominique Stroobant continued his work photographing the sun. He made many cameras that could remain outside for extended periods of time, even as long as 6 months. For many of his projects he used multiple cameras, each of which was aimed at different angles—from horizon to zenith in the sky. One such set is shown in Figure 3.17. Two of the cameras were left to photograph for 6 months. What is amazing is that Stroobant can still achieve a correctly exposed view of the landscape while photographing the sun for as long as 6 months. Stroobant used very slow litho film to make these images, and he layered many sheets of film in the cameras. After taking each camera back into the darkroom, he selected the piece of litho film that seemed to be exposed correctly for both the landscape and the solar image. Many of Stroobant's extended-time images connect to archetypal circularity.

Viewing the sun's path across the sky with a pinhole solar image has a beautiful precedent in the Kogi, a native tribe from the lower Colombian Andes. Their concept of the cosmos is demonstrated in their conical temples with a small aperture in the top. According to ancient Kogi beliefs, the earth is an immense, four-cornered loom on which the sun weaves two pieces of cloth each year.[16] The temple floor models this loom in miniature; the four corners of the earth are fireplace designations. This is further explained by the archaeoastronomer Gary Urton as follows:

> This temple loom is operated by the sun. At the apex of the conical temple is a small hole which is usually covered by a potsherd. On certain occasions, the shaman of the temple removes the potsherd and allows the sunlight to enter the temple. At the beginning of the Kogi year, on the morning of the June solstice, the potsherd is removed at 9:00 A.M. and sunlight strikes the fireplace in the southwest; during the day, the shaft of light [the pinhole solar image] moves along the temple floor from west to the east until, at 3:00 P.M. it rests in the southeastern fireplace. On the morning of the December solstice, the shaft of sunlight makes a line on the ground from the fireplace in the northwest to the fireplace in the northeast. The Kogi say that in this way the sun is weaving a fabric on the loom of the temple. The warp threads of the fabric, running north–south, are laid down by the Earth Mother, and the sun completes the textile by weaving in the east–west threads of the weft. Thus, during the daytime throughout the year, the sun weaves a white fabric. During the night however, the sun weaves another fabric, but this fabric is black.
>
> The weft of the black fabric is woven during the night when the light of the night sun (what the Kogi refer to as the "black sun") passes through the apex of the inverted subterranean temple. The night sun, however, lays down the black weft of the temple fabric in lines moving from right to left, as opposed to the left-to-right pattern of the white weft of the daytime fabric. Throughout the year, then, the sun weaves one black and one white fabric by the alternation, or opposition, of the left-to-right moving rays of the daytime sun and the right-to-left moving rays of the nighttime sun.
>
> This theme of resolution of oppositions is reflected in virtually every aspect of Kogi life and thought.[17]

Continuance within the cosmos has also been viewed as circularity. The circularity archetype, basic to pinhole and small apertures in photographing "time," was best expressed by the Native American Black Elk in his famous quote:

> Everything the Power of the World does is done in a circle. The sky is round, and I have heard that the earth is round like a ball, and so are all the stars. The wind in its greatest power, whirls. Birds make their nests in circles, for theirs is the same religion as ours. The sun comes forth and goes down again in a circle. The moon does the same, and both are round. Even the seasons form a great circle in their changing, and always come back again to where they were. The life of a man is a circle from childhood to childhood, and so it is in everything where power moves. Our tepees were round like the nests of birds, and these are always set in a circle, the nation's hoop, a nest of many nests, where the Great Spirit means for us to hatch our children.[18]

In the early 1980s, Adam Fuss, originally from London but living in New York, began photographing classical sculpture (Figure 3.18). In an interview conducted by the Smithsonian for its book *Pinhole Photographs: Adam Fuss* (Washington, DC: Smithsonian Institution Press, 1996), Adam Fuss said:

> When I first arrived in New York, I worked at the Metropolitan Museum. Sometimes I'd be walking at night through the classical sculpture galleries. The figures have a certain kind of life, perhaps because their life span is so much longer than ours. They've seen generations of people walk past. In the daytime the museum environment seemed so *inappropriate*. But at night they'd come alive, full of power and mystery. When I thought

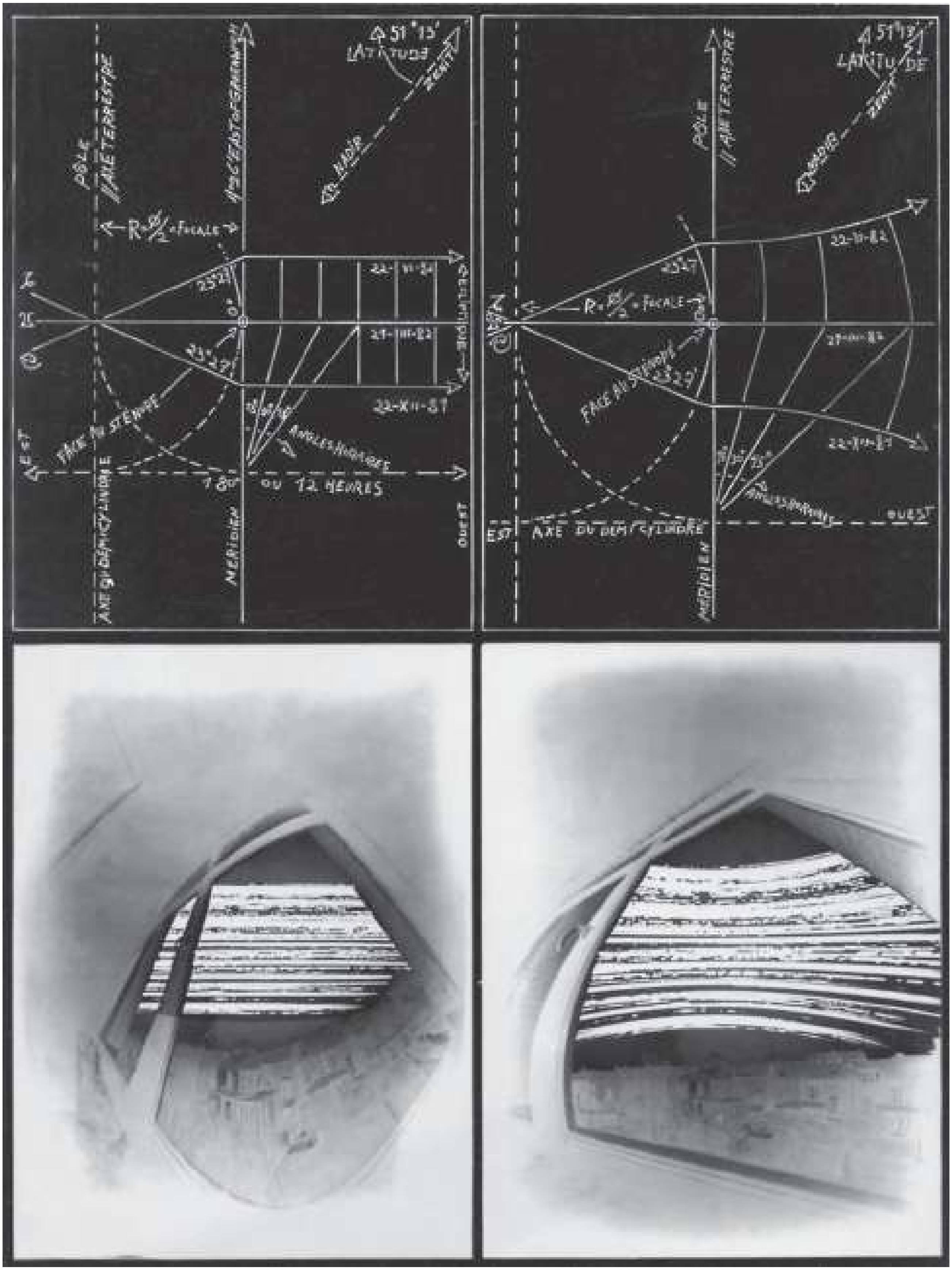
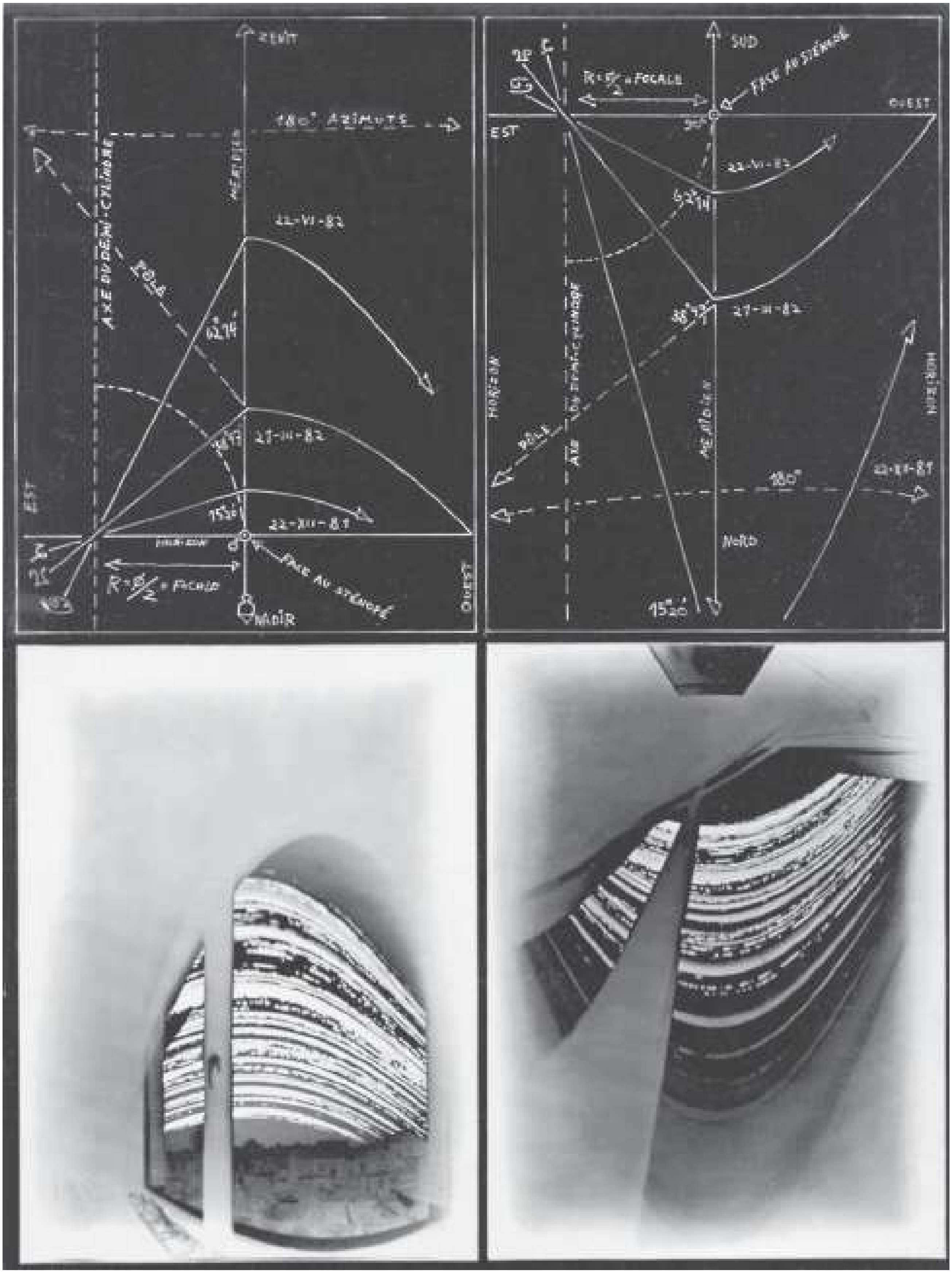


FIGURE 3.17

© Dominique Stroobant, *6 Months of Photographs from December 22, 1981, to June 22, 1982;* four pinhole cameras set at different angles, each 9-½ × 7-inch pinhole photograph made with litho film for negative. From the collection of the photographer.


ZENIT
180° AZIMUTS
MERIDIEN
AXE DU DEMI-CYLINDRE
POLE
22-VI-82
21-III-82
22-XII-81
NADIR
FACE AU STÉNOPÉ
EST
OUEST
SUD
NORD
HORIZON
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15°20'

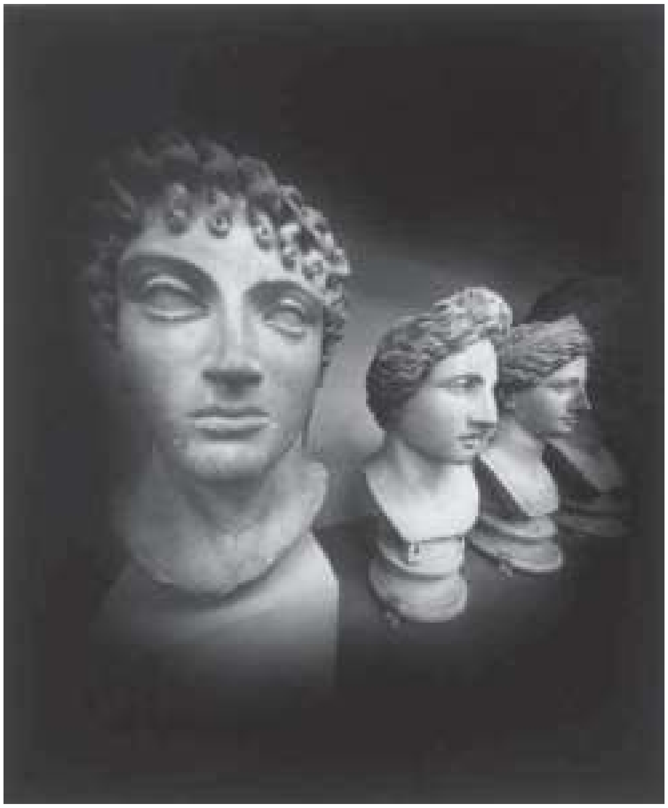

FIGURE 3.18
© Adam Fuss, *Untitled,* 24 × 20-inch pinhole photograph, #7/10, courtesy Cheim & Read Gallery.

> about taking these pinhole pictures I thought of my experience of walking through the galleries at night, completely alone, and that teacher's words, about the pinhole camera came back to me.[19]

Fuss's art teacher's words had been: "Well, it doesn't matter. You can take the best pictures in the world with a pinhole camera."[20] For Adam Fuss, this was an awakening, because at 15 he was "obsessed,"[21] thinking he needed expensive photo equipment. Had the teacher agreed with him about expensive equipment, the world may have well been that much poorer without Fuss's ethereal pinhole series.

Lenseless camera of Santa Barbara. This solid wood 4 × 5, 5 × 7, or 8 × 10 pinhole camera appeared in 1985, designed by Walter Boye. It is still available in Baltic birch and exotic woods.

FIGURE 3.19
© Sarah Van Keuren, *Mourner*, 10 × 8-inch cyanotype and gum bichromate photograph, 1987. From the collection of the photographer.

Sarah Van Keuren of Philadelphia, originally a printmaker, began making pinhole images several years after she became fascinated by Phil Simkin's displacement project (Figures 3.7B). Over the years she has generally used 8 × 10 commercial film; her printing techniques involve an initial layer of cyanotype with multiple glazing layers of gum bichromate (Figure 3.19). One singular image can often be constructed of eight layers. Of her intense portraits she remarked:

> I had always done portraits as a lithographer—for years and years. I began to realize that a pinhole photograph provided a composite image of a person—like what you get when you're drawing a model over a period of time. It's a collection of expressions. The body slumps into a characteristic pose if I'm doing a full figure during the 6 or 7 minute duration of my indoor exposures. You don't get a fleeting expression of someone's face. . . . To me it seems to get at a certain inner truth—like a psychological X-ray.[22]

In 1984, the not-for-profit Pinhole Resource Inc. started collecting pinhole photographs, a valuable idea that I put into practical reality, with a lot of help from pinhole artists worldwide. The idea was to have a way to preserve many contemporary pinhole images and to publish a magazine from those images that were collected (since so few pinhole images were preserved from the century before—1880s–1910). Many gave very generously of their images (the Pinhole Resource has of this writing over 3000 pinhole images).

In 1985, Lauren Smith's *The Visionary Pinhole* (Layton, Utah: Peregrine Smith Books) was published. Smith's book (Figure 3.20) was the first to show that there were many serious artists making pinhole photographs. That same year, *Pinhole Journal*, the periodical from Pinhole Resource, published its first issue. Shortly thereafter, the Spanish periodical *PhotoVision* devoted an entire issue to international proponents of pinhole photography.

In the steamy rolling fields of Virginia in 1987, Nancy Spencer made her soulful series *Turkeys*, photographing the thousands of ephemeral white turkeys as they were fattened over the summer months for the Thanksgiving harvest. Her pinhole camera's lengthy time exposures created a gestural analogue: the thousands of white turkeys moved across the landscape matched by the summer's white billowing clouds (Figure 3.21A). At season's end, all that was left was their shed feathers (Figure 3.21B) and a ominous sky. Spencer's series spoke of transformation.

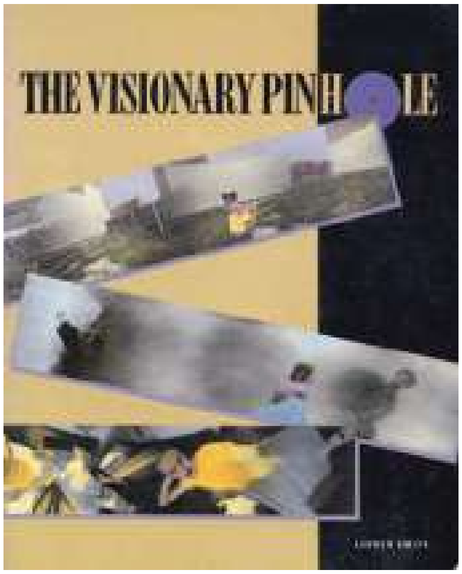

FIGURE 3.20
Lauren Smith, *The Visionary Pinhole*, 1985. On its cover were three images by David Lebe. From the collection at Pinhole Resource.

FIGURE 3.21A
© Nancy Spencer, *Turkeys*, series *Turkeys*, 11 × 14-inch selenium-toned pinhole photograph, 1987. From the collection of the photographer.

FIGURE 3.21B
© Nancy Spencer, *Turkey Feathers,* series *Turkeys*, 11 × 14-inch selenium-toned pinhole photograph, 1987. From the collection of the photographer.

By the end of the 1980s, many accomplished photographers who might otherwise have known only lens photography chose to try pinhole. They brought with them a strong sense and knowledge of the photographic medium. One was Martha Casanave, a well-known portrait photographer from Monterey, California, who affixed a pinhole on the lens board of her 4 × 5 camera and began photographing friends and even customers in 1984 (Figure 3.22). She commented:

> I've often heard myself say that if I could make a photograph with just my eyes and brain and not this clumsy and noisy mechanical device, I would be very happy. Using a pinhole camera comes closer to this ideal.[23]

Similarly, David Plakke of New Jersey brought a prior sense of the medium to pinhole photography. His emotionally intense pinhole images (Figure 3.23) dealt with AIDS and issues of sexuality. In the following statements Plakke speaks openly of his hesitancy to try pinhole photography, although he had previously collaborated with a blind person who used

FIGURE 3.22
© Martha Casanave, *Untitled*, 20 × 16-inch pinhole photograph, 1986. From the collection of the photographer.

FIGURE 3.23
© David Plakke, *Untitled,* 50 × 40-inch pinhole photograph and 100 pounds of nails, 1988. From the collection of the photographer.

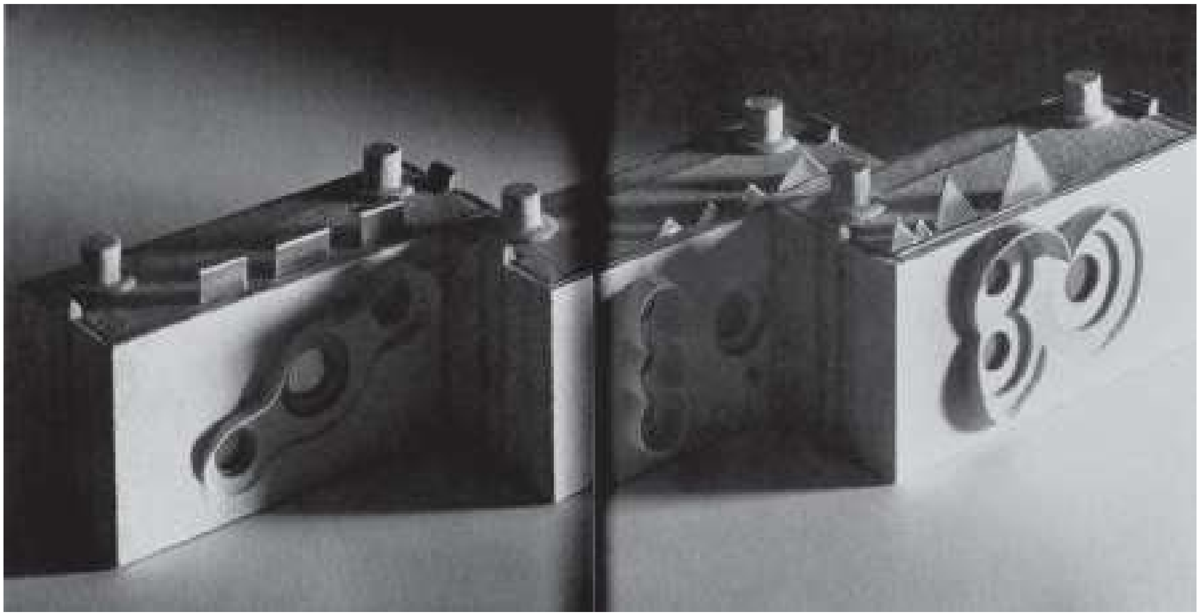

FIGURE 3.24A
© Peter Olpe, 120 roll film cameras. Lens photograph from Die Lochkameras von Peter Olpe, Basel, 1992.

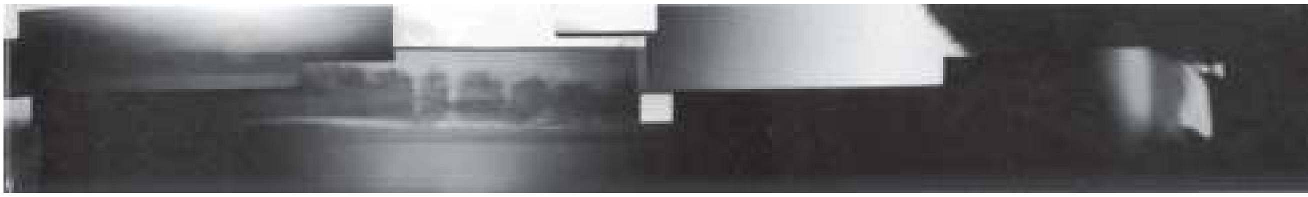

FIGURE 3.24B
© Peter Olpe, *Hinterjarten,* 2¼ × 30-inch pinhole photograph, 1992. From the collection at Pinhole Resource.

Plakke's Widelux to make images of what he felt without sight on the streets of New York. Plakke said:

> I wondered if I could do pinhole images, but I was always afraid of doing them because I was such a control oriented person. But then I did my first shot of my friend who was going through a very difficult divorce, who was trying to be more of a person than her husband. In my very first shot, I had her wrists tied. She came off looking like half man, half woman—I couldn't even read the negative. I thought I really couldn't understand this at all. And I made the print and I thought oh my God, pinhole photography captured so much more than I was able to see with my naked eye.[24]

Peter Olpe, professor at the Basel School of Design, began making pinhole cameras as part of his film-technique course in the mid-1970s. By the 1980s he was completely enamored, making numbers of archectonic miniatures reminiscent of abstracted ramparts in defense against extraneous light. Of his imaginative "image picture factories" (Figure 3.24A), Olpe explained:

> Perhaps it is not a coincidence that in the 70s with the emergence of video that my passion for all kinds of mechanical-optical picture machines started. . . . All of my pinhole cameras accept roll film. In this way they are independent from the darkroom. This is my only concession in respect to the modern camera. Because these cameras are set up for roll film, correspondingly there are three successive interior rooms or compartments. These spaces serve, in a logical order the purpose of housing the light sensitive materials, to provide pictures and to also store the exposed materials before development. The largest and most central compartment is perhaps the most important. This is the *camera obscura*. It is here around this dark room with the small window where I build houses, fortresses, bunkers, temples of light and image picture factories.[25]

Of the image *Hinterjarten* (Figure 3.24B), Olpe stated:

> The pictures are a report of the train ride from Basel to Hinterjarten. It's the only picture I made with this camera. The positive is a contact print of the full length of the roll film.[26]

By 1988, Olpe was commissioned to design the humorous stereo Swiss cheese *Foto-World* 120 camera (Figures 3.24C and 3.24D). It was a perfect visual metaphor for the holes in Swiss cheese, but unfortunately the camera was never available to the photo world.

Politically, the 1980s ended abruptly—the USSR crumbled. In one brilliant statement, West German Marcus Kaiser used holes that had been torn through the Berlin Wall as pinhole cameras (Figure 3.25A). On one side of the hole in the wall, he taped a pinhole; on the other side he taped a film holder (Figure 3.25B). For the first time in decades, any person could photograph through this cherished light toward the East (Figure 3.25C) or move his pinhole and film holder around and photograph toward the West (Figure 3.25D). Long-dreamt-of capitalism had arrived, as so had the pinhole. Marcus Kaiser's imagery represents a *turning of consciousness,* but not in the way Karl Marx would have envisioned.

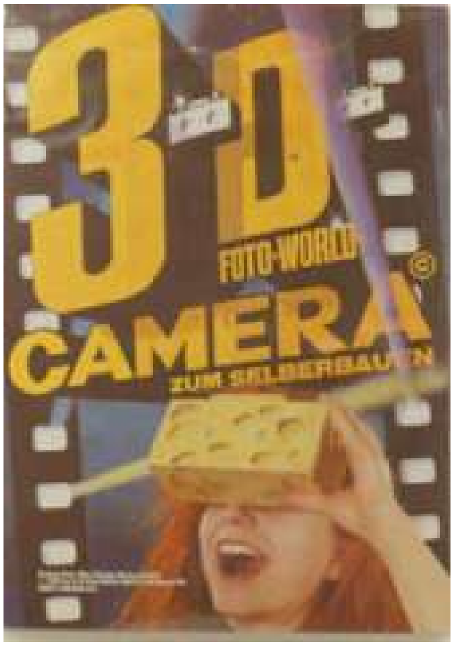

FIGURE 3.24C
© Peter Olpe, Foto-World camera, advertising photograph, 1988. Lens photograph by Peter Olpe. From the collection of the photographer.

FIGURE 3.24D
© Peter Olpe, Foto-World pinhole camera for 120 roll film, 1988. This unusual stereo camera was made in Switzerland, but was never sold commercially; very few exist. Lens photograph by Peter Olpe. From the collection of the photographer.

FIGURE 3.25A
© Marcus Kaiser, pinhole camera made in a hole in the Berlin Wall, *Mauerblicke* series, lens photograph, 1990. From the collection at Pinhole Resource.

FIGURE 3.25B
© Marcus Kaiser, placing film holder (back of pinhole camera) over a hole in the Berlin wall, *Mauerblicke* series, lens photograph, 1990. From the collection at Pinhole Resource.

FIGURE 3.25C
© Marcus Kaiser, *Looking East,* 7 × 5-inch *Mauerblicke* series pinhole photograph, 1990. From the collection at Pinhole Resource.

FIGURE 3.25D
© Marcus Kaiser, *Looking West,* 7 × 5-inch *Mauerblicke* series pinhole photograph, 1990. From the collection at Pinhole Resource.

Notes

1. Paolo Gioli, "Photographs/Cameras," *Pinhole Journal*, 2 (1986): 16–17. Many books are available on Paolo Gioli's pinhole photographs. Three are: *Paolo Gioli Obscura, la natura riflessa*, Electa, Milano, 1991; *Paolo Gioli Gran Positivo nel crudele spazio stenopeico*, Alinari, Firenze, 1991; and *Paolo Gioli: fotografie, dipinti, grafica, film*, Art&, Tavagnacco, 1993.
2. Ando Gilardi, *Paolo Gioli: Spiracolografie*, (Milan: Galleria e Libreria dell'immagine, 1978), unpaginated.
3. David Lebe, "Artist's Statements," in *The Visionary Pinhole*, ed. Lauren Smith (Layton, UT: Peregrine Smith Books, 1985), p. 76.
4. Eric Renner, "Interview," *Pinhole Journal*, Vol. 3#3 (1987): 25–26.
5. Maurice Pirenne, *Optics, Painting, and Photography* (London: Cambridge University Press, 1970), xxi.
6. Maurice Pirenne, *Optics, Painting, and Photography* (London: Cambridge University Press, 1970), p. 17.
7. Kenneth A. Connors, "Resolution and Definition in Pinhole Photography," *Pinhole Journal*, Vol. 4#1 (1986): 10.
8. Willie Anne Wright, "Photographs: Pools," *Pinhole Journal* 2 (1986): 25.
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16. Gary Urton, "The Use of Native Cosmologies in Archaeoastronomical Studies: The View from South America," in *Archaeoastronomy in the Americas*, ed. Ray A. Williamson (Los Altos CA, and College Park, MD: Ballena Press Anthropological Papers and the Center for Archeaoastronomy, 1981), 296.
17. Gary Urton, "The Use of Native Cosmologies in Archaeoastronomical Studies: The View from South America," in *Archaeoastronomy in the Americas*, ed. Ray A. Williamson (Los Altos CA, and College Park, MD: Ballena Press Anthropological Papers and the Center for Archeaoastronomy, 1981), 297.
18. John G. Neihardt, *Black Elk Speaks* (Lincoln, Nebraska: University of Nebraska Press, 1961), 198–200.
19. *Pinhole Photographs: Adam Fuss*, ed. by Constance Sullivan and Amy Pastan (Washington: Smithsonian Institution Press, 1996), 6.
20. *Pinhole Photographs: Adam Fuss*, ed. by Constance Sullivan and Amy Pastan (Washington: Smithsonian Institution Press, 1996), 5.
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CHAPTER 4

The Body as Camera, the Room as *Camera Obscura*

I am fascinated by the purity of gesture in 'frugal' photography, with no optical barriers, no view-finder, no shutters or distances or heights and the equally pure but not at all frugal—on the contrary, clamorous—image reflected. Volumes and geometric perspectives take shape through a pencil mark made 'transparent' by a pinhole and, by looking 'through' it, an image with a peculiar 'fidelity' of its own may be seen.

—PAOLO GIOLI, *Pinhole Journal*, 1996

The hole has become an important element. Looking into a deep hole unnerves me. My concept of stability is questioned and I am aware of the potent energies within the earth. The black is that energy made visible.

—ANDY GOLDSWORTHY

Pinhole photography can be the art of surprise, like looking at the world through a child's eyes. This curious attribute is the pinhole camera's greatest gift to its user. I truly appreciate that something as easy to make as a pinhole camera performs such a seemingly complex task as producing an image. Here, within mere minutes is a camera and in a few more minutes an image! Some people have tried to make pinhole photography complicated, but it is not, and it should not be. Knowing *f*/stops and exact pinhole diameters, making view finders, and using light meters are not always necessary considerations. The inherent simplicity of a pinhole camera is the basis of its character. The excitement of making and using something so simple appeals to a childlike innocence retained within some of us. It was Charles Baudelaire who said, "Genius is simply childhood, rediscovered by an act of will." It has taken me 40 years of slowly thinking about pinhole photography with the question: *Why do I use a pinhole camera?* Finally I arrived at this explanation of innocence: because this is a long-nurtured way to retain *self*.

THE BODY AS CAMERA

A pinhole camera consists of four parts (more or less): the aperture, the camera body, the light-sensitive material placed inside the camera, and the shutter. Each part can be enormously varied according to artistic need. The completed pinhole camera and image

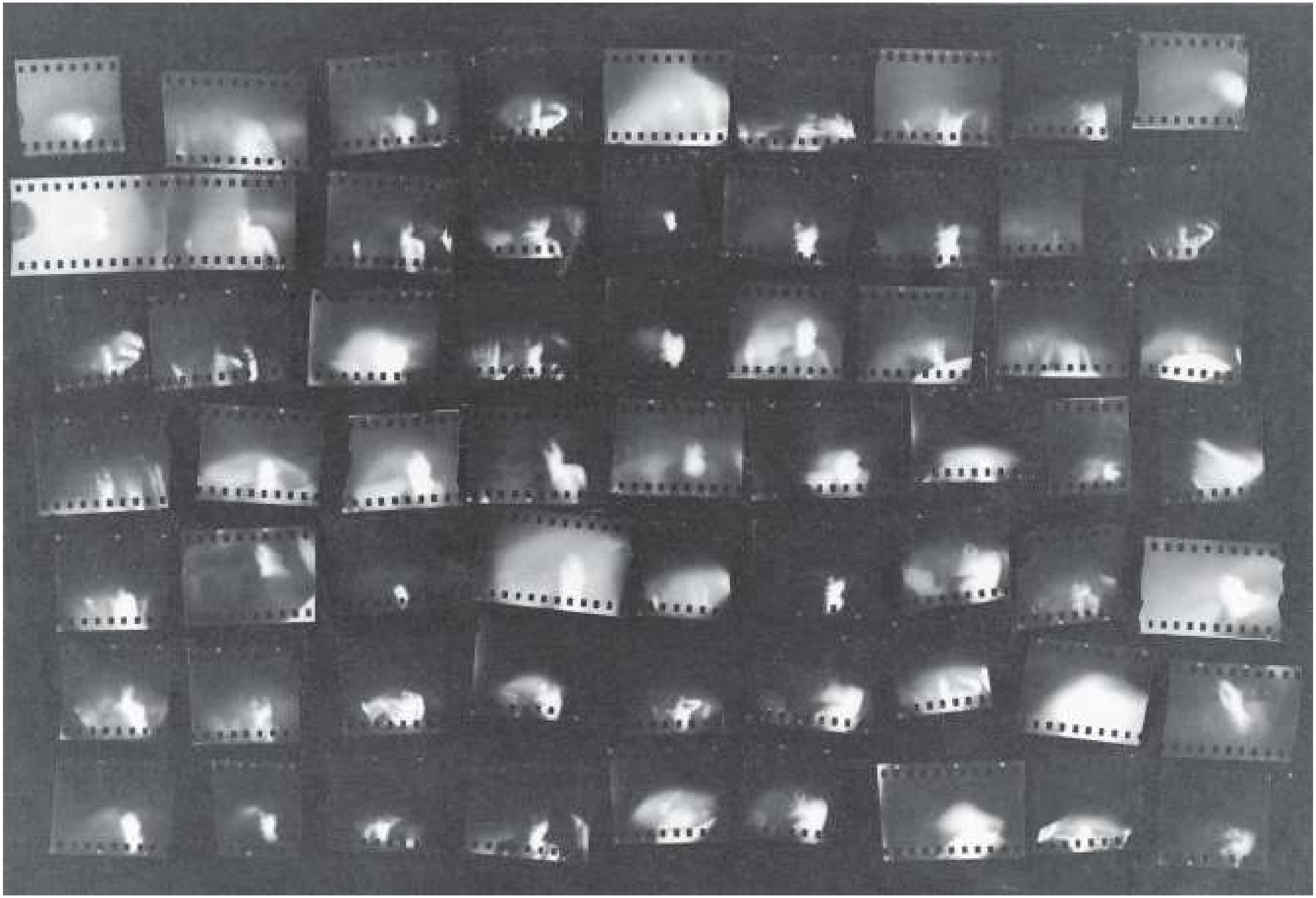

FIGURE 4.1

© Thomas Bachler, *The Third Eye*, lips-hole photographs made with the mouth, using lips as an aperture, film in mouth, standing in front of a mirror; all self portraits; 15 × 20-inch contact print of 63 mouth photographs, 1986. From the collection at Pinhole Resource.

undoubtedly reflect its maker's thought processes. For example, in a darkroom, Thomas Bachler of Kassell, Germany, in 1986 placed short cut pieces of film in his mouth. He left the darkroom and stood in the light in front of a mirror. Opening his lips to resemble a pinhole aperture for an instant, he formed a self-image on the film. In this process his lips acted as the aperture and the shutter. Returning to the darkroom, Bachler took the film out of his mouth, which had been the camera body, and reloaded. The entire process was recreated at least 63 times, as this was the number of images he later contact printed onto one sheet of black and white paper (Figure 4.1). The completed piece was physiologically entitled *The Third Eye, pinhole photographs made with the mouth, using lips as an aperture, film in mouth, standing in front of a mirror, all self portraits*.

In a shifted new reality, Bachler physically became the camera when he placed unexposed film inside himself. Exposing the film, he imaged his "camera-self" in the mirror, thus becoming the "photograph" too, in much the same manner of Narcissus, who saw his mirrored image reflected on the surface of the pool, as mentioned by Alberti in the quotation at the beginning of Chapter 2. Through this purposeful redefinition of photography, Bachler makes the camera, image, and himself *one*. The "*Third Eye*" in his title makes reference to this inner ***oneness***. Bachler's third eye is a metaphoric repeat of Leonardo's *the eye is the window to the soul*. Leonardo's quote attempts to tell us how to access our inner being—our *self*. What might at first seem like child's play actually is. Bachler's mouth camera endeavors are, however a perfectly natural and brilliant exploration for using pinhole photography as a valued and rewarding means for identifying *self*. The third eye for Bachler was his mouth. This circular orifice is a third eye archetype, looking from the outside back in. The mirror is primary in this process.

Scott McMahon used time and movement (Figure 4.2) to express the third eye in his cyanotype and gum self-portrait. Placing a third eye can be found in many cultural representations (Figure 4.3).

In 1992, Jeff Guess, an American living in Paris, who previously did not know of Bachler's work, made his own mouth camera series titled *From Hand to Mouth* (Figure 4.4A). Integral with making the series was a monumental panorama of *hand to mouth* images printed onto one 75-foot-long roll of photographic paper (Figure 4.4B). To produce this, he enlarged each film negative one by one and then developed the entire roll all at once. That's high-risk photography! It is interesting that both Bachler and Guess wanted many of these images to be seen simultaneously. The first pinhole mouth camera that I ever saw was made by Jewelanne Kowalski in a workshop I taught in 1977 in Kentucky. For her camera, she put cut photo paper in the back of her mouth, held a 1-inch square piece of metal shim behind her lips (with a pinhole in it), and then opened her lips to make a perfectly clear image of me on her first try. It was hard not to laugh. Back then, I never thought of the third eye archetype. Imaging through the mouth is hardly a late-20th-century phenomenon—remember the solar image at the Tower of Winds coming through the God of the South Wind's mouth in *La Tempesta sedata* (Figures 1.20A and Figure 1.20B)—a reminder of how connected everything is.

The *window/eye* ***oneness*** of *self* has been transferred to the human hand by Paolo Gioli. In 1989, he used his closed fist as a camera, pinhole aperture, and shutter (Figure 4.5A) to produce images appropriately titled *Fist Against Myself* (Figure 4.5B) and *Window in My Fist* (Figure 4.5C). Gioli had long been fascinated by windows (Figure 3.1). His pinhole photograph *Small Talbot's Window Seen by Myself as a Child* (Figure 4.5D) was made in his snap pinhole camera in 1977 (his play on the word snapshot). Images like these are the rewards for a dedication to art. Gioli's window is an archetypal motif for entrance at birth, which was alluded to in the "childhood" part of his title. These images by Gioli are fully expressing *the eye is the window to the soul* archetype.

Certain artists will have accessed his or her "birth window" archetype as they have made their passage, one after another, through time immemorial: back through Gioli's *Window*

FIGURE 4.2
© Scott McMahon, *Self-Portrait*, 10 × 8-inch cyanotype and gum bichromate pinhole photograph, 1994. From the collection of the photographer.

FIGURE 4.3
The Third Eye on a Mexican Figurine, circa 1000 B.C., lens photograph, photographer unknown.

FIGURE 4.4A
© Jeff Guess, *From Hand to Mouth*, 7 × 11-inch lips-hole photograph, 1992. From the collection at Pinhole Resource.

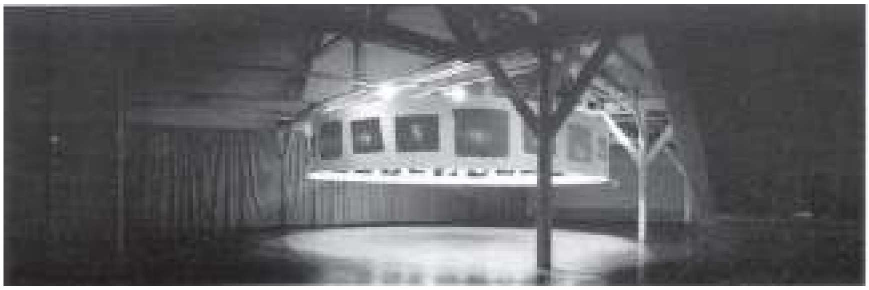

FIGURE 4.4B
© Jeff Guess, *From Hand to Mouth*, continuous composite 3 × 75-foot circular format in exhibition, 1994. Lens photograph by Véronique Huyghe. From the collection at Pinhole Resource.

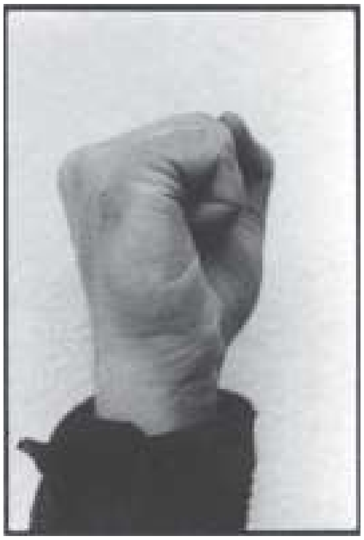

FIGURE 4.5A
© Paolo Gioli, *Pinhole Fist*, fist used as a camera, 4 × 7-inch lens photograph, 1989. From the collection of the photographer.

FIGURE 4.5B
© Paolo Gioli, *Fist Against Myself*, 4 × 5-inch fist-hole photograph, 1989. From the collection of the photographer.

FIGURE 4.5C
© Paolo Gioli, *Window in My Fist*, 4 × 5-inch fist-hole photograph, 1989. From the collection of the photographer.

FIGURE 4.5D
© Paoli Gioli, *Small Talbot's Window Seen by Myself as a Child*, 4 × 5-inch snap pinhole photograph, 1989. From the collection of the photographer.

FIGURE 4.6
© Peter Olpe, painted window detail on 120 roll film camera. Lens photograph. From the collection of the photographer from *Die Lochkameras von Peter Olpe*, Basel, 1992.

FIGURE 4.7
© Gregg Kemp, *Jane Always Dreaded Flying Home*, 7¼ × 9¼-inch pinhole inkjet print from digital scan of a 4 × 5-inch negative, 1983–2000. From the collection of the photographer.

in My Fist; through Peter Olpe's architectural picture factories with small windows painted around the pinhole on his cameras (Figure 4.6); through Leonardo's window (Figure 2.7); through Brunelleschi's lentil-sized perspective window (Figure 2.1; through Alhazen's mythological hole in his tent displaying an inverted pinhole image on the wall[1]); through Plato's metaphoric cave simile (mentioned by Willie Anne Wright, Figure 3.5); through Mo Ti's "the turning of the shadow"; and even further back through the Trevethy Quoit capstone window. We reach a place where we cannot find the original source for a specific visual archetype. Carl Jung explained his use of the word archetype:

> The archetype is a tendency to form representations of a motif—representations that can vary a great deal in detail without losing their basic pattern. There are, for instance, many representations of the motif of the hostile brethren, but the motif itself remains the same. My critics have incorrectly assumed that I am dealing with "inherited representations," and on that ground they have dismissed the idea of the archetype as mere superstition. They have failed to take into account the fact that if archetypes were representations that originated in our consciousness (or were acquired by consciousness), we should surely understand them, and not be bewildered and astonished when they present themselves in our consciousness. They are, indeed, an instinctive trend, as marked as the impulse of birds to build nests, or ants to form organized colonies.
>
> Here I must clarify the relation between instincts and archetypes: What we properly call instincts are physiological urges, and are perceived by the senses. But at the same time, they also manifest themselves in fantasies and often reveal their presence by symbolic images. These manifestations are what I call the archetypes. They are without known origin; and they reproduce themselves in any time or in any part of the world—even where transmission by direct descent or "cross fertilization" through migration must be ruled out.[2]

By "fantasies and symbolic images," oneiroscopist (dream analyst) Jung was referring to dream imagery, both night dreams, day dreams, lucid dreams—all subconscious symbols woven into the diaphanous zones of inner life. Archetypal motifs create instinctive feelings that are stronger than learned (more logical) abilities of understanding and acceptance. Gregg Kemp's image *Jane Always Dreaded Flying Home*, now even more than ever, arouses feelings of a plane crash (Figure 4.7), even though his image was created some years before the 9/11 tragedy.

To return to the body as camera, there is a tangential idea of ***oneness*** in my plaster face cameras begun in 1985. I made the first plaster face camera by the usual process of having someone pour plaster over my face, which had been covered with Vaseline, while breathing through drinking straws placed in my nose. After removal of the dried plaster, this casting became a negative mold for the final face camera. Several hours after it was cast, I carved away behind the eye area so that there was only an inverted cone shape with a very fine pinhole made directly into the plaster, at the apex of one eye. In this first plaster face camera, the pinhole was in my right eye only, making reference to visual things I had seen from within. Again: Leonardo's *the eye is the window to the soul*. For many years, I had seen what I refer to as "little movies" in my right eye when the lid is closed at night. An example of one these "little movies," which Jung probably would have called a "lucid dream," happened late one night in 1983 after putting my 2-year-old son Zephyr back to bed for the eighth time (no exaggeration; I counted). When I got back in bed, in my right eye I saw a pyramid with a door in it which opened. Out of the door came a small figure (Zephyr?) who walked along a long, low wall extending from the pyramid. At the end of the wall, the figure stopped and turned, looked around and said to me, "Everything is going to be all right." The figure then retraced its steps back into the pyramid—surely the door to the pyramid was a remembrance example of the "window" archetype.

The first plaster face camera was an attempt to make tangible the "little movie" experience. This pinhole camera was used for self-portraits—the camera was "I." In later versions of the plaster face cameras, there were pinholes in both eyes, and the photographs were not always so intensely "self"-oriented. It took me almost 20 years of working in pinhole photography to come to the realization that I should make my face and mind into a camera—for that is what I really am! I did not want the camera to have a back; as if, metaphorically, my mind was free. There was my world for the first time—through the innocence of child's eyes. When making a photograph, I held the plaster face camera upside down (Figure 4.8A) so that the image would be right side up on the Ilfochrome Classic color paper held against the flattened back. The pinhole image area was quite sharp and clear (Figure 4.8B), even though I hand-held the camera for 5- to 7-second exposures. Sunlight always worked its way under edges of the plaster face or faces, in photogram fashion, making a variety of planned accidents. When the camera was used in low sunlight, the inner dark area remained black and unexposed; when it was used in bright sunlight, the exposure was purple-blue.

In 1988, after Nancy Spencer and I were married, I made plaster face cameras of both of us (Figure 4.9A) and used these for double self-portraits (Figure 4.9B), with the idea that we were one. In the images, we were looking at each other *through each others' eyes*—that was the series title. To make the images I held the plaster face cameras against the Ilfochrome Classic with a backing board to keep it all flat while Nancy removed the black electrical tape from over the eyes. The Ilfochrome Classic on the outer edges of the faces became overexposed quickly (white), while the light tried to sneak under the edges of the plaster faces, even making unusual colors (the yellow in Figure 4.9B).

There is a strong collective connection that ties all the *body as camera* imaging (shown previously in this chapter) together. It might be best explained as another analogue to Plato's cave, as well as to the following quote, spoken by Kyzlasov to Vilmos Dioszegi for his article "Tracing Shamans in Siberia," 1968, we hear the famous Siberian shaman from the Sagay village of Kyzlan tell:

> It was not the talent I inherited, but the shaman spirits of my clan. . . . I had been sick and I had been dreaming. In my dreams I had been taken to the ancestor and cut to pieces

FIGURE 4.8A
© Eric Renner, plaster face camera, pinhole in one eye, pinhole made in plaster, 1985, lens photograph. From the collection of the photographer.

FIGURE 4.8B
© Eric Renner, *Self*, 10 × 8-inch unfiltered Ilfochrome Classic pinhole photograph, 1985. From the collection of the photographer.

FIGURE 4.9A
© Nancy Spencer and Eric Renner, plaster face cameras, for *Through Each Other's Eyes* series, 1988; 8 × 10-inch pinhole photograph, pinholes in all four eyes, pinhole made in plaster. From the collection of the photographers.

on a black table. They chopped me up then threw me into the kettle and I was boiled. . . . While the pieces of my body were boiled, they found a bone around the ribs, which had a hole in the middle. This was the excess-bone. This brought about my becoming a shaman. One looks across the hole of this bone and begins to see all, to know all, and that is when one becomes a shaman. . . . When I came to from this state I woke up. This meant that my soul had returned.[3]

FIGURE 4.9B
© Nancy Spencer and Eric Renner, self-portraits, *Through Each Other's Eyes* series, 8 × 10-inch unfiltered Ilfochrome Classic pinhole photograph made from a 7-second exposure, 1989. From the collection of the photographers.

ROOM-SIZED *CAMERA OBSCURAS*

The body as a camera is one way of participating *self* into the image-making process. Another possibility is being inside a room-sized *camera obscura*, intimately involved with the image. Once you see and and feel the projected image on the wall—it's memorable! By the 1990s, making *camera obscuras* was in the air. One of the most interesting facets about the multitude of recent contemporary *camera obscuras* is that each photographer makes a different use of mobility (some are car or truck *camera obscuras*) or nonmobility (existing rooms as *camera obscuras*), or some artists construct buildings to be specialized *camera obscuras*. Each *camera obscura* requires a different type of participation.

One of the first to make pinhole images inside a *camera obscura* was the late Nobuo Yamanaka (1948–1982) from Japan in 1971. Yamanaka's images (Figure 4.10), as well as his photo-objects, were made between 1971 and his untimely death from blood poisoning (he was 34) while visiting New York after participating in the Paris Biennial. His images are little known outside of Japan, where his work is central to many contemporary exhibitions. His work predates that of other, more widely known artists, who in the 1990s made room-sized *camera obscura* imagery so popular. Of his imagery, Janet Koplos, art critic for the *Asahi Evening News*, wrote:

> His next 'movie' *Pinhole Camera* (1972) was a decisive change that introduced the approach he pursued for the remainder of his life: Yamanaka made his first *camera obscura*. He is best known for using entire rooms as *camera obscuras*—photographing scenes outside his home and catching his presence inside the camera at the same time. He recorded the view from a ninth-floor apartment as the image fell on the back and side walls, and on the floor and ceiling. He held two-part exhibitions in which the exposure process went on for several days, and the results were shown precisely where they had been made. Not surprisingly, Yamanaka also worked with a pinhole camera (a 35 mm camera with a copper plate over the lens opening), thus taking his *camera obscura* on the road. He made a series of color prints taking the sun as his theme—a new expression of his fascination with light.

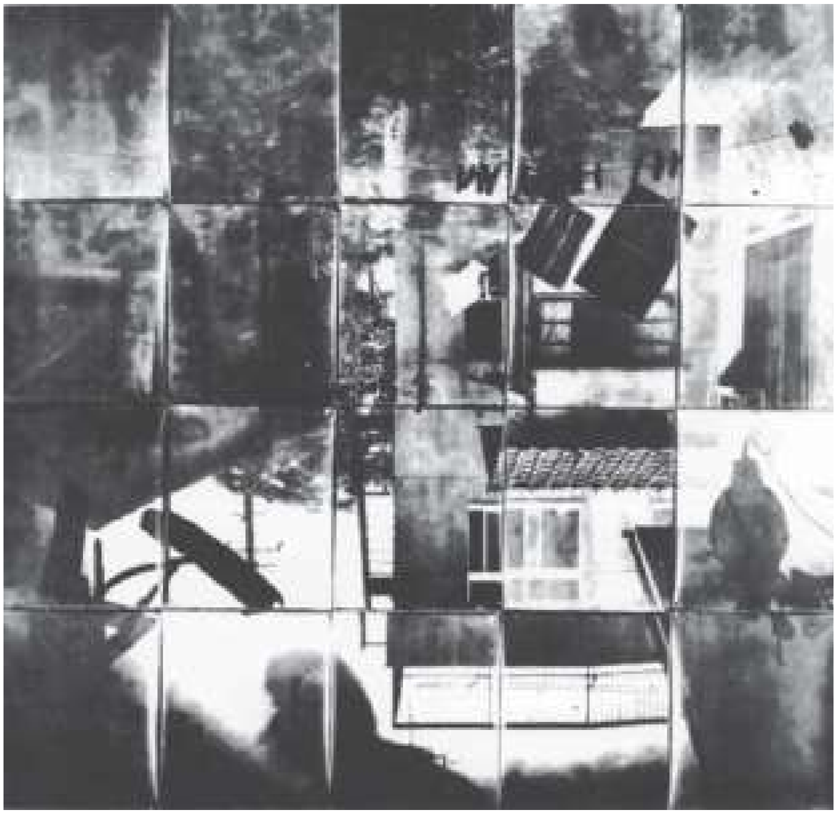

FIGURE 4.10
© Nobuo Yamanaka, *Pinhole Room*, 1973. From the collection of the estate of the photographer.

> His last several works made his photographs into objects: the image was fractured into fragmentary planes and wrapped around the interior of one or more black-painted wooden boxes. Though the box was supposedly just a more convenient way to send his work to the Paris Biennial, he was actually recapitulating both the camera-room and the camera-device in a literal and symbolic black box.[4]

In 1973, Joe Babcock of Berkeley, California, turned a van into a pinhole camera by blocking out the windows with black polyethylene (a few images were made, but then the van was sold). In 1989, Jo Babcock turned his vehicle into a *camera obscura* again (Figures 4.11A and 4.11B). Bob Rosinski of Boston, Massachusetts (Figures 2.2A–2.2D) gave clear instructions on building *camera obscuras* (these instructions have been published in all previous editions of this book).

Peggy Ann Jones in 1984 turned her Dasher station wagon into the *Auto Focus*, a four-wheeled movable light-tight double entendre. Unlike her nonfunctioning series of lead cameras (Figures 3.9A and B), entitled *One Thing Lead to Another*, the *Auto Focus* worked quite well—it lead the way (a pun). A few years later, Sandra Moss, in a heartfelt teaching context, helped six imprisoned teenage boys in 1987 build their own *camera obscura* (Figure 4.12) while they were serving jail sentences as inmates at the New Mexico Boys School (a sanitized name for a juvenile prison) in Springer, New Mexico. Moss was on a grant from the NM Arts Commission.

The late Pia Arke (1958–2007) was born in the little east Greenland town of Scoresbysund/lttoqqortoormiit. In the Danish photography magazine *Katalog*, Mai Misfeldt published "Silent History," a tribute to Arke's work. Of Pia Arke's *camera obscura* process and her imagery, Misfeldt wrote:

> In her exploration of the photographic field she developed a primitive pinhole camera which before long grew into a whole 'camera house'—that is, a camera she could be inside.

FIGURE 4.11A
© Jo Babcock, VW bus pinhole *camera obscura*, pinhole in the door, lens periscope *camera obscura* in the roof, 1989. Lens photograph. From the collection of the photographer.

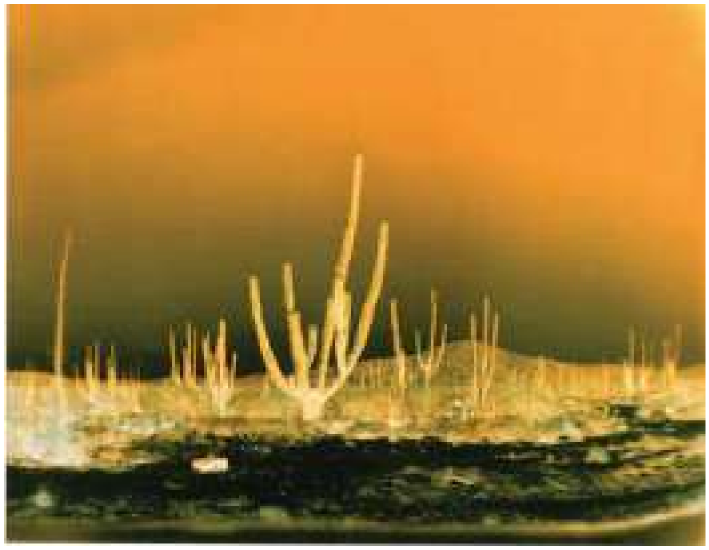

FIGURE 4.11B
© Jo Babcock, *Desierto Central, Baja*, 40 × 70-inch paper negative pinhole photograph, 2001. From the collection of the photographer.

FIGURE 4.12
© Sandy Moss and six teenage boys, *camera obscura* made at the New Mexico School for Boys, Springer, New Mexico, lens photograph by Sandy Moss. From the collection at Pinhole Resource.

FIGURE 4.13
Pia Arke, *Nuugaarsuk (2)*, 49.5 × 59.5 cm, 1990.

> With this large *camera obscura* she went back to Scorebysund, placed herself in the landscape she had herself come from, and photographed the place where her childhood home [Fig. 4.13], demolished in the meantime, had stood. She said herself it was important to her to be inside the camera, that is to be a part of the photographic process.[5]

> [Arke stated] 'I wanted to be inside the camera during the exposure, among other reasons to explore some of the concepts I had come across at the Academy, concepts of space, memory, time. . . I sat inside the camera house and saw the whole landscape of my childhood stood on its head in there, on all sides of the box. The fifteen minutes it takes to expose the picture, and then the developing method, mean that you get many 'flaws' in the finished picture—a kind of structure—so that 25 years that have passed since I lived there were in a way precipitated in the picture.'[6]

What was once known as the "World's Largest Pinhole Camera" (Figure 4.14) was a giant, ready-made *camera obscura*, accidentally created by the building contractors who worked on supporting the Bay Bridge over San Francisco Bay in 1930. To anchor the two suspension towers in place as they were being built, two huge, extremely heavy, 115-foot-square concrete rooms were constructed out in the bay. Cables went from them to the suspension towers to hold the towers upright. High on the wall in each of these two anchor rooms were two rectangular, 1 × 2-foot openings, included as air vents. There was an access door as well. When someone observant went through the access door—*voila* (!)—there was the 50-foot-high pinhole image of the two suspension towers. Each vent had naturally acted as a large pinhole aperture with a focal length of 115 feet. Fortunately, someone was observant enough to see the projected images. After the images were discovered, a photographer was called in to capture San Francisco's Eighth Wonder of the world—a giant *camera obscura image*. When the Bay Bridge was completed, these anchor rooms were destroyed. So much for the "World's Largest Pinhole Camera." It became a disposable camera.

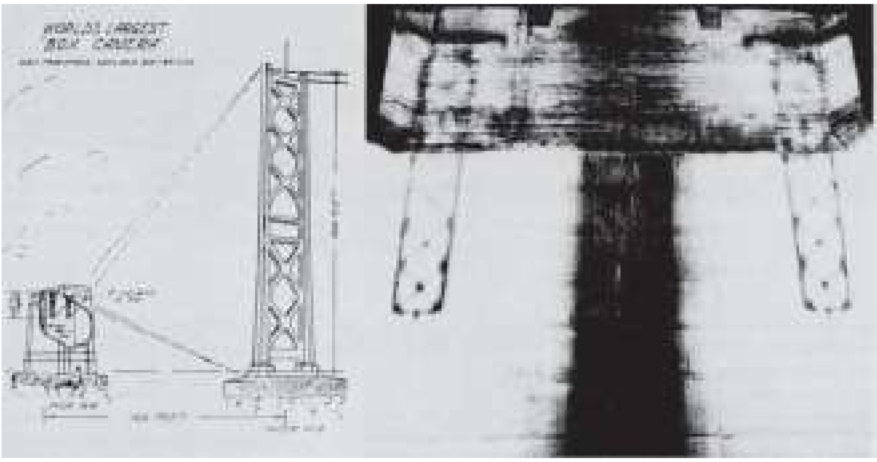

FIGURE 4.14
© World's largest pinhole *camera obscura*, lens photograph by Gabriel Moulin Studios, circa 1930. From the collection of Gayle Smalley.

FIGURE 4.15
© Eddie Howells, *Bay Bridge*, 4 × 5-inch Polaroid pinhole photograph, 1997. From the collection of the photographer.

FIGURE 4.16
© Franz John, *Battery Wagner*, series *Military Eyes*, lens photograph of *camera obscura* image on graffiti wall inside bunker. From the collection of the photographer.

The Bay Bridge was photographed by Eddie Howells recently. Ethereal fog suggests that the bridge spans into infinity (Figure 4.15).

San Francisco is also home to a series of old, dilapidated World War II army bunkers set high on the hills overlooking the Golden Gate Bridge. Franz John from Berlin, Germany, turned these bunkers into working pinhole *camera obscuras* in 1996 (Figure 4.16) as part of an ongoing project entitled *Military Eyes* with the Headlands Center for The Arts in California. There is history here: We all know that on December 7, 1941, Japanese planes attacked Pearl Harbor. Few know that in the following spring, a Japanese submarine surfaced off the coast of southern California and fired shells that exploded on an oil field near Santa Barbara, extremely close to Los Padres National Forest. Fear enveloped the west—the Japanese would bring war to the mainland—as a defense these bunkers had been built as lookouts.

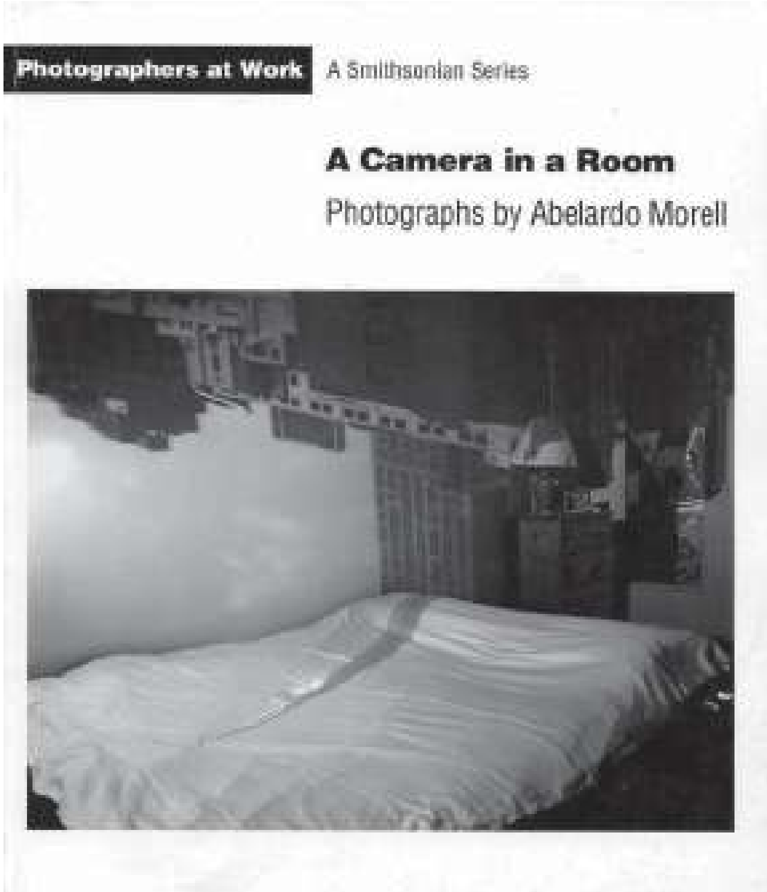

FIGURE 4.17
© Abelardo Morell, *Camera Obscura Image of the Empire State Building*, 1994, on the cover of *A Camera in a Room* (Washington, D.C.: Smithsonian Institution Press, 1995). Lens photograph of a pinhole *camera obscura* image.

In 1994, Abelardo Morell of Brookline, Massachusetts, made his evocative lens photograph of a pinhole *camera obscura* image entitled *Camera Obscura Image of the Empire State Building in Bedroom*. The building's topmost pointed stories ended up on the white bedsheet in an angled anamorphic view with phallic undertones. The bulkier lower portion of the building projected against the room's flat wall (similar to how it would have appeared if it had been photographed onto the flat back of most cameras). Morell's image readily demonstrates the enhanced beauty that an anamorphic projection onto a horizontal surface can add to a photograph, particularly one like a rumpled sheet. Of his work, Morell said:

> Basically I cover all the windows in a room with black plastic so that the room is totally dark. Then I make a hole about 3/8 inch looking out on some interesting view. . . . And every time I got a room ready for a camera obscura picture, my wife and son would witness it. I remember lying in bed with them watching neighbors going to work and squirrels walking on telephone poles. That summer I felt that I had touched on something very important: that the very basics of photography could be potent and strange. So why not make pictures about the medium itself and see where they would take me?[7]

In 1995 the Smithsonian Institution Press published a monograph on Abelardo Morell's lens photographs of rooms containing his preconstructed *camera obscura* images titled *A Camera in a Room* (Figure 4.17). Symbols such as America's Empire State Building are archetypes promoting nationalism. Morell's Empire State Building was the only image in the book that played upon such reactions so it is not surprising that the publishers placed it on their cover. The Empire State Building began its 42-year reign as the world's tallest building, making

FIGURE 4.18
© Marja Pirilä, *Snow Camera Obscura*, for the Arctic Festival, 1996, in Luleå, Sweden. To the right of the *camera obscura* is *Pinhole Camera in an Ice Cube*, lens photograph. From the collection of the photographer.

Americans proud in 1931 with their number one know-how. It demonstrated to everyone that America was a technically advanced civilization (as something to look up to—ironically during the devastating Depression). Just 3 years later, in 1934, Hollywood producers–directors and real-life arrivistes Cooper and Schoedsack had an uncivilized God–gorilla–monster known worldwide as “King Kong” scale the Empire State Building’s walls with his white lover in hand. African-Americans knew the film was racist—King Kong’s predicament was reminiscent of the shackles of slavery.[8]

In a unique innovation using snow, Marja Pirilä built her *Snow Camera Obscura* (Figure 4.18) for the Arctic Festival, 1996, in Luleå, Sweden. To the right of the *camera obscura* is a *Pinhole Camera in an Ice Cube*. That same year she began her daylight *Sleeping Rooms* series, turning bedrooms into image projecting *camera obscuras* (Figure 4.19).

Thomas Bachler has always been fascinated by imaging over distances, letting the camera produce its own image. Bachler, like a number of other pinhole artists, has gone so far as to let his pinhole camera operate as basic light receptor—with ensuing insights gained from each camera’s specific light-gathering qualities and each film’s latent-imaging sensitivities. This is extreme hand-held imagery where movement is important. In 1998 he turned his van into an innovative *camera obscura* (Figure 4.20C) when he left the pinhole open as he drove the van for 60 miles (Figures 4.20A and 4.20B). In his series *Bon Voyage!*, Bachler, while driving, did not get to witness the moving image inside the *camera obscura* as it constantly recreated itself along the highway. *Bon Voyage!* is a motion picture; the technique is similar to Hollywood’s long takes, except that all the exposed takes are rolled into one—one that is constantly being exposed on top of itself. Bachler explained his concept of imaging over distances:

> The eye fixes on some central point somewhere far away: the end of the road, the vanishing point. . . . The destination will be reached but not that vanishing point. The faster we go the more it withdraws. Furthermore, a similar picture appears in the rear mirror; the road which again refers to the vanishing point with its markings and its lines. Being caught in between vanishing points can cause the nauseating feeling of being lost: Should we proceed forward or backwards? Whatever the decision, the vanishing point does not care.[9]

FIGURE 4.19
© Marja Pirilä, *Paula, camera obscura* portrait, lens photograph of a pinhole *camera obscura image*, 1996. From the collection of the photographer.

FIGURE 4.20A
© Thomas Bachler, *Untitled*, from series *Bon Voyage!*, 105 × 150-cm negative on paper *camera obscura* photograph, 1998. The photograph took approximately 100 km of road distance. From the collection of the photographer.

Most important historically, *Bon Voyage!* is an evolutionary step (following in the footsteps) of DuChamp's *Étant donnés* on the destruction of the picture plane.

On July 27, 28, and 29, 1830, in a bloody moment that happened only 4 years after the world's first successful photograph was unceremoniously created by the Frenchman Nicéphore Niépce, revolutionary-minded Parisians overthrew the monarchy of Charles X. Later that year it was decided that a 52-meter-high commemorative column be designed and

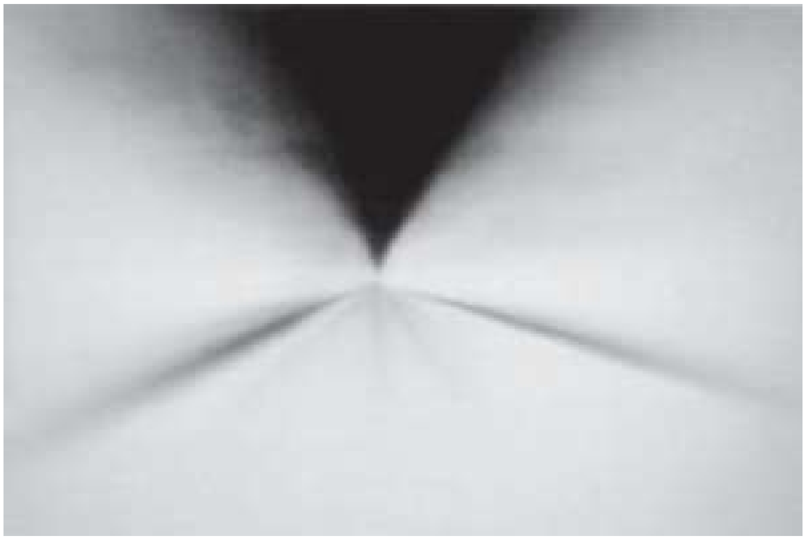

FIGURE 4.20B
© Thomas Bachler, *Untitled*, from series *Bon Voyage!*, 105 × 150-cm negative on paper *camera obscura* photograph, 1998. The photograph took approximately 100 km of road distance. From the collection of the photographer.

FIGURE 4.20C
© Thomas Bachler, drilling the pinhole, for *Bon Voyage!* series, lens photograph, 1998. From the collection of the photographer.

erected at *Place de la Bastille* in honor of the 504 victims who died during the *Trois Glorieuses*. In 1840, the column, by then appropriately named *Colonne de Juillet,* was erected. The gilded flying man at its top referenced "Liberty." Had Nicéphore Niépce lived (Niépce died in 1833), he might have photographed the transfer of those martyred revolutionaries, whose remains were reburied during a solemn ceremony at *Colonne de Juillet* somewhat later that year—preserved for all eternity within the immense crypt below the towering column.

By 1992, Ilan Wolff, who was living in Paris at the time, had created *stenograms* (his name for a pinhole image with a photogram within it—made inside his *camera obscura* van; Figure 4.21A). Five years later, in 1997, he drove his van to the *Colonne de Juillet* and made this *camera obscura stenogram*, which he titled *Place de la Bastille* (Figure 4.21B). By placing his own naked body onto the edge of a pinhole image of the *Colonne de Juillet,* Ilan Wolff participated imaginatively, evocatively, and ceremoniously in a most *primal* event. His intensely darkened silhouette resembles the winged form of the gilded flying man of Liberty at the column's top (Wolff is also naked). Even Ilan Wolff's genitals are silhouetted in this photogram! Wolff's arms are outstretched; his soul is flying—reminiscent of those who have died leaving this world and traveling to another. To complete the image, Wolff added the

FIGURE 4.21A
© Ilan Wolff, car as a *camera obscura*, lens photograph, 1997. From the collection of the photographer.

FIGURE 4.21B
© Ilan Wolff, *Place de la Bastille*, 195 × 126-cm toned stenogram photograph, 1997. From the collection of the photographer.

earthiness, the reality, and metaphors of the grim struggle using wet army boot-sole marks—ones that are perfectly placed into wet developer on the surface of the black and white negative on paper (a one-of-a-kind photograph). Wolff's chemical developer has become an analogue to the ancients' revolutionary bloodshed—their courage in revolution has become Wolff's *raison d'etre*. This is a powerful, emotional archetypal image. It represents the artist's desire for creative *liberty* through his or her own search for a visual revolution. It is not an image promoting war, death, and propaganda for further carnage—it is an image emulating and articulating life. Wolff explained his process:

> There are no limitations to the technical possibilities of the *camera obscura* and that is exactly why I use it. Since 1992 I have used my studio and my van as a *camera obscura*. This allows me to work on a large scale, sometimes several meters in size. During the exposure I place objects or people against the photographic paper and create interior landscapes. This physical contact (photogram) blends with the image of the outside external world to create a new meaning and reality. The large size of the paper offers the possibility to develop the photograph using sponges, brushes or even my hands for a better control of the process. The photographic image is a drawing made by light, but by painting it with chemicals, I can create a new image filled with color and texture.
>
> I have named these images '*stenograms*': a combination of pin-hole photographs and photograms, that unite exterior and interior landscapes and create a new style of photography.[10]

In a personal statement about the singular light beam at sunset in his bedroom, Dominique Stroobant used his adjustable square pinhole device, composed of four separate sharply edged sliding blades that overlapped one another (Figure 4.22A) in his shuttered window (Figure 4.22B) to make *My Bedroom* (Figure 4.22C).

Nilu Izadi, a sculptor/photographer from London, England, has made a career of building *camera obscuras* throughout the world. Her fascination began while making drawings of the solar path (Figure 4.23A) in a *camera obscura* built for her undergraduate thesis at Surrey, England (Figure 4.23B). Prior to making a building, she was unaware that a hole in the wall would become a point in space and project an image. Because the Surrey *camera obscura* eventually was dismantled, Izadi began making permanent *camera obscuras*—the first one is located at Pinhole Resource in San Lorenzo, New Mexico. It took 3 months to build and was designed to resemble a nautilus shell (Figure 4.23C), the only animal with pinhole eyes.

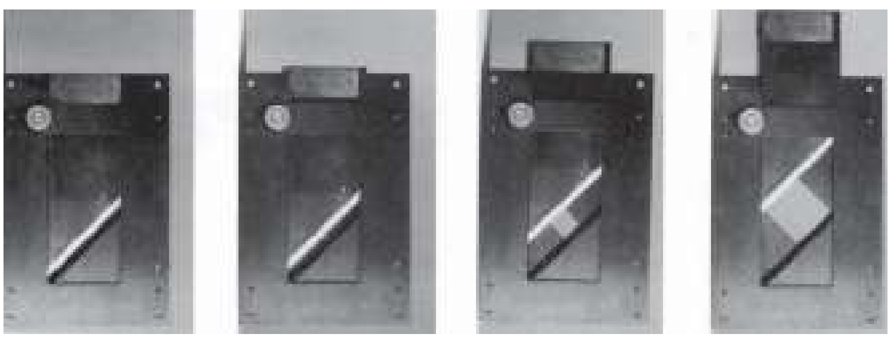

FIGURE 4.22A
© Dominique Stroobant, PV, shutter (pinhole of variable aperture), 1998; 210 × 140 × 8-mm anodized duralumin; square diffraction device for rooms and other cameras. The edges of the four separated blades are sharpened like razors and overlap like the blades of a scissors. They remain on one plane and guarantee better diffraction. Lens photograph, 1999. From the collection at Pinhole Resource.

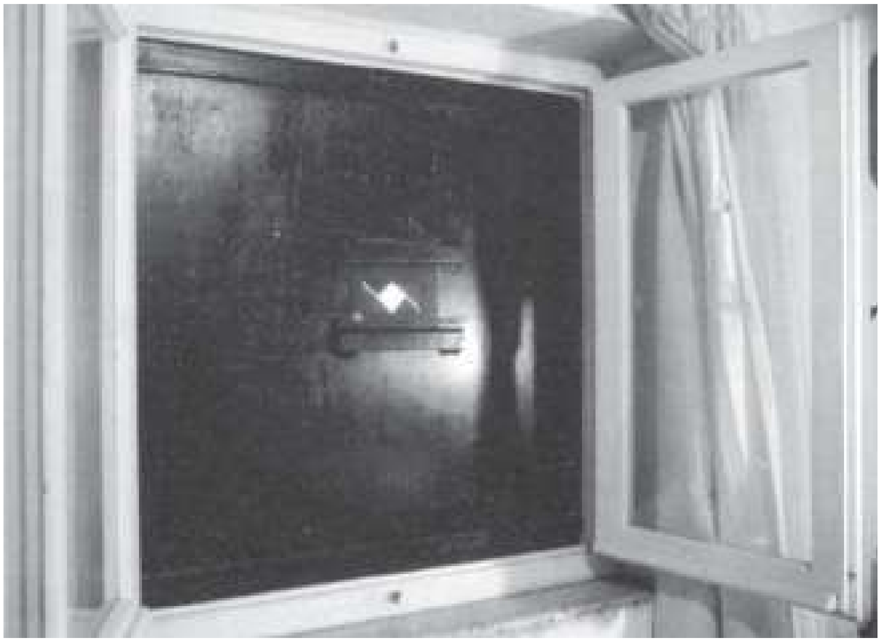

FIGURE 4.22B
© Dominique Stroobant, square pinhole in the shutter, lens photograph, 1999. From the collection at Pinhole Resource.

FIGURE 4.22C
© Dominique Stroobant, *My Bedroom*, lens photograph of *camera obscura* image, 1999. From the collection at Pinhole Resource.

In 2000, Izadi's *camera obscura* in Alibaug, Nagaon, India, was built with the help of a village, practically all in one night (Figures 4.23E and 4.23F). It had to be moved as the tide came in (Figures 4.23G and 4.23H). Her work in India was commissioned by *Indian Architect and Builder* magazine.

In 2004, The Victoria and Albert Museum, London, commissioned 10 artists' projects that would coincide with the Chelsea Flower Show, held annually in June. For her commission, Nilu Izadi transformed a small building into a *camera obscura* (Figure 4.23I). A large pinhole aperture was cut into the roof. It projected an image of the sky, clouds, and trees onto a table in the darkened room. Below that pinhole aperture a motorized lens moved up and down, bringing the center of the pinhole projection in and out of focus (Figure 4.23J). Izadi's *camera obscura* combined the sharper focus of a lens image with the softer focus of the pinhole image.

FIGURE 4.23A
© Nilu Izadi, drawing sun tracks, inside *camera obscura*, Surrey Institute of Art and Design, England. Lens photograph, 1995. Inner white-domed *camera obscura* had 18 holes in the ceiling projecting solar images and also clouds as they passed the sun. Sun tracks are being traced by Izadi. From the collection of the photographer.

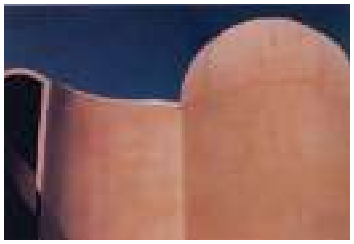

FIGURE 4.23B
© Nilu Izadi, *camera obscura*, Surrey Institute of Art and Design, England. Lens photograph, 1995. From the collection of the photographer.

FIGURE 4.23C
© Nilu Izadi, *camera obscura*, Pinhole Resource, NM, 20 × 16-inch pinhole photograph, 1997. From the collection of the photographer.

FIGURE 4.23D
© Nilu Izadi, projected image looking upward toward curved ceiling, *camera obscura* at Pinhole Resource, NM. Lens photograph, 1997. From the collection of the photographer.

FIGURE 4.23E
© Nilu Izadi, *camera obscura*, Alibaug, Nagaon, India. Lens photograph, 2000. Commission from *Indian Architect and Builder* magazine; 60 people participated in pinhole photography and the *camera obscura* workshop. From the collection of the photographer.

FIGURE 4.23F
© Nilu Izadi, *camera obscura* in the landscape, Alibaug, Nagaon, India. Lens photograph, 2000. From the collection of the photographer.

FIGURE 4.23G
© Nilu Izadi, projection inside *camera obscura*, Alibaug, Nagaon, India. Lens photograph, 2000. From the collection of the photographer.

FIGURE 4.23H
© Nilu Izadi, projection inside *camera obscura*, Alibaug, Nagaon, India. Lens photograph, 2000. From the collection of the photographer.

FIGURE 4.23I
© Nilu Izadi, projection inside *camera obscura*, commission by Victoria and Albert Museum, Chelsea Flower Show, London, England. Lens photograph, 2004. From the collection of the photographer.

FIGURE 4.23J
© Nilu Izadi, *Sky Image*, pinhole, and lens, commission by Victoria and Albert Museum, London, England. From the collection of the photographer.

Shi Guorui of Beijing, China, began making pinhole images in the 1990s after a life-altering experience. Prior to that he was working with a group of close friends doing commercial photography when a fatal car accident occurred. He was injured; his friends died in the accident. To recuperate, and to begin life again, he stayed for a time with monks at the temples in Wu Tai Shan—the serene Buddhist mountain site half-a-day's-drive from Beijing. In an interview with Jori Finkel of the *New York Times*, Shi Guorui explained this moment in his life (when he started doing pinhole photography). He said:

> I started to engage in activities that required a lot of time to complete. I decided that everything I do, I will do slowly, in recognition of the fact that I am still alive.[11]

His initial pinhole images were of the monks and the temples at Wu Tai Shan. Later he began making large *camera obscura* images of Shanghai and also of the Great Wall of China, which gave him international recognition. When photographing *The Great Wall of China* he lived in the *camera obscura* for 3 days while making a series of similar images. Of these hours inside the *camera obscura*, Shi Guorui spoke of this as a special time:

> This is a spiritual experience for me, sitting inside the camera. I am not a practicing Buddhist but this is my form of meditation. This is my practice.[12]

In a letter to the author, Shi Guorui further explained his recent *camera obscura* image of Mount Everest:

> In 2005, the Chinese government made a new measurement of the height of Mount Everest. With old instruments, the height of Everest Mount was thought to be 8848.13 slm. The 2005 measurement revealed it to be 8844.43 slm.
>
> After three years of repeated attempts and three trips to Tibet, in November and December of 2005 Shi Guorui eventually succeeded with his project to photograph Mt. Everest [Figure 4.24] with a large *camera obscura*, built on the spot. The photographs were shot from a mountain facing the Everest and at an altitude of 5,200 metres.[13]

Taken with Time: A *Camera Obscura* Project

In 2005–2006, *The Print Center* of Philadelphia commissioned three artists to make *camera obscura* imagery for their exhibition entitled *Taken with Time: A Camera Obscura Project* (Figure 4.25). The images were meant to "address the relationship between light, movement and time in photography as well as commenting upon the historical and contemporary issues of industry, culture, politics and religion in Philadelphia and in our greater society."[14] One of the artists, Vera Lutter of New York, internationally known for her *camera obscura* images—often made in large shipping containers—exclaimed her early fascination with the process (an archetypal response upholding the Christian imprimatur):

> The first time I created a *camera obscura*, after I had realized how long I had to sit in there to adjust my eyes to the darkness, to see the projection, which is about 20 or

FIGURE 4.24
© Shi Guorui, *Himalayas Everest Mount 8844.43 slm*, November 20, 2005, unique *camera obscura* gelatin silver print 129 × 685 cm.

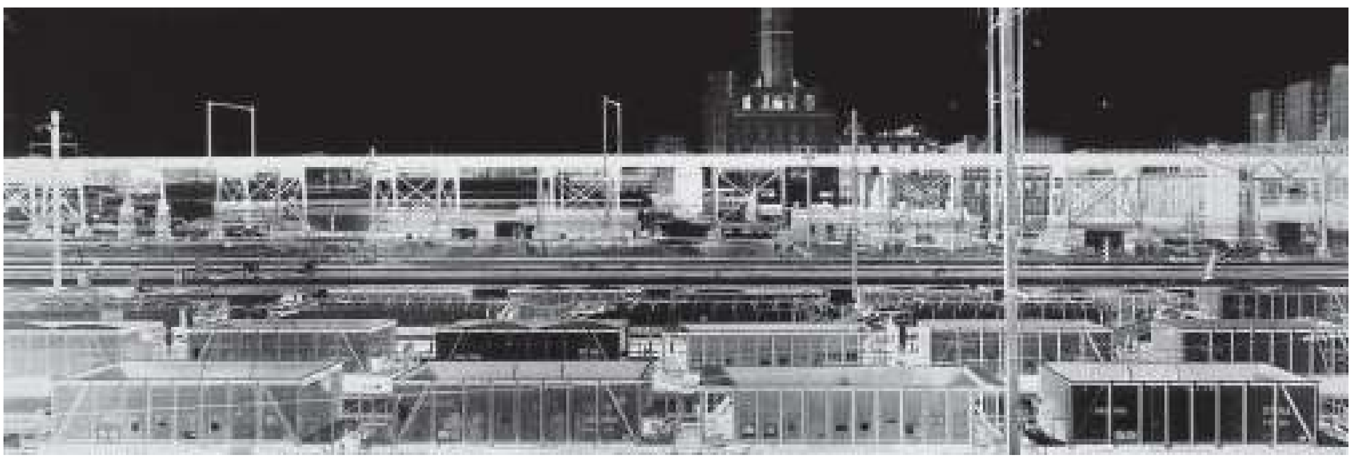

FIGURE 4.25
Vera Lutter, *30th Street Station, Philadelphia, IV: April 20, 2006*, 49½ × 146¼-inch unique gelatin silver print, 105-minute exposure. Commissioned by The Print Center, *Taken With Time: A Camera Obscura Project* © Vera Lutter. Courtesy of Gagosian Gallery, New York.

> 30 minutes—I thought I'd seen God. When I saw the first projection, it was an epiphany. It was probably one of the most overwhelming moments of my life.[15]

In an interview for the Fall 2003 issue of *Bomb* magazine conducted by Peter Wollen, Vera Lutter spoke of her conceptual pinhole *camera obscura* imagery as:

> I never know what is going to happen. My way of working is very hands-off. I install the apparatus of observation, the camera, and then endure the process of observation and record whatever happens. The work is essentially about the passage of time, not about ideas of representation.[16]

The Legacy Project: *The Great Picture*

By the 1980s major gallery owners who specialized in photography realized that very large photographs could be sold at high enough prices to keep their galleries afloat, whereas smaller photographs, unless they were vintage and from a highly recognized photographer, would not. Large photographs could be priced by the square inch or foot (as is done with paintings—this may sound like a jaded view, but it is accurate). Galleries and artists make strange bedfellows, particularly when capitalism, collectors, and high-end auction houses are all involved under the fuzzy, warm blankets of "art."

For many galleries, this "bigger is better" approach was satisfied through the creation of huge prints made traditionally or digitally from enlarged lens' negatives. Another way was possible. Rolls of large photographic paper could be used to capture a *pinhole* image in negative form inside a darkened room. Thus this pinhole image was given a new calling—a new name for an old process. It became known as the *camera obscura* image.

Many who worked in this vein photographed the *camera obscura* image on the wall with a large-format lens camera and then enlarged that image greatly. The viewer of the final image had the benefit of seeing and feeling two images in one. For the photographer, being inside the *camera obscura* became a highly charged fascination—this was an exciting experience—genuinely a new participatory extension to photographic image making. By the year 2000, pinhole, and particularly *camera obscura* imagery, became very trendy. Some lens photographers who had never made pinhole images before were intrigued with pinhole and *camera obscura* imagery as a new means of expression.

Also around the year 2000, and to the dismay of traditional film photographers, most professional and amateur photographers alike turned to digital imaging, thus creating a unique collision of those who venerated the old chemical processes versus those who were enamored by the the new electronic ones. This odd combination of forces—pushing out the old film format cameras (and film and photo paper as well) with the arrival of low- to high-end digital cameras, scanners, Adobe Photoshop, and digital printers—created an odd backlash. The traditionalists certainly felt the pressure.

Because the galleries had promoted "bigger is better" for decades, along came the idea for the "Legacy Project: *The Great Picture*" (Figure 4.26A). This large image could have been made any time after 1965 when Rockland liquid emulsion was first available; however, America's attitude toward public art, the momentary trendiness of pinhole *camera obscura* imagery, sponsorship, wealth, and of the pressure of digital imaging all made *The Great Picture* a necessary project in 2006. (It's not an image driven by any Great Depression mentality, nor is it a 1960s back-to-basics "less is more" oatmeal-box pinhole approach.)

The six artists who combined energies to make *The Great Picture*—Jerry Burchfield, March Chamberlain, Jacques Garnier, Rob Johnson, Douglas McCulloh, and Clayton Spada—billed *The Great Picture* as an attempted "Guiness Book of World Records" image as well as a "Guiness Book of World Records" camera. One couldn't print out something as large as a

FIGURE 4.26A
© Jerry Burchfield, March Chamberlain, Jacques Garnier, Rob Johnson, Douglas McCulloh, and Clayton Spada, *The Great Picture*, lens photo by Robert Johnson, *The Legacy Project.*

FIGURE 4.26B
© Jerry Burchfield, March Chamberlain, Jacques Garnier, Rob Johnson, Douglas McCulloh, and Clayton Spada, pinhole camera for *The Great Picture*, lens photo by Douglas McCulloh, *The Legacy Project*.

31.5 × 107.5-foot piece of paper in digital format; however, it could be done with Rockland liquid emulsion painted onto that size canvas. The Legacy Project's *The Great Picture* would be a farewell salute emblazoned in the photo history books—a monument to the end of traditional film photography.

The Great Picture, made in an F-18 jet-fighter hangar of the closed U.S. Marine Corps Air Station El Toro in California, was an archetypal American thing to do—a promotion of the nationalistic art ego—we're going to make the biggest! Some may have seen the quirky humor in converting an F-18 fighter-jet hangar into a pinhole camera (Figure 4.26B) that could create a work of art. At the time of this writing, the "Guiness Book of World Records" is considering its world recordness. Ultimately, art critics and the public will say whether the image is a valued expressive work of art as well as a monument to the end of traditional film photography.

Of the image and facts about it, its makers say:

> *The Great Picture* is a marker of decisive change as the 168-year film/chemistry dominance of photography gives way to the digital era. The scale of the undertaking and of

> the image reinforce *The Great Picture's* position as a milestone that acknowledges the past while signaling photography's move away from film and into pixels.
>
> *The Great Picture* is an object made for the least complicated of reasons—the possibility was there. A group of artists found themselves with the opportunity to climb what looked to be a very large and interesting mountain, so they set out on the journey. All other considerations—the deep implication of both digital and traditional technologies, the employment of a pinhole *camera obscura*, the hand-painting of the photosensitive emulsion—were merely attempts to find the clearest path up the mountain.[17]

THE GREAT PICTURE FACTS

- **Finished Size:** 107′-5″ × 31′-5″; 3375 square feet (Figure 4.26A).
- **Photograph Type:** Black and white negative image with a gelatin sizing and a hand-coated gelatin silver emulsion.
- **Subjects Depicted**: The Marine Corps Air Station El Toro control tower, twin runways, and heart of the future Orange County Great Park, with a backdrop of the San Joaquin Hills and the Laguna Beach Wilderness.
- **Camera**: Building #115, an F-18 fighter plane hangar at Marine Corps Air Station El Toro, Irvine, California.
- **Camera Size:** 44′-2″ feet high by 79′-6″ feet deep by 161′-6″ feet wide [Figure 4.26B].
- **Materials to Darken Hangar:** 24,000 square feet of six mil black viscuine; 1300 gallons foam gap filler; 1.52 miles of 2-inch-wide black gorilla tape; 40 cans of black spray paint.
- **Fabric Substrate:** Seamless unbleached muslin specially ordered from Germany and weighing 1200 pounds rigged.
- **Aperture Size:** One-quarter-inch (6 mm) pinhole 15 feet above ground level—no lens or other optics.
- **Emulsion:** 80 liters of Rockland *Liquid Light*—a gelatin silver black and white sensitizer hand-painted onto the fabric under safelight illumination. Emulsion applied on July 7, 2006.
- **Exposure**: 35 minutes beginning at 11:30 a.m. July 8, 2006.
- **Date of Development**: July 8, 2006.
- **Developing Materials:** 600 gallons traditional black-and-white developer and 1200 gallons fixer delivered by 10 high-volume submersible pumps.
- **Developing Tray:** Eight mil vinyl pool liner contained by a wooden sidewall—114 feet × 35 feet × 6 inches deep.
- **Print Wash:** Twin 4.5-inch fire hoses connected to a pair of hydrants tested at 750 gallons per minute.[18]

Very quietly, *The Great Picture* might hear a few complaints from nay sayer environmentalists, ones who could wonder at the use of 80 liters of silver-based emulsion, 600 gallons of developer, 1200 gallons of fixer, and all the wash water just to make one incredibly large image. Those same few would say that it hardly takes into consideration the needs of those less fortunate around the world with far less photographic resources (or other resources) at their command.

THE FINAL PICTURE

An interesting comparison to *The Great Picture*, going back in real time to a nuclear Orwellian 1984, Thomas Bachler and a group, whom he refers to as "the association," planned to build 15-foot-high *camera obscuras* (Figure 4.27) at the edge of all large German cities to make *The Final Picture*. He explained the need:

> The task that the association *The Final Picture* braced itself to meet was huge: Pinhole cameras about five metres large and framed with lead should be placed facing major German cities. Supported by a mechanism yet to develop they should take the "final

picture" of the town exploding in a nuclear strike—glass lenses would have molten with the heat.

To this end, we founded an association in 1984. We thought that this might be the only way to secure the means necessary to finance the work in form of donations. It did not turn out this way. The simplest administrational task asked too much of us so that the association dissolved in 1987. It is astonishing that we actually planned to put up the cameras—to approach the idea as mere fiction or as a mental model apparently not being an option we considered. I think, all of that was utterly serious to us.[19]

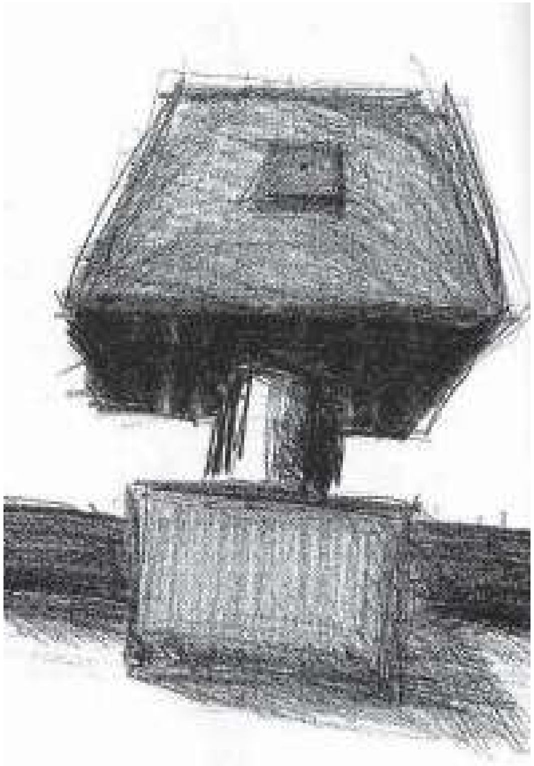

FIGURE 4.27
© Thomas Bachler and the association, drawing of planned *camera obscuras*, 1984. From the collection of the photographer.

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15. Vera Lutter, "Interview: Vera Lutter by Peter Wollen," *Bomb* (Fall, 2003): 51.
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17. Jerry Burchfield unpaginated, *The Legacy Project* press release to the author August 27, 2007.
18. Jerry Burchfield (unpaginated, *The Legacy Project* press release to the author) "The World's Largest Photograph—Controversies about Meaning," August 27, 2007.
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CHAPTER 5

The Basic How-To of Pinhole Photography

One of my teachers recalled a memory of a discarded refrigerator box. Climbing inside the box and closing up the flaps, he and his brother found images of an upside-down world. Soon they had all the kids on the block assembled to view the spectacle, for a penny, and then jump up and down outside for the benefit of the other viewers.

HARRY LITTEL, personal letter to the author, 1990

The pinhole is one of the two natural systems that form an image (Figure 5.1). The other system is a lens, as in our eyes. One animal uses pinhole eyes for sight, the mollusk Nautilus (Figures 5.2A and B), which has been a species on this planet since the dinosaurs. The open aperture in each eye can accommodate (enlarge or shrink), and sea water goes directly into its opened, pinhole eyes.

If you already have knowledge of basic black and white photography, here are very quick instructions for making a pinhole camera. If not, skip this paragraph and go to the next paragraph entitled “Basic Instructions for Pinhole Photography.”

Find a light-tight box about 3–6 inches across and paint it flat black on the inside. Make a 1/2-inch hole on the side. Take a small sewing needle and twist its point into a 1-inch-square thin piece of metal—a soda drink aluminum can will do. Push and twist the needle until it goes about 1/4 inch up the shaft. Sand off the burr on the metal. Using black electrical tape, fasten the metal square so that it completely covers the hole cut in the box. Then load the camera with RC Pearl multigrade photo paper, emulsion side out toward the pinhole.

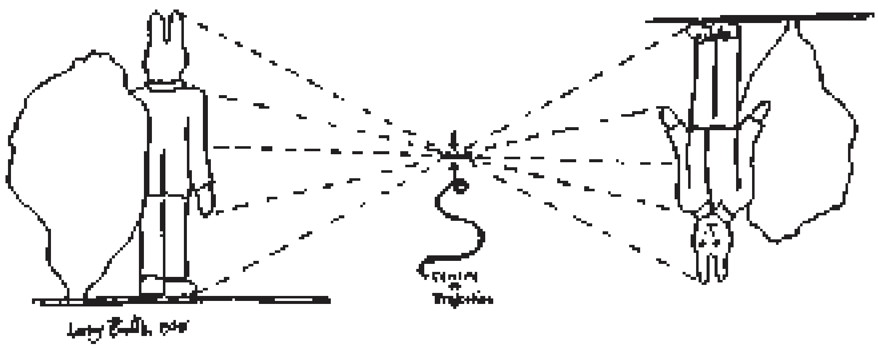


FIGURE 5.1
© Larry Bullis, drawing of image entering a pinhole and being projected onto the film plane, 1988. From the collection at Pinhole Resource.

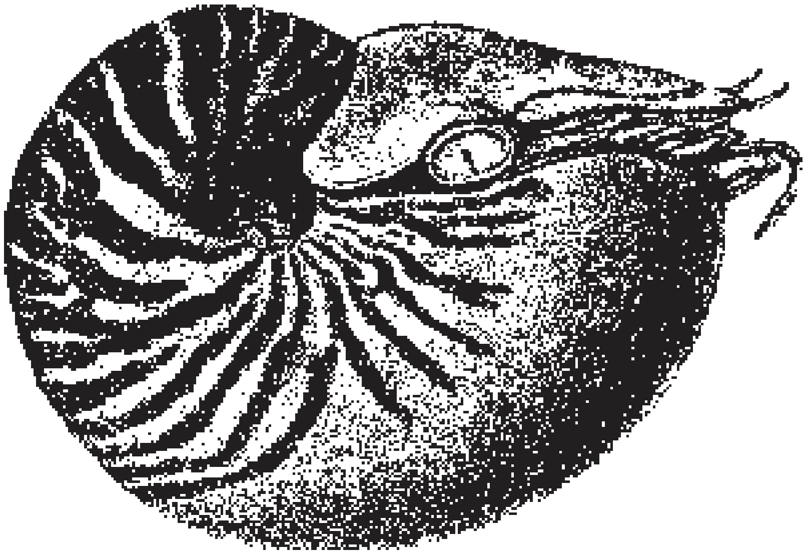


FIGURE 5.2A
Nautilus, one of its pinhole eyes is oval in upper right. From Arthur Willey Zoological results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere collected during the years 1895, 1896, and 1897 (London: Cambridge University Press, 1900).

FIGURE 5.2B
Enlarged view of the eye in vertical section. From Arthur Willey Zoological results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere collected during the years 1895, 1896, and 1897 (London: Cambridge University Press, 1900).

FIGURE 5.3
© John Wood, *Paper Bag Pinhole Photograph of a Chevy,* 6 × 7½-inch pinhole photograph, 1975. From the collection at Pinhole Resource.

Tape the top of the box all around with black electrical tape. Put a piece of black electrical tape over the pinhole on the outside, which becomes the shutter. Expose outdoors on a sunny day for 1 minute, setting the camera down so that it's stable—don't have the sun on the pinhole. You should have an image. Load your camera again and adjust the exposure time so that the image is correct. A simple pinhole camera can be made in about 10 minutes. The simplicity of pinhole cameras was demonstrated by John Wood while he was professor of photography in New York, who painted the inside of a paper grocery bag black, put photographic paper inside, folded over the top several times, and poked a hole in the bag with a pin (Figure 5.3).

BASIC INSTRUCTIONS FOR PINHOLE PHOTOGRAPHY

A pinhole is basically a very sophisticated light leak, usually a small round hole in thin material, about the size of the smallest sewing needle. Because much in pinhole photography is intuitive, the beginning pinhole photographer does not necessarily need viewfinders, light meters, or expensive cameras. The following procedures will help you make a pinhole camera from an already existing box, make the pinhole, attach it, load the camera, expose outdoors, and develop the first images. If you need to make a simple black and white darkroom, buy four 8 × 10-inch photo trays and an opaque red 15-watt light bulb or cheap safelight (or you can paint red onto the surface of a white 15-watt bulb several times to make it opaque red if you do that, tape over the threaded screw base so it doesn't get paint on it). You'll need to have a room that can be made completely dark with just the red light on. Running water, a sink, and table are useful too, but not necessary if primitive. Even a safelight can be made out of a flashlight with a red filter taped over the front lens. This type of red-filtered flashlight was used to load and develop the 39 pinhole paper negatives (altogether over 100 negatives were made) for the *Flight* series that Nancy Spencer and Rebecca Wackler created in Virginia in 1986 (Figure 5.19). The final prints in the series were hand colored from black and white Portriga photographic paper. For a darkroom, Spencer and Wackler used a primitive cabin with heavy quilts to block out most of the light from the windows. Quite a lot can be accomplished with no more than a quality changing bag or working in a darkened space at night.

THE CAMERA

There are several ready-made boxes that can be transformed easily into pinhole cameras. The first is the classic small cylindrical cardboard oatmeal box, the one that is approximately 3 inches in diameter. Even though it has a translucent white plastic lid, it can be adapted. First empty out the contents—only in pinhole photography does a camera come packed with food—then take a cloth and dust out the insides. Even a camera can be edible, as in my red pepper *Natural Safelight Camera* (Figures 5.4A and 5.4B).

FIGURE 5.4A
© Eric Renner, natural safelight camera for black and white film, lens photograph by the author, 1987. From the collection of the photographer. Because it is red, this pepper simulated a small darkroom as a natural safelight for black and white photographic paper. The darkest red pepper worked best.

FIGURE 5.4B
© Eric Renner, *Self*, 2½ × 3-inch pinhole photograph by the author, 1987; 5-second exposure. From the collection of the photographer.

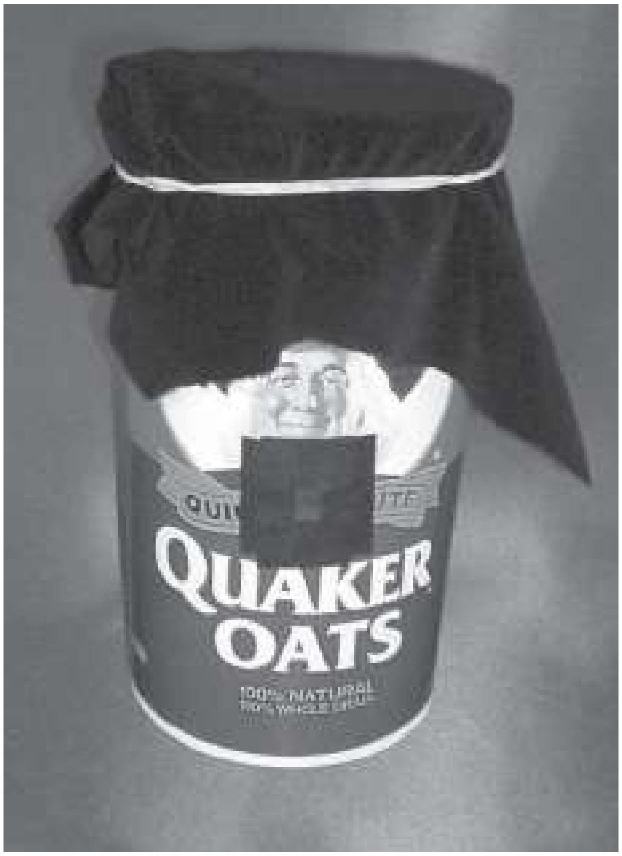


FIGURE 5.5
An oatmeal box with a black cap cover and taped on pinhole. Lens photo by the author.

Continuing with the oatmeal box, wrap flat black paper around the inside of the box. This is better than spray painting the inner cardboard flat black; it doesn't destroy the ozone layer, nor are you using carcinogens. Tape the lid on both sides with layers of black electrical tape that overlap slightly. It is not necessary to tape the small inner edge of the lid. Use a piece of dense foldable black fabric, such as velvet, or thick black plastic cut into a 1-foot-round piece that can be held in place with a rubber band over the top of the camera to shield the lid from direct light once the camera has been loaded with photo paper. The fabric or plastic acts like an extra light barrier when taken outside. The completed oatmeal box camera minus the black tape shutter is shown in Figure 5.5. Use a 3-inch piece of black electrical tape for a shutter, folding over 1/2 inch of it onto itself so that it is easily removable.

Another easily adapted ready-made camera is a small cylindrical or rectangular cookie or candy tin with a tight-fitting lid. These tins come in endless varieties in discount stores. Some are particularly suited to personal artistic statements, as Jo Babcock has done using a tin scaled-down Decatur House (Figure 5.6A) to photograph *The White House* (Figure 5.6B). His pinhole was in an upstairs window. It is fun to select an unusual tin. Very simple cameras can make very sophisticated images. Your tin will need to have a 1/2-inch hole drilled through the tin where you want to place the pinhole. A metal shim with a pinhole in its center gets taped over this hole. (You can try drilling a pinhole in the tin box, but usually the metal is too hard for a clean hole—so get a round file and work on the edges until they are burr-free.) Use black paper around the insides of the lid and the container (hopefully you won't have to use spray paint). After the photo paper is loaded into the tin, the tin lid will need to be taped around its edges with black electrical tape. *Even though it may look light tight, light can actually sneak under that edge if it's not taped.*

If you are already a photographer who has an empty 100-sheet box of photo paper or 25- or 50-sheet box of film, this makes a wonderful three-part box pinhole camera.

FIGURE 5.6A
© Jo Babcock, Decatur House pinhole camera, 1998. Lens photograph. Decatur House is located in Washington, DC, one block north of the White House. From the collection of the photographer.

FIGURE 5.6B
© Jo Babcock, *The White House,* 20 × 24-inch color coupler pinhole print, 2001. From the collection of the photographer.

At the end of this chapter (Figures 5.24A and 5.24B) is information on using a pinhole body cap on an already existing film camera. Chapter 7 provides slightly different information on adding body caps to digital single lens reflex cameras.

Materials Needed

- An oatmeal box, cookie tin box, or empty 100-sheet box of photo paper. The 3-inch-diameter oatmeal box is better than the 5-inch-diameter family-size container in that it exposes quicker. If you want to use larger paper, get the 5-inch-diameter box.
- An electric drill and a 1/2-inch bit if a tin is being used.
- 0.002 gauge metal, a soda can, or an aluminum recyclable cookie sheet found in your local supermarket.
- A small sewing needle.
- A sheet of #600 grit emery sanding paper.
- One roll of black vinyl electrical tape. It will be lightproof but can get sticky in the sun if you are doing 2- to 3-hour exposures. A better quality lightproof tape is Scotch #235 black photo tape available at good photo supply stores. Not all black photo tape is lightproof, but Scotch #235 is. Don't buy black gaffer's tape as it is not really lightproof.
- One roll of masking tape, used to tape the photo paper in the camera if necessary.
- A pair of scissors.
- A single-edged razor or mat knife.
- A 10-sheet package of RC multigrade matte-surfaced photographic paper.

- Flat black paper for the insides of the camera container.
- A normal photographic darkroom with black and white chemistry.

Adding the Pinhole

The most readily available materials for pinholes are semidisposable baking sheets or pie pans, which come in a variety of sizes and shapes in most food markets, or aluminum soda cans. The pie-pan aluminum is approximately 0.002 gauge, and one pan will supply many pinholes. Those wanting "higher class" pinholes can buy 0.002-gauge brass shim stock at an automotive, hardware, or bearing store, but this is more expensive and not always readily available. Inexpensive pie-pan aluminum is almost as good as the expensive brass in both workability and gauge. Aluminum from a soft drink can is slightly less than 0.002 gauge and is slightly harder to push a needle through, but is still a good choice and can also be used.

After getting the metal you want for pinholes, cut out a 1-inch square. Under this square place a sheet of cardboard, such as the kind that comes on the back of a yellow-lined writing pad, as this will make the best working surface for drilling the pinhole. Get a small sewing needle. I'm not suggesting a certain numbered needle size because they are difficult to find. (Numbered needle shaft diameters are shown in Figure 6.1B.) Tape a piece of masking tape across the eyed end of the needle to prevent it from pressing into your fingertip. Hold the needle point on the center of the piece of 1-inch square metal and spin the metal while holding the point of the needle against it. The metal should be on top of the cardboard. With some amount of pressure and spinning, you will see the needle begin to drill a hole into the metal. Spinning the metal will keep the hole round. Continue spinning until the needle point sticks through the metal to about 1/8 of an inch. The pinhole will be about 0.5 mm. The optimum-size pinhole for an approximate 3-inch focal-length camera is 0.0130 inch or 0.3300 mm. When you drill the pinhole, it is better to make it slightly too small than too large. *Don't worry about making a perfectly sized hole—a less than optimal pinhole will make an image just fine!*

With a piece of 600 grit emery paper, sand off the burr that remains on the back side of the pinhole. Then sand the front side of the metal, which helps thin the metal and make the hole cleaner. The thinner the metal, the less diffraction bounces off the edges of the metal—what you don't want is a pinhole that is like a tunnel. Clean out the sanded metal that has been trapped in the pinhole by placing the needle in the pinhole and spinning it gently.

It is not necessary to measure the pinhole. If you must, then instructions for this are in the next chapter. Sometimes when drilling a pinhole, you may accidentally drill two pinholes very close to one another, resulting in an image that looks blurred or as if movement occurred. A simple way to see the pinhole is to look at it with an ordinary magnifying glass.

Mounting the Pinhole

If you are Using an Oatmeal Box

With a sharp, single-edged razor blade or mat knife, cut a 1/2-inch-square hole in the center of the front of the box. Make sure that the cardboard and paper are cut cleanly, as leftover material will block some of the image entering the box. Using black vinyl electrical tape, tape the pinhole onto the outside of the box. Black vinyl electrical tape is lightproof. As you are doing this, look into the inside of the box to see that the pinhole is placed in the center of the cut opening. The back of the metal should go inward. Cut an extra piece of tape to act as a shutter and place it over the pinhole. If you happen to be using an old-style oatmeal box with an actual paper lid (available at antique stores for outrageous prices), it will work without the fabric cap. If you get one of these, then take a strip of masking tape and encircle the container just below the edge of the lid. Also encircle the edge of the lid with masking tape. These two surfaces will give you an area around which to run the black electrical tape, stopping any light leaks that may occur around the lid. The masking tape will also keep the top of the box from being torn each time the black tape is removed.

If you are Using a Cookie Tin

Drill a 1/2-inch hole halfway up the front of the tin container. To do this, place a foot-long block of wood, such as a two by four, horizontally in a vice. Put the inside of the tin over the wood and drill the hole carefully through the tin against the wood. Make sure that the metal on the back side of the hole is cut cleanly or file it clean.

If you are Using a Three-Part Photo Paper Box

Cut a 1/2-inch-square hole in the middle of the front box, which is the largest of the three compartments and which gets the pinhole taped onto it. Cut a 1-inch-square hole in the middle of the smallest-sized box. The mid-sized box becomes the back of the camera. No tape is needed around the edges of the boxes when the camera is loaded, although tape may be useful in keeping the boxes from separating.

All Other Containers

Anything that can be made light-tight will become a pinhole camera and selecting which one suits the persona of the photographer is always a challenge from the simplest to the most complex (Figures 5.7, 6.48b, and 6.48c). There are innumerable examples of personal cameras throughout this book. Making the camera light-tight is sometimes more difficult than it seems, yet sometimes a rewarding image comes from it, even though it leaks light. For example, Robert Mann, an American living in Paris, found that an unintentional light leak enhanced his imagery because it went on the same angle as the portrait (Figure 5.8). Dana Day of Chicago has made pinhole cameras with intentional light leaks to enhance the edges or other parts of the image. In doing so she has created an alien shadow of herself in an other-world landscape (Figure 5.9).

Painting the Interior of the Camera Black

If you are unable to use black paper inside the camera for the environmental reasons mentioned earlier then paint the interior with *flat* black spray paint. If you want to be assured of the best nonreflectivity, try to use *ultraflat* black, although it is certainly not necessary for

FIGURE 5.7
© Nancy Spencer and Eric Renner, Elvis oats pinhole camera, lens photograph, 1993. Using a small oatmeal box to transform the conventional oatmeal man into Elvis with the pinhole placed in Elvis' right eye. From the collection of the photographers.

FIGURE 5.8
© Robert Mann, *19960000-03,* from *Head* series, 8 × 10-inch pinhole photograph printed on Kentmere Art Classic and developed in lithographic developer, 1996. From the collection of the photographer.

FIGURE 5.9
© Dana Day, *Shadow,* from series *New Mexico*, intentional light leaks in 16 × 20-inch sepia-toned pinhole photograph, 2002. From the collection of the photographer.

most basic pinhole cameras, nor as obtainable. Any object or box that is being transformed into a pinhole camera should be blackened if the interior is white or reflective. When in doubt, blacken it. If possible, use brushed-on acrylic paint rather than spray paint. The back of the pinhole metal (facing inside the camera) does not need to be painted black; however, if you do want to darken it, use black photographic tape or a black felt-tip marker to cover most of the area. Do not allow paint to flow into the pinhole or tape too close to it. If you want to be overly technical, extraneous light can also be reduced by using a lens hood and attaching extremely flat black fabric on the camera's inside to attempt to cut down on bouncing light (which is what a bellows naturally accomplishes). These two additional items are useful in zone plate photography, but are not at all necessary in basic pinhole photography.

Loading the Pinhole Camera

In a darkroom under a red or orange safelight, load your camera with a piece of the recommended RC matte multigrade photographic paper. (People ask what the ISO of photographic paper is—about 8 or less is my guess.) If you are using an oatmeal box, try cutting the paper to 5×8 inches. Why photographic paper? Because if you are new to photography you can see the image develop in the tray, which is exciting! It's a lot more fun than film and a lot easier, particularly at first. To use film you need total darkness to load and develop. The best type of photographic paper to use for paper negatives is an RC multigrade matte-surfaced paper known as pearl. Why RC? Because it dries perfectly flat for making positive contact prints from your paper negative. Why multigrade? Because it works best both on gray days and in sunshine. RC paper is generally high contrast; for perfectly exposed negatives, try photographing an image in the shade. It works great on overcast and even rainy days. Why matte surfaced? Because it doesn't produce a reflected fogged strip the way shiny-surfaced papers do (Figures 5.10A and 5.10B) when curved inside a cylindrical pinhole camera like an oatmeal box.

(A)

(B)

FIGURE 5.10 A and B

Pinhole photographs (paper negative and positive print) illustrating reflective fogged strip across center of glossy RC paper. This will usually happen when using glossy surfaced paper as a negative. This reflective area is one of the most common mistakes with first pinhole images in a curved camera. With a 1-minute exposure in sun, the camera was placed on its side approximately 10 feet from the tree. Photographs by author.

When loading an oatmeal box, curve the photographic paper around the inside of the cylindrical box opposite the pinhole. Don't cover up the pinhole. The emulsion side should face the pinhole. You might want to cut the 8 × 10-inch paper in half to two pieces that are 5 × 8 inches. Generally, it is difficult to distinguish the emulsion side of RC multigrade matte-surfaced paper from the nonemulsion side, although the emulsion side has a slightly shinier surface. A wide variety of traditional photographic paper is available from Freestyle Photographic Sales in Los Angeles (www.freestylephoto.biz). Figure 5.11A shows what happens when photographic paper is put in correctly; Figure 5.11B shows what happens when it is inserted backward. When a concave curved container is used like an oatmeal box, a pinhole casts an image of approximately 160° onto photographic paper that has been wrapped almost completely around the inside of the container, with the paper and the image reaching almost to the pinhole (Figure 5.12). A pinhole will photograph this wide an angle inside a curved container because the photographic paper is being curved back toward the pinhole, where the light intensity is strongest. However, the image size near the pinhole is small; it increases as the paper curves toward the back of the container (Figure 5.13). This explains why a cylindrical container makes an elliptical image if the paper is long enough. The image in Figure 5.13 is well exposed. The sky looks black and the shades and shadows are varying amounts of gray.

FIGURE 5.11A
Pinhole photograph (paper negative) illustrating photographic paper loaded correctly with emulsion side toward the pinhole. A 1-minute exposure with hazy, bright sky. Photograph by author.

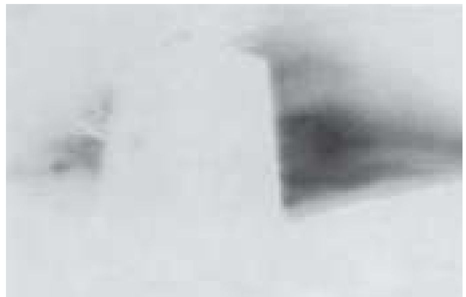


FIGURE 5.11B
Pinhole photograph (paper negative) illustrating photographic paper loaded incorrectly, paper put in backward, that is, emulsion side away from pinhole. A 1-minute exposure with hazy bright sky. Photograph by author.

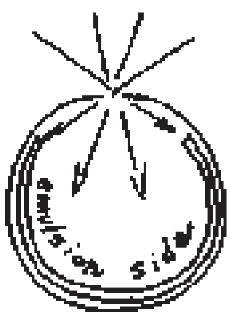


FIGURE 5.12
Drawing illustrating photographic image reaching around inside oatmeal box. Drawing by the author.

FIGURE 5.13
Pinhole photograph (paper negative) illustrating image shape when paper is wrapped almost completely around inside a cylinder. A 45-second exposure in full sun. Photograph by the author.

Make sure that the black electrical tape is over the pinhole to act as a shutter. After the camera is loaded, seal the top with black electrical or photo tape. If you use an oatmeal box, add the fabric cap. You are now ready to make a photograph.

You can always check to see if your camera leaks light. Load fresh photo paper inside of it in the darkroom, taping the camera up, and then take it outside into the sunlight for 5 minutes. Don't uncover the pinhole. Take the camera back inside; develop the photo paper. If there isn't any fogging on the photo paper, then the camera is light-tight. Old photo paper can develop and look gray because it has been fogged. Don't throw slightly fogged old photographic paper out, as it is useful for nonconventional experiments.

When photographic film is used in an oatmeal box, exposure times are shortened to a few seconds. Because film is so much more light sensitive than photographic paper, the camera must be taped with black electrical tape along the thinner cardboard seams that spiral up the outside and inside of the container. These seams are visible on the inside and can be felt as slight indentations under the paper on the outside.

There are certain "don'ts" to making a pinhole photograph for the first time. These don'ts can be experimented with later, for many unusual results come from breaking the rules. For now, it is important to see whether the camera is light-tight, working, and giving you an idea of exposure times. The don'ts are as follows.

- Don't have the sun shine directly on the pinhole when exposing. This will create solar flare diffracting off the edges of the pinhole. You can attempt to make solar flare images later for defraction rainbows (Figure 5.14), which look feathery on black and white

FIGURE 5.14
Eric Renner, detail, *December 27, 1975, Sun–Cloud*, 20 × 16-inch pinhole photograph, 7 pinhole camera, from series *Sky*, 5-second exposure.

film or on black and white photographic paper. The flare can be quite spectral in color (Figure 9.13).

- Don't hold the camera in your hand (Figure 5.15A). Exposure time and sharpness should be considered first. Set the camera on a wall, the ground, or another solid base. If it's windy, place a weight on top to hold it steady (Figure 5.15B).
- Don't photograph into really deep shade. It's best to try to photograph where there is some brightness, partial shade, and shadow all in the same image.
- Don't try to photograph indoors while making your first images. Inside exposures can be very long and difficult to estimate.
- Make sure that the photo paper inside is held firmly. Sometimes if it breaks loose a lucky result happens (Figure 5.16), but that is rare. Use masking tape doubled over behind the paper if necessary.

Exposing the Negative

To expose the negative, simply remove the shutter tape. With the size pinhole described earlier, your oatmeal-box camera should make an image outside in full sun in about 30 to

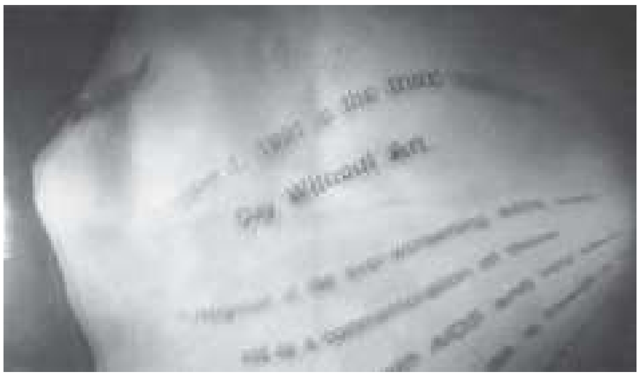


FIGURE 5.15A
Pinhole photograph (paper negative) illustrating hand-held camera. A 25-second exposure in sun. Photograph by author.

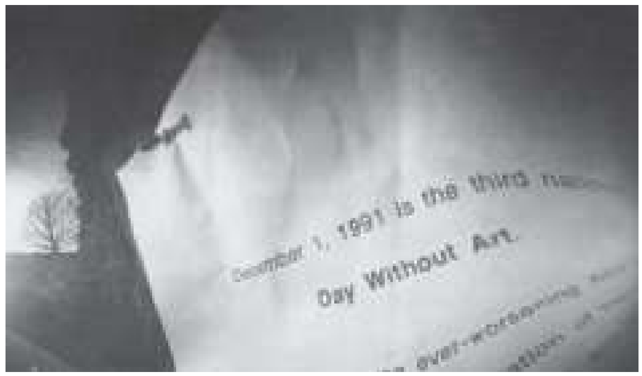


FIGURE 5.15B
Pinhole photograph (paper negative) illustrating results of camera on a firm surface. A 25-second exposure in sun. Photograph by author.

FIGURE 5.16
© Pertti Saloheimo, untitled, series *On Human Evolution*, 7 × 8¾-inch pinhole photograph, 1990. From the collection of the photographer.

45 seconds with the 3-inch-diameter box; if it's cloudy or overcast, exposure should be 2 to 3 minutes, depending on just how dark it is. As the sun goes down in the afternoon, exposure times increase greatly. Indoors can take hours or even days with photographic paper in the camera. If you are using a 5-inch-diameter box, exposure time in full sun should be about 2 to 3 minutes. Times may vary somewhat from these depending on the size pinhole made.

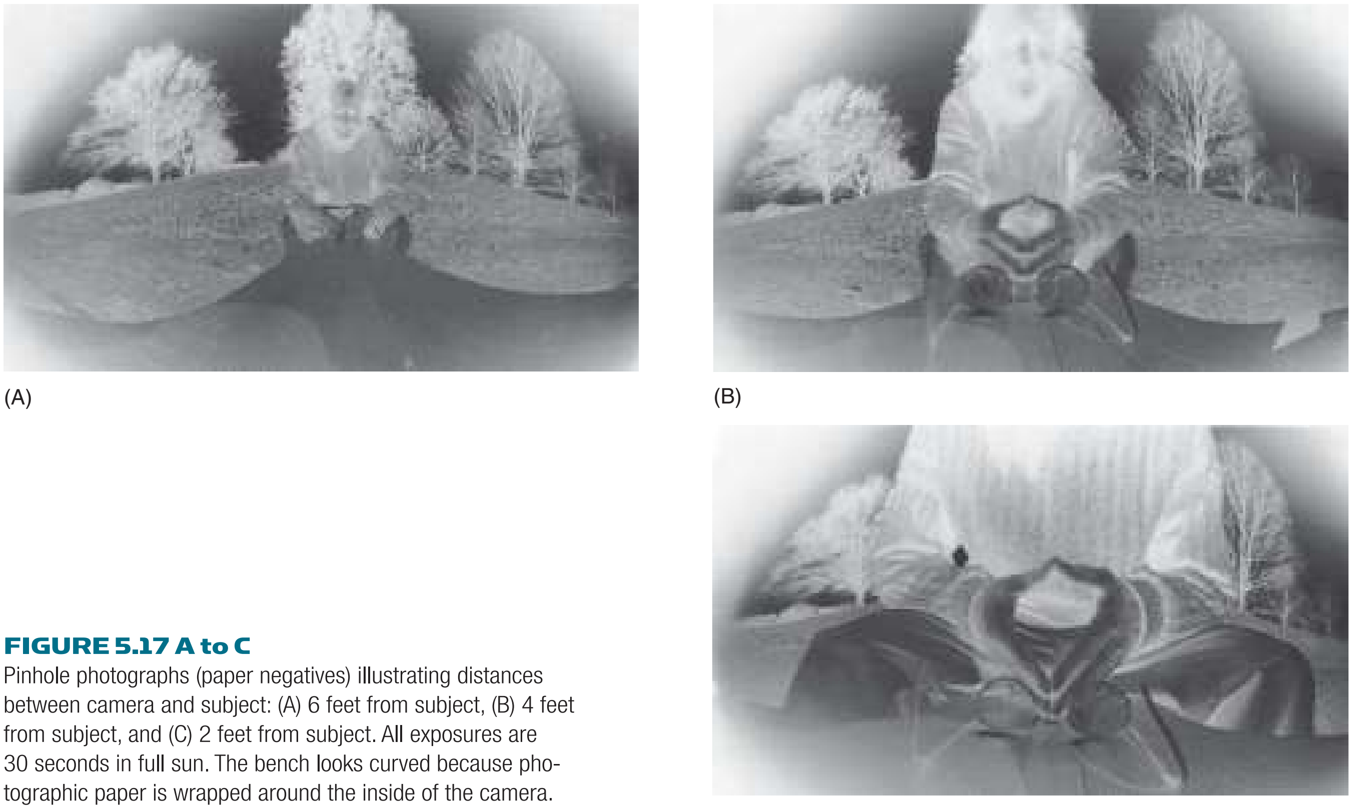
Here's a very basic exposure chart for RC paper:

Light condition	Camera focal length	RC paper
Full sun	1½ inch (38 mm)	15 seconds
	3 inch (75 mm)	40 seconds
	6 inch (150 mm)	3 minutes
Hazy sun	1½ inch (38 mm)	40 seconds
	3 inch (75 mm)	3 minutes
	6 inch (150 mm)	8 minutes
Cloudy	1½ inch (38 mm)	3 minutes
	3 inch (75 mm)	8 minutes
	6 inch (150 mm)	18 minutes
Deep shade	1½ inch (38 mm)	8 minutes
	3 inch (75 mm)	18 minutes
	6 inch (150 mm)	40 minutes

This chapter does not suggest that you calculate *f*/stops or measure the exact size of the pinhole. The aforementioned chart provides you with a beginning point, but you will need to adjust it to your first evenly exposed paper negative, which should look somewhat similar in tonal values to Figure 5.13. For example, if you used a 3-inch (75-mm) focal-length box and your image only took 20 seconds to expose correctly in full sun (rather than the suggested 40 seconds suggested in the chart), then cut all the suggested exposure times in half. Pinhole exposures are generally forgiving in that when you are using photographic paper as a negative, exposure times do not have to be calculated to the exact second. A darker negative can still be printed or it can be left as a negative on paper. If you like that look, try various fiber-based photo papers.

With an oatmeal-box camera, get closer to the subject than you think you should be (Figures 5.17A–5.17C). A pinhole image is a superwide angle, particularly if you have wrapped the paper almost all the way around the inside of the box. The image will be somewhat football shaped as it comes closer to the pinhole. If you think you should be 3 feet from the subject, more like 1 foot away would probably be better. You might be surprised to find that a pinhole camera can photograph within 1 inch or less from the subject, as long as there is light on what is being photographed.

I have photographed objects 1/8 inch away from the pinhole. To do this I taped translucent objects almost right over the pinhole, took the camera out in the sun, and let it shine through their translucence. In this way I made the image *Grandma Becomes the Moon* on the frontispiece of this book I photographed through a vintage picture of my grandmother from 1919. In that original image, her face was only 1/4 inch across. In my final image, exposed by the sun and enlarged by the pinhole, her face became 9 inches wide. When I developed the negative she looked like the moon, so I made a positive print on a bright white base bromide paper. This image was one of the most magical that I have ever made. I'll explain. I had written a little book a year before and in it I imagined that my Grandmother had become the moon. I wasn't aware at the time that this was a visual archetype—a connection made by many people over eons of time. My image *Grandma becomes the Moon* was later exhibited at the Virginia Museum of Contemporary Art, in a show curated by Willie Anne Wright in 1987. When the exhibit traveled to Sweet Briar College, Nancy Spencer, who taught photography there, was intrigued by the ethereal qualities of the *Grandma becomes the Moon* image.



(A) (B) (C)

FIGURE 5.17 A to C
Pinhole photographs (paper negatives) illustrating distances between camera and subject: (A) 6 feet from subject, (B) 4 feet from subject, and (C) 2 feet from subject. All exposures are 30 seconds in full sun. The bench looks curved because photographic paper is wrapped around the inside of the camera. Photographs by author.

FIGURE 5.18
© Eric Renner, *George Washington on a One Dollar Bill*, from series *Translucency*, detail from 16 × 20-inch pinhole negative on paper, 1976. From the collection of the photographer.

She told me later that she studied the image many times and was entranced by it. Through some unusual set of coincidences that image helped to bring us together.

In the close-up of *George Washington on a One Dollar Bill* (Figure 5.18), the bill was taped 1/4 inch in front of the pinhole. The camera was then set on the ground with the sun shining through the dollar bill. The printing on both the front and the back of the bill shows up in the image because it was translucent. Note that the lines across Washington's face are actually from the back of the dollar bill.

Use a watch or count seconds so that you can repeat, lengthen, or shorten your next exposure time or learn to count seconds in your head. A little bit of rain usually won't hurt an oatmeal-box or tin camera, so don't be afraid to try it for about a 2- to 3-minute exposure in the rain. Water puddles reflect the sky adding light into the image.

Developing

In the darkroom, develop your paper negative as you would any black and white RC paper (probably 2 minutes in developer, 30 seconds in stop bath, and 3 minutes in fixer). The resulting image is a paper negative that you can see develop in the tray. Usually the area to darken first will be the sky; areas that remain light are the deep shadows.

While developing, if there is a large light leak in your camera, the paper negative will overdevelop quickly and become black, probably all over. Usually this does not mean you simply overexposed. If the image does appear but the entire photograph seems gray, you have a very slight light leak that is fogging the paper. It's always good to keep in mind that what appears as a light leak in the sky area is actually something wrong at the bottom edge of the camera and vice versa; if there is a darkened area on the ground, it means that the top of the container leaked light. If the cardboard by the pinhole is not fully cut away, it will block some of the image.

Because RC paper dries flat, it is easy to make contact-print positives from your negative. Simply place your negative with the image side down on top of an unexposed piece of photographic paper with its emulsion side up. Both should be pressed together under a piece of glass or in a contact-print frame. If they are not pressed tightly, the image will be blurred where the sheets don't fully touch. Expose for about 3 to 5 seconds under an enlarger with its lens wide open, making sure that the circle of light covers the paper area. Different photographic papers can be used for positive prints, as RC matte paper is certainly not the best for tonal values in positives nor is it particularly archival. Experiment with as many photographic papers as you can.

Motion

Moving objects will not image unless they are moving very, very, slowly—if you walk in front of a 30-second exposure, you won't appear in the image. If you want to make an image where a ghost appears (Figure 3.22), you have to remain motionless for at least half of the exposure time, depending on the background. The reverse works too. In Willie Anne Wright's image (Figure 3.5), the beach appears desolate, although other people were walking and playing there during the duration of a 3-minute exposure while the subject held still. Wright knew the camera would only capture what was still. The slight motion in the flowing dress adds to the beauty of the image. In Nancy Spencer's image from her *Flight* series (Figure 5.19), the water appears silky because the exposure time is long and light was constantly sparkling off the water, although the stream was actually clear. To make the horizon line more distorted, Spencer angled the oatmeal-box camera slightly toward the ground. Donna Fay Allen chose to make a floating image (Figure 5.20) of a boat's churning wake as it moved away from the vanishing point. The entire image is a dreamy metaphor for having left and moved onward. The image was made with the popular Zero2000 pinhole camera (Figure 5.21) made in Hong Kong by Zernike Au.

If you are making a portrait and move somewhat while the image is being made, a bright background shows up through you as in *Portrait à la case* (Figure 5.22) from Mopti, Mali. From 1996 to 2000 a project group named *Oscura*, composed of French and Spanish persons whose knowledge covered many disciplines, traveled to Mali to the areas of Kayes, Mopti, and Bamako. There they gave workshops in pinhole photography to the youth of the areas, most of who lived in great difficulty. Photography became an intrinsic part of many young lives. Later in 2001, photographs from the project were assembled into the beautiful and profoundly touching book *Mali Photos: Sténopés d' Afrique* (Figure 5.23). Some of the *Oscura* trainers were Jean-Christophe Bardot, Richard Danquigny, Pascal Ferrer, Jean-Michel Galley, Elisabeth Towns, and Frédéric Vidal.

Of the pinhole camera, *Obscura* stated:

> The pinhole camera is a learning device. Far from snapshots, far from photos taken on the run, it teaches us to make time more familiar; it teaches us patience.[1]

FIGURE 5.19
© Nancy Spencer and Rebecca Wackler, *Oh My*, series *Flight*, 8 × 10-inch hand-colored pinhole photograph, 1986. Note that the oatmeal-box camera has been angled slightly downward (not perpendicular to the ground), which creates an exaggerated curved-earth effect. From the collection of the photographers.

FIGURE 5.20
© Donna Fay Allen, *Inside Passage Alaska Cruise,* 5¼ × 9½-inch pinhole photograph made with a Zero2000 6 × 6 pinhole camera, June 2002. From the collection of the photographer.

Motion can be used in many ways because pinhole images are generally connected to lengthy time exposures. Hand holding the camera was perfected by Michael Mideke in his ominous 2004 images of the Trinity Site, New Mexico—a remote place where the atomic bomb was first tested. Figures 5.24A and 5.24B were made with Fuji color print film in a 35-mm camera

FIGURE 5.21
© Zernike Au, zero image pinhole cameras. The popular Zero2000 120-roll film 6 × 6 camera has been available since 1999, shown far right third row. Included with it are the many finely crafted wooden pinhole cameras made by Zero Image and sold commercially, lens photograph, 2007.

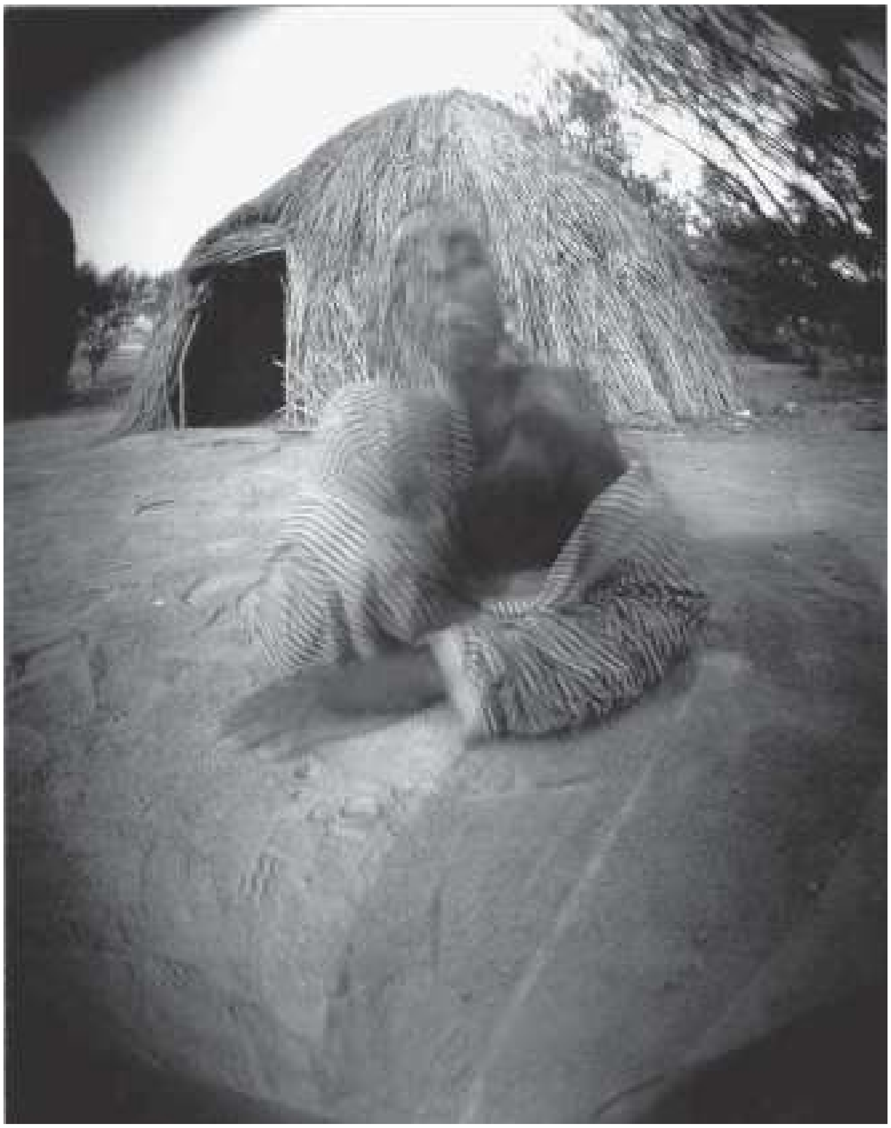


FIGURE 5.22
© *Atelier collectif de l'association Oscura*, Portrait à la case, Mopti, Mali, 1997. From the collection of *Atelier collectif de l'association Oscura.*

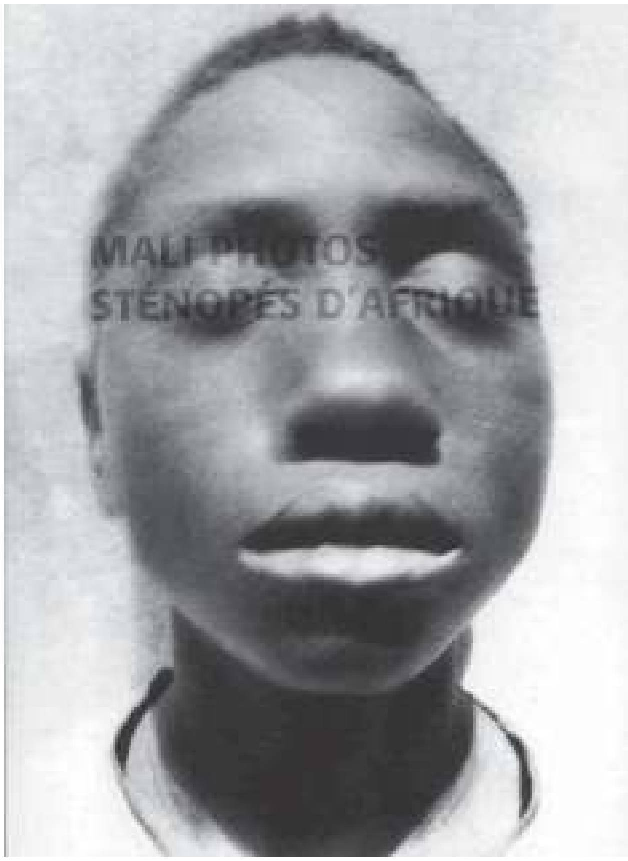


FIGURE 5.23
© *Atelier collectif de l'association Oscura*, cover, Mali photos: *Sténopés d'Afrique* (Paris: Atalante, 2001). From the collection of *Atelier collectif de l'association Oscura.*

with the lens removed and a pinhole body cap attached. (In 1945, the U.S. government was also there with a pinhole camera; Figure 1.35). Mideke explained:

> All exposures were hand-held, ranging from about 1/2 second to 15 seconds and more. . . . Quite soon I became enamored of intentional camera movements and the intriguing question of where to place a move within the exposure period. (If the exposure is long enough for reciprocity failure to become a factor, a move at the beginning of the exposure will have quite a different effect on the emulsion than the same move made at exposure's end.) . . . Underneath the clutter of subject matter, technique, and style, I kept rediscovering the question of just what it is in seeing that nourishes my heart. After nearly five decades of picture-making, of gazing into the world through all manner of cameras and with no camera at all, I still wonder what I have been looking for. What is the practice of seeing? How is it done and why? These are very large questions, wrapped in mystery and, I suspect, wrapped specially for each of us to find afresh from within our own solitude.[3]

Placing a body cap with a pinhole added into it onto any existing removable lens camera makes for an instant pinhole camera. The camera's built-in light meter will usually read the correct exposure time. The only drawback, if there is one, is that 35-mm cameras give a relatively small image.

Hand holding and using a double, triple, or quadruple exposure can make for an altered and new reality. When Nancy and I were traveling in Brittainy, I wanted to photograph the megaliths that dot the landscape, mostly in the coastal areas. The largest one still standing is 30 feet tall and every part of it is carved to a final smoothed surface! First I figured out what a correct exposure time would be for the Fuji NPS color film I was using. Then, when I arrived at a megalith, I would move around the tall standing stone and photograph it from several vantage points—all onto the same piece of 4 × 5 film. If I made four exposures I would attempt to have each one be about one-fourth the full exposure time. I felt that this was the

FIGURE 5.24A
© Michael Mideke, *Trinity Site 10,* 4 × 4-inch type C pinhole photograph, 2004. From the collection of the photographer.

FIGURE 5.24B
© Michael Mideke, *Trinity Site* 4, 4 × 4-inch type C pinhole photograph, 2004. From the collection of the photographer.

only way I could really photograph the feelings that I had about the stone and its connection to time—my time and its time. In some of the exposures, I was near the stone and other exposures farther away from it (Figure 5.25). The longer I look at that specific image the more the vanishing points and picture planes move. That is what I was after.

Using a tripod in *Birdman*, Edward Levinson from Japan made use of a white, horizontally railed fence to separate sky from ground. White birds sit on the silhouetted fence railing; they too are silhouetted against the gray sea while one bird flutters on top of the birdman's head (Figure 5.26A). White is rarely used as a silhouette but works well in this image because it is not as hard edged as a dark fence would have been. The longer the picture is viewed, the more restless it becomes, filled with fluttering birds. Levinson's images have been published in the monograph *Timescapes Japan: "A Pinhole Journey"* (Figure 5.26B).

Using a moving tripod, Joseph Jakusz placed a pinhole camera on top of a Union Pacific train cab (the moving train cab became the fixed tripod) to get the images in his series *Motion Blur* (Figures 5.27A and 5.27B).

Photographing the Miniature

Pinhole photography adapts well to photographing small objects, making them look lifelike or larger than they actually are (Figure 5.28A), as the pinhole has an infinite depth of field. To make this image, David Pugh of Delaware used his PinZip Instamatic cartridge camera (Figure 5.28B), which was available from 1985 to 1995.

A number of pinhole artists have created miniature landscapes and building complexes. Bethany de Forest of The Netherlands has worked in this reality/fantasy realm for many years. She builds elaborate structures (Figures 5.29A and 5.30) that are contemporary *tromp l'oeil*. Her cameras are quite basic. Figure 5.29B is her old Balda 120-roll film camera turned into a pinhole camera and used for *Canyon*. The image *Highway* was made with a Zero2000 Panorama camera.

FIGURE 5.25
© Eric Renner, *Megalith*, series *Vantage Points*, Brittainy. Two pinhole exposures, 2004.

Multiple Cameras

Because the simple cameras I have suggested make only one image at a time, you might consider carrying more than one camera. I've seen someone carry as many as 10 oatmeal boxes at a time, all in a basket and each marked as it was exposed! Thomas Mezzanotte uses 7 curved-back pinhole cameras at one time for figure studies that are an homage to Albrecht

FIGURE 5.26A
© Edward Levinson, *Bird Man*, Yokohama, Japan, 9 × 10-inch selenium-toned pinhole photograph, 2000. A 40-second exposure using a yellow filter. From the collection of the photographer.

FIGURE 5.26B
© Edward Levinson and Nippon Camera Publishing Company, *Timescapes Japan: A Pinhole Journey*, 2006.

FIGURE 5.27A
© Joseph Jakusz, *Tunnel 10,* from series *Motion Blur* (west of Caliente, NV), 5 × 8-inch type C pinhole photograph, Fujichrome 50, pinhole mounted in C3 Argus, shot from Union Pacific cab, 1991. From the collection of the photographer.

FIGURE 5.27B
© Joseph Jakusz, *Tunnel 7,* from series *Motion Blur* (approach to Stine, NV), 5 × 8-inch type C pinhole photograph, Fujichrome 50, pinhole mounted in C3 Argus, shot from Union Pacific cab, 1991. From the collection of the photographer.

FIGURE 5.28A
© David Pugh, *Pig on a Manhole Cover,* 6¼ × 8½-inch pinhole photograph, from a PinZip camera, 4-second exposure of a 3-inch high brass pig, 1982. The raised letters of the word "Salisbury" are about 1/8 inch high and the square bumps are about 1/4 inch high. From the collection at Pinhole Resource.

FIGURE 5.28B
© David Pugh, PinZip camera, Instamatic cartridge camera, designed by David Pugh, who used a 0.130-mm pinhole. The camera was held together with hot glue. Ten thousand were sold.

FIGURE 5.29A
© Bethany de Forest, *Canyon,* 125 × 125 cm, 2000. From the collection of the photographer.

FIGURE 5.29B
© Bethany de Forest, Balda adapted to pinhole camera. From the collection of the photographer.

Durer's *Dresden Sketchbooks* and Eadweard Muybridge's photographic motion studies. Of this project (Figures 5.31A and 5.31B) Mezzanotte said:

> I have fabricated a steel stand to hold seven pinhole cameras vertically at intervals of one foot. I shoot all seven images at the same time by removing a single cover. . . . All the images are shot in front of a 16 foot high set constructed to give scale and perspective to the figure. The entire series for each figure will include seven shots from 12, 24, and 48 inches for front, side and rear, a total of 63 images.[4]

FIGURE 5.30
© Bethany de Forest, *Highway*, 80 × 160 cm, 2000. From the collection of the photographer.

Popular Misconceptions

- *The smaller the pinhole, the sharper the image*. This seems to prevail among those who have used short focal-length pinhole cameras, that is, none over 75 mm (3 inches) in which a small hole still makes a somewhat sharp image. Beyond 75 mm it is readily apparent that the correctly sized hole should be slightly larger as focal length increases. An optimal pinhole chart is supplied in the next chapter.
- *A small pinhole will give a wide-angle image*. This seems to be a confusion held by those who have not experimented enough with different film sizes at the same focal length. Every pinhole does make a very wide-angle image. It's a matter of how much of the image is captured on the size of film you are using. For example, a 6-inch focal-length 4 × 5-inch pinhole camera gives a normal image, but a 16 × 20-inch piece of photographic paper in a 6-inch deep suitcase (with a pinhole on one side) gives a very wide-angle image of approximately 20 inches.
- *Laser-drilled pinholes are sharper than hand-made microdrilled pinholes*. Not necessarily. If the laser pinhole metal is not thinned near the pinhole, its thickness acts as a tunnel. For pinhole photography, microdrilled pinholes are less expensive and work well.
- *Only black and white photo materials can be used with pinhole, not color*. Just about every light-sensitive material works in a pinhole camera. The only emulsions that are almost impossible to use directly inside a pinhole camera are papers coated with nonsilver emulsions, such as cyanotype, Van Dyke, or platinum. You can image the sun with any of these papers because the sun is so much brighter than the landscape.
- *The first photographers used pinhole cameras*. As far as I am aware, the first cameras had simple lenses; for instance, Talbot's "mousetraps" used a single lens over a large hole. It wasn't until emulsions were fast enough that pinhole cameras became useful.
- *Pinhole images are romantic*. This seems to be a pigeonhole for the photo critic or photo historian; maybe this preconceived notion dates back to pictorialism.
- *The Internet has all the answers about pinhole photography*. Exposure charts and optimal pinhole sizes are not always correct on the Internet. Much information is copied and second hand, third hand. . . !

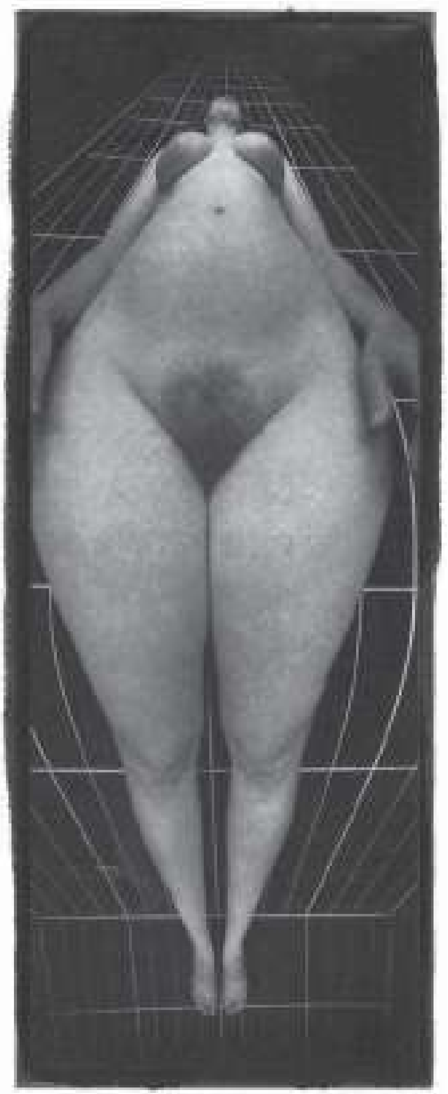


FIGURE 5.31A
© Thomas Mezzanotte, *Untitled,* 8 × 3-inch pinhole palladium photograph, 2005.

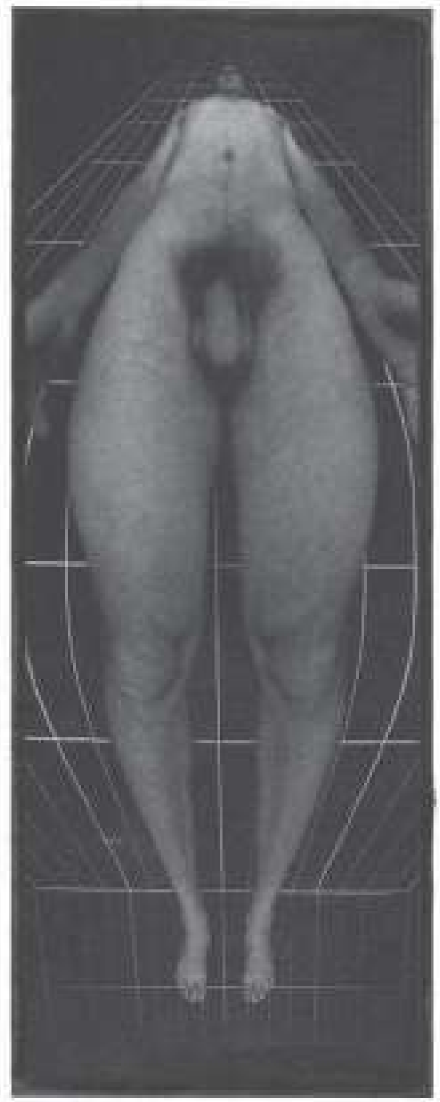


FIGURE 5.31B
© Thomas Mezzanotte, *Untitled,* 8 × 3-inch pinhole palladium photograph, 2005.

- *Low ISO film does not get destroyed by X-ray machines at the airport.* When you are traveling with film getting onto an airplane, have a changing bag ready for the security personnel to use. Don't send your film through the X-ray machine. This idea came from Gabriel Biderman. He explained his dilemma:

    I had about six boxes of 4 × 5 and about 20 rolls of 120 film to check and I had it nicely organized in a see-through ziplock bag. I asked to hand check it and the 120 was no problem but they wanted to open up the 4 × 5 boxes. I told them that they couldn't and shook the boxes and showed them some of the negatives, holders, cameras, etc. Finally, he called his supervisor in to talk to me. I did the same old song and dance but he repeated that he had to see what was inside those boxes. At that moment I remembered that I had at the last minute brought my changing bag on carry-on. I showed him how it worked and then put one of the boxes inside. His hand went in one end and mine in the other. In the darkness of the changing bag I led his hand over to the box, opened it, and looked him deep in the eye and said, 'You do know that this will be the topic of discussion over our

> dinners tonight!' He laughed and asked to see another. By the time we got to the third 4 × 5 box inside the changing bag (that's why we go to the airport so early) I looked him deeper in the eye and said, "You do realize that everyone is watching us!" He nervously chuckled and said that that was all he needed to check.[5]

I would guess that most airport TSA personnel would not let you put your hand into the changing bag with theirs (as of this writing), but you could attempt to tell them how to open and close the film boxes. Going digital removes this problem.

Worldwide Pinhole Photography Day

Gregg Kemp of Cary, North Carolina, described *Worldwide Pinhole Photography Day* history as:

> Worldwide Pinhole Photography Day is a one-day event that has been held on the last Sunday of April each year since 2001. The goal is to encourage people in all parts of the world to take a fresh look at the world around them, and capture a piece of it using a simple pinhole camera. Photos taken on Pinhole Day may be uploaded to the on-line gallery to further share the day's experience with others.
>
> The idea for Pinhole Day came from Zernike Au of Hong Kong, owner of the Zero Image Company and designer of the Zero Image pinhole cameras, in an e-mail he posted to the "pinhole discussion list" (http://spitbite.org/pinhole-discussion/).
>
> The first Worldwide Pinhole Photography Day was held on April 29, 2001. Each year, the pinhole day team provides free technical support and publicity for individuals and groups organizing workshops, lectures, and exhibitions of pinhole photography, as well as school classroom activities related to pinhole day. The Worldwide Pinhole Photography Day website http://www.pinholeday.org/ is freely available to all on the internet. It is funded solely by voluntary contributions. Team members likewise volunteer their time without compensation.
>
> The founding members of the Worldwide Pinhole Photography Day (2001) were: Gregg Kemp, (USA), Zernike Au (Hong Kong), Diana Bloomfield (USA), Jean Daubas (France), Larry Fratkin (USA), Guy Glorieux (Canada), James Kellar (USA), Edward Levinson (Japan), Pam Niedermayer (USA), Guillermo Peñate (El Salvador), George Smyth (USA).
>
> Dozens of volunteers have contributed to the translation of the website into 16 languages, and promoting the event in the media and through posters in local libraries and camera stores around the world.
>
> Number of people participating in pinhole day with their pinhole images posted to the Web site each year:
>
> - 2001: 291 participants from 24 countries
> - 2002: 903 participants from 35 countries
> - 2003: 1082 participants from 43 countries
> - 2004: 1512 participants from 43 countries
> - 2005: 1815 participants from 52 countries
> - 2006: 2267 participants from 60 countries
> - 2007: 2946 participants from 68 countries[6]

NOTES

1. Oscura, *Mali Photos: Sténopés d'Afrique* (Paris: Atalante, 2001) unpaginated. E-mail address is oscura@wanadoo.fr.
2. Eric Renner, *The Horsefetter* (Rochester, NY: Visual Studies Workshop, 1986).
3. Michael Mideke, *Pinhole Journal* Vol. 19 #2 (2003): 19.
4. Thomas Mezzanotte, *Pinhole Journal* 22 #3 (2006): 9.
5. Gabriel Biderman, personal communication to the author, November 13, 2003.
6. Gregg Kemp, personal communication to the author, September 3, 2007.

CHAPTER 6

The Advanced How-To of Pinhole Photography

Learning without thought is useless. Thought without learning is dangerous.

CONFUCIUS, 500 B.C.

Can scenarios of perception be created with the pinhole camera that were not anticipated by nature?

HANS KNUCHEL, *Camera Obscura*, 1992

OPTIMAL PINHOLE FORMULAS

Useful information:

- *Light intensity decreases the further it travels from the pinhole.* For instance, a 4-inch focal distance takes more time to expose than a 3-inch focal distance when the optimal pinhole is used.
- *As the focal distance increases, the optimal pinhole increases in diameter.* For every focal length, there is an optimal pinhole diameter. Robert Mikrut and Kenneth A. Connors developed a chart of focal distances and corresponding optimal pinholes (Figure 6.1A). Needle shaft diameters are shown in Figure 6.1B. An example of an optimally sharp pinhole image can be seen in Figure 1.34. If the pinhole is too large for the focal length, the image will be blurry. If the pinhole is very, very small, the image will also be faint and blurry because light cannot enter the pinhole properly without destroying itself.

The *Time-Rel. to f/64* column in the chart is useful if you have a light meter that only reads as high as *f*/64 and you are using an optimal pinhole of a specified focal length and known *f*/stop. You would set your meter to your film speed and read the exposure time for *f*/64 related to your optimal pinhole focal length and then multiply that time by the numbers on the chart's *Time-Rel. to f/64* column. For instance, if you had a focal length of 150 mm (6 inches) using an optimal pinhole of 0.4532 mm, you would read your light meter's exposure time for *f*/64 and multiply it by 5.91. That would be your exposure time for an *f*/stop of 331.

A formula can be derived for making pinholes of the correct size. Any number of slightly differing formulas have been calculated since Lord Rayleigh calculated his in the 1880s. The one shown here is by Bob Dome of Washington State. It is derived from Rayleigh's formula, as well as from Mikrut and Connors':

$$A = 55\,F$$

Pinholes 10 mm 0.037 used in function
Increment 10 mm

Focal Length(mm)	Pinhole Diam.(mm)	Pinhole Diam.(in)	f-stop	Time-Rel. to f/64	Focal Length(in)	Focal Length(ft)
10	0.1170	0.0046	85	1.0	0.39	0.03
20	0.1655	0.0065	121	3.6	0.79	0.07
30	0.2027	0.0080	148	5.3	1.18	0.10
40	0.2340	0.0092	171	7.1	1.57	0.13
50	0.2616	0.0103	191	8.9	1.97	0.16
60	0.2866	0.0113	209	10.7	2.36	0.20
70	0.3096	0.0122	226	12.5	2.76	0.23
80	0.3309	0.0130	242	14.3	3.15	0.26
90	0.3510	0.0138	256	16.0	3.54	0.30
100	0.3700	0.0146	270	17.8	3.94	0.33
110	0.3881	0.0153	283	19.6	4.33	0.36
120	0.4053	0.0160	296	21.4	4.72	0.39
130	0.4218	0.0166	308	23.2	5.12	0.43
140	0.4378	0.0172	320	25.0	5.51	0.46
150	0.4532	0.0178	331	26.7	5.91	0.49
160	0.4680	0.0184	342	28.6	6.30	0.52
170	0.4824	0.0190	352	30.3	6.69	0.56
180	0.4964	0.0195	363	32.2	7.09	0.59
190	0.5100	0.0201	373	34.0	7.48	0.62
200	0.5233	0.0206	382	35.6	7.87	0.66
210	0.5362	0.0211	392	37.5	8.27	0.69
220	0.5488	0.0216	401	39.3	8.66	0.72
230	0.5611	0.0221	410	41.0	9.06	0.75
240	0.5732	0.0226	419	42.9	9.45	0.79
250	0.5850	0.0230	427	44.5	9.84	0.82
260	0.5966	0.0235	436	46.4	10.24	0.85
270	0.6080	0.0239	444	48.1	10.63	0.89
280	0.6191	0.0244	452	49.9	11.02	0.92
290	0.6301	0.0248	460	51.7	11.42	0.95
300	0.6409	0.0252	468	53.5	11.81	0.98
310	0.6515	0.0256	476	55.3	12.20	1.02
320	0.6619	0.0261	483	57.0	12.60	1.05
330	0.6721	0.0265	491	58.9	12.99	1.08
340	0.6822	0.0269	498	60.5	13.39	1.12
350	0.6922	0.0273	506	62.5	13.78	1.15
360	0.7020	0.0276	513	64.3	14.17	1.18
370	0.7117	0.0280	520	66.0	14.57	1.21
380	0.7213	0.0284	527	67.8	14.96	1.25
390	0.7307	0.0288	534	69.6	15.35	1.28
400	0.7400	0.0291	541	71.5	15.75	1.31
410	0.7492	0.0295	547	73.0	16.14	1.35
420	0.7583	0.0299	554	74.9	16.54	1.38
430	0.7672	0.0302	560	76.6	16.93	1.41
440	0.7761	0.0306	567	78.5	17.32	1.44
450	0.7849	0.0309	573	80.2	17.72	1.48
460	0.7936	0.0312	580	82.1	18.11	1.51
470	0.8022	0.0316	586	83.8	18.50	1.54
480	0.8106	0.0319	592	85.6	18.90	1.57
490	0.8190	0.0322	598	87.3	19.29	1.61
500	0.8273	0.0326	604	89.1	19.69	1.64
510	0.8356	0.0329	610	90.8	20.08	1.67
520	0.8437	0.0332	616	92.6	20.47	1.71
530	0.8518	0.0335	622	94.5	20.87	1.74
540	0.8598	0.0339	628	96.3	21.26	1.77
550	0.8677	0.0342	634	98.1	21.65	1.80
560	0.8756	0.0345	640	100.0	22.05	1.84
570	0.8834	0.0348	645	101.4	22.44	1.87
580	0.8911	0.0351	651	103.5	22.83	1.90
590	0.8987	0.0354	656	105.1	23.23	1.94
600	0.9063	0.0357	662	107.0	23.62	1.97
610	0.9138	0.0360	668	108.9	24.02	2.00
620	0.9213	0.0363	673	110.6	24.41	2.03
630	0.9287	0.0366	678	112.2	24.80	2.07
640	0.9360	0.0369	684	114.2	25.20	2.10
650	0.9433	0.0371	689	115.9	25.59	2.13
660	0.9505	0.0374	695	117.9	25.98	2.17
670	0.9577	0.0377	700	119.6	26.38	2.20
680	0.9648	0.0380	705	121.3	26.77	2.23
690	0.9719	0.0383	710	123.1	27.17	2.26
700	0.9789	0.0385	715	124.8	27.56	2.30
710	0.9859	0.0388	720	126.6	27.95	2.33
720	0.9928	0.0391	725	128.3	28.35	2.36
730	0.9997	0.0394	730	130.1	28.74	2.40
740	1.0065	0.0396	735	131.9	29.13	2.43
750	1.0133	0.0399	740	133.7	29.53	2.46
760	1.0200	0.0402	745	135.5	29.92	2.49
770	1.0267	0.0404	750	137.3	30.31	2.53
780	1.0334	0.0407	755	139.2	30.71	2.56
790	1.0400	0.0409	760	141.0	31.10	2.59
800	1.0465	0.0412	764	142.5	31.50	2.62
810	1.0530	0.0415	769	144.4	31.89	2.66
820	1.0595	0.0417	774	146.3	32.28	2.69
830	1.0660	0.0420	779	148.2	32.68	2.72
840	1.0724	0.0422	783	149.7	33.07	2.76
850	1.0787	0.0425	788	151.6	33.46	2.79
860	1.0851	0.0427	793	153.5	33.86	2.82
870	1.0913	0.0430	797	155.1	34.25	2.85
880	1.0976	0.0432	802	157.0	34.65	2.89
890	1.1038	0.0435	806	158.6	35.04	2.92
900	1.1100	0.0437	811	160.6	35.43	2.95
910	1.1161	0.0439	815	162.2	35.83	2.99
920	1.1223	0.0442	820	164.2	36.22	3.02
930	1.1283	0.0444	824	165.8	36.61	3.05
940	1.1344	0.0447	829	167.8	37.01	3.08
950	1.1404	0.0449	833	169.4	37.40	3.12
960	1.1464	0.0451	837	171.0	37.80	3.15
970	1.1524	0.0454	842	173.1	38.19	3.18
980	1.1583	0.0456	846	174.7	38.58	3.22
990	1.1642	0.0458	850	176.4	38.98	3.25
1000	1.1700	0.0461	855	178.5	39.37	3.28

FIGURE 6.1A

where *A* equals the aperture diameter in thousandths of an inch and *F* equals the focal length in inches. An example: You're converting an old box camera and want to use a focal length of 4 inches. The square root of 220 (55 × 4) is 14.8, so the optimal size pinhole diameter is 14.8 thousandths of an inch or 0.0148 inches.

For the curious, here is the evolution of the aperture diameter formula just presented. Most formulas I've seen for determining an optimum size pinhole are of the following general form:

$$R = WCF$$

where *R* is radius of the aperture, *W* is wavelength of light, *C* is a constant factor, usually a decimal fraction between –12 and 1, and *F* is focal length.

To be useful, the formula just given relies on one's choice of wavelength (ranging from about 15 to 30 millionths of an inch) and one's choice of the constant factor. After studying the work of many researchers, especially Ken Connors, I decided upon a wavelength as multiplied by a chosen constant to arrive at the following:

$$R = 0.00001375F$$

where *R* is radius of the aperture in inches and *F* is focal length in inches. Because most pinhole experimenters want to know the diameter of the aperture, not the radius, I rewrote the formula again:

$$R = (0.00001375)\,(4)\,F$$

and then, of course:

$$A = 0.000055F$$

where *A* is aperture diameter in inches.

It now remained to do something about all those zeroes because they can cause entry, processing, and data retrieval problems on some handheld calculators. So

$$A = 55F$$

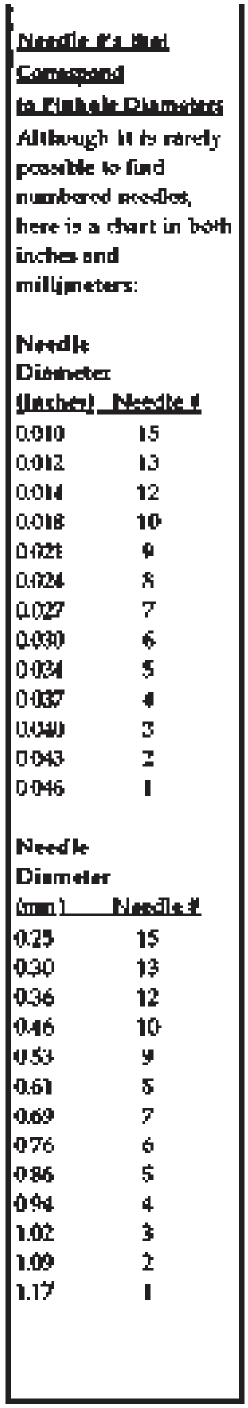
where *A* is aperture diameter in thousandths of an inch and, as before, *F* is focal length in inches.[1]

In the last 140 years of years of pinhole photography, at least 50 charts suggesting pinhole diameters have been devised. One of the most curious formulas came from M. Jules Combe in France in 1899, whose pinhole photographs were very sharp. Combe's formula is as follows: multiply the diameter of the hole in thousandths of an inch by itself, then by 4, and divide the result by 127. This gives the camera extension in inches. Example: I will take the case of the hole made by a No. 10 needle, which has a diameter of eighteen-thousandths of an inch.

$$18 \times 18 \times 4 = 1296$$

$$1296/127 = 10.20$$

The distance is therefore 10.20 inches.[2]



Needle #'s that Correspond to Pinhole Diameters

Although it is rarely possible to find numbered needles, here is a chart in both inches and millimeters:

Needle Diameter (Inches)	Needle #
0.010	15
0.012	13
0.014	12
0.018	10
0.021	9
0.024	8
0.027	7
0.030	6
0.034	5
0.037	4
0.040	3
0.043	2
0.046	1

Needle Diameter (mm)	Needle #
0.25	15
0.30	13
0.36	12
0.46	10
0.53	9
0.61	8
0.69	7
0.76	6
0.86	5
0.94	4
1.02	3
1.09	2
1.17	1

FIGURE 6.1B
Needle shaft diameters.

Another way to sharpen the image is to use Photoshop. Go to *Filter* in the top menu bar and scroll down to *Sharpen*. Information on this came from John Kimmich Javier, whose image is Figure 6.2. He said:

> As far as how I make the images so sharp. It is really quite simple. I use Polaroid 55N film and in Photoshop I use it twice (or three times as much sharpening as I would normally use. In other words I over-sharpen the images). It also requires a good scanner.[3]

FIGURE 6.2
© John Kimmich Javier, *Stenar in Wheat Field* Skane, Sweden, 15.8 × 20.8-inch pinhole photograph made with Polaroid 55N film printed on Epson enhanced matte paper with ultrachrome ink.

Finding the *f*/stop

When you need to calculate the *f*/stop of your pinhole, simply divide your focal length by the pinhole diameter.

METHODS USED FOR MEASURING THE PINHOLE

If you want to measure the diameter of your pinhole, then using a small hand *comparator,* with millimeters or parts-of-an-inch *reticle,* is a quite easy and quick method. These are available from Edmund Scientific.

A less expensive method is Tom Fuller's *homemade comparator* (Figure 6.3). Fuller explained:

> The pinhole plate to be measured is placed on a light box, a thin steel rule is laid over it, and an 8x loupe is set on top. Pieces of thin cardboard are used to shim the stack so that the transparent base of the magnifier rests evenly. I move the pinhole so that it can be seen through the exact center of the lens, then jog the rule slightly so that one of its graduation marks meets the left edge of the hole. I then read the diameter by merely counting the number of rule marks. Hardly a patentable idea, but it works. The drawback is that the thickness of the rule introduces some error, making the hole appear smaller than it really is, but you can learn to estimate this difference. Examine a hole of known size to see what it measures on your rule.
>
> The photograph shows a hole that is about 1.5 mm in diameter. If you use this technique, buy a rule with the finest possible graduations for best accuracy. This utility rule is graduated in full millimeters along one edge, with 1/64 inch markings along the other. Edmund Scientific #C35,321 Optician's Rule has a metric scale graduated in 1/2 mm increments, and an English scale marked to 1/100 inch.[4]

FIGURE 6.3A
© Tom Fuller, home-made comparator, lens photograph, 1991. From the collection of the photographer.

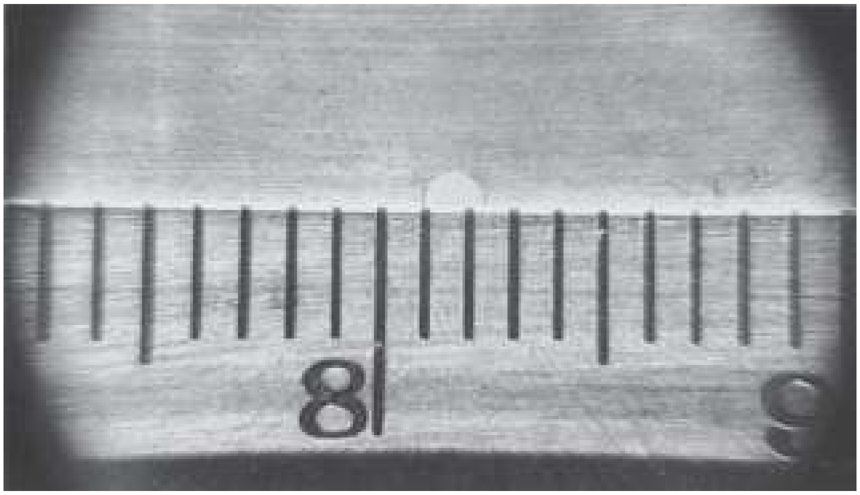


FIGURE 6.3B
© Tom Fuller, view of pinhole through comparator, lens photograph, 1991. From the collection of the photographer.

Another method for measuring the diameter of a pinhole was devised by Jay Bender of Washington State, using a traditional darkroom enlarger. Bender wrote:

> Since most of us do not have access to 100× microscopes, and since many of us do have enlargers, a method has been devised to use the enlarger to measure pinholes. At the bottom of this page are two scales and calibration lines [Figure 6.4]. Make a Xerox copy and place Scale #1's calibration line in a negative carrier in your enlarger as you would a negative. Place Scale #1 on the baseboard and project the image of the calibration line down onto the scale. By moving the enlarger head up, or down, and refocusing, make the line 5.0 mm long according to the scale. Once the calibration line is 5.0 mm long, when sharply focused, your enlarger is calibrated and the scale is accurate.
>
> If you find that you cannot get the line to 5.0 mm long, even with your enlarger all the way up, switch to a shorter focal length enlarging lens or use Scale #2 and calibration line.
>
> Now place your pinhole in the negative carrier (tape or some support may be needed to suspend it there) and project the tiny round spot onto the scale. Focus it carefully and measure it on the scale. Simple! Obviously, the smaller the pinhole, the less accurate your measurement will be.
>
> Put a grain focuser at the baseboard and line up the image of the pinhole in it. *Voila!* You have a 100× (or thereabouts) microscope! You can see if your pinhole is clean, round, and free from burrs.[5]

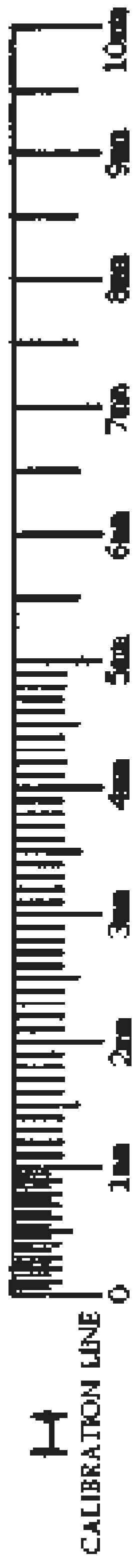


FIGURE 6.4A
© Jay Bender, scale #1 for measuring pinholes, 1990. From the collection of the photographer.

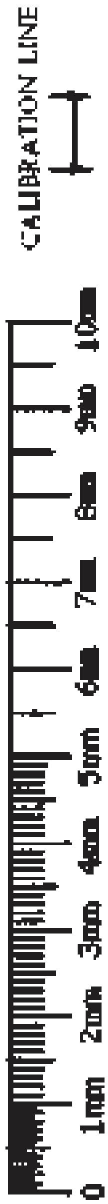


FIGURE 6.4B
© Jay Bender, scale #2 for measuring pinholes, 1990. From the collection of the photographer.

Measuring a pinhole can also be accomplished using a scanner. This information came from Marcus Kazmierczak at mkaz.com:

> I used my flatbed scanner to measure the pinhole. I did this by putting the brass shim with the hole on the scanner and scanning at 1200dpi. I then loaded the scan file in Photoshop and zoomed real tight on the hole. Using the marquee tool, I made a box across the width of the hole. Be sure to measure the hole and not the reflection next to it. I found the easiest way to get a measurement is to do a copy and then paste the selected part into a new image. Photoshop will keep the same dimensions and dpi of the copied part for the new image. You can then get the width of that image from the Image Size tool, change units to mm.[6]

ADDITIONAL INFORMATION ABOUT THE PINHOLE

To cut down on diffraction, a pinhole should be as *clean edged* as possible. It does not necessarily have to be round, as a square pinhole will work equally well as an oblong pinhole. *The thinner the metal is at the edge of the pinhole the less diffraction*. Because a laser-drilled pinhole leaves a tunnel unless the material is thinned, sand the pinhole area with 600 grit emery paper if you want a more optimal pinhole. For photographic uses, microdrilled pinholes are equally sharp compared to laser pinholes. Laser pinholes are better if the material is thinned by the pinhole, unless it is already very thin.

After saying all this, optimal sharpness is seldom the first requirement for most pinhole artists, as most pinhole images are made with considerably less definition than an optimal pinhole would achieve. Some pinhole artists choose to make an oversized or irregularly shaped pinhole in various materials such as aluminum foil, which is generally difficult to use for optimal pinholes. Thomas Bachler of Germany used a swastika-shaped pinhole for his series *German Cars* (Figure 6.5). Of this new work still in progress, Bachler explains:

> Hard to describe, why I designed this camera, of course, it has to do with the German history and the fact, that we (the Germans) can never get rid of that. It's the point of view, people have: you still can see a lot of things, having to do with the Nazi era but on the other side, the society, the type of state, the laws, etc changed completely. Some want to hide their history (like the big car companies, they were all deeply involved in the war, the forced labour system. . .) other people try to find proofs, that the Nazi idea still exisits, they want to find something bad here. My work deals about the perception people have, looking around today and, at the same time, having old, historical pictures in their mind.[7]

BUILDING PLANS FOR A 4 × 5-INCH SUPERWIDE PINHOLE CAMERA

It's easy to make pinhole cameras that hold single sheets of photographic paper or single pieces of film, but not nearly as easy to make pinhole cameras that accept 4 × 5-inch commercial film holders and Polaroid backs. Standard double-sided film holders allow photographers twice as many images as they have film holders. It's useful to place each film

FIGURE 6.5A
© Thomas Bachler, swastika-shaped pinhole, series *German Cars*, lens image, 2007.

FIGURE 6.5B
© Thomas Bachler, *Untitled,* series *German Cars*, swastika-shaped pinhole onto 6 × 9 color negative roll film, prints 40 × 60 cm and various sizes, 2007.

holder into a zip-lock bag if dust is a problem. Figure 6.6 shows how to make a 4 × 5-inch superwide pinhole camera that is very similar to the superwide *Leonardo* camera sold by Pinhole Resource. Usually it is ***not*** advisable to buy used film holders unless you are aware of their weak points. The angles of view on various sizes of 4 × 5-inch pinhole cameras are as follows:

- 1½-inch (38 mm) focal length 4 × 5 inch (superwide) = about 112°
- 3-inch (75 mm) focal length 4 × 5 inch (wide) = about 78°
- 6-inch (150 mm) focal length 4 × 5 inch (normal) = about 45°

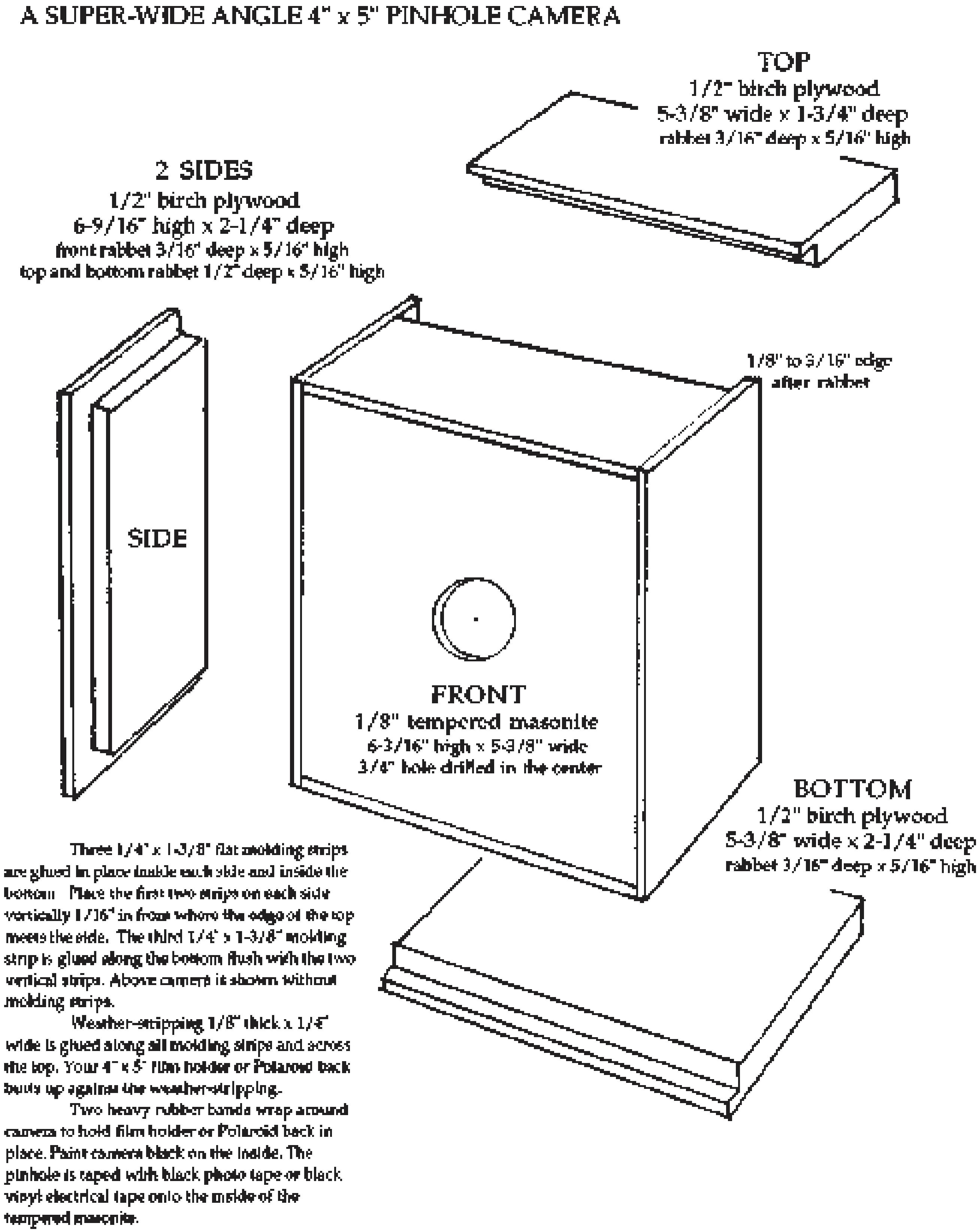


FIGURE 6.6

Superwide pinhole camera, 4 × 5 inch, 1998, designed by the author. This camera can be made easily if you have access to a bench saw. Materials needed are 1/2-inch Baltic birch plywood (preferred; usually available at places like Home Depot), 1/8-inch tempered Masonite, a 1/4 × 1-3/8-inch wood molding strip, a 1/8-inch thick × 1/4-inch wide piece of foam weather stripping, and wood glue (like Elmer's Woodworkers).

A Polaroid 545 or 545i back also fits this fixed focal length design. For pinhole photography, 4 × 5 inches is a useful size. It's not difficult to enlarge 4 × 5-inch film to large prints (24 × 30 inches; if you have an optimal pinhole) and still retain relative sharpness. Used Omega D2V enlargers are available at reasonable prices. Exposure time for this 1½-inch camera using ISO 400 speed Tri-X film in bright sun is 2 to 3 seconds.

Many pinhole camera designs can be configured and there are few limitations. Much credit is due the visual perception theorist Hans Knuchel of Switzerland, whose beautifully illustrated book *Camera Obscura* (Baden, Switzerland: Lars Müller Publishers, 1992) influenced many in the 1990s to attempt pinhole or slit photography. His very ingenious repertoire of pinhole and slit camera designs (Figure 6.7A) and his adept line drawings (Figure 6.7B) simplified the procedure of visualizing what a pinhole or slit camera could do from the most basic to complex. Knuchel's image from the diagonal slit camera demonstrated how the angled bicyclist (Figure 6.7C) naturally flowed from the angled slit on the front of his camera.

Making a Pinhole Turret

Using a pinhole turret is one of the best ways to produce a set of images showing varying degrees of definition, from blurry to sharp (Figures 6.8A–6.8H). Jim Moninger of New York

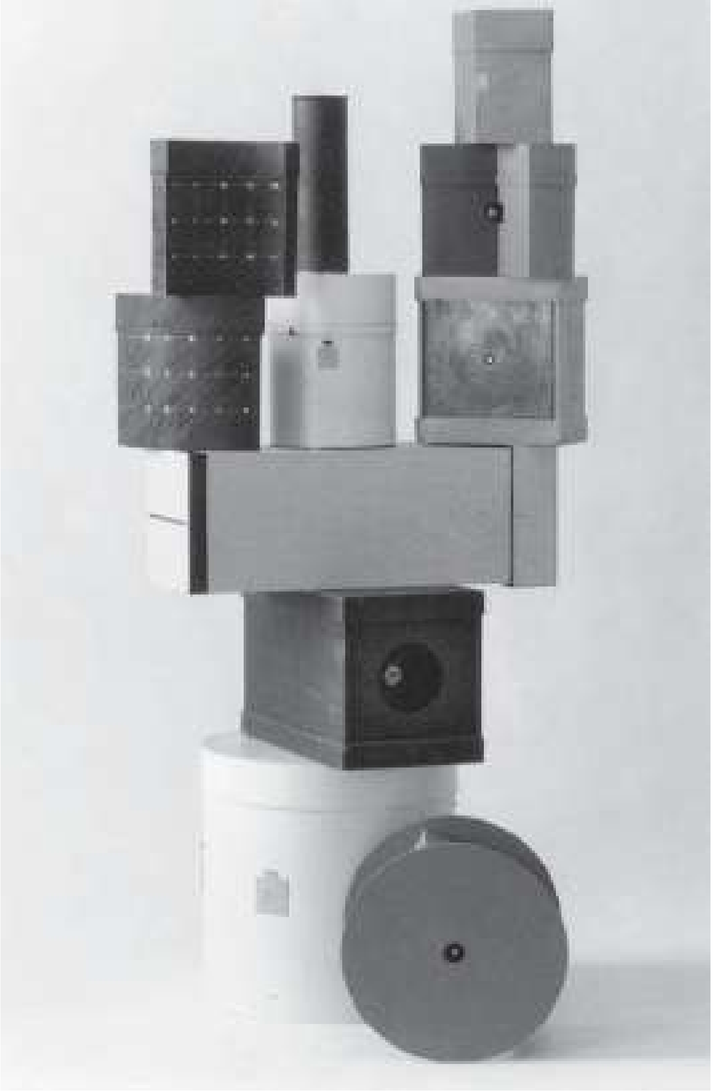


FIGURE 6.7A
© Hans Knuchel, pinhole and slit cameras, lens photograph from *Camera Obscura* (Baden, Switzerland: Lars Müller Publishers, 1992). From the collection of the photographer.

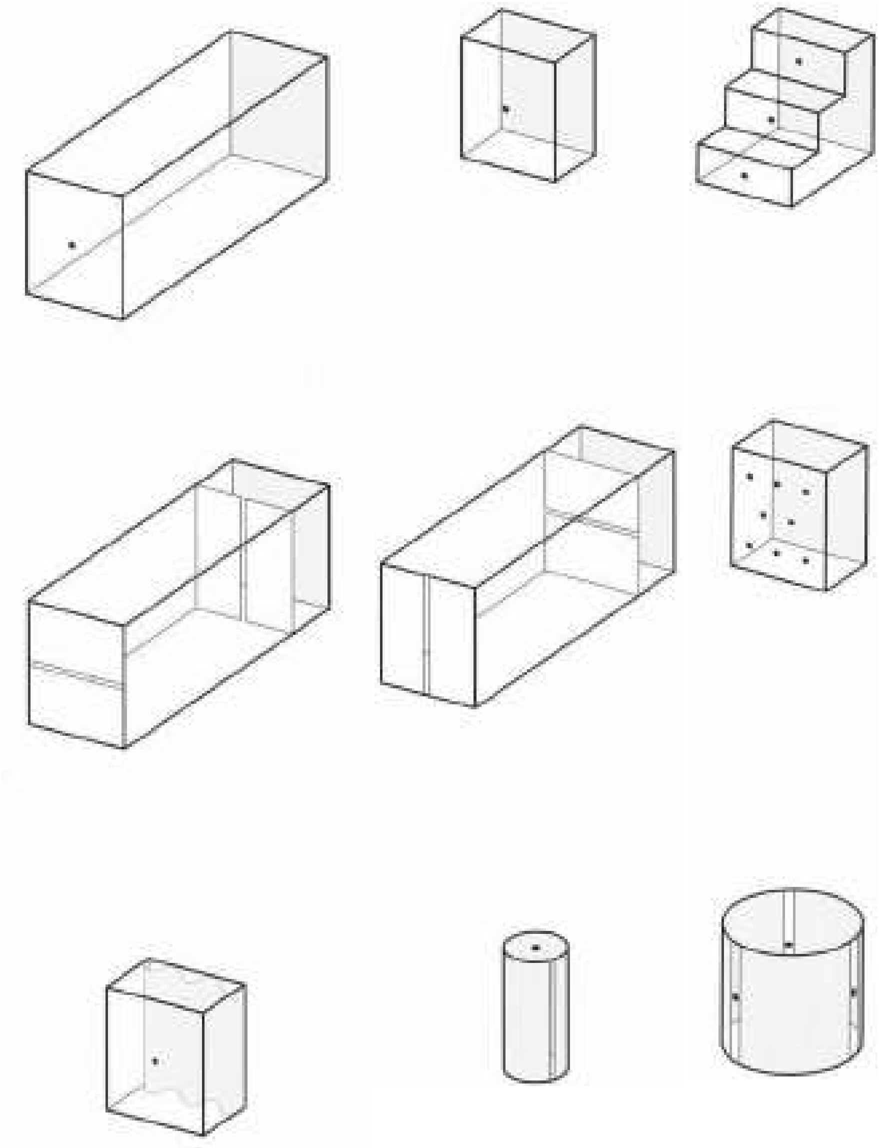
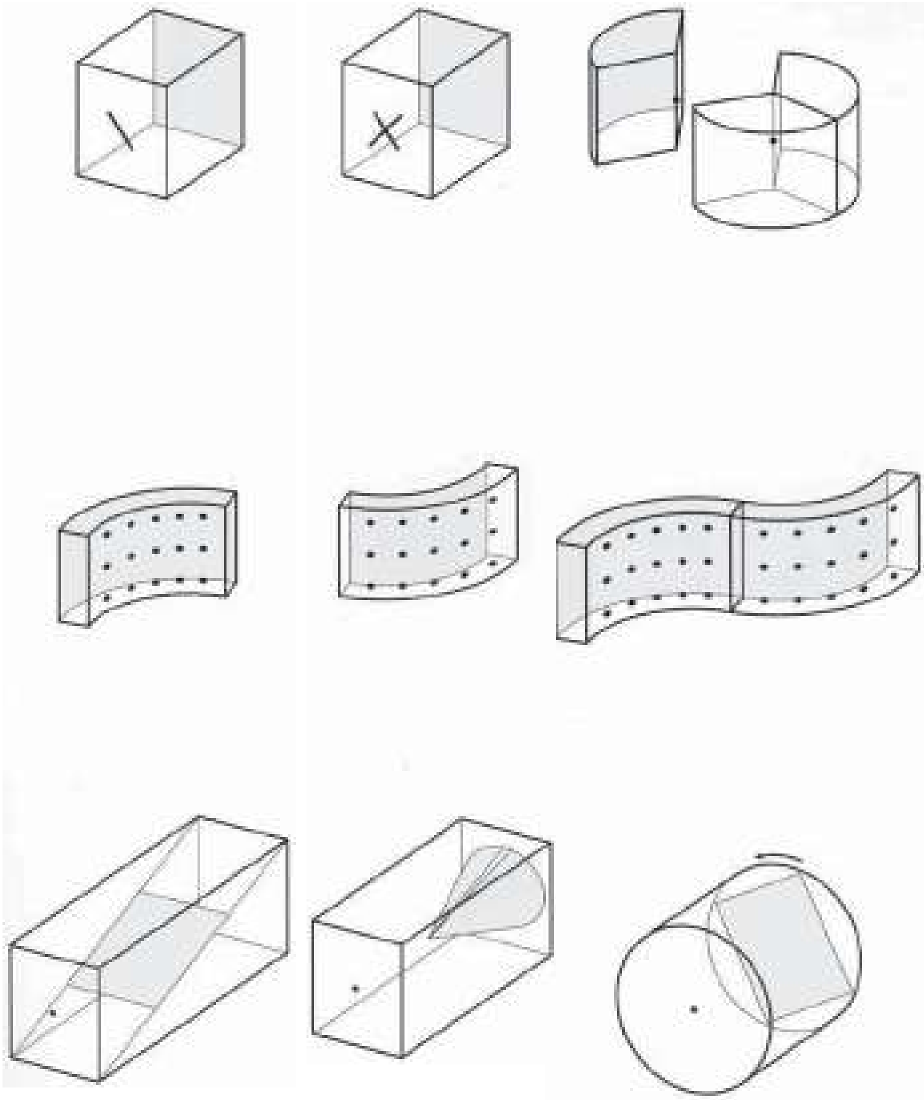


FIGURE 6.7B
© Hans Knuchel, line drawings of pinhole and slit cameras, from *Camera Obscura* (Baden, Switzerland: Lars Müller Publishers, 1992). From the collection of the photographer.

has made several turret designs (Figures 6.9A and 6.9B) and explained his procedure:

> To make it I drew two circles on a sheet of .002 inch brass: one to mark the diameter of the disc and another inside to mark the circle on which to drill the pinholes. I then divided the disc so that eight evenly spaced pinholes could be drilled at marked locations. After selecting the sizes of the pinholes desired, I carefully drilled them. Next I drilled a plastic disc with eight holes which would line up with the pinholes. This was stuck to the brass disc with rubber cement. This plastic disc serves as a retainer to keep the brass disc flat and to provide a "dial" to change apertures. A lens board was drilled in the center for the light path of the pinholes. Another hole was drilled off center to secure the disc at its center. The holes are carefully placed so that the pinholes on the rotating disc will line up one at a time with the center hole on the lens board. In order to avoid light leaking between the disc and the lens board, I pressed discs of black self-stick flock paper (paper felt, available at art supply stores) to the back of the brass disc and to the face of the lens board. The turret was fastened to the lens board with a small machine screw. The threads on this had to be filed down just below the head so that they wouldn't chew up the center hole in the turret. The nut was tightened enough to allow free rotation of the disc while holding a tight connection with the lens board.



> Once adjusted, I permanently fixed its position with epoxy. For this project I was primarily interested in wide-angle work in the field so I planned to use the minimum bellows draw for most of the pictures shot with this pinhole turret. The fixed focal length enabled me to calculate specific *f*/stop values for the holes. I was also able to adjust the pinhole sizes so that they were close to one *f*/stop apart and could be easily used with a light meter and adjusted for various conditions of light intensity and the desired level of softness.[8]

The *Abelson Scope Works* six position *Abelson Pinhole, Zone Plate, Slit Turret* with integral shutter kit has been available commercially for several years. It was designed by Matt Abelson of Boston, Massachusetts. This turret allows the user to select from 10 pinholes, 2 slits, and 2 zone plates (Figure 6.10). It is designed to fit on a Copal-0 or Copal-1 lensboard and can be adapted to fit on other pinhole cameras. It is available from Pinhole Resource.

PINHOLE CAMERA GEOMETRIES

Depth of Field

- *A pinhole image has infinite depth of field*. Everything from the closest object to the most distant object is in the same relative focus. The only exception is 100 or more yards

FIGURE 6.7C
© Hans Knuchel, *Untitled,* slit image, from diagonal slit camera (fourth from left in top row of preceding figure), from *Camera Obscura* (Baden, Switzerland: Lars Müller Publishers, 1992). From the collection of the photographer.

away—these objects will be less sharp due to particles in the atmosphere. A beautiful example of depth of field is demonstrated by Mieko Tadokoro from Japan who photographed (Figure 6.10) on a clear day, yet image clarity did fade due to atmospheric particles in the distance. Because a pinhole has infinite depth of field, much can be made of the soft light when there is a mist or fog in the air—then everything in the image does not seem to be in the same focus (Figure 6.12). In this way the background becomes an even tone, obscuring unnecessary buildings, trees, or landscape. This effect can be used to simplify the image—by drawing attention to specific objects in the foreground. Because of the mist or fog, the viewer attempts to perceive the objects that are becoming obscured in the distance, thereby being drawn into the image. Figures 6.11 and 6.12 were both made in Paris.

Photographing onto a Flat Film Plane

- *A pinhole casts a usable circular image of approximately 125° onto a flat film plane*. The image fades from the center outward because the focal distance increases toward the edges, resulting in a decrease in light intensity (Figure 6.13). Most pinhole photographers choose to photograph with a superwide angle to capture most of the image, including its falloff toward the edge (Figure 3.5).

FIGURE 6.8

© Jim Moninger, *Postmodern Saint: Our Lady of the Immaculate Confection*, 1991. Various degrees of sharpness are shown. Focal length is 2¼ inches. Pinholes mounted in a Super Speed Graphic. From the collection of the photographer.

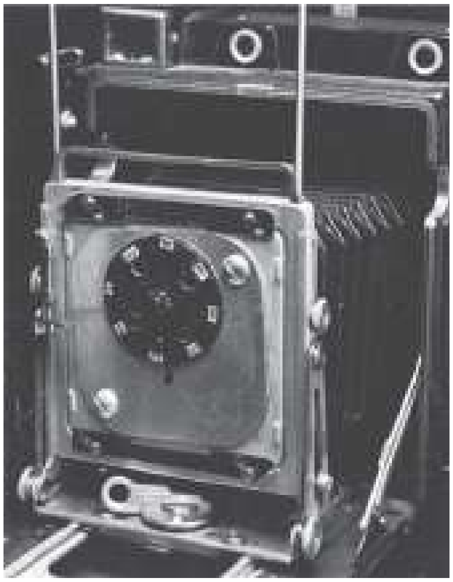


FIGURE 6.9A
© Jim Moninger, speed graphic with turret attached, lens photograph. From the collection of the photographer.

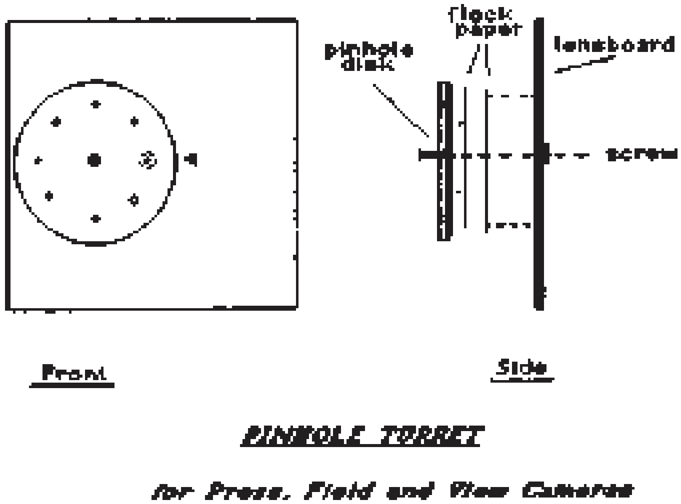


FIGURE 6.9B
© Jim Moninger, sketch of pinhole turret. From the collection of the photographer.

FIGURE 6.10
© Matt Abelson, Abelson Scope Works, Abelson pinhole, zone plate, and slit turret, lens photograph, 2007.

- Image size increases as the focal length increases. One example of how the image increases in size as the focal length increases can be seen in Figure 6.14 and made from commercial *Leonardo* 4 × 5-inch pinhole cameras with fixed focal lengths of 1½ inches (38 mm), 3 inches (75 mm), and 6 inches (150 mm). All three are shown in

FIGURE 6.11
© Mieko Tadokoro, *Another Point of View—Paris*, from the top of the Montmartre, 6¼ × 7¾-inch pinhole photograph. From the collection at Pinhole Resource.

Figure 6.15. All three cameras used 4 × 5-inch film holders. The 1½-inch focal length acts as a superwide angle. The 3-inch focal length acts as a wide angle. The 6-inch length is normal, which is equal to the angle that a person sees. Even though the pinhole image increases in size with distance, what is really happening in the 3- and 6-inch cameras is that most of the image falls outside the film holder. In other words, most of the image is past the film edge and, therefore, not recorded. If each camera were to take a considerably larger film size as focal length increased, all three images would appear superwide angle. Note the sighting lines drawn on the side and top of each camera. Visually extending these lines shows what is within the image.

For undistorted full-frame portraits, use a normal focal length pinhole camera. To know how to arrive at the focal length of a "normal" pinhole camera, you can simply use the age-old rule of diagonal measurement of the film size you intend to use. That measurement becomes the focal length for normal, as follows:

- For 4 × 5 inches, the diagonal measure is 6 inches.
- For 8 × 10 inches, the diagonal measure is 12½ inches.

FIGURE 6.12
© Ian Paterson, *Luxembourg Gardens*, 5¼ × 7¼-inch pinhole photograph, 1989. From the collection of the photographer.

FIGURE 6.13
Drawing illustrating how light intensity decreases as focal length increases (note that the rays of light going toward the edges of the film are decreasing in light intensity). Drawing by the author.

To make a true stereo 3-inch (75 mm) focal length 4 × 5-inch camera, the pinholes need to be 2½ inches apart and the center of the camera inside needs to be baffled so that two separate images are captured. When printing, the negative needs to be cut at the baffle edge and both images switched from left to right. That way a three-dimensional effect occurs when the print is viewed with a stereo viewer or your eyes, if you are able.

A pinhole tube camera can be made with an extremely long focal length to create a "telephoto" image, but it is only useful for imaging the sun, moon, or an eclipse. The landscape would cast an image through the optimal pinhole for that focal length, but because the diameter of the tube is so small, too much light bounces around inside, making the image grayed out. The camera body for a telephoto image would need to be large (a refrigerator box turned sideways—that becomes a room-sized *camera obscura*!). Jim Jones of Missouri photographed the sun during a solar eclipse (Figure 6.16A) with a 10-foot-long piece of plastic pipe (Figure 6.16B). Jones explained:

> The solar eclipse camera was made of a 3 inch plastic pipe with a pinhole and shutter at one end and an improvised springback for a 4 × 5 inch film holder at the other. In use, the camera is pointed at the sun so that the shadow of the front is centered on the back. A string attached to the shutter runs the length of the camera for convenient operation. A self-cocking shutter from old folding cameras usually has adequate speeds—of a second with a .070-inch pinhole worked on outdated Kodalith film developed in Dektol.[9]

- *The image circle is three to three-and-one-half times the focal length.* A 1-inch focal length (pinhole to film plane) produces an approximately 3½-inch-diameter circular image

FIGURE 6.14A
© Nancy Spencer, superwide image from *Leonardo* 1½-inch (38 mm) pinhole camera, 1998.

FIGURE 6.14B
© Nancy Spencer, Wide Image from *Leonardo* 3-inch (75 mm) pinhole camera, 1998.

FIGURE 6.14C
© Nancy Spencer, Normal Image from *Leonardo* 6-inch (150 mm) pinhole camera, 1998.

FIGURE 6.15A
© Pinhole Resource, 1½-inch (38 mm) superwide *Leonardo* pinhole camera.

FIGURE 6.15B
© Pinhole Resource, 3-inch (75 mm) wide *Leonardo* pinhole camera.

FIGURE 6.15C
© Pinhole Resource, 6-inch (150 mm) normal *Leonardo* pinhole camera.

FIGURE 6.16A
© Jim Jones, *Solar Eclipse, May 30, 1984*, 4¼ × 3¼-inch pinhole photograph. From the collection at Pinhole Resource.

FIGURE 6.16B
© Jim Jones, self-portrait holding the solar eclipse camera, 1984 lens photograph. From the collection at Pinhole Resource.

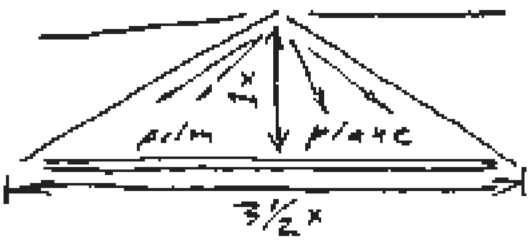


FIGURE 6.17
Drawing illustrating image diameter-to-focal length ratio. Image diameter is approximately three-and-one-half times the size of any given focal length. Drawing by the author.

(Figure 6.17). A 2-inch focal length produces an approximately 7-inch-diameter circular image. This ratio is valuable in making multiple-pinhole cameras, which may produce images that overlap slightly. The amount of overlap can vary according to each photographer's need (Figures 6.18 and 6.19). If the holes are placed too close, each image can destroy the one next to it.

- If the flat film plane is parallel to the subject being photographed, there is no linear distortion in a wide-angle image. The wide-angle image may look distorted at its edges because we are not accustomed to seeing as wide an angle as a pinhole can photograph. There is actually no linear distortion in Figure 6.20, an example of extreme foreshortening as the figure is placed angled toward the viewer. Human's eyes are physiologically designed to see the normal view, so naturally this looks somewhat odd. Photographers rarely arrange their subject to be angled toward the viewer, yet this adds drama. Jane Alden Steven's photograph is visually rare.

The normal view is particularly noticeable when pinhole artists take commercial lens cameras, which originally were designed to have a normal view, and turn them into pinhole cameras, as in Robert Oehl's Polaroid SX-70 series taken around New York City. In Figure 6.21, the camera's normal angle of view appears wider, giving the speeding marathoner a feeling of rolling right off the edge of the image. The dark and light areas are juxtaposed in the background to support this leaning composition from truly escaping, much like Vermeer's use of light and dark in the corners of certain of his paintings. The yellow-orange wheel in the center stabilizes the movement.

FIGURE 6.18
© Eric Renner, *Dale Gottlieb*, 10-inch diameter pinhole photograph from a 19-pinhole camera, 1972, 30-second exposure. From the collection of the photographer.

FIGURE 6.19
© Herbert Böttcher, *Vitra Design Fire Station*, 1999/01/04, 30 × 64-cm type C print Kodak Endura, Courtesy of in focus Fotografie, Cologne.

When Douglas Frank of Oregon turned to pinhole photography in the 1980s, he made ultra wide-angle pinhole landscapes on a flat film plane that employed a series of masks in the darkroom to either accentuate or deaccentuate the edges of the image (Figure 6.22). If wide-angle images are desired, you can photograph shaded areas so that they fall in the center of the image, while sunlit areas are on the edges. This increases the duration of the exposure and makes the image expose wider or you can use an expensive center neutral density filter. Another method is to dodge the center of a superwide angle image using a 50-cent-piece sized black circle of paper taped onto the end of a wire. This becomes your dodge tool. Hold it in front of the camera just far enough away so that the edges of the image are still being exposed. Keep it moving slightly for the duration of the exposure so that the dodge tool does

FIGURE 6.20
© Jane Alden Stevens, *Le Wettstein, French Military Cemetery*, France, from *Tears of Stone*, 4⅝ × 2⅛-inch negative, unsized pinhole photograph, 2001. From the collection at Pinhole Resource.

FIGURE 6.21
© Robert Oehl, *Wheelchair Marathoner*, NYC Marathon, 3½ × 3½-inch Polaroid SX-70 pinhole photograph, 1996. From the collection at Pinhole Resource.

not show up in the final image. This is a very useful device and can be made easily, sometimes on the spot. Even a black hat comes in handy for this sophisticated, yet simple, operation. Use your moving hand as a partial lens hood. Like all photography, pinhole requires a bag of tricks.

Photographing onto a Curved Film Plane

A curved film plane produces a distorted image. Why? Because the image has been captured on a curved surface possibly similar to the oatmeal box interior discussed in the last chapter. The image in Figure 5.14 looks distorted when it is viewed on a piece of photographic paper held flat. If viewed curved, as it had been photographed originally, it would not be distorted. To make it perfectly undistorted, one would have to use only one eye and view it at the original position of the pinhole while the paper is curled around as it had been inside the oatmeal box.

For his series *Without End*, Joakim Eneroth of Stockholm, Sweden, has created a simple curved back camera using 35-mm film that can produce an image with end views on the left and right sides that seem to go to infinity (Figure 6.23).

FIGURE 6.22
© Douglas Frank, *Untitled,* 11 × 14-inch platinum pinhole photograph, 1990. From the collection at Pinhole Resource.

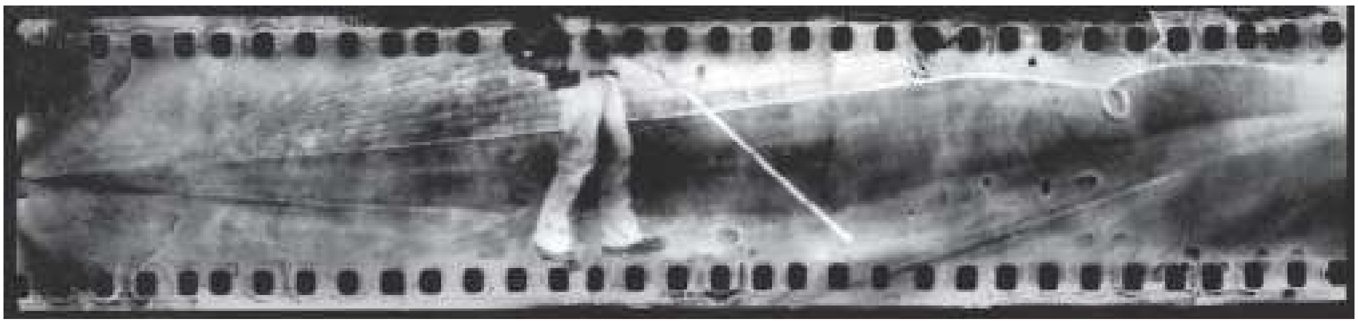


FIGURE 6.23
© Joakim Eneroth, *My Friend Stephen Svanholm,* series *Without End*, 1¾ × 8½-inch pinhole photograph, 2003. From the collection at Pinhole Resource.

Walter Crump of Boston used concave distortion in many of his images (Figure 6.24A). The viewer's eye is immediately drawn into the hazy vortex in the middle. The immense height of the bridge gives the viewer a feeling of being dwarfed by civilization. Safety seems to lie in the vortex or beyond. Crump's brightly colored pinhole camera is also shown (Figure 6.24B).

Cutting a cylinder in half and adding a flat front creates a pinhole camera with even exposure across the entire negative, as the focal length is constant (Figure 6.25A). However, because

FIGURE 6.24A
© Walter Crump, *Two Bridges,* series *Urban Artifacts,* 15½ × 19-inch unique bleached and toned pinhole photograph from a 16 × 20-inch paper negative, 1988. From the collection of the photographer.

FIGURE 6.24B
© Walter Crump, 16 × 20 pinhole camera, lens photograph, 2002. From the collection of the photographer.

FIGURE 6.25A
© Larry Bullis, double pinhole camera. Lens photograph using 35-mm pinhole image with 2475 recording film at *f*/125, 1/15 second in an industrial setting, 1976. From the collection of the photographer.

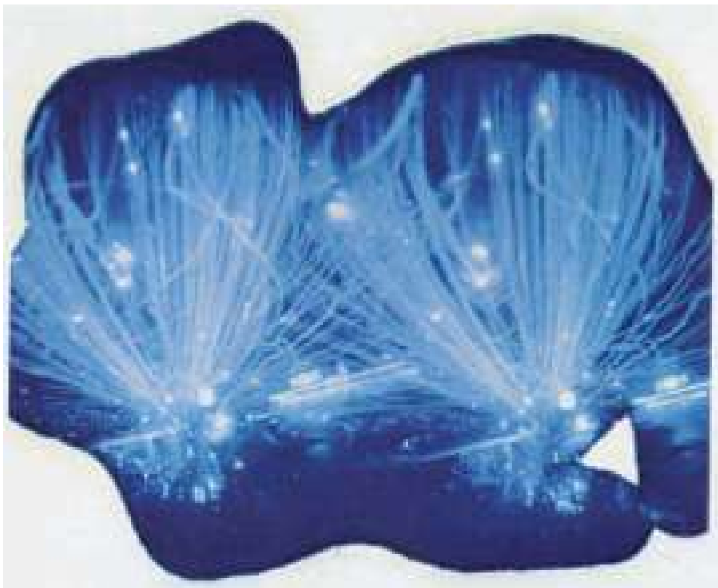


FIGURE 6.25B
© Larry Bullis, *Another Night Wasted at Seven-Eleven,* cyanotype from double pinhole camera, 1976. The image was made while driving around on a rainy night. The negative was 8 × 10-inch Ortho film developed in Windisch pyrocatechin. From the collection of the photographer.

this camera is curved, it produces a distorted image—one that covers about 160° when a very sharp pinhole in very thin material is used.

Photographing onto a convex surface makes the image fade quicker at the edge because light intensity decreases rapidly around the curve (Figure 6.26). This fading can be advantageous, particularly when multiple pinholes are used and photographic film or paper is wrapped around an inner cylinder. A camera can be devised with six pinholes with each hole casting a 60° image onto the cylinder. Each image is consecutively flipped so that the panorama is not continuous. This is similar to my first pinhole camera from 1968 (Figures 3.3A and 3.3B), which took several months to fully design. Each image fades proportionally into the one next to it so that the overall total image is an even double exposure (Figure 6.27). Where one image is coming in at 70% light intensity, the one overlapping it at that spot is coming in at 30%; 80 and 20%; 90 and 10%, and so on. More or fewer than six pinholes can also be used around an inner cylinder. When using six pinholes, each one capturing 60° of the image, a mathematical formula can be given for structuring any size camera: the focal distance equals the radius of the inner cylinder. Even though the six images times 60° add up to 360°, they do not make a complete panorama because the pinhole images are not being photographed from one central point (as if the central point were in the middle of a pie cut into six pieces).

An ingenious all-metal 5-inch-diameter 120 film version of my six pinhole camera is the *Hexomniscope* (Figure 6.28), designed, created, and beautifully crafted by Matt Abelson of *Abelson Scope Works*. It has six independently operated shutters. It is available from Pinhole Resource.

To create images that will reproduce a 180° panorama correctly, Craig J. Barber of Woodstock, New York, ingeniously used two flat film plane pinhole cameras that were angled away from one another. In the darkroom the developed images were printed flipped—this returned the panorama to how it was seen by the eye (Figure 6.29A). His work

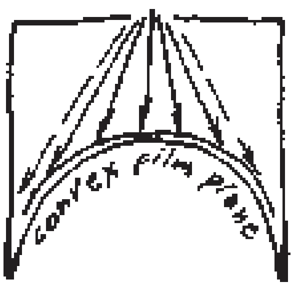


FIGURE 6.26
Drawing illustrating pinhole image going onto convex film plane. Drawing by the author.

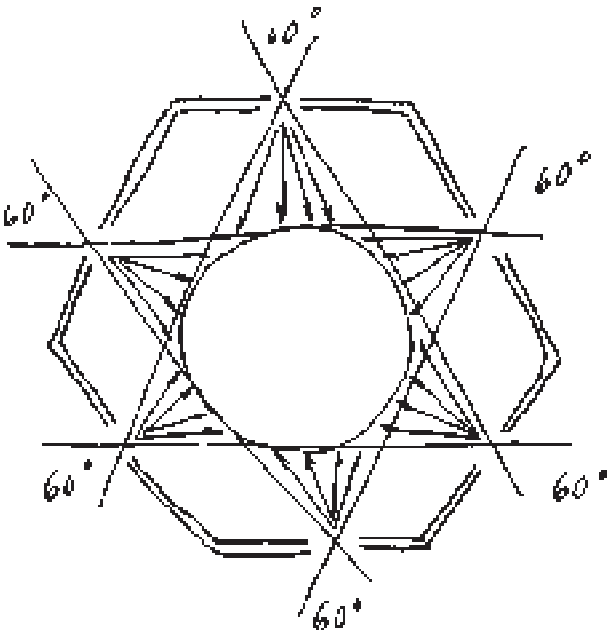


FIGURE 6.27
Drawing illustrating a six pinhole camera. Drawing by the author.

FIGURE 6.28
© Matt *Abelson, Abelson Scope Works, Hexomniscope*, designed by Matt Abelson, lens photograph, 2007.

FIGURE 6.29A
© Craig J. Barber, *Enwrapped Buddha,* series *SE Asia*, 8 × 20-inch platinum pinhole photograph, 2006. Collection of the photographer.

has been published in a monograph *Ghosts in the Landscape: Vietnam Revisited* (Figure 6.29B). Of his use of these cameras, Barber explained:

> I work with two 8 × 10 inch cardboard pinhole cameras which sit at a right angle to each other upon a small piece of plywood which is on top of a tripod. Each box covers a 90 degree field of view and the combination creates a 180 degree panoramic image. The two boxes are exposed simultaneously with the resulting negatives being printed simultaneously, too. While there are two boxes and two sheets of film, I consider the camera as a whole that just happens to have two halves. The same is true for the negative—it is one that comes as two.[10]

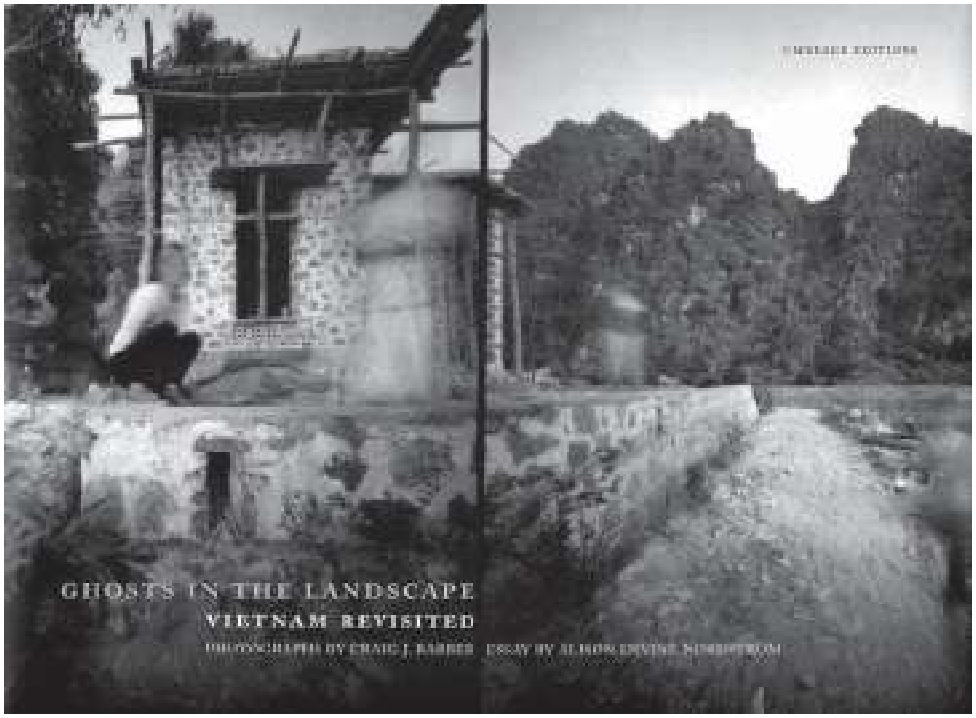


FIGURE 6.29B
© Craig Barber and Umbrage Editions, *Ghosts in the Landscape: Vietnam Revisited*, 2006.

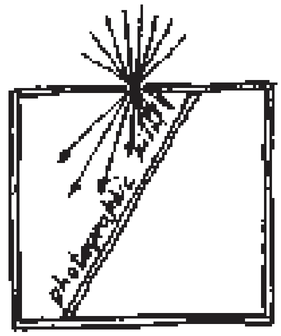


FIGURE 6.30
Drawing illustrating an anamorphic flat film plane on which photographic film or paper is severely angled away from the pinhole. Drawing by the author.

FIGURE 6.31
© Peggy Ann Jones, *Taos Pueblo Church,* from series *Preconceptions of Japan*, #1, 8 × 16-inch pinhole photograph, 1988.

Photographing onto an Angled Flat Film Plane

In anamorphic photography, the film plane is angled from the pinhole (Figure 6.30). (However, any film plane that is not perpendicular to the pinhole produces an anamorph—in other words, all of the angled image created inside an oatmeal box is also an anamorph.)

Bending photographic paper into a fan shape before photographing proved to be the perfect anamorphic answer for Peggy Ann Jones in Figure 6.31. The image was then flattened for printing.

FIGURE 6.32
© Eric Renner, *Stretching Marilyn,* 11 × 14-inch anamorphic pinhole photograph, 1996. From the collection of the photographer. The 11 × 14-inch Ilford HP-5 film was placed on the side of the camera with the pinhole in the front near the film edge. To see the original image of Marilyn, view the image from the extreme left edge with one eye. The original Marilyn Monroe photograph was placed approximately 2 inches from the pinhole with sunlight perpendicular to the camera lighting the image for a 1-minute exposure. The leading film edge was considerably overexposed while the distant film edge was underexposed. The challenge in this image was the placement of her stretched left eye as well as gaining a useful exposure. I had tried many kinds of film and paper before I found success with the Ilford HP-5.

FIGURE 6.33
© Matt Abelson, *Abelson Scope Works, Omniscope* anamorph camera, designed by Matt Abelson, 2000. The 120 roll film is rotated inside an inner cylinder for a 360° anamorph.

Images can be produced with the film plane angled radically—almost perpendicular to the pinhole. However, light falloff is severe. I was able to make an anamorph from a well-known image of Marilyn Monroe (Figure 6.32) using Ilford HP-5 and dodging and burning in the darkroom. The film angle was even more severe than shown in the drawing in Figure 6.30.

Anamorphic images with a radically angled film plane can be seen only in their original form with one eye placed where the pinhole would have been. Leonardo's drawing in Figure 2.11 is another example, as is the top stories of the Empire State Building on the bed sheet in Abelardo Morell's image in Figure 4.17. Working in anamorphs is an unexplored and rewarding area of pinhole photography.

The 120 *Omniscope* anamorph camera is the only commercially available pinhole camera that fully plays with one long anamorphic image projected onto an inner curved film plane inside a tube (Figure 6.33). A pinhole is centered at the end of the tube; 120 film wraps 360° around the inside of the tube so that the image is projected at an angle throughout the tube. Four 7-inch-long images can be cast onto one roll of 120 film. The all-metal *Omniscope* was designed by Matt Abelson of *Abelson Scope Works* in 1999. It is one of the most unconventional cameras to emerge from the renaissance era of pinhole photography. The photographic world is fortunate to have such an unusual camera available. Once its perspective distortions are understood, wonderful images can be produced (Figure 6.34). It is available from Pinhole Resource.

FIGURE 6.34
© John Ashburne, *Kulturform #1: Sony Center, Berlin,* 210 × 32-cm pinhole duotone Mystis digital print from Ilford FP4 120 film, 2006. From the collection of the photographer.

It is relatively easy to construct a one-shot anamorph camera from a tube with a pinhole centered at the end (or even both ends).

Having a slightly angled film plane backward at the top of the camera means that more of the ground image is photographed when the camera is held perpendicular to the ground. This can give an extremely superwide angle side-to-side view of 160° if the pinhole is enlarged considerably over what would be optimal. Use of the small dodging device (mentioned earlier) to control overexposure in the image center is sometimes necessary.

The reverse of angling the film plane backward at the top of the camera would be angling it backward at the bottom or angling the pinhole and shutter area on the front of the camera upward so that more of the sky image is photographed when the camera is held perpendicular to the ground. This is used to compensate for distortion when photographing tall buildings.

EXPOSURE TIMES

There are many ways to calculate exposure times. Whatever works for you is best. Here are several different methods:

- For myself, I generally use the trial-and-error method for exposure. After making a camera, I try it out and arrive at an exposure time. Because pinhole has a wide latitude, I can usually guess fairly well. I've done pinhole for a number of years, so most often my memory bank has enough in it to work. I've rarely used a light meter and don't own one. The most difficult exposures to measure without a light meter, at least for me, are ones in very low light situations or where light is fading rapidly, for instance, at dusk.

Nancy Spencer explained her exposure value (on a light meter) method:

> I generally use Tri-X film which I rate at ISO 200. I use this rating because I think that if you overexpose Tri-X, the shadow detail is better. I use a Gossen Luna-Pro meter set at ISO 200. I then point the meter at a Kodak 18 percent gray card placed as closely as possible and in the same light as my subject. I turn on the meter, turn the dial until the needle is on zero, and then read the exposure value (EV), sometimes also referred to as the exposure index. The EV is a chart, available on most handheld meters, which has numbers from 19 to -4. In bright sunlight in New Mexico in the summer, the EV is 16 or slightly higher. On the east coast in bright sunlight in the summer, the EV is usually around 15. I have worked out a chart, which I have recorded on the back of my gray card. Through tests, I have decided that 2 seconds is a good exposure time for EV 16 with Tri-X film and a 1-½ inch *Leonardo* camera. I have then worked out the other EV numbers from 16 to 11, with 11 being the darkest lighting situation attempted outdoors. For example, at EV 15, I expose for 4 seconds, at EV 14 for 10 seconds, etc.
>
> With this method, you don't have to know your *f*/stop, pinhole diameter, or focal length. You simply measure the amount of light available and learn through trial and error how your film, camera, and developer will react to this lighting situation. In the normal range of lighting situations outdoors, I usually work in the EV 16 to EV 11 range, which

amounts to six different exposure times. You will have to run new tests if you use a different size camera. I suggest you work out your own times, taking into consideration type of film, developer and developing times, and reciprocity.[11]

It is useful to understand reciprocity departure—it can help rather than hinder pinhole image making. In reciprocity departure bright areas continue to expose more and show up lighter, whereas dark areas stay dark. For the series *on deaf ears* Nancy Spencer and I used Fuji NPS color negative film with long exposure times (Figure 6.35). Even though we used

FIGURE 6.35A
© Nancy Spencer and Eric Renner, *End of the World,* series *on deaf ears,* 30 × 23-inch pinhole photograph, 2003. The image was made with a 1½-inch focal length *Leonardo* 4 × 5-inch pinhole camera. The 10-minute exposure was made on Fuji NPS in the shade. No direct sunlight was used for lighting.

FIGURE 6.35B
© Nancy Spencer and Eric Renner, *on deaf ears*, Flying Monkey Press, 2008, cover image *13 Moons*.

film designed for exposure at a maximum of 1/4 second for true color accuracy, our images were enhanced by using exposure times of 6 to 10 minutes by photographing in the shade. By selecting certain films, reciprocity departure can make some of the colors more saturated, make brighter areas lighter (as if they were lit by photo floods), and make deeply shaded areas darker, as well as giving increased contrast.

Here are four of the most widely used *f*/stops and focal lengths with their corresponding optimal pinhole diameters.

Focal length (mm)	Pinhole size (mm)	*f*/stop
38	0.23	170
75	0.32	230
150	0.45	330
300	0.64	470

Focal length (inches)	Pinhole size (inches)	*f*/stop
1½	0.0092	170
3	0.0127	230
6	0.0178	330
12	0.0252	470

Exposure Chart for Pinhole Photography[a]

Light condition	*f*/stop	RC paper	ISO 100	ISO 200	ISO 400
Full sun (distinct shadows, EV 16)	160	15	7	3	1.2
	230	40	16	7	3
	330	3 M	34	16	7
	470	8 M	1 M 15	34	16
Hazy sun (weak shadows, EV 15)	160	40	16	7	3
	230	3 M	34	16	7
	330	8 M	1 M 15	34	16
	470	18 M	3 M	1 M 15	34
Cloudy (no shadows, EV 14)	160	3 M	34	16	7
	230	8 M	1 M 15	34	16
	330	18 M	3 M	1 M 15	34
	470	40 M	8 M	3 M	1 M 15
Deep shade (heavy overcast, EV 13)	160	8 M	1 M 15	34	16
	230	18 M	3 M	1 M 15	34
	330	40 M	8 M	3 M	1 M 15
	470	90 M	18 M	8 M	3 M

[a]*All times in seconds unless indicated. M, minutes; EV, exposure value.*

To use the aforementioned chart, you'll need to know your camera's *f*/stop. *To calculate your f/stop, divide your camera's focal length by the pinhole diameter.* Remember, if you measure your focal length in millimeters, use millimeters for the pinhole diameter (and inches with inches).

Generally, with black and white film, it is best to overexpose slightly to get the details within the shadows. With transparency (color slide) film, it should be slightly underexposed. Slide film is much harder to expose correctly than color negative film, which is preferred. For color negative film, overexpose slightly for deeper color saturation. Because various films act differently with reciprocity, try a variety before settling on one type.

- All exposure charts are basic starting points. If you don't own a light meter or use the aforementioned chart, another method is to use the *Black Cat Exposure Guide* (Figure 6.36). Again, you'll need to know your *f*/stop. This guide is particularly useful for pinhole because it shows *f*/stops up to 1024. It covers a wide variety of lighting situations that you select. You match your film speed and *f*/stop to the lighting situation to obtain the correct exposure time. The times in the *Black Cat Exposure Guide* are slightly faster than those on the aforementioned chart, so we tend to use the *Black Cat Exposure Guide* at plus 2.

Chapter 7 contains an exposure chart useful for zone plates with *f*/stops of *f*/25 to *f*/120. Chapter 8 contains information on exposing with digital cameras.

There are many times where using an optimal pinhole is not as important as getting an exposure that might be much shorter than what an optimal pinhole will give. This means enlarging the pinhole and getting a softer-looking image in a shorter time.

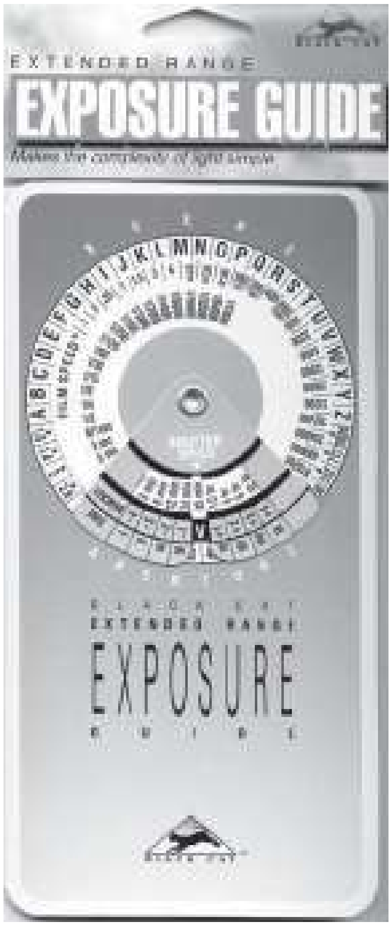


FIGURE 6.36
© Jim Lehman, *Black Cat Exposure Guide*. This guide has *f*/stops up to 1024 shown on the right of the dial. Plus and minus zones are in the blue part of the dial. It includes a gray card. It is available from Pinhole Resource.

Additional Exposing Techniques

Sarah Van Keuren offered these suggestions for additional exposing techniques in her book *A Non-Silver Manual* (Third Edition, 2005):

- If, during the pinhole exposure of a sunny landscape, a cloud floats in front of the sun, exposure time may have to be prolonged. The combination of highlights gilded by the sun and shadows illuminated by diffuse cloudy light can produce a negative with a sculpted fullness that sun or cloud alone could not reveal.
- If no cloud floats in front of the sun, a hand mirror can be used to reflect the sun into areas that need illumination.
- Sometimes it may enhance and even change the meaning of a pinhole image to hold a sheet of cloth behind the subject for at least part of the exposure. (In a print called *Passage of Time* I held a light gray cloth in front of a bank of blooming flowers for part of the exposure to boost its tonality into a lighter range of values but let foreground flowers that were past their prime print darker. To me this conveyed bright summer followed by autumn.)[12]

Exposing with Polaroid Materials

When using Polaroid products, one of their most useful films for pinhole might be type 55 positive/negative black and white film, where you get a retrievable negative, one that can be used in a 4 × 5 enlarger to make additional prints (Figure 6.37). When exposing type 55 Polaroid P/N film, you will want to achieve a correctly exposed negative; the positive should look somewhat underexposed. Long exposures outside with Polaroid color will generally expose into a very blue-cast image.

Brice Bischoff photographed with Polaroid in New Orleans 3 months after Hurricane Katrina. In *Mr. Ricky, Three Months After the Storm* (Figure 6.38), the grid becomes a visual barrier that inherently confines. Brice Bischoff spoke of his process:

Each photograph I take uses 49 sheets of Polaroid 600 film. The pinhole camera I built has a dagger board that slides into the back with 49 plastic sleeves

> attached to it. This allows the Polaroids to slide right in. I break open the Polaroid 600 film cartridges in the darkroom and slide them in the sleeves. Then I load the camera by sliding the board down into the camera and seal it up. I bring the camera out of the darkroom and make an exposure. Once the film is exposed, I bring the camera back into the darkroom. I take the Polaroids out from their plastic sleeves making sure to remember how I take them out (left to right). I put the stack of 49 exposed Polaroids into a light tight box making sure to leave them in order. Still in the darkroom I get an empty Polaroid cartridge, a Polaroid camera, and 8 or 9 Polaroids from the top of the stack. I load the Polaroids into the empty cartridge and develop them letting the Polaroid camera push them through the rollers by clicking the shutter in the darkroom. As each Polaroid develops I reassemble the group just outside the darkroom. I keep loading the cartridge until all 49 Polaroids from the stack are developed and the photograph is finished.[13]

When I exposed Polaroid 809 inside with long 10- to 20-minute exposures, I used two 500-watt lights, on one side tungsten and on the other side daylight to create very unusual colors (Figure 6.39) for the series of images of prizes won at carnivals throughout the United States from 1910 to 1965. These images were published in *American Disguise* (Flying Monkey Press, 2007)—a book that attempts to explain how visual images construct meaning and impact culture.

Polaroid materials are generally not as sharp as images onto film when using a pinhole. An example of exposing for solarization effects using Polaroid materials is exemplified in Patrick

FIGURE 6.37
© Chris Andrews, *Diva Tow-Up*, 10 × 8-inch pinhole photograph from Polaroid type 55 film, 2007. From the collection at Pinhole Resource.

Poels *Shoes* (Figure 9.5). Unpredictable solarization can result when using outdated Polaroid materials.

Filters

Adding a filter means increasing the exposure time. Many pinhole artists who use outdoor color film in daylight do not necessarily feel the need to use filters for color correction. However, filters can be built into many unique pinhole cameras, either in front of or behind the pinhole. If they are behind, they will not scratch as easily. Paolo Gioli used filters directly over the holes in crackers (Figure 6.40). Unconventional filters can be a creative part of the camera and image. I used the red fluid in the pumping heart of a scientific child's toy to partially filter some of the projected image onto Ilfochrome Classic in *My Plaster Chest* and *Mid-Life Crisis Heart* series (Figure 6.41A). In these images, I photographed through a pinhole that was naturally left in the plaster (Figure 6.41B) when it was being molded over my chest, where my left nipple had been. (As a side note, for a little humor to this story, I tried using Vaseline on my chest so that the mold would be removed easily. Unfortunately, it wasn't removed easily! The hair on my chest stuck in the plaster. The plaster had to be ripped off, along with a lot of hair, which still remains in the plaster.) The unfiltered part of the Ilfochrome Classic image in Figure 6.41C had a magenta cast.

FIGURE 6.38
© Brice Bischoff, *Mr. Ricky, Three Months After the Storm*, 24 × 24-inch polaroid pinhole photograph (49 sheets of Polaroid 600 film) from series *New Orleans*, January 2006.

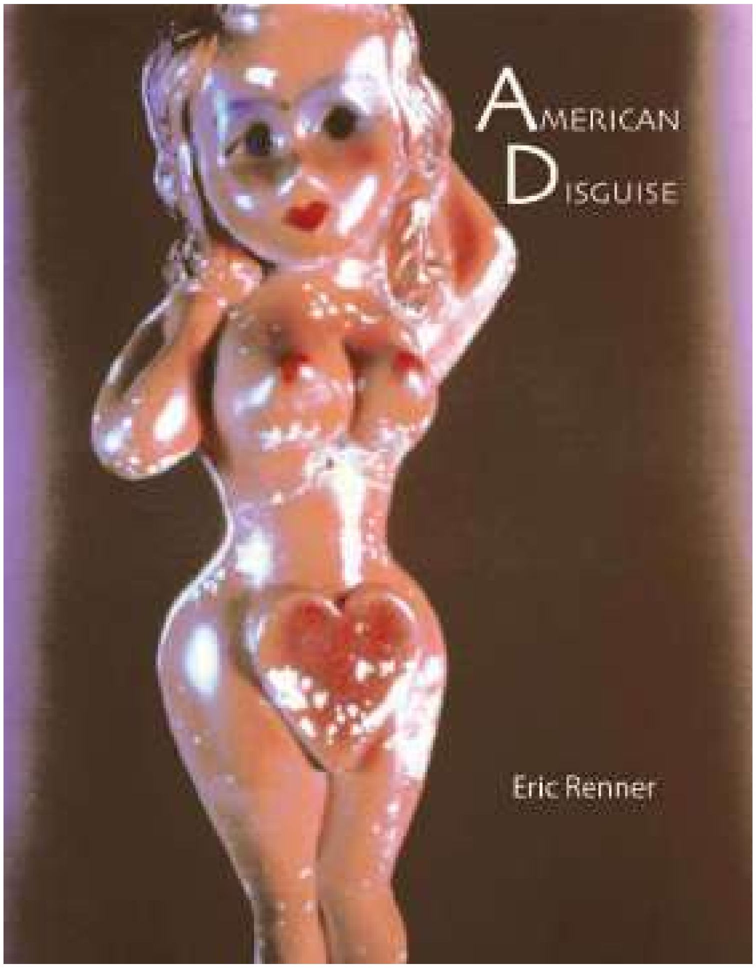


FIGURE 6.39
© Eric Renner, Flying Monkey Press, *American Disguise*, 2007, cover 10 × 8-inch Polaroid 809.

FIGURE 6.40A
© Paoli Gioli, *Camera Crackerstenopeica*, 1981. Lens photograph. From the collection at Pinhole Resource.

FIGURE 6.40B
© Paoli Gioli, *Interno di Camera Crackerstenopeica, con filtri colore di carta trasparente*, 1984. Filters are placed over some of the holes. Lens photograph. From the collection at Pinhole Resource.

FIGURE 6.40C
© Paoli Gioli, *Autoritratto*, Polaroid SX-70 *Crackerstenopeica*, 1984. From the collection of the photographer.

FIGURE 6.41A
© Eric Renner, pumping heart behind baffle. A plaster cast of my chest is placed in front of a black baffle. Light enters through an oblong pinhole in the plaster and projects through a rectangular open area of baffle. Light partially continues through the red liquid in the heart onto Ilfochrome Classic paper. Lens photograph, 1988. From the collection of the photographer.

FIGURE 6.41B
© Eric Renner, plaster cast of my chest. The pinhole is oblong and is placed in the lower left of my chest. The plaster chest sits inside the front opening black box. Lens photograph, 1988. From the collection of the photographer.

FIGURE 6.41C
© Eric Renner, *Self,* 10 × 8-inch Ilfochrome Classic pinhole photograph, 1988. From the collection of the photographer.

Shutters

A variety of sliding shutters for pinholes can be devised. If you have a large front on your pinhole camera, an old 4 × 5 film holder can work as a convenient shutter. Just tape it to the front to see if it will work.

One of the best shutter examples comes from Sam Wang and the late Todd McKinney-Cull, both from Clemson, South Carolina. Their shutter (Figure 6.42) is made from a bent brass plate, piano wire, a cable release, a paddle, and bolts. Multi-ply model airplane plywood with a 1/8th-inch thickness also is very useful for shutters and is available from a woodworker's supply catalog such as woodcraft.com. Thin black urethane foam is available from hobby stores such as hobbylobby.com. All kinds of washers, T-nuts, and hardware useful for cameras can be purchased from McFeely's Square Drive Screws listed on the Internet.

A beautiful cable release-operated shutter known as the *Apo II* (Figure 6.43) has been available commercially for a decade made by Bill Christiansen of *Minute Aperture Imaging*, available from Pinhole Resource. Various pinhole and zone plate discs are inserted on its front. The *Apo II* shutter is an extremely useful system for use with large-format cameras that have Compur-1 or Copal-1 lensboards. It can be adapted to other pinhole cameras.

VIEWFINDERS

To help visualize the boundaries of the image, straight lines can be drawn on the top and both sides of your camera. This is particularly easy to use if your camera is rectangular or square. Start from a point that is on the top of the camera directly above the pinhole. Extend this point two ways by drawing two lines to the outer edges of the film plane—as in an upside-down V. These form the lower half of an X; you can easily visualize the extended top part of the X in space. Everything within the upper part of the X will image.

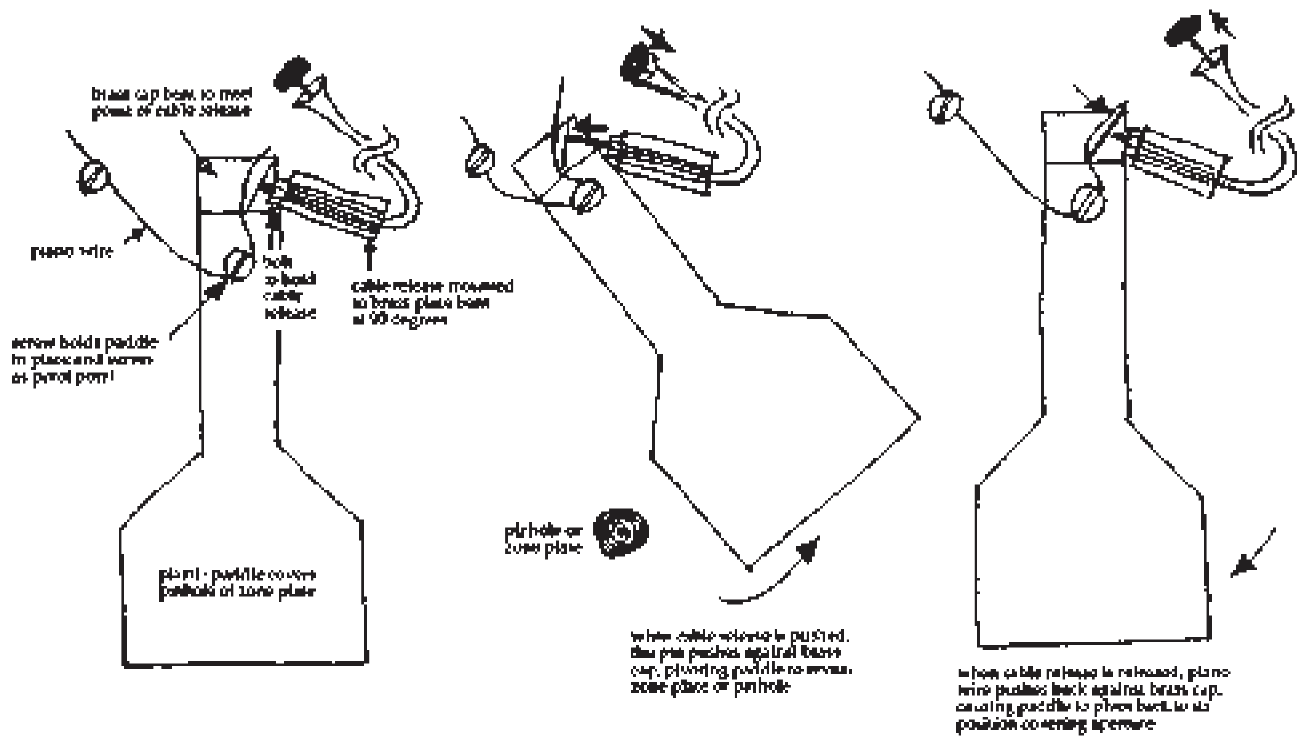


FIGURE 6.42
© Sam Wang and Todd McKinney-Cull, shutter drawing, 1993.

FIGURE 6.43
© Bill Christiansen, minute aperture imaging, Apo II shutter, 2000. For use with pinholes and zone plates. The two round head bolts screw out for changing Apo II discs.

Other Unusual Pinhole Cameras

Instead of using large pinhole cameras, Jaroslaw Klups, from Poland, takes a single piece of 35-mm film and loads a match box supported in front of his face (Figure 6.44A). His images average about an hour or more (Figure 6.44B). Of his series *Self Forms*, Klups explained:

> My way to express a creative influence of people and places as well as a variety of situations that I happen to find myself in is through photography. The aim is to 'objectively' comment on my 'true self' in reference to the surroundings. I hope to cross a thin border and get an insight into an emotional mirror of the others who not only influence but simultaneously create and destruct me. I am trying to find a universal face, without the artificiality of posing in front of the camera. I installed a pinhole camera in front of my face so that I could prolong exposure up to a few hours. It was supposed to objectivise vision: ephemeral gestures and short-lived mimics invalidated each other leaving only hardly visible traces.
>
> 19th century physiognomists believed short-lived mimics reveal the truth about man. I am looking for it in endurance: exposing my own face I am busy with everyday activities—I talk to my friends, listen to music, work, eat, walk, sleep and so on. The initial result is astonishing. The first photograph depicts a face not much different from the one seen in the mirror. I decide to continue, and, after development, my impression is that I know much less about myself than I used to. The obtained images are full of mysterious traces of the outside world, suggesting passages of time and their uniqueness. My surroundings become a synonym of some remote period in my life, and the image obtained—its mask, a hybrid of various emotions and reactions to the world.[14]

Roger Sayre of New York has worked with lengthened exposure portraiture in his series *Sitting*. Sayre has taken the ancient photo-booth quickie image—one usually composed of smiles and lightness—and reversed these qualities into a subject's shadowed darkness (Figure 6.45). Sayre spoke of his process:

> . . . . The closest my work has come to traditional photography in years is a piece called *Sitting*. This piece combines primitive photography with meditation, collaboration and endurance. *Sitting* consists of a very large custom-made pinhole camera that sits in the

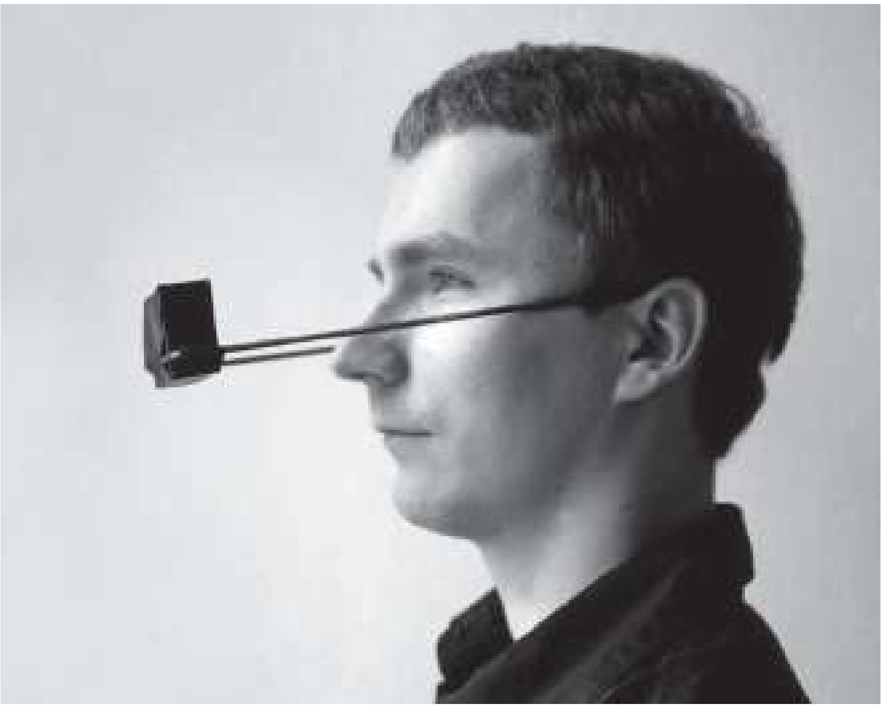


FIGURE 6.44A
© Jaroslaw Klups, self with camera, used in series *Self Forms*, lens photograph, 2003. From the collection of the photographer.

FIGURE 6.44B
© Jaroslaw Klups, *Untitled,* series *Self Forms,* from a 1 × 1¾-inch negative, 50-minute exposure while listening to music, washing up, singing, and talking, June 14, 2003. From the collection of the photographer.

middle of a gallery, a chair and a set of lights on a timer. The camera is approximately the size of a phone booth and produces 20 × 24 inch or 16 × 20 inch photographic portraits using a paper negative. Subjects make an appointment to sit for a portrait during the exhibition. A sitting takes one hour. As a collaborator, the subject sits as still as they can, meditating on their own image in a mirror mounted on the front of the camera. *Sitting* is as much about the participants' collaboration and perseverance as it is about the actual portraits that result. To sit for a portrait is an individual and personal act, and is essential to truly experience the piece. The sitter is, in essence, on exhibit during the time they are sitting for their one-hour exposure, in the middle of the gallery. Once the portrait is processed it is hung on the gallery walls surrounding the camera. As the exhibition continues, more and more images are generated and the walls fill with portraits. The resulting portraits, in addition to harkening back to an earlier era of photography, resonate with a likeness of the sitter that is possibly truer than a traditional fraction-of-a-second photograph

FIGURE 6.45A © Roger Sayre, side view of the pinhole camera and sitter, lens photograph, 2002. From the collection of the photographer.

> or snapshot. One cannot hold any single expression for the span of an hour; instead, all expressions are merged into one image. The sitter's essence, distilled and averaged over time, is revealed.[15]

Even the smallest of readily accessible visual areas, but ones usually not considered, are viewed in Janet Neuhauser's series *Loupe Holes* using a 4 × 5 *Leonardo* pinhole camera that has an 8× Peak loupe attached with duct tape over the pinhole. Neuhauser's *The Point of a Pencil* (Figure 6.46) is reflective of the pinhole itself as a visual point in space. Of her view into the macrocosm with 6- to 30-minute exposures, Neuhauser explained:

> For several years I have worn an 8× loupe around my neck almost every day. I initially used it to examine negatives and contact sheets. As time went on and my close-up vision grew less reliable, I started to use the loupe for many different purposes—from examining my daughter's cuts and scratches to finding telephone numbers in the phone book to reading labels in grocery stores. What I explored under the loupe expanded as I used it to look closely at the little things in the world I couldn't see clearly. The loupe became an intrinsic part of my visual field and I fell in love with the way *everything* looked through it. . . . I have long been interested in photographing the still-life and worked with an 8 × 10 camera to do so in the past. With the pinhole/loupe, I can't see these tiny still-lifes when they are under the camera and the shutter is ready to be opened. I am never sure how much of the subject will translate onto the film. The depth of field is always in question. The process is fraught with mishap and happy accident. The loupe shows me a small slice of the world, 1 × 1-½ inch, and yet within it exists light, drama, tension, moment—all important to me in photography. I make these images

FIGURE 6.45B
© Roger Sayre, *David*, from series *Sitting*, 20 × 16 pinhole photograph, 2002. From the collection of the photographer.

> to preserve the little things before they decay and disappear or get tossed out. I am interested in how a cheap, plastic loupe and a tiny hole transform light and give this macroscopic world such a strange and beautiful glow.[16]

Combining humor, irony, and adventure, Donald Lawrence of Kamloops, B.C., Canada, crafted a workable portable darkroom into and onto his kayak (Figure 6.47A), created functioning underwater pinhole cameras (Figures 6.47B and 6.47C), and floated into a new reality photographing objects that inhabit the watery depths below (Figure 6.47D). His kayak, reminiscent of recent space travelers ready to explore our solar system, is fitted up and hopefully prepared for whatever is out there—yet their vulnerability, as well as Lawrence's, is obvious. An overburdened tippable kayak (Figure 6.47A) is not exactly a lounging cabin cruiser nor have NASA's shuttles proven to always be indestructible. Nor are the creatures under the sea and the sea itself indestructible. George Harris, director of the Yukon Arts Centre, wrote of the *Kayak* project:

> . . . . Once a simple unadorned kayak, it has been transformed into a floating self-sufficient darkroom complete with underwater pinhole camera. Supporting flasks of chemicals, an enlarger, a stove, a cache of photographic paper and a camera, the kayak is literally weighed down by technology while in the water.

FIGURE 6.46
© Janet Neuhauser, *The Point of a Pencil, series Loupe Holes*, 11 × 14-inch split-toned pinhole photograph made through a 8× loupe, 2003. From the collection of the photographer.

FIGURE 6.47A
© Donald Lawrence, kayak/darkroom, 1998. Slalom whitewater kayak converted into floating darkroom, primarily fiberglass, and aluminum, with miscellaneous fittings and apparatus. Thirty-eight inches high (on pedestals), 30 inches wide, and 160 inches long. Lens photograph collection of the photographer.

In practice, the camera, an over-elaborated version of the common pinhole camera, which sits forward of the cockpit, is cast overboard on a line. When it hits bottom the camera's front falls forward uncovering the aperture and exposing the film. It is brought to the surface, where the negative is developed in the camera by pouring developer into it through a tube assembly which doubles as a handle and a light trap. When developed, the negative is removed and placed in the enlarger astern of the cockpit where a print can be made and set to dry on the bow.[17]

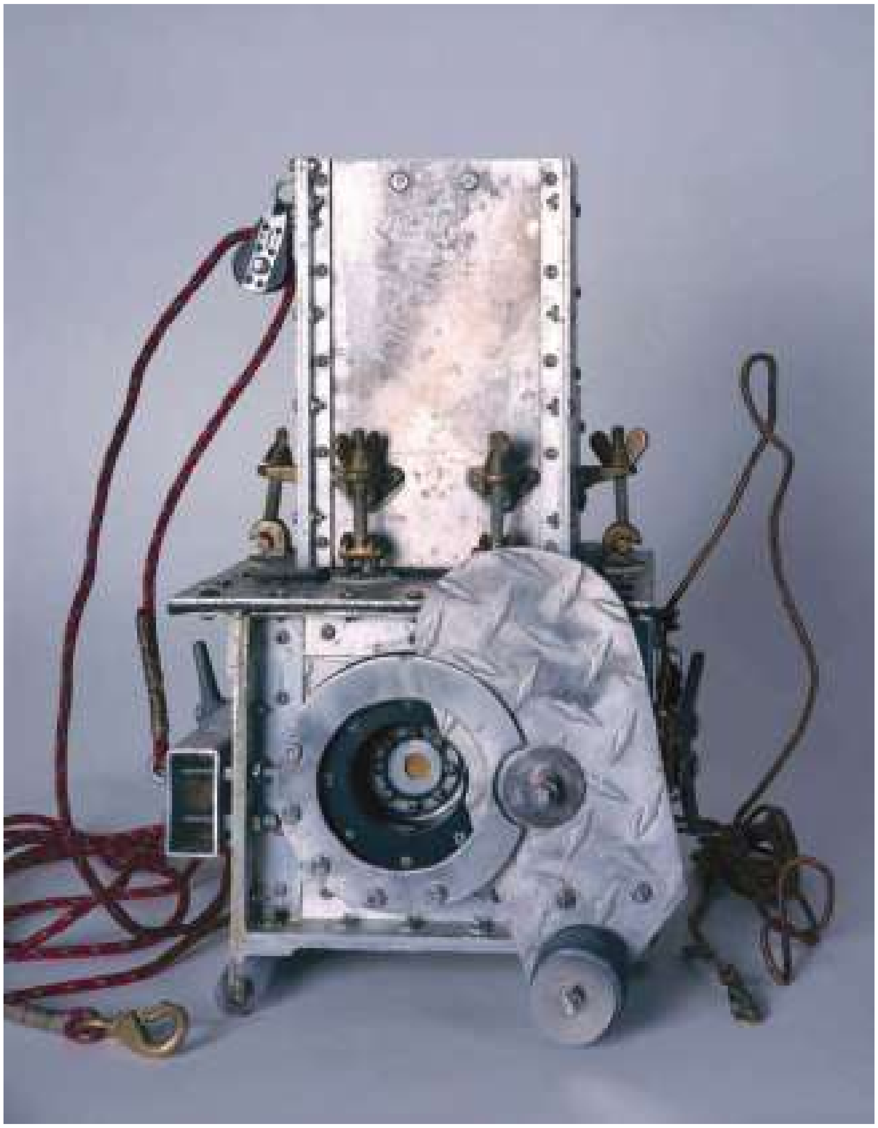


FIGURE 6.47B
© Donald Lawrence, underwater pinhole Polaroid camera, 1999. Aluminum, and cintra construction, with marine plumbing and electrical fittings: accommodates a standard 4 × 5 Polaroid back, lens photograph collection of the photographer.

In the recent gallery catalog *The Underwater Pinhole Photography Project—Donald Lawrence,* Katy McCormick perceptively wrote:

> Literary references such as Jules Verne's *20,000 Leagues Under the Sea* come to mind. Verne's Captain Nemo "sought refuge from Western civilization in the bosom of the waters. . . . The ocean becomes an extension of Nemo's imagination, and the ingenious vessel in which he penetrates it is but a prosthetic device geared to facilitate all these activities denied a terrestrial being. . . ."[18]
>
> Lawrence's remote control pinhole cameras, cast over the side of his kayak, are akin to Captain Nemo's vessel (the Nautilus) which "Opening and closing its eyes. . . catches underwater life at its most quotidian."[19]

A curiously rewarding coincidence to all this: Captain Nemo's fantasy vessel is named the Nautilus; the real Nautilus is an underwater creature with pinhole eyes (Figure 5.2).

Altering Existing Cameras to Pinhole

Most commercial cameras can be altered to pinhole. Being able to remove the lens easily while keeping the shutter intact is the first criterion. The pinhole that is added should not get in the way of the shutter. Selecting a camera that will give you the angle of view required

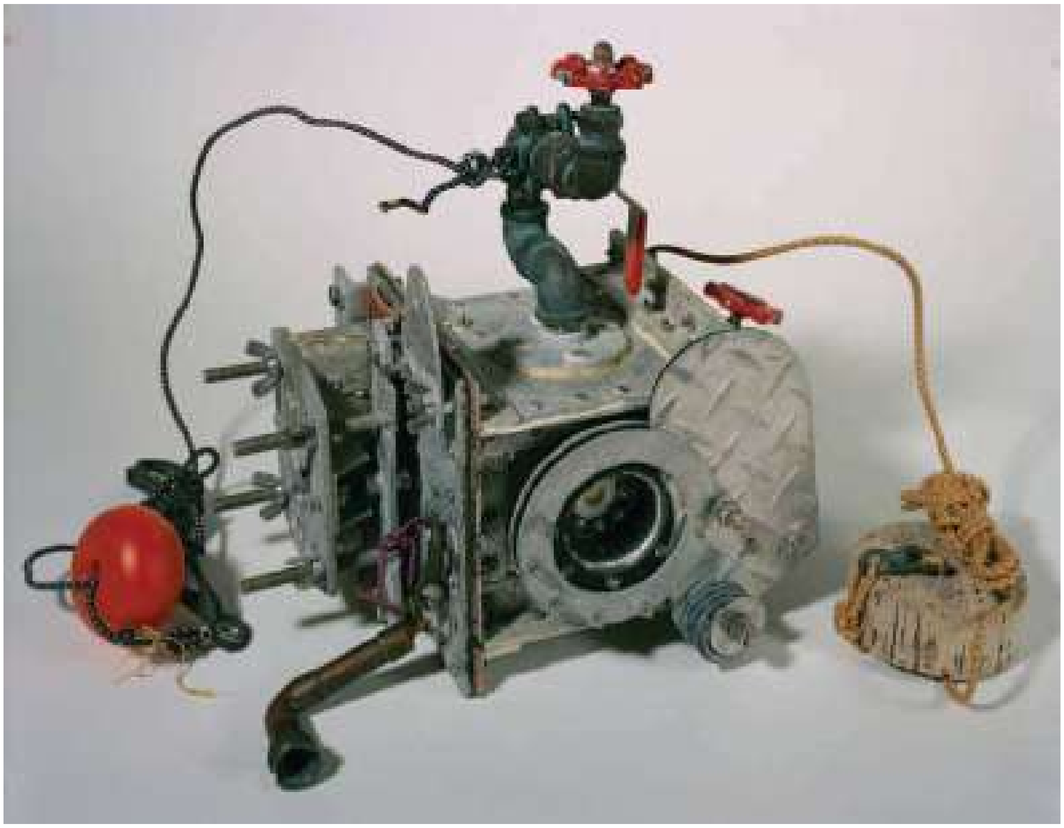


FIGURE 6.47C
© Donald Lawrence, underwater pinhole camera, b/w model iii, 2002. aluminum, and cintra construction, with marine plumbing and electrical fittings: accommodates a standard 4 × 5 film holder and allows for development of films inside the camera, lens photograph collection of the photographer.

FIGURE 6.47D
© Donald Lawrence, *Starfish in Tidal Surge,* underwater pinhole photograph, contact print from 4 × 5-inch negative, 1998. Collection of the photographer.

is equally important. Many photographers select a 120-roll film camera because the image is large versus a 35-mm camera. A Lubitel is a good choice. Removing the lenses from a Lubitel is explained in Chapter 7.

An inexpensive Holga, usually available new for about $15 to $20, has been the choice of many photographers who want a 120-roll film camera to alter for pinhole. The camera sometimes leaks light and can deteriorate somewhat quickly.

However, a used vintage metal 120 camera, which can be found for not much more in cost, will last forever. The Holga does have a place in pinhole imaging and is usually the first choice for those who have not had experience with a used 120. To transform a Holga, unscrew the focusing ring and then pry it off gently with a regular screwdriver. The plastic plate holding the lens can be pried out next. Save the focusing ring. After you have attached the pinhole, screw the focusing ring back on if you want unusual vignetted images. To add the pinhole, gently pull off the angled spring you see when looking into the camera. The shutter should still work by hand, using its visually hidden spring. Match the two rectangular holes that have created the shutter and tape them so the the top hole does not slide when they are open. Make a paper punch-size hole in about a 3/4-inch square of black photo tape. Carefully adhere this tape to a small pinhole in a 1/4-inch square sheet of metal that is placed under the shutter metal on the camera front so that it is exactly in the center of the rectangular hole area. This takes patience. If it is not in the exact center the image will be slightly cut off. An alternative to this is to buy a pinhole Pinholga (Figure 6.48) from holgamods.com.

Most large-format cameras can be adapted to pinhole by simply dedicating various lens boards to pinhole. If you have an existing large-format camera, one whose front was not designed to drop, a superwide-angle image is impossible. Using a viewing pinhole of 3/32 of an inch or larger under a large dark cloth allows you to view the image on the ground glass. It won’t be as bright as a lens image.

FIGURE 6.48
© Randy Smith, Pinholga, lens photograph of altered Holga camera, 2007.

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CHAPTER 7

Alternative Apertures: Zone Plates and Slits

Only a weak light glimmers, like a tiny point in an enormous circle of blackness. This weak light is no more than an intimation which the soul scarcely has the courage to perceive, doubtful whether the light might not itself be a dream, and the circle of blackness, reality.

VASILY KANDINSKY

ZONE PLATES

Had it not been for Kenneth A. Connors, zone plates may have been overlooked when alternative processes came into their own in the 1990s. He researched the enigmatic zone plate (Figure 7.1), contributed articles about its properties in *Interest* during the 1970s,[1] and made his findings available to a wider audience through *Pinhole Journal*. If not for Connors, zone plates would have quietly remained within the realm of science.

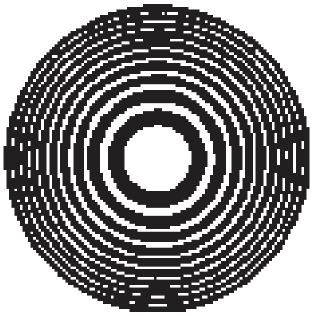

FIGURE 7.1
© Kenneth A. Connors, zone plate drawing, 1988, used to make a zone plate. Reproduced from *Pinhole Journal* Vol. 4#1.

The beauty within a zone plate image is the recognizable halo or glow that surrounds any strong contrast edge, such as the edge of the moon's path on a dark night in Nancy Spencer's *Moonrise Over Pinhole Resource* (Figure 7.2). This glow occurs because light rays from the bright moon are considerably bent (diffracted) when hitting the edges of the opaque rings within the zone plate. Reciprocity departure is also helping to make the glow stronger.

A zone plate *diffracts* light; consequently, zone plates are closely related to pinhole. Zone plates render soft-focus imagery, their look is not like soft-focus lens imagery, nor is their look at all like pinhole imagery. Foliage such as grasses and leaves under certain lighting conditions resemble infrared imagery.

Matt Young, a physicist who has written widely on zone plates and pinholes since the 1970s, stated:

> The zone plate consists of a series of concentric rings, alternating clear and opaque. It works by blocking diffracted rays that would have caused destructive interference at the image point.[2]
>
> The zone plate, like the pinhole camera, exhibits no linear distortion. . . . Zone plates have resolution limits comparable to lenses with the same F-number, and they may be overlapped to form multiple images spaced by less than the diameter of the zone plate themselves. Unfortunately, the zone plate has low efficiency and suffers from veiling glare because most of the light incident on the zone plate passes through it undiffracted and falls onto the image plane.[3]

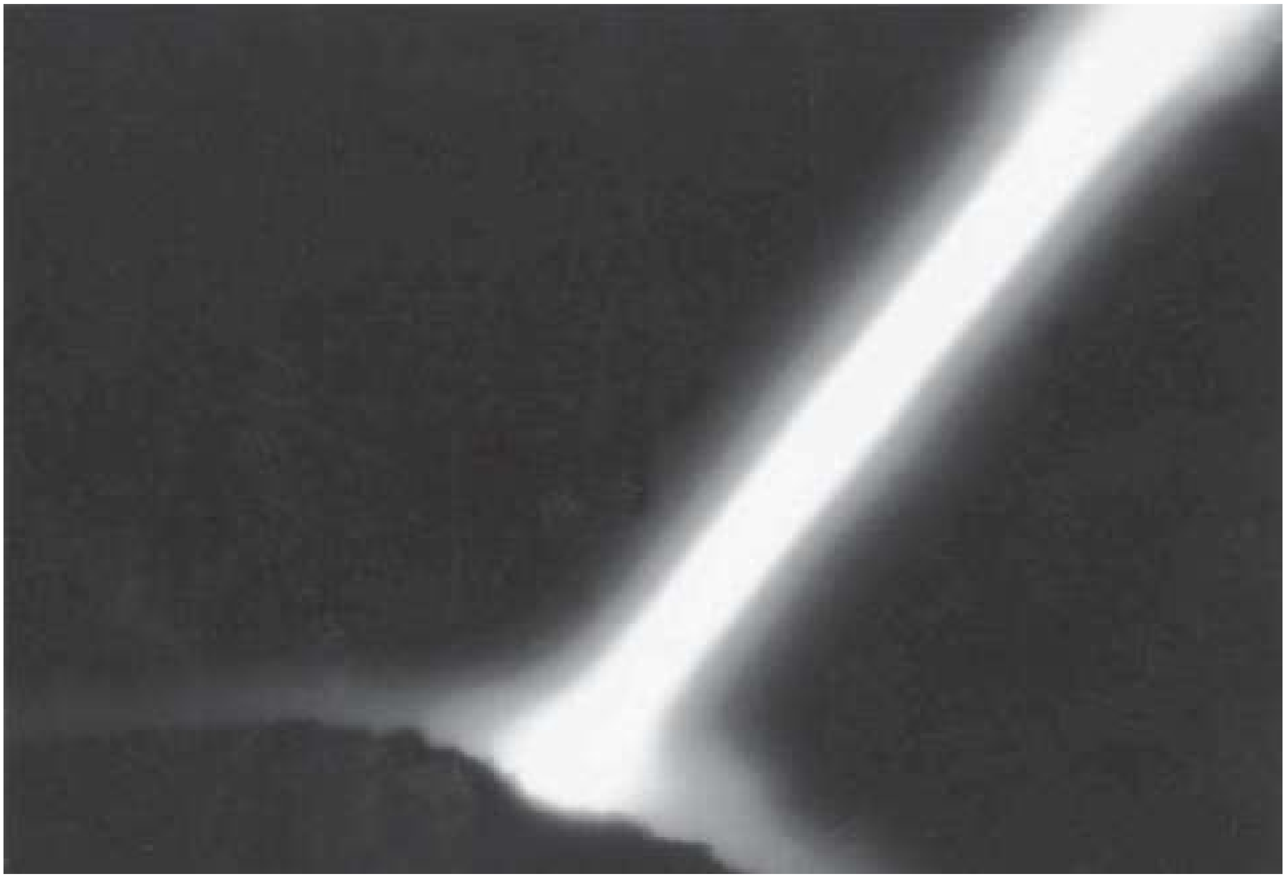

FIGURE 7.2
© Nancy Spencer, *Moonrise Over Pinhole Resource*, 10½ × 12½-inch zone-plate photograph, 1995. From the collection of the photographer.

Because zone plates involve constructive interference, exposure times for zone plate images are drastically reduced to approximately one-seventh of those for pinhole images. Zone plates have *f*/stops in the range of 25 to 120 when used for focal lengths of 38 mm (1½ inches) to 300 mm (almost 12 inches).

Pinholes are examples of destructive interference because many of the light rays going into a pinhole are destroyed by one another. That is why pinhole *f*/stops begin around 100 for 20 mm (about 3/4 inch) and go upward fairly rapidly to 468 at 300 mm (almost 12 inches). Zone plates focus to a point, as lenses do, so you need a zone plate of specific diameter and focal length designation to match the focal length of your camera. Due to veiling glare, zone plate black and white negatives lack contrast and color negatives lack saturated color as compared to pinhole negatives in black and white and color. Zone plates render sharper resolution than pinhole.

Lord Rayleigh was the first to design a zone plate. The entry in his research diary for April 11, 1871, reads as follows:

> The experiment of blocking out the odd Hughens' zones so as to increase light at centre succeeded very well and could be shown in quite a short space. The negatives should not be varnished. I have little doubt that the number of zones blocked might be advantageously increased much beyond what I used (15). No great accuracy is required in filling in the odd zones with black.[4]

In 1888, Lord Rayleigh suggested a phase-reversal zone plate, which increased light intensity fourfold rather than blocking out alternative zones.[5] In 1898, the well-known American physicist Robert Wood drew a 230 zone-phase reversal zone plate and was the first to use zone plates for landscape photography. This zone plate can be found in Wood's classic, *Physical Optics*, which reintroduced zone plates to a wider scientific community.

In the 1980s, Kenneth A. Connors wrote of his zone plates:

> Fresnel half-wave diffraction zones have been rendered opaque, so that destructive interference of waves from adjacent zones does not take place; instead, the waves passing through the remaining transparent zones constructively interfere, with the consequent large increase in amplitude of the optical disturbance.[6]

Connors explains the preliminary drawing and completed photographic reduction for a zone plate:

> The classical preparation of a zone plate begins with the drawing of concentric rings having radii proportional to the square roots of the integers; alternate zones are blackened, and a photographic reduction is made on high-contrast film. This film negative serves as a zone plate.
>
> The degree of photographic reduction required to produce a zone plate with desired focal length is readily calculated. For the copy camera set-up the following equations are applicable:

$$F = f(1 + 1/M)$$

$$U = f(1 + M)$$

$$M = U/F$$

> where M is the ratio object-to-image size as recorded on the negative, f is the focal length of the copy lens, F is the lens-to-film distance, and U is the object-to-lens distance. It may be necessary to carry out the reduction in two steps.[7]

Zone Plate Cameras

Connors's zone plate photograph *Surf at Salmon Creek* (Figure 7.3) is a perfect example of the evocative qualities available to artists using a zone plate with its inherent short exposure times. Subtle yet surprising shifts in gray values as the ocean waves build and crash give the water a feeling of kinetic substance.

Sam Wang, a retired professor of photography at Clemson University, has worked extensively with zone plate imaging for many years using them under various lighting conditions and exposure times. *Figure with Outstretched Arms* (Figure 7.4) relies upon subtle lighting shifts on the darkly lit figure, the unusual rectangular area behind the figure, as well as the two dark spots on the lower left and right side of the image. Her arms create a stabilized tension.

When zone plate exposures fall within the one-fourth to a several-second range, Sam Wang suggests the use of a commercial shutter as follows:

> The resulting short exposures (1/30 to 1/4 second in normal outdoor situations) make it fairly awkward to use without a fairly precise shutter—one that's more precise than a lens cap or the proverbial photographer's hat. Unfortunately spare shutters are not readily available. Consequently it is desirable to convert a cheap existing camera or a really beat-up one to zone plate than to build it from the ground up.[8]

Wang continues his article suggesting the use of a 120-roll film Russian Lubitel Twin Lens Reflex with a 75-mm zone plate attached after the three lenses are removed. The Model 166 Lubitel is usually available on eBay for well under $100 from a U.S. seller. Once you own a

FIGURE 7.3
© Kenneth A. Connors, *Surf at Salmon Creek, CA,* 9 × 11¾-inch zone plate photograph, 1986. From the collection at Pinhole Resource.

FIGURE 7.4
© Sam Wang, *Figure with Outstretched Arms*, 11 × 14-inch zone plate photograph, 2002. From the collection at Pinhole Resource.

Lubitel, try it first as a lens camera. If you like it that way, then buy another to convert for pinhole. Always try the shutter to see if it works properly before you disassemble the camera. A Lubitel has a built-in lens hood and an interior bellows configuration, both of which destroy some amount of veiling glare. A Lubitel usually makes a well-exposed negative with reasonable contrast, although when developing the negatives, they could be overdeveloped by 20 to 30% (Figure 7.5).

To start the disassembly of the Lubitel 166 you'll need to pry off the lower lens gear mechanism. It pops off fairly easily by prying it from behind with a flat screwdriver. Later you can place it back on the camera's lens ring if it has small set screws holding it in place—some of the models do. If not, you should leave it off. Screw out the front lens ring (#1). Take a small pointed nut-pick or small "Leatherman" pick and pry off the metal c-rings holding the remaining two lenses that are both inside and outside of the lower portion of the camera. These are tricky to remove and take patience and the right tool. *Make sure you don't injure the shutter*. Place the first lens ring (#1) you screwed out on a very flat smooth board and break the lens using a sharp nail with a hammer. This will obliterate the glass. Wear protective eye wear when doing this. There's no way to save this lens in most Lubitels as it is held firmly in place. Don't hit it too hard because you'll need the lens ring afterward. You'll also need to have these threads in perfect condition. Use that metal lens ring as a pattern to draw onto a piece of shim to create a donut-shaped metal plate. Before cutting it out you should make about a 3/32th-inch hole in the center of the shim (or use a paper punched size hole—if you use a paper punch of low quality, it will usually wreck the metal even if you back it

FIGURE 7.5
© Nancy Spencer, *Eric Renner*, 8 × 8 zone plate photograph, 2001.

with a sheet of cardboard when punching it). If you have purchased a zone plate from Pinhole Resource, it will come with a shim with a hole in its center. Place the zone plate behind that hole, emulsion side in, taping it carefully to the shim. Rescrew the lens ring, shim, and zone plate in place. The shim and zone plate should sit in front of the shutter. If you want a square image, make sure the diaphragm is completely open. If you leave the diaphragm partly closed you will get an image with a circular vignette. Try the shutter. It should still function. The lens ring now acts as a lens hood, making the Lubitel a perfect zone plate camera.

Often a zone plate is simply attached to an extra lensboard and used on a large format (4×5 or 8×10) camera with focal lengths of 38 mm or more. Another rarely used option is to convert an existing 35-mm lens camera by removing the lens and adding a zone plate that has been placed behind a hole in the center of a body cap with extension tubes on the camera to bring the zone plate out to the correct focal length.

Recently, however, many artists are putting a 45-mm (*f*/32) zone plate body cap on a Nikon, Canon EOS, Olympus, or Minolta Maxxum digital camera (one that has removable lenses) and photographing in full sun for about 1/20th of a second. This latter use is covered in the following chapter on digital. These zone plate caps are available from Pinhole Resource.

Mounting a Zone Plate

Commercially available zone plates from Pinhole Resource come on heavy film. Their sizes and *f*/stops are as follows:

38-mm zone plate = *f*/25
45-mm zone plate = *f*/32
75-mm zone plate = *f*/65
90-mm zone plate = *f*/70
120-mm zone plate = *f*/80
150-mm zone plate = *f*/90
180-mm zone plate = *f*/95
210-mm zone plate = *f*/100
240-mm zone plate = *f*/110
300-mm zone plate = *f*/120

A zone plate should be mounted with the emulsion side toward the inside of the camera. A 2-inch-square piece of shim stock or pie-pan aluminum should have a centered hole made in it, slightly larger than the outermost zone plate ring. The zone plate should then be mounted behind the shim. Black photographic tape (Scotch #235—it's the best) can be used to attach the shim and zone plate to the inside of the camera opening. Black photo tape should be affixed to the emulsion side of the film near the zone plate. The tape decreases light reflection from the slightly reflective surface, much the same way as darkening the metal around a pinhole. The shim offers protection for the zone plate. A scratch will destroy the usefulness of the zone plate so care must be taken. Dust can be removed with canned air or a very soft brush, although generally the zone plate should not be left open to the air to catch dust. Never use black photographic tape as a shutter over the zone plate; this works over a pinhole made in metal but will destroy a zone plate.

Exposing

The following exposure chart can be used for zone plate photography. If you prefer a denser negative, double the times.

Exposure Chart For Zone Plate Photography[a]						
Light condition	**Focal length**	***f*/stop**	**RC paper**	**ISO 100**	**ISO 200**	**ISO 400**
Full sun (distinct shadows, EV 16)	75 mm	65	4	1	0.4	0.2
	150 mm	90	10	2.2	1	0.4
Hazy sun (weak shadows, EV 15)	75 mm	65	10	2.2	1	0.4
	150 mm	90	22	4.8	2.2	1
Cloudy (no shadows, EV 14)	75 mm	65	22	4.8	2.2	1
	150 mm	*f*/90	48	10.7	4.8	2.2
Deep shade (heavy overcast, EV 13)	75 mm	*f*/65	48	10.7	4.8	2.2
	150 mm	*f*/90	1M 40	25	10.71	4.8

[a]*All times in seconds unless indicated. M, minutes; EV, Exposure value.*

Increasing Contrast in Zone Plate Negatives

As stated earlier, because of veiling glare, zone plate black and white negatives lack contrast and color negatives lack saturated color as compared to pinhole negatives in black and white and color. When viewing most zone plate negatives, the contrast is generally low and the tonal-range information is difficult to read. A contact print should be made rather than throwing away what looks to be a poorly exposed low-contrast negative. *Do not assume that a low-contrast or difficult-to-read negative is useless*. With color, use ISO 400 and lower speed films, as these have better color saturation.

Several procedures can be used to heighten contrast in addition to the usual procedure of developing negatives 30% longer, which was used for Figure 7.6. To heighten contrast, it's important to add a lens hood. A simple tube painted black works well. An interior light-trapping device (which is what a bellows is) between the zone plate and the film is

FIGURE 7.6
© Nancy Spencer, *Beth,* 11 × 14-inch zone plate photograph, 1996. From a 4 × 5 negative. Collection of the photographer. Film developing time was increased by one-third to increase contrast.

FIGURE 7.7
© Victoria Cooper, *January—Summer Angophora*, series *Natural Encounter*, 9½ × 12 inch type C zone plate photograph, 1999. From the collection of the photographer.

also useful. Black-flocked paper can be placed inside the camera to trap extraneous light that would otherwise go beyond the film area. There is a marked difference between images obtained with and without light-trapping devices.

The zone plate glow can be as obvious in color as it is in black and white. To heighten color saturation, Victoria Cooper from Australia cross-processed color-transparency film with negative chemistry in her image *January—Summer Angophora* (Figure 7.7).

When the sun hits the zone plate directly, its rings are recreated as a facsimile in the image flare. The use of zone plate flare was deliberately placed in the center of *Lost City Near Cape Crawford* (Figure 7.8) by Doug Spowart of Australia. He used his hand to form a pinhole solar image—this was transformed through his camera's zone plate. Extremely bright point sources of light at night also create ray lines extending outward from the center of the zone plate.

In a surprising use of reciprocity departure, Katarzyna Majak from Poland used a zone plate for 25–minute exposures (Figure 7.9) of her friends as figure studies. Her work in pinhole photography is conceptually linked to the Balzac quote, "All physical bodies are made up entirely of layers of ghostlike images, an infinite number of leaf-like skins laid one on top of the other." Majak explained:

> It was only after I had analyzed body emanation in *Sofa* series that I fully realized the nature and possibilities of zone plate imagery. In the series I invited my friends to visit me and pose naked on my sofa. Each exposure took approximately 25 minutes. The prolonged penetration gave the series a unique insight into body-light sensitive material interaction.[9]

FIGURE 7.8
© Doug Spowart, *Lost City near Cape Crawford*, from series *Icons of the Australian Landscape*, 17 × 22-cm toned zone plate photograph, 1997. From the collection of the photographer.

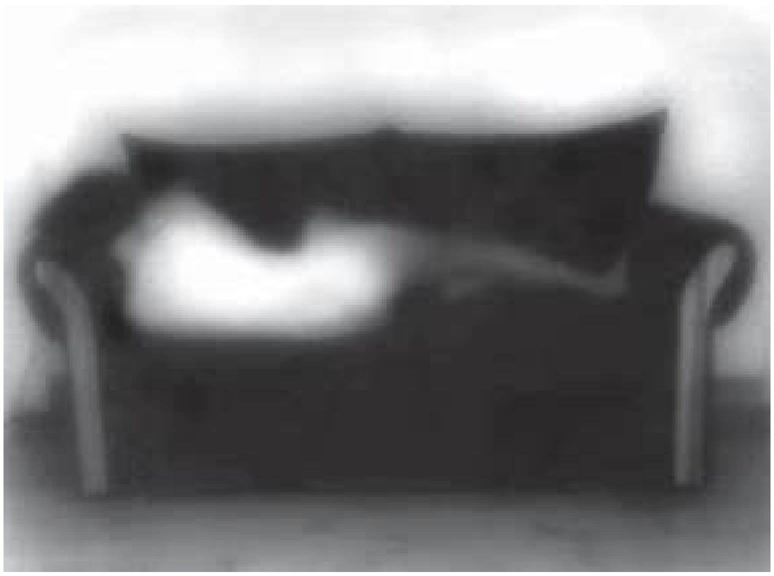

FIGURE 7.9
© Katarzyna Majak, *Sofa 1*, from series *Sofa*, 5 × 7-inch zone plate photograph, 2002. From the collection of the photographer.

FIGURE 7.10
© Robert Willis, *Untitled Nude,* 3 × 5-inch zone plate sepia toned photograph, 2001. Reflection from a flexible mirror. From the collection at Pinhole Resource.

Robert Willis of Jacksonville, Florida, used a zone plate to photograph into a flexible mirror for *Untitled Nude* (Figure 7.10). The distortion is unusual—it slightly altered a one-point perspective and added a depth of mystery to the archetypal image of a nude woman.

Many additional zone plate images are shown in the following chapter.

SLIT IMAGING

Slit imaging is one of the least explored areas in art photography and can be one of the most sophisticated. In Chapter 6, Hans Knuchel's *Untitled Slit Image* is shown in Figure 6.7C. In slit imaging, a pinhole as a point of light is stretched to a line of light, allowing an image to be formed. This aperture still produces an image of very reasonable quality. If the image is considerably blurred, the slit may be too large for the focal length.

Michael Wesely from Germany made a very simple 4 × 5 slit camera to photograph his *Palazzi di Roma* and *New York* series in 1995. The slit runs lengthwise along the 5-inch side of the film. For these images, the slit camera was placed vertically to photograph upright buildings with strong vertical linearity. Due to the lack of space within the city, Wesely had to be near the buildings he photographed. This accentuated the strong hard edges, contrasty light, and cool glitz of the cityscape.

Four years later, from 1999 to 2000, Michael Wesely went to the American west to concentrate on form rather than linearity and on warmth rather than coolness using his slit 4 × 5 camera. Due to the miles of distance being photographed, he chose specific sites that exhibited a strong horizontal flatness with a softening of the horizon line—places such as Death Valley, the Grand Canyon, the foggy Pacific Ocean at La Jolla, the Westfall Meadows in Yosemite, and even the maze-like overview of Los Angeles at Mulholland Drive. These are places with subtle color values, few shifts in linearity, and miles upon miles of blended view. For these he placed the slit camera horizontally. In his beautifully evocative image *Zabriskie Point, Death Valley* (Figure 7.11), Wesely has given the viewer a new way to access the beauty in a sometimes familiar landscape. He erases that familiar postcard view and the Brunelleschi construct and concentrates on the aura of a superbly grand place. Wesely's images would have been equally striking even if the postcard view had not been indelibly placed in my mindset beforehand. Wesely's landscapes are hauntingly real, not abstract. Michael Wesley explained his slit camera:

> The camera works like a pinhole camera, but across the front of my self-built wooden 4 × 5 camera runs a fine slit. The camera is not moved at all, or traveling. Many people think that these landscape pieces I make are also related to long exposures, they aren't. The horizontal slit erases all vertical aspects of the objects in front of the camera and delivers color values of all horizontal sections of the landscapes.
>
> But one thing for sure: there is no computer manipulation; the picture is a straight image, very low-tech.[10]

Slit photography, which dates back to the late 1800s, seems to have been first mentioned by William H. Pickering, a professor at Harvard Observatory, as follows:

> The pinhole principle may also be used for another purpose, more amusing, perhaps, than artistic, which was first suggested to me by Mr. J. R. Edmands. Let us substitute for the lens a narrow vertical slit, about three inches long by one-fiftieth of an inch wide, made by pasting two strips of black paper side by side. About two inches behind this arrange a horizontal slit of the same dimensions. Two inches behind this place the sensitive plate. The apparatus is analogous to two cylindrical lenses of different foci placed at right angles, but is more readily adjusted. If an exposure is now made we shall find everything distorted to twice the size horizontally that it is vertically. By turning the camera on its side we get a vertical distortion. By inclining the slits at different angles variously distorted pictures may be obtained.[11]

FIGURE 7.11
© Michael Wesely, *Zabriskie Point, Death Valley*, 125 × 200-cm type C slit photograph, Diasec mounted, steel frame, unique print, 1999. From the collection of the photographer.

Slit photography was also mentioned in a paper by Louis Ducos Du Hauron (Figure 7.12) submitted to the *Société Française de Photographie* in 1889. He spoke highly of slit experiments and its usefulness in the following:

> Photography has been reproved to provide only blunt minutes and a servile representation of what nature offers us. I have the honour to submit to the attention of this Society the first proofs I performed of a way to photograph which will free of any slavishness the art of reproducing through light, allowing the Ideal, Fantasy, and even Science to take part to this operation . . . what I imagined rests on an optical law which has, as far as I know, never been exposed by any physicist. Thus I believe I could formulate it after having proved it experimentally.
>
> When, inside a dark room, a beam of light finds his way in, not through a small aperture, but through the intersection of two slits, orientated differently, both situated on parallel screens distant from each other in a determined way, the inner surface exposed to the light will reveal how the relative proportions of what is represented has been changed. . . . A precise symmetric image resulting from a single hole if done through the intersection of two slits placed at due intervals will make emerge a multitude of intersection points so that the shape of what is represented could modify itself in infinite ways. . . . If the first slit, vertical, close to what has to be reproduced and the second one, horizontal, closer to the emulsion, the impressed image will be amplified in a vertical way and reversed if the first slit is orientated in a horizontal way and the second one vertical.[12]

Pickering's dimensions and Ducos Du Hauron's ideas are perfectly useful today. A combination of two slits, one placed vertically and the other placed horizontally, will produce distorted images such as those made by Doris Markley of Philadelphia (Figure 7.13).

Wolfgang Otto patented a slit camera in 1909, and his ominous photograph of a leaning street published in *Scientific American* on February 15, 1913 gave warning as World War I approached (Figure 7.14).

The late Marnie Cardozo chose to photograph friends as well as herself in intimate portraiture using her double slit camera (Figure 7.15A), letting each friend select the shapes of

FIGURE 7.12
Louis Ducos Du Hauron, *Self Portrait,* from *Anamorfosi*, Jurgis Baltrusaitis (Adelphi Edizioni, Milano, 1990) 220. (The author does not know if this image was made with a single slit or a combination of slits.)

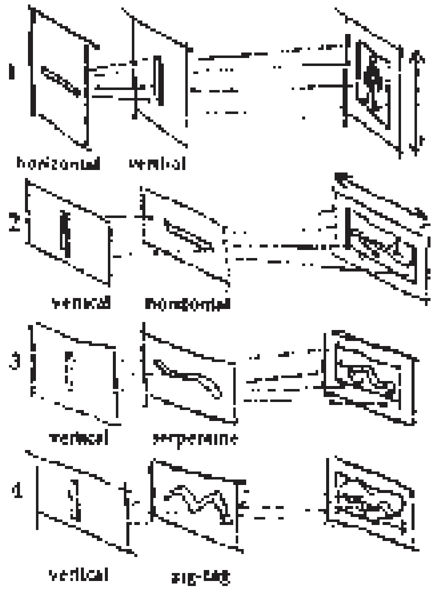

FIGURE 7.13A
© Doris Markley, slit drawings, 1987. From the collection at Pinhole Resource.

FIGURE 7.13B
© Doris Markley, *Untitled,* 4 × 5-inch slit photograph made using vertical front slit, horizontal back slit, 1987. From the collection at Pinhole Resource.

FIGURE 7.13C
© Doris Markley, *Untitled,* 4 × 5-inch slit photograph made using horizontal front slit, vertical back slit, 1987. From the collection at Pinhole Resource.

two linear slits that corresponded to their own psyche. Cardozo's images dramatically transformed their faces, but in a purposeful way that fit. In her strongly cubist, archetypal self-image entitled *Self Portrait, Vase* (Figure 7.15B), her face resembles the floating crescent moon and her figure becomes the lower portion of an hourglass—she is a universal mother time floating across a draped night sky. Marnie Cardozo explained how to make a slit as follows:

> Making Slits
> An ideal material for making slits is exposed litho film. Lay sheets of litho film in a sunny place for several days, and develop them in full strength paper developer. Fix and wash

FIGURE 7.14
© Wolfgang Otto, slit photograph, from "Slit Camera." From *Scientific American*, February 15, 1913.

FIGURE 7.15A
© Marnie Cardozo, Cardozo slit camera.

FIGURE 7.15B
© Marnie Cardozo, *Self Portrait, Vase*, 10 × 16-inch slit photograph, 1998. From the collection of the photographer.

the film normally. When the film is dry, use a Sharpie pen to draw the slit you want to make on the emulsion side of the film. Use sharp, clean scissors to cut the film in half along the line.

Cut pieces of black-on-black matboard the same size as the lens board of the camera you'll be using. Center a piece of cut film on the matboard, and trace around the cut side to transfer the shape of the slit to the matboard. With a knife, made a 1/4 inch cutout around the tracing. The cutout should be centered on both axes of the lens board. For a 4 × 5 camera, it should be approximately 3 inches long on the vertical axis, and 2-1/2 inches long on the horizontal axis.

Use slow drying water-soluble contact cement or other glue to glue the film to the matboard. Spread glue on the matboard on the top, or the right, side of the cutout; leave an unglued 1/8 inch border around the cutout. While the glue still is wet, glue the appropriate piece of the film to the matboard so the cut edge of the film covers half of the cutout and is centered over it. Glue the other piece of film to the matboard. The second piece must line up with the first and make a slit approximately 0.5 mm wide. A strip of double-weight photo paper should slide through the slit with ease. To define the length of the slit, cover both ends with light-proof tape. Tape the outer edges of the film to the matboard.

Inspect the slit with a comparator or loupe; make sure the edges are clean. If the edges are ragged or dirty, remove the first pieces of film from the matboard and make a new slit.

Put the lensboard-with-slit between two pieces of waxed paper, lay it on a flat surface, weight it, and let the glue dry. Repeat this process with all your slits.

Straight-line slits don't need to be trimmed to keep the width of the slit consistent from one end to the other. Curved slits may need to be trimmed to keep the same width at the ends of the curve as in the center. Trim the slits before you glue them to the lens board.

Shooting through Two Linear Slits
The image in a slit camera is exposed at two different focal lengths. . . . Thus a slit image is recorded at two different scales. The image also passes through slits of two different shapes and is bent by both of them. It follows, then, that the image will be doubly distorted in the camera. If nothing else, slit images are studies in distortion.[13]

Alternatives to Slits

Images can be made using a vertical slit as a shutter placed immediately in front of the film in a conventional lens camera while the film is wound and moving (an offshoot of the focal plane shutter—a technique that has a long photographic history). Even though this technique uses a lens, it seems worthwhile to mention, since the images I have included have pinhole sensibilities. Paolo Gioli began working with this type of *Fotofinish* imaging in 1974 and has continued his investigations. By 1987, Gioli began using masking plates of blackened film with various thin clear areas—these clear areas would let the image pass through, while the blackened area blocked the light. Later in 1996, Paolo Gioli traveled to Japan imaging with a variety of about 25 masks using high-contrast black and white film and ink photographing symbols and "signs" he saw in Tokyo. These images are published in *Paolo Gioli: Volti Attraverso/Tokyo 1996* (Chaisso, Italy: Folini, 2007). Figure 7.16 was made using pubic hair as clear lines on the masking plate. Gioli spoke of this work:

> The technique of photo-finish, which I started to use and reinvent in the early Seventies, involves deconstruction and recomposition and other plastic phenomena which call to mind certain computerized graphic processing. It is essentially about the creation of a series of real time movements and sudden stops.

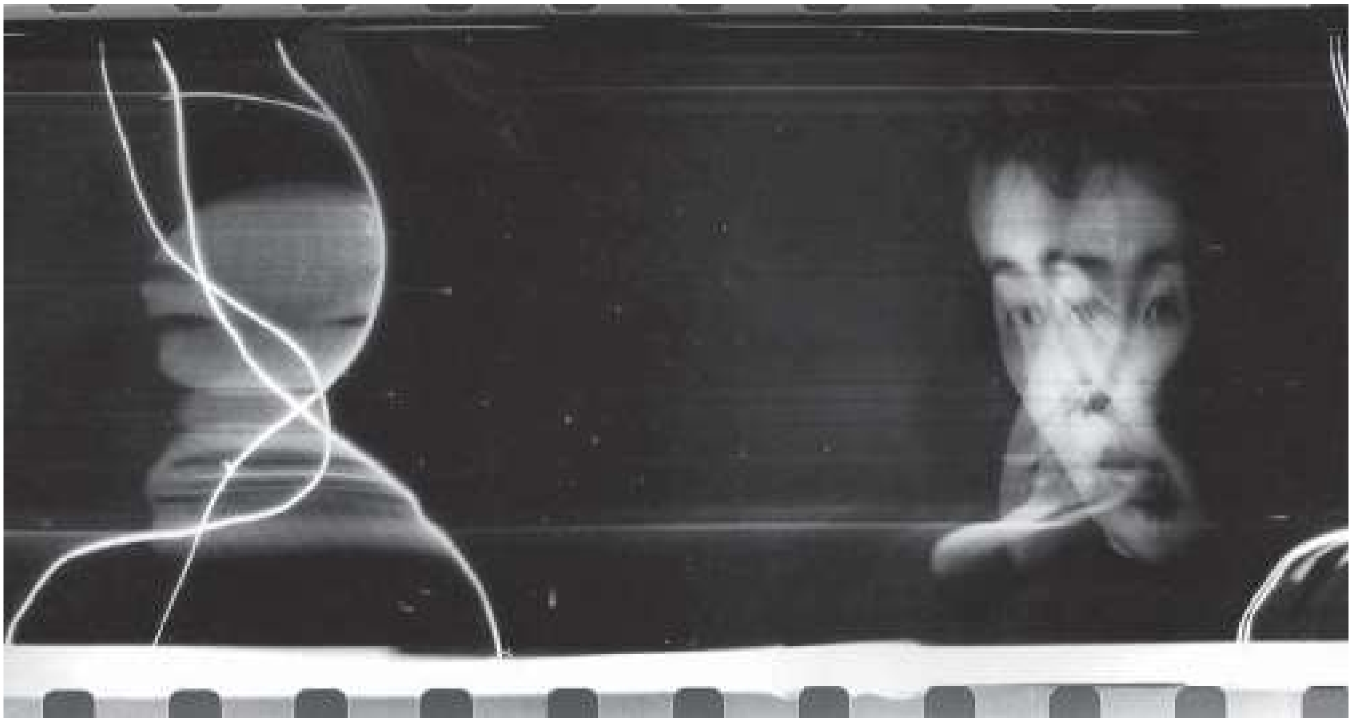

FIGURE 7.16
© Paolo Gioli, *Volto attraverso peli di pube*, 40 × 50 cm, 1996. Collection of the photographer.

> So the figure taken enters into conflict with a fixed image positioned in the viewfinder of the camera itself. In this way, one establishes unrelenting contact with a moving figure which at the same time is transformed into another, in a continual mutation of the figure (the other) blocked inside. The traditional fissured line is substituted by a fragment of image, perhaps even of the very face taken, or his signature, or any other part belonging to him or not; a face "forced" to pass through its own face, its own signature, or swallowed up by the graphic grid of itself. I have photographically dissected an entire body and inserted it piece by piece into the photo-finish camera so that the image can be analyzed with fragments of itself. Its identity is turned inside out and scaled through the slender thickness of the interposed fragment. As many identities as possible modelled on a single one, inert, face with unexpected plastic resolutions, with progressive movements and actions, as if struck by an inserted "twisted" memory.
>
> These faces of Tokyo from the darkness make their way toward the "signs" that I have gathered throughout the city, toward my paradoxical photo-motion-picture camera, my obscure lapis.[14]

Jonathan Trundle of Baltimore, Maryland, spoke of his slit image in Figure 7.17:

> The image of the chair swings is a slit shutter camera image from a highly modified Hasselblad camera. I attached the camera onto a tripod and pointed the lens up toward the riders. As the ride moved I hand wound the film past the slit (the modified section of the camera) via a simple crank and thus exposing the film as one long continuous negative, rather than into individual separate frames. As the ride spun in a circle it changed pitch, causing the wavy band at the top and the riders to change pitch and speed. Four and a half (4.5) complete 360 revolutions are visible within this one image.[15]

FIGURE 7.17A
© Jonathan Trundle, *Chair Swings*, 4.3 × 55-inch slit photograph, 2007. Collection of the photographer.

FIGURE 7.17B
© Jonathan Trundle, detail, *Chair Swings*, 4.3 × 16-inch slit photograph, 2007. Collection of the photographer.

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CHAPTER 8

Digital Imaging with Pinholes, Zone Plates, and Alternatives

Techniques vary, art stays the same: it is a transposition of nature at once forceful and sensitive.

—CLAUDE MONET

One of the first homemade digital pinhole images was created by Sam Wang in 1989 (Figure 8.1), which seems like eons ago for digital technology. Sam Wang described his process as follows—actually it was nail hole not a pinhole:

> The nail hole picture was made by using a digitizer on the computer to convert the video signal to digital, so that the color separated images can be manipulated on the computer and combined and printed one color at a time on a computer (digital) printer.
>
> It was crude, but all early digital imaging was crude. Instead of being captured on CCD sensors like today's digital cameras, it was captured as continuous video signal, but translated into digital by a converter. Slower, but same concept.
>
> Makes sense? Look ma, no film! Just electronic bits and bytes. Must be digital.

But that was almost 20 years ago. Presently, many artists are using pinhole and zone plate body caps on their digital single lens reflex cameras. First of all, it's easy to turn a DSLR into a pinhole or zone plate camera! Just about any removable lens digital camera will accept a body cap. All Nikon models take the same cap, as do all the Canon EOS models. It's the Photoshop and printing part of digital photography that has a long learning curve. If you have a digital single lens reflex camera you should only use a "no dust" pinhole or zone plate body cap. "No dust" means that the pinhole or zone plate has been made with a very opaque *black area on film; the pinhole or zone plate area is clear on the film*. A "no dust" pinhole is **not** an open pinhole made with a needle—a place where air and dust could enter your digital camera and end up on the CCD sensors.

If you have dust on the light sensors in your digital camera, it will show up as little dark spots on the final image. The spots will always be in the same place on every image. After you get a pinhole or zone plate body cap and if you notice dust right away on images, it means it was there before. If you are unsure if the spots are dust, make a picture of a white wall by setting the camera on manual (with its lens back on) and make the image with the lens set way out of focus. Then see if the spots still show up in the image. If they do, it's dust!

FIGURE 8.1
© Sam Wang, *Untitled Still Life*, 4¼ × 7-inch nail hole color-separated computer print, Macintosh ported to Atari ST, printed on Star, 1989. From the collection at Pinhole Resource.

A little piece of dust or dirt right on the pinhole or zone plate will not show up as a little spot in the image. "No dust" pinhole and zone plate caps should not get wet in the rain.

When changing lenses or changing to a pinhole or zone plate cap, you should **always** hold the camera lens area **toward the ground** so dust doesn't naturally fall into the camera. It's very important to not change lenses in a windy or dusty area.

If you do have dust in your digital camera, you should use one of the wet or dry products recommended by the Website cleaningdigitalcameras.com. You can try a Giotto Rocket Blower (we use that method) and if that does not get all the dust removed, possibly Eclipse cleaning solution will. Care is recommended. Don't use canned air!

"No dust" pinhole and zone plate caps are available from Pinhole Resource.

Making Digital Pinhole and Zone Plate Images

After putting the pinhole or zone plate cap on your camera, set your camera to manual. In the menu, adjust for the lighting condition: tungsten, daylight, and so on.

Set the ISO at a low rating unless you want pixel artifacts in the final image. Try a pinhole image at about 1 second in bright sun. Try a zone plate image at about 1/20th of a second in bright sun. Zone plates work well too, even when imaging in lower unshadowed light than always in bright sun (Figure 8.2) and will still provide a subtle glow at the edge of a contrast break. Because of veiling glare, some zone plate images will lack saturated color as compared to pinhole images. Saturation can be increased in Photoshop.

Check the viewing screen on the back of the camera and either add or decrease the time. The beauty of digital is that you can see how the image looks and you can always delete. Trial and error is the only method and it's the best. Unless you have some other specific reason, you should probably always shoot *raw* files.

Most DSLR cameras such as the Nikon series, Canon EOS series, and Olympus are easy to convert to pinhole or zone plate imaging. If, however, you are using a Minolta Maxxum DSLR with a pinhole or zone plate cap, set your menu to *star*, go to *custom*, and then set it to *Shutter Lock Off*.

Since you can buy DSLR camera bodies without a lens, that makes digital much less expensive, particularly if you only want the camera for pinhole or zone plate imaging.

In 2006, Nancy Spencer and I were invited to China to make images on a photo trek in Qinghai Province, a very rural area that was originally northeastern Tibet. We knew we would be on a little bus accompanied by other artists, probably none of whom did pinhole or zone

FIGURE 8.2
Nancy Spencer, *Trees*, Shenzhen, China, digital zone plate photograph from a Nikon D50, 2007. From the collection of the photographer.

FIGURE 8.3
Nancy Spencer, *Circumambulating Ancient Woman*, Qinghai Province, China, digital zone plate photograph from a Nikon D50, 2006. From the collection of the photographer.

plate imaging. They would probably be using very high-end digital cameras, which made us realize that if we used film holders, 4 × 5 pinhole cameras, changing bags, and tripods that these traditional methods would be cumbersome and time-consuming—undoubtedly our setup time would be unappreciated by the others. As a result, we opted for digital zone plate imaging. Because zone plates make an image seven times faster than pinhole, we figured that this too would speed things up. It did; we actually blended in with the other photographers and made images (Figures 8.3 and 8.4) as easily as anyone else. At an exhibition in Xining we met up with a large group of commercial photographers who watched how Nancy and I were using our digital cameras. They thought we had forgotten to take the body caps off—where were our lenses? Humbly, they came over to correct us. When we showed them that we actually could get an image to show up on the screen with a body cap on the camera they all were appreciably happy, but puzzled. We showed them the tiny little hole in the body cap—then, they understood and everyone laughed even harder.

Less than a year earlier, Nancy had purchased a Nikon D50 in Beijing. From Beijing we went to an exhibition of our photographs in Pingyao, a small city that is a World Heritage Site. We wanted to put a pinhole onto the body cap of Nancy's new digital camera. Having no drill or

FIGURE 8.4
© Eric Renner, *Face*, Qinghai, China, 16 × 24-inch digital zone plate photograph from a Nikon D50, 2006. From the collection of the photographer.

FIGURE 8.5
© Nancy Spencer, *Black Horse, White Horse*, New Mexico, 16 × 24-inch digital pinhole photograph from a Nikon D50, 2006. From the collection of the photographer.

other tools, we went out on the street. Luckily we found a bike repairman. We showed him the body cap and, using hand language, asked him if he had a hand drill that would put a hole through it. He quickly understood, went into the back of his shop, and came out with a hand drill and just the right size drill bit. He drilled a 3/8-inch hole through the cap. Next we cut a piece of metal from a soda can, took a pushpin, made a pinhole, sanded it somewhat smooth with a nail file, and taped it onto the body cap with black electrical tape that we had brought along. In about 15 minutes we had a working digital *pinhole* camera. of course this physical hole let a small amount of dust into the camera, however, it was the best we could do. A roll of black electrical tape always comes in handy when traveling. Other advice when traveling with a pinhole or zone plate digital camera is to take many extra image cards, extra batteries, a Giotto Rocket Blower, and a good camera bag.

Returning to the United States, Nancy made handheld digital images (Figures 8.5 and 8.6). *Black Horse, White Horse* was one of those surprise images that appear as an enhanced

FIGURE 8.6A
© Nancy Spencer, *Cypresses*, North Carolina, 16 × 24-inch digital pinhole photograph from a Nikon D50, 2006. From the collection of the photographer.

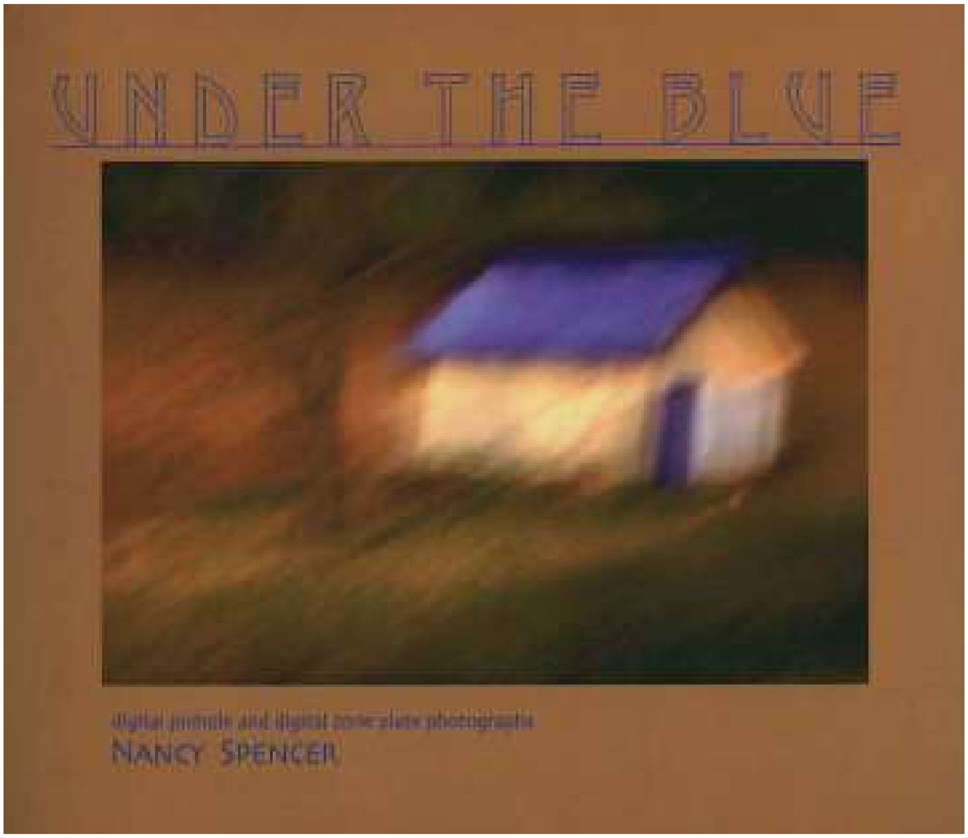

FIGURE 8.6B
© Nancy Spencer, *Under the Blue*, Flying Monkey Press, 2008, cover, digital zone plate photograph.

mishap. Many of Nancy's digital landscape images are in *Under the Blue* (Flying Monkey Press, 2008) (Figure 8.6B).

Thomas Micklin used a "no dust" 0.29-mm pinhole on his Canon 5D to photograph *The Meadows* at Washington Park Arboretum in Seattle (Figure 8.7). The image has a slightly different look and feel than if it had been photographed using a pinhole on a film camera. Using the same "no dust" 0.29-mm pinhole, Micklin added a 25-mm extension tube onto his Canon D5 and photographed *Falling Light* at Madison Falls (Figure 8.8). Because the

FIGURE 8.7
© Thomas Micklin, *The Meadow*, Washington Park Arboretum, 8 × 12-inch digital pinhole photograph from a Canon 5D, 2007. From the collection of the photographer.

FIGURE 8.8
© Thomas Micklin, *Falling Light*, Madison Falls, 8 × 12-inch digital pinhole photograph from a Canon 5D, 2007. From the collection of the photographer.

pinhole was not optimal for that increased focal length, the image has an even softer look, surprisingly like a zone plate image.

Sam Wang has continued his use of zone plates (Figure 8.9) and in 2006 was instrumental in developing short focal-length zone plates: 45 mm, 38 mm, and even shorter.

Stefano Bandini of Kyoto, Japan, used a Canon EOS 5D with a Kenko pinhole adaptor to make handheld *Nico the Clown* (Figure 8.10). Of the Kenko adaptor available in Japan, Bandini explains:

> The Kenko Adaptor is basically a camera cap which is installed on the camera instead of the lens. It consists of two pieces, one is a threaded circular plate in which the pin hole is drilled. The second one is a ring that is sold with different mount (Canon, Nikon etc.); the threaded part is mounted in the ring and the assembly is mounted in the camera as a lens. It has a focal length of about 50 mm and an f number of 250. The Kenko Adaptor can be seen at http://www.yodobashi.com/enjoy/more/i/cat_13_23_12219283/1233177.html and http://www.yodobashi.com/enjoy/more/i/1219575.html.[1]

FIGURE 8.9
© Sam Wang, *Encounter in Forest*, 12 × 18-inch digital zone plate image from Canon Rebel, 2003. From the collection of the photographer.

FIGURE 8.10
© Stefano Bandini, *Niko the Clown*, 30 × 20-cm digital pinhole image from Canon EOS 5D with Kenko pinhole adaptor, lighting with a lateral spot and white umbrella and opposite side a reflecting panel, 1600 ISO, 3-second exposure. 2003. From the collection of the photographer.

Digital camera options were explored by Jürgen Königs from Germany, who used an Olympus E500 to create *AB-Seher* (Figure 8.11). He explained:

> I modified a DSLR camera into a pinhole camera by replacing the objective with pinholes of different shapes, zone plates and slot systems. I also used a kind of bellows lens hood to combine positive and negative masked images sections. On the other hand such a digital pinhole camera has some limitations: you can't get wide angle pictures and there is only one image size. The image field is always plane. Multiple exposure isn't possible—and so on. On the other hand you can choose for example between different

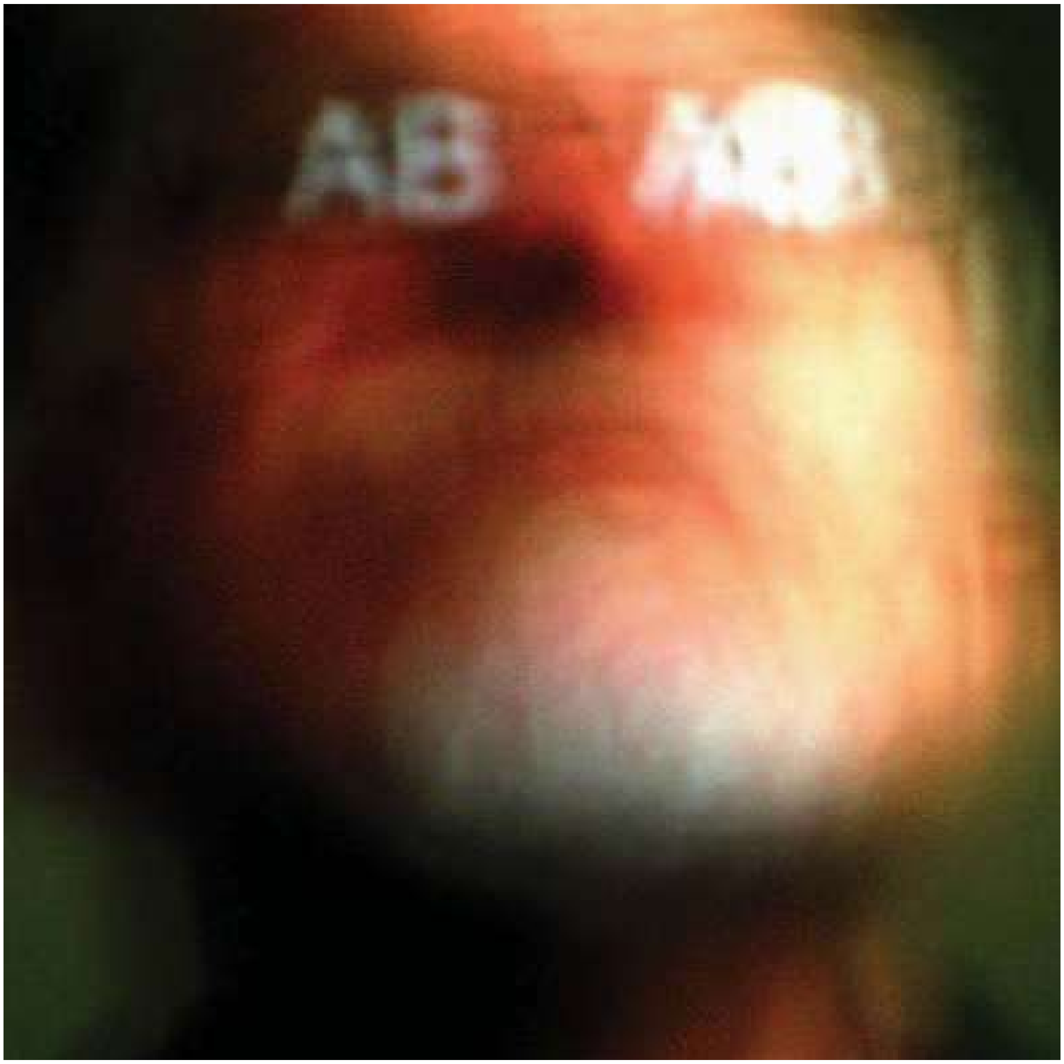

FIGURE 8.11
© Jürgen Königs, *AB-Seher* series *Präfixel*, 2007. From the collection of the photographer.

> modes of monochrome or colored picture and of sensitivity. You can use noise reduction or accept or push noise as a means of expression. Furthermore you can control the images immediately.
>
> The picture *AB-Seher* of the *Präfixel* series is made with a letter shaped pinhole. I used the German prefixes (AB-, VOR-, NACH-) each of them differentiating the meaning of the german word 'Bild' (=image).[2]

Pinhole Spy Cameras

Hardly a spy camera, but this 1885 rendition of a pinhole *camera obscura* made with a derby hat suggests imaging discretion (Figure 8.11) and humor (as no one would have known you had a *camera obscura* with you). I guess you were meant to wear the hat on your head until that special magic moment appeared. Then you swiftly got under your oversized black cape, saw the upside down image on translucent paper, traced it, and then put your hat back on your head and continued onward, with no one the wiser.

A digital pinhole camera may someday be manufactured, but only if there is a market for it. However, there are digital pinhole *spy* cameras. . .hmmm? In fact, an overwhelming surfeit of them are on the market. That lipstick sitting on your bureau may just be a camera or the Teddy bear (Figure 8.13) sitting high on a shelf may image your babysitter.

FIGURE 8.12
Derby hat *camera obscura*. In 1885, a simple *camera obscura* was made from a derby hat, translucent paper, and a dark cloth, from *Scientific American*, April 1885. From the collection of Julie Schachter.

FIGURE 8.13
Teddy bear spy camera, one of many objects available commercially as a spy camera.

Jim Moninger from New York used a pinhole spy camera and then wrote about its usefulness in "Pinhole Videography and the Digital Still" in Volume 18#2 of *Pinhole Journal* (2002). The pinhole on his Visiontech VC25P3 spy camera (Figure 8.14a) is less than 1 mm. Moninger stated:

> Pinhole imaging is widely used in the commercial production of state of the art micro-miniature video cameras. Designated "Spy Cameras or Nanny Cams," these are extraordinarily small, relatively low cost, video cameras which have powerful imaging capabilities.
>
> Their tiny size makes them ideal for concealment in ordinary household objects like clocks and books. They're available in both black and white and in color, and deliver the

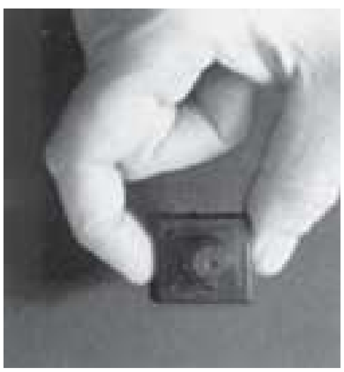

FIGURE 8.14A
© Jim Moninger, pinhole spy camera, 2002. Lens photograph. From the collection of the photographer.

FIGURE 8.14B
© Jim Moninger, *Pinhole Videograph Shot in a Dark Cafe,* 2 × 3-inch pinhole photograph, 2002. From the collection of the photographer.

FIGURE 8.14C
© Jim Moninger, *Intense Man*, 2½ × 3-inch pinhole photograph, 2002. From the collection of the photographer.

same picture quality as VHS camcorders. . . . Many of these devices have glass lenses, but many have a pinhole for primary imaging. Color models cost well under $100.

Art and the Pinhole Videograph

Miniature pinhole video cameras, connected to a conventional camcorder, can be a powerful imaging tool for the artist creating still photographic images. Rather than being limited to art applications in the video medium alone, many of today's camcorders have the ability to capture still photographs from their own tape recordings in a digital form which is readily downloaded to a computer. Images can then be improved with imaging software and printed out on a wide variety of papers with a digital printer. These video/still camera hybrids often feature input jacks which enable them to record the images played back on tape by another camera; for example, the pinhole spy camera. This is the method I've been using to explore the aesthetic potential of this new pinhole technology. I've connected a miniature pinhole video camera to a conventional miniature digital video camcorder. The camcorder records, like a portable VCR, the footage imaged by the pinhole security camera. Later, the tapes are played back and the camcorder is used to extract still images from the moving pictures.

Low Light Pinhole Imaging

Exploring these technological advances has opened the opportunity to expand the vocabulary of pinhole photography into radically new dimensions of creative expression. First: low light. One of the most serious inherent limitations in pinhole work is largely overcome: The dependency on bright light or slow shutter speeds. Very low light images formed by pinhole video cameras are electronically enhanced. It is now possible to shoot with a pinhole camera in extremely dim light, including that of city street light, and at action-stopping shutter speeds. At last, night photography of moving subjects is possible with a pinhole camera.

These tiny video cameras, roughly the size of a sugar cube, contain circuitry which delivers a remarkably accurate exposure down to an incredible .2 Lux level of light. Some even have automatic backlight compensation. The color versions have automatic color correction built in. Although the expanded depth of field of pinholes is reasonably maintained, the cameras focus automatically. Focal lengths are somewhat limited, but some cameras feature a fairly wide angle of view comparable to the 28–35 mm ranges. The technology that allows this is based on the use of electronic components, most often CCDs (Charge Coupled Devices). CCDs function something like the light-sensitive photoelectric cells used in light meters which respond to varying levels of light intensity. Instead of a single area of sensitivity, CCDs contain a host of microscopic photosites which respond to the light intensity of various areas of the image projected to them from the pinhole. The CCD is connected to circuitry which creates an electronic reproduction of the image's light response. This is then recorded on conventional magnetic video tape. Typically, CCD imaging systems contain 320,000–1.3 million photosites. The more photosites and the larger the CCD, the greater the resolution of the image. This is an expression of the clarity and detail of the recorded image. By using additional circuitry, the cameras can amplify dark areas of the scene to compensate for low light conditions. They can also read a backlight situation and adjust the exposure accordingly. Often, they focus by detecting changes in the frequency of the light striking the photosites in various parts of the CCD.

Image Quality Issues

Image quality of spy cameras for VHS movie recording is quite good. However, the quality of "captured" still photo images is very low when measured by conventional photographic standards. Of course, one of the liberating aspects of venturing into pinhole photography is that the soft and low contrast images, the motion blur and camera shake, the flare and other weaknesses have opened up our visual sensibilities to the expressive capabilities of these characteristics. Spy cameras deliver very low resolution and are practical for only very small prints of reasonable quality at this period in the technology's evolution. In addition to the images being soft and flare-prone, like most pinhole images, video-captured images made with pinhole spy cameras contain video artifacts such as scan lines, jagged edges, and patches of phantom color which appear in various parts of the image.

Image quality of video captures is significantly improved by using Digital Video Camcorders, but it is still very far from the quality that can be expected from film cameras and digital still cameras of high resolution. Capture resolution of digital cameras is listed in terms of 'megapixels,' or one million pixels. Pixels are tiny areas of light and dark (and color, where relevant) which comprise the image. It is convenient to think of pixels as being like the silver metal crystals which form the image on conventional photographic film. The more megapixels, the higher the resolution of the image.

For the work illustrated here, I'm using a SONY TRV900 camcorder capable of only 1.3 megapixels of resolution. This delivers a print of adequate quality for snapshots only to a size of about 4×5 inch. By comparison, higher quality 35 mm digital still cameras deliver images comprised of 5 to 6 megapixels, or four times as much clarity and detail than the best consumer grade camcorders. And, although very low light images are now feasible using these cameras, the lower the light level, the lower the quality of the image. The weak link is not the camcorder but the spy camera which is of far lower resolution and creates a lot of visual noise in low light.

Among the images illustrated here is a series made in the New York City subway [Figures 8.14b and 8.14c]. Light conditions there are such that, with an ISO 400 film, exposures at 1/30 range from f1.8 to f4. This low light level is impossible for ordinary pinhole work shot at hand holdable and action-stopping shutter speeds. If the quality is low today, dramatic improvements in both camera types can be expected in the near future.[3]

Digital Printing for Nonsilver Processes

Sarah Van Keuren, author of *A Non-Silver Manual,* has generously contributed detailed information for digital printing with nonsilver processes.

From the perspective of a non-silver printer working in gum bichromate and cyanotype: many imperfect pinhole negatives may be scanned and improved in Photoshop. Barely perceptible shadow details in underexposed pinhole negatives, both paper and film, often appear in scans and can be boosted in Levels or Curves, adding richness to the image.

Working in hand-applied alternative processes requires contact negatives that are the size of the printed image. A small pinhole negative may be scanned at a high enough resolution so that the resized larger negative has a resolution of 300 dpi. Enlarged negatives may be printed on inkjet acetate film or on vellum or lightweight plain paper. (You will obtain a richer inkjet negative if you print in color with the cyan, magenta and yellow cartridges contributing to the info and density of your negatives that will still look monochromatic.)

If your printer does not produce large enough negatives you can tile them together printing one segment of an image at a time and taping them together. Or if you have access to a copy camera you can print out a positive from your computer printer on, say, 8 1/2 by 11 inch paper, and then in the copy camera enlarge onto bigger ortholith film to obtain a negative.

If you are printing from a color negative or positive you might want to change to CMYK mode and print color separation negatives by highlighting one channel at a time and printing a monochromatic (black but in color) negative from it. If you wish to inject color

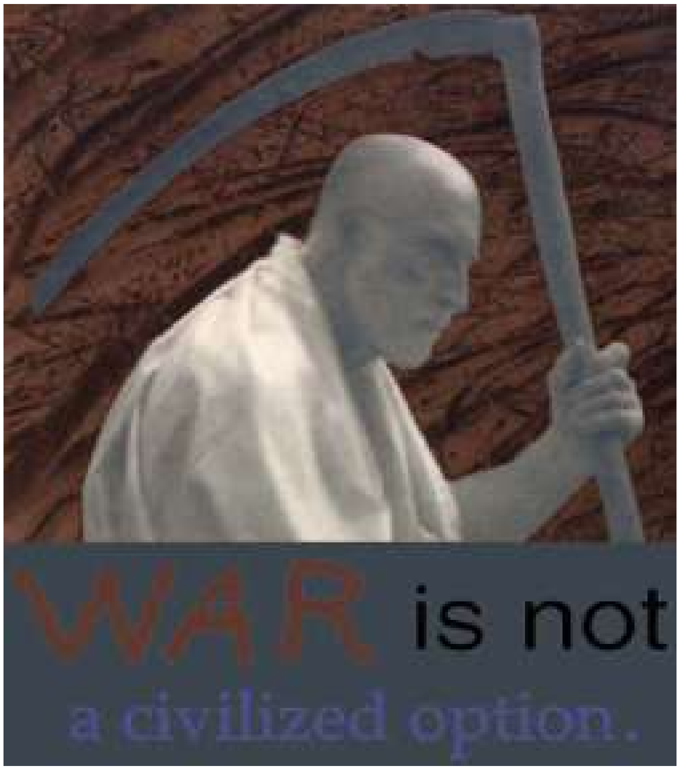

FIGURE 8.15
© Sarah Van Keuren, *War is Not a Civilized Option*, composite pinhole negative and pinhole positive cyanotype and gum bichromate photograph, 2003. From the collection of the photographer.

into a b/w negative you can also switch into CMYK mode and then in the manner of a printmaker, make changes in each separation so that an in-color imager emerges.

Theoretically duotone, tri-tone or quad-tone negatives can be generated in Photoshop from continuous-tone b/w pinhole negatives. In practice I have only generated duotones negatives from enlarged lens negatives. Sometime I would like to compare the look of a Photoshop duotone rendition of a pinhole negative with my old way of printing two layers in gum from a single 8 by 10 inch pinhole negative with a short exposure in a dark color for the shadow details and a subsequent much longer exposure in a lighter color to extend into the highlights.

I save all of my pinhole negatives so that eventually I can scan and compose from them. Certain negatives that may seem empty and a bit dull such as a field with woods in the background can function as stages upon which I place my 'actors' or symbolic elements. Pinhole negatives work especially well in this montaging activity because they have fairly uniform soft resolution rather than being in or out of focus. The effect is painterly.

Another use of the computer when printing from b/w pinhole contact negatives in alternative processes is as a source of accurate nuanced masks [Figure 8.15]. This is especially handy when attempting to produce areas of local color from a b/w pinhole negative. The mask can be feathered and gradated and specified to be of a particular opacity that would be hard to achieve by other means.

Finally, it is useful to be able to produce in advance a positive inkjet proof that roughly approximates to what you are heading towards in your non-silver print.[4]

NOTES

1. Stefano Bandini, personal communication with the author, 4 January 2008.
2. Jürgen Königs, personal communication with the author, 15 August 2007.
3. Jim Moninger, "Pinhole Videography and the Digital Still," *Pinhole Journal*, Vol. 18#2 (2002): 13, 24.
4. Sarah Van Keuren, personal communication with the author, 28 November, 2007.

CHAPTER 9

The Changing Pinhole Image

Seeing light is a metaphor for seeing the invisible in the visible, for detecting the fragile imaginal garment that holds our planet and all existence together. Once we have learned to see the light, surely everything else will follow.

ARTHUR ZAJONC, *Catching the Light*, Oxford University Press

Brunelleschi, looking through a hole at a street in Florence, makes a depiction of it from a fixed viewpoint. . . . The photographic process is simply the invention in the 19th century of a chemical substance that could "freeze" the image projected from the hole in the wall, as it were, onto a surface. It was the invention of the chemicals that was new, not the particular way of seeing. . . . So the photograph is, in a sense, the end of something old, not the beginning of something new.

DAVID HOCKNEY, *That's The Way I See It*, Chronicle Books

THEORY

The painter–photographer David Hockney, in the aforementioned quote, is expressing a mechanistic viewpoint toward the perspective produced by a camera, whether it be a pinhole camera or lens camera.

The camera, as well as the photograph, unless one or both are altered, produces one-point perspective and they are indeed the end product of the Italian Renaissance, even though we are beginning another millennium. Over 500 years have passed since Brunelleschi's device, yet it is still the basis for much of art, science, and everyday existence. This conundrum brings to mind the William Faulkner quote: "The past is never dead. It's not even past."

Hockney challenged us to find "the beginning of something new"—to reinvestigate the altering, destruction, or natural evolution of one-point perspective and create another visual structure. This, of course, is a grand request. It is not so easy to remove the vanishing point, in photography, which is central to the camera's physicality.

The deepest level of this book is to show that certain pinhole images can break with Brunelleschi's one-point perspective construct or question specific archetypes.[1]

Nor is it easy to remove the centuries of institutionalized Christian miracle propagandism displayed in visual archetypes that were reinforced by Renaissance artists' use of one-point perspective and the vanishing point. Leonardo spoke of the point in space as divine in *Codex Atlanticus* (mentioned earlier in Chapter 2):

> Who would believe that so small a space could contain the image of all the universe? O mighty process! What talent can avail to penetrate a nature such as these? What tongue will it be that can unfold so great a wonder? Verily, none! This it is that guides the human discourse to the considering of divine things. Here the figures, here the colors, here all the images of every part of the universe are contracted to a point. O what a point is so marvelous!

To use an appropriate word cliché: it all needs to be "put into perspective." I do not mean to cast disparaging words upon the great Renaissance artist Leonardo. He worked at a time when the corrupt Rodrigo Borgia (Pope Alexander VI) reigned (1492–1503). Papal biographers tell of Alexander VI's murders, orgasm competitions, multiple mistresses, incest with an illegitimate daughter Lucretia, and buying his Popeship. In the end he was fatally poisoned. Leonardo lived at a critical moment in time. He would have been intimate with Toscanelli's pinhole placed in the lantern of Brunelleschi's dome in Florence in 1475, as it was Leonardo who helped place the great copper sphere on top of the lantern a year earlier. By 1492, when Columbus sailed west, the Spanish Inquisition, which began in 1481, was in full swing (the Jews were sent away in ships as Columbus' boat left the port). By 1542 the Roman Inquisition began. To put it mildly, this was not a friendly time for the unconventional mind, much less a radical artist. Undoubtedly the great Leonardo had to speak admiringly about something that he felt was *divine*.

To challenge one-point perspective within a photograph, as well as challenge the invisible "Christian imprimatur," pinhole artists must seriously rearrange their own theoretical picture-making constructs, as well as their final imagery if art is to be free of conventionalism.

IMAGES

My image *Twentieth Century Man* (Figure 9.1) is a continuum archetype displaying man as the perfect macho/savior—an outdated visual analogue, but one that is still held in high esteem by many because it arouses instinctive feelings of power, strength, and moral saviorhood. Superman is a fantasy anachronism. My image is a well-considered parody about believing in visual myths that are archetypes. The word "superman," from the German ubermensch, was coined by the philosopher Friedrich Nietzsche (1844–1900) in his book *Thus Spake Zarathustra* (1891). Zarathustra was to be superior in his morals and virtues—he would apparently uplift the world.

Twentieth Century Man is meant to have its textural origin in Leonardo's *Man of Perfect Proportions*, his well-known drawing of a man standing within the edges of a square and a circle (Figure 9.2). Leonardo's drawing was made from Vitruvius' *De architectura* (1521), wherein the Roman architect stated that a perfectly proportioned man can stand erect with outspread arms in a square or with his arms raised and legs spread so that he can be inscribed within the edge of a circle. These images became a paradigm for the patriarchal. *Twentieth Century Man* also shares its present posture with the highly prized, golden Hollywood "Oscar" man, the pinnacle of Hollywood success and promotionalism, representative of the archetypal top—a place for instinctive feelings of "the best."

Historically, a circular rose window in a Gothic church was meant to symbolize the church's sacred concept of completeness and balance. Often an image of the Virgin Mother was at the center of the rose window in stained glass, a further example of the circular hole as a birth archetype. By juxtaposing a rose window (actually a double-exposed rose window) with the deteriorating face of a dead person in her nether-world series *Third Death* (Figure 9.3), Nancy Spencer has created a photographic analog that confronts the basis of western civilization's belief system. The image speaks of death and deterioration, post-transformation, not birth. Spencer made the zone plate image in the popular Mummy Museum in Guanajuato, Mexico.

FIGURE 9.1
© Eric Renner, *Twentieth Century Man*, 10 × 8-inch Polaroid 809 pinhole photograph, 2003. From the collection of the photographer. The light streaks were accidental, yet seem to be perfectly placed. In processing the Polaroid, the positive/negative sleeve shot up through the midsection of the Polaroid processor, which never happened before or after.

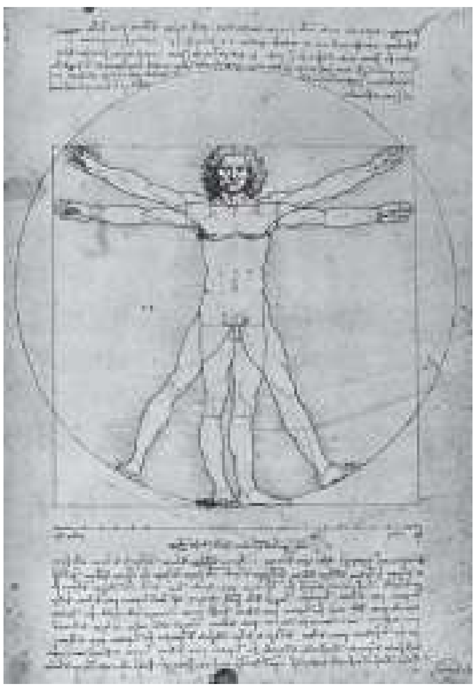

FIGURE 9.2
Leonadro da Vinci, *Man of Perfect Proportions*, 13½ × 9½-inch drawing, Accademia Venice, 1492.

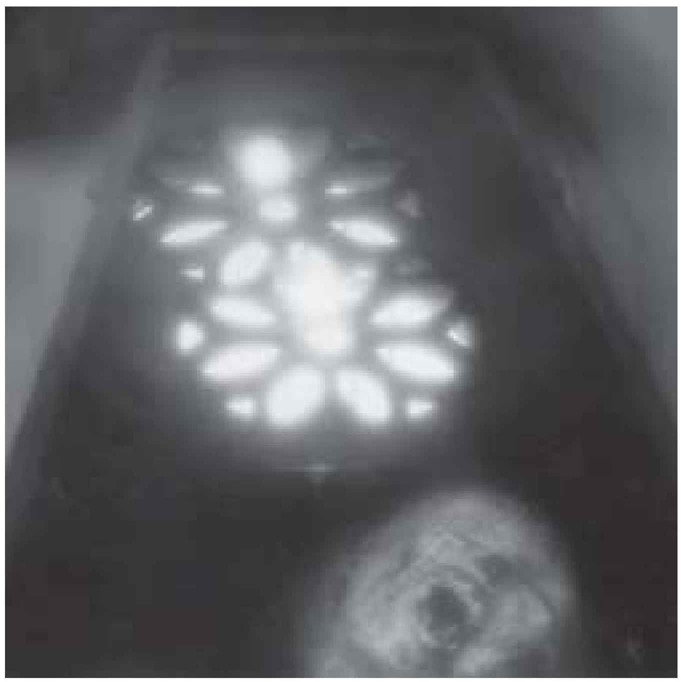

FIGURE 9.3
© Nancy Spencer, *Third Death*, sepia toned 11 × 11-inch zone plate photograph, 4-minute exposure on HP5 using a Lubitel altered to zone plate, 2003. From the collection of the photographer.

According to certain beliefs, the first death is when the body physically dies, the second death is when the body is buried, and the third death is when there is no one left to remember the person who died. Artists have always been fascinated with death, yet Spencer's photograph questions the hypocrisy of supplying all the answers, that is, why would there be a "sacred" concept of completeness and balance when the *Third Death* is staring all of us in the face?

Thomas Bachler had serious questions in mind when he started his bullet-hole experiment in 1994. The project seems to have evolved as an extension of his mirror-image *The Third Eye* (Figure 4.1). By sighting down a pistol barrel and shooting a bullet into a closed-camera box with photographic paper inside—paper that looked back at him like a mirror (Figure 9.4)—Bachler has postrealized his *The Third Eye* construct from 8 years earlier. His proverbial *Third Eye* has been philosophically driven by the bullet to the outside of a no-longer closed box. The object of Bachler's *Shot in a Head* image was to redefine his own experiential limitations, which are now "outside the box" (a metaphor and a cliché, but the bullet does go completely through the box). Thomas Bachler explained his process:

> I 'opened' a (still closed) pinhole camera with a pistol shot [Figure 9.4]. The picture of me has been made through the entry hole of the bullet. The bullet went through the pinhole camera and left through a hole at the back side. That is why there is a hole exactly where my eye is supposed to be. The photograph has thus been made with the help of the bullet, which at the same time destroys the most important part of the picture, my eye.[2]

FIGURE 9.4
© Thomas Bachler, *Shot in the Head*, 8 × 6-inch pistol bullet hole photograph, 1994. From the collection at Pinhole Resource.

Bachler's act is not a substitution for self-destruction, it is a metaphor for opening one's eyes as wide as possible, thus creating clear vision. Thomas Bachler's bullet-hole camera is an intellectual achievement, not one of violence. It represents a *turning of consciousness. Shot in the Head* could well be a theoretical response to the Karl Marx quote mentioned earlier in Chapter 1 as:

> If in all ideology men and their circumstances appear upside down in a *camera obscura*, this phenomenon arises just as much from their historical life-process as the inversion of objects on the retina does from their physical life-process.[3]

Patrick Poels of Belgium challenged his own sensitivity as well as the photographic process when he went to the Nazi extermination camps to "fight a plague called forgetting."[4] In making each image he purposely solarized the Polaroid's latent image that remained in the outer edges of his negative after the positive print had been separated, trying to force a catharsis onto his film and thereby onto himself. *Shoes, Majdanek* (Figure 9.5) exemplifies what he did. Of his use of Polaroid 665 he stated:

> I spent more than a year experimenting with the Polaroid 665 material I wanted to use for this series. I wanted to be absolutely sure that the esthetic elements that would

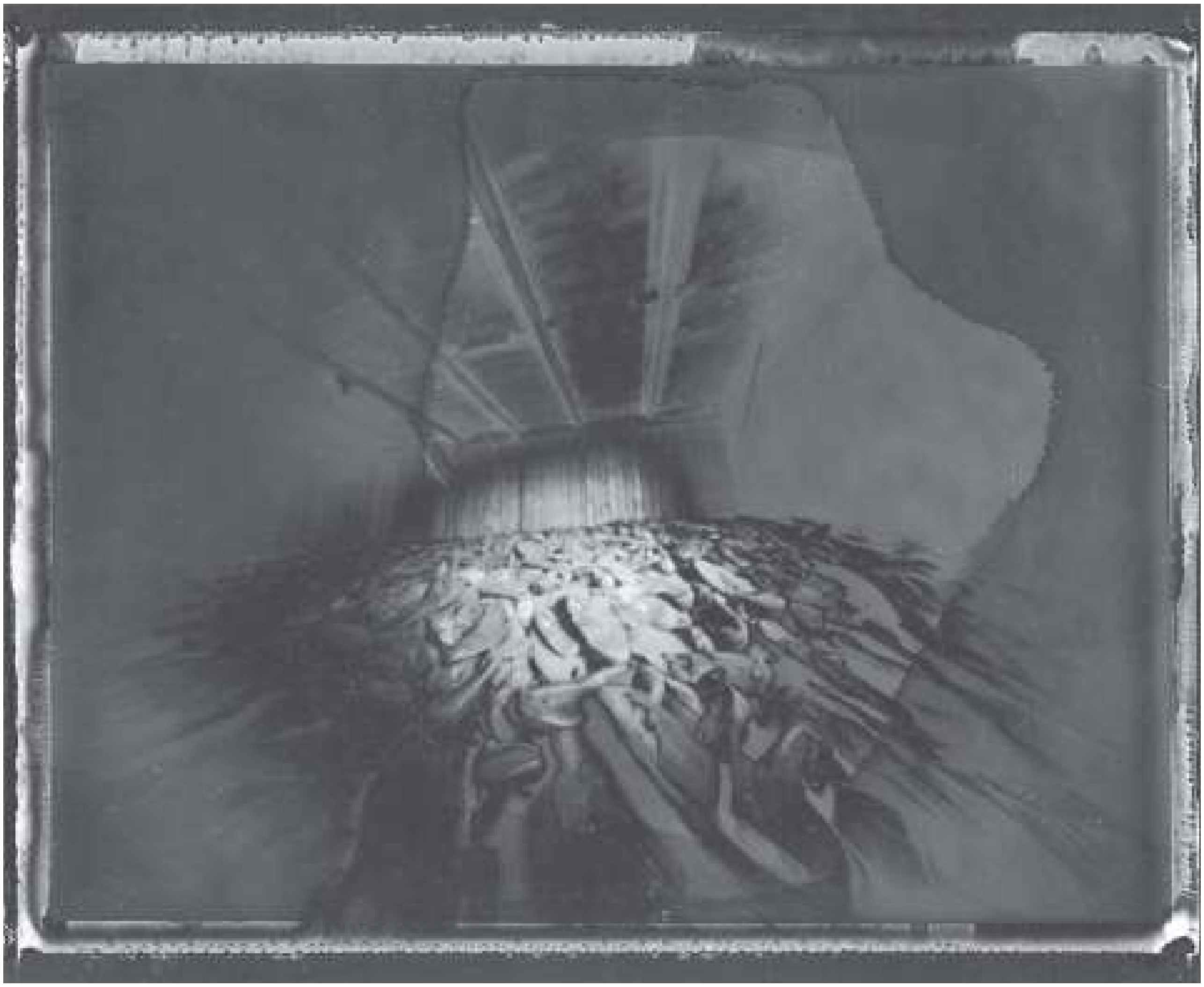

FIGURE 9.5
© Patrick Poels, *Shoes, Majdanek*, 6 × 7½-inch Polaroid pinhole photograph, 1992–1993. From the collection of the photographer.

> characterize the photographs could evoke my personal confrontation with these sinister places. I did my utmost to avoid these pictures would be 'beautiful' and I got rid of the usual standards going with Polaroid material. Because the camera I used had a small focal length in relation to the large size of the negative, the phenomenon of a well-exposed center and very thin corners was accentuated—a hot spot. I noticed that in the area outside the center there was sufficient latent image present to be developed via a second exposure. This second exposure was done immediately after development and after the positive and negative had been separated with white light from a handheld strobe, a solarization of the parts outside the center. Frequently, light conditions were poor, needing an exposure of several hours. However, I managed to reduce the exposure time to about 30 to 45 minutes through the second exposure (the solarization) and still have a negative containing all the required information. Times of exposure varied from a few seconds to several tens of minutes. I didn't use a tripod, the photographs were made with the camera in my hand or I placed it somewhere. After this was done, I stuck the developed and re-exposed negative again on the positive and put it all in a plastic bag to keep the negatives cool and humid. At night, in the hotel room, the negatives were again separated from the positives, cleaned in sodium sulphite, rinsed and dried. This method explains the spots and blurs and therefore the rudimentary character of the photographs.[5]

Poels stated reasons for attempting this difficult series are as follows:

> This documentary series was made in several Nazi extermination camps in Poland. During trips in 1992 and 1993, I visited Auschwitz, Birkenau, Chelmno, Majdanek, Belzec, Treblinka and Sobibor. . . . Maybe the realization of this series can help in fighting a plague called "forgetting," if only it were the struggle against my own moral amnesia. A pilgrim's journey. Possibly the pictures can tell more about my motivation than an elaborate written answer. . . . Before starting this series I dug into the necessary literature and watched many photographs and documentaries. I thought this the best way to have an idea of what I might find once I got to Poland. However, when one actually visits a camp or a former campsite, one becomes aware that 50 years after the facts, one is entering a museum. It is quiet and desolate (I even thought I could hear more birds sing outside the camp than inside). You can smell the mowed grass and the humid dark pinewoods in the area. So it is like archeology: you only have a few fragments or details from which you have to reconstruct the awful things that have happened here. You can only but say that words are not enough for this. I could only "hang onto" a few details that moved me in a big way and served as pars pro toto: in Majdanek I found a child's shoe in a large heap of tens of thousands of men's and women's shoes. In Birkenau and Sobibor, I dug a couple of inches in the soil and found ashes and fragments of human bones, even a tooth. In Auschwitz I saw a photograph of a newborn, literally thrown in the corner of a room, the navel string still there. Sometimes I was relieved that, as some sort of protection, I could place my pinhole camera between these horrible places and myself.[6]

To destroy the preciousness of the camera and its cherished yet usually completely separated image, Ilan Wolff reversed the process and made the camera and image one. Between 1994 and 1996, Wolff painted liquid emulsion (Figure 9.6) onto the inside of containers that were later assembled into pinhole cameras. After each camera was used for its one image, its emulsion was developed and then the camera was completely deconstructed into pieces laid flat. These could be exhibited; the original camera was always reconfigured into the final piece. Of his work, Wolff stated simply:

> The camera becomes part of the image and the image is part of the camera.[7]

Jürgen Königs used a double cylinder pinhole camera to create an intimate anamorphic view of a sliced squash (Figure 9.7). The double exposure leaves little trace of Brunelleschi's

FIGURE 9.6
© Ilan Wolff, *Architecture in Paris* (work in progress), pinhole photograph using Liquid Light inside a metal container with pinhole, with pinhole camera taken apart and exhibited flat, 1994–1995. From the collection of the photographer.

FIGURE 9.7
© Jürgen Königs, *Kürbisse*, 8¼ × 12½-inch platinum pinhole photograph, 2001. From a double cylinder pinhole camera. From the collection at Pinhole Resource.

one-point perspective construct. The image forces the viewer to accept this blending of an everyday object into a bizarre, constantly shifting form. While the eye wants to put pieces of the puzzle together, the image constantly pulls them apart.

Sarah Van Keuren has recently created prints that speak not only to the qualities of reflected light in clouds, sky, water, and of seascape, but also in emotional terms that strongly mirror her own vision of inner self. *Geometric Seascape* clearly shows the emotions held within her own being (Figure 9.8). Very little of the image is an actual seascape. Van Keuren is the ocean. The unpainted horizon is an opening—a place of her *transformation*.

FIGURE 9.8
© Sarah Van Keuren, *Geometric Seascape*, 8¼ × 10½-inch cyanotype and gum bichromate pinhole photograph, 2003. From the collection of the photographer.

After I wrote the above, Sarah Van Keuren generously added to my explanation with:

> The way the movement of waves during the pinhole exposure resolved into tubular shapes intrigued me. I scanned the 8 × 10 inch black-and-white negative and created in Photoshop three different negatives, my own eccentric color separations. Using a Scitex image setter at the University of the Arts in Philadelphia, I had the separations output onto film that was slightly larger than the original pinhole negative. Then on BFK Rives paper I printed from one negative in cyanotype and from the other two in layers of maroon and ivory black gum bichromate. There is an undertow of violence in the bloody maroon of the beach and the breaking waves and a menace in the red-black sky as in "Red sky at morning/Sailors take warning." Looking at the print now I am reminded of a recurring nightmare I had as a child. My family vacationed on the beaches of Kittyhawk and Nagshead, North Carolina where the waves were often towering and the undertow strong. In my dream the sea would draw back exposing the dark ocean floor and on the horizon I saw a dark line moving towards us which was a tidal wave. My family turned into cartoon-like cut-outs, frozen in harm's way.
>
> But there was also something exciting about the force of the angry sea, the oncoming tidal wave. And to the extent that one must own the parts of a dream—and of a print—as projections of one's self, the waves are an image of female arousal.[8]

Scott McMahon, of Boston, has been making contemporary tintypes for several years. His image *Harmonic Grid* (Figure 9.9) relies upon an evocative message about self—with feelings that are entirely different from the qualities seen in a historic tintype. McMahon's *Ill at Ease* (Figure 9.10) has a piece of accidental magic in it—the black hole next to his right arm—his body seems to have emerged through it. McMahon has been working in pinhole and zone plates, as evidenced by his stack of cameras (Figure 9.10B).

A finely stitched obscuring grid and page corner has purposely covered part of one eye in *Timid and Bashful* by Rebecca Sexton Larson of Florida, who enlarges from Polaroid negatives and paints on them (Figure 9.11). The partly hidden uncolored eye tells that preserving the child's inner self is utmost. The painted part of the face is simply cosmetic—that's the part that the world sees—the rest is held by the child in secret.

FIGURE 9.9
© Scott McMahon, *Harmonic Grid*, 8 × 8-inch anodized aluminum tintype zone plate photograph, 2001. From the collection of the photographer.

FIGURE 9.10A
© Scott McMahon, *Ill at Ease*, 4 × 5 contemporay tintype, 2001. From the collection of the photographer.

FIGURE 9.10B
© Scott McMahon, pinhole and zone plate cameras, used 1993–2001. From the collection of the photographer.

FIGURE 9.11
© Rebecca Sexton Larson, *Timid and Bashful*, 26 × 22-inch pinhole photo base, mixed media, 2003.

Jesseca Ferguson of Boston, Massachusetts uses the ghost image and partial exposure to add a sense of life and movement to her otherwise still-life imagery (Figure 9.12). Her figure is surrounded by mythical and allegorical objects, which speak mysteriously and meaningfully—seeming to fill her world with surreal oneiromancy. I see layers of symbols and gestures within her personal objects. By their very existence, some of her objects are her protection, whereas others are not (possibly like Adam and Eve). *In My Studio* offers the viewer much more than just a casual glimpse of her outer reality. The diaphanous nudity of her figure tells of her inner vulnerability. Ferguson stated:

> Working alone in my studio, I set up objects deeply encoded (for me) with personal associations, my private mythology. The (scary) fairy tale that was my childhood continues to haunt me as I dip into and drink from what novelist Michael Ondaatje has termed "the well of memory." I am witnessing myself being photographed, as if in a dream. The existence of this particular visual (and psychological) situation is possible only through pinhole photography.[9]

The strange positioning of the arm and the enduring question "What is the hand holding?" all add to the mysterious workings of the artist's mind at play in Bobbe Besold's painted

FIGURE 9.12
© Jesseca Ferguson, *In My Studio* (self/pig skull/rabbit), 10 × 8-inch Van Dyck pinhole photograph, 1993. From the collection of the photographer.

Van Dyke *My House* (Figure 9.13). The image is meant to cast a dark spell on its viewer and is an archetypal motif for woman's psychic strength.[10] Besold has used Van Dyke brown as a base for her decades-long search into the painted photograph. Light from behind the figure is rare in pinhole photography; it gives chiaroscuro to this powerful image.

FIGURE 9.13
© Bobbe Besold, *My House*, 20 × 16-inch Van Dyke, gouache, watercolor, and pencil pinhole photograph. Negative on lithographic film, 1992. From the collection of the photographer.

INTO SPACE: SOLAR AND LUNAR IMAGING

In many of his pinhole images Yazu Suzuka of Kyoto, Japan displays an intense fascination with the sun. In *Ziggurat at Monte d'Accoddi* (Figure 9.14) he makes use of a strong solar flare diffracting off of the edges of the pinhole while it successfully surrounds the subject in the landscape, without completely obscuring it. In a way the image seems to have two picture planes, the solar flare floats in front of the land, yet, of course, it was actually behind the pyramidal form.

Photographing the sun's arc (Figure 9.15) while controlling the amount of solar flare in the image seems to fascinate many pinhole artists too. It is not so easy to accomplish. There are several ways:

- Use a very, very small pinhole, one so small that you almost cannot see it in the metal. It has to be so small that it will not function to photograph the landscape, but it will let a streak of the bright sun in.
- A pinhole will make an image of the sun if you are photographing onto a very slow nonsilver emulsion.
- Use a neutral density filter.
- Use sheets of litho film stacked in a layer. Each acts as a filter, as Dominique Stroobant did in Figures 3.10A, 3.10B, and 3.17. After exposure, about the fourth or fifth sheet of litho film in the stack had the correctly exposed image.

Sunlight is one million times brighter than moonlight. Photographing the moon's arc is somewhat easier. There are several ways:

- Using a large pinhole will expose the moon's arc directly onto photographic paper.
- Using a zone plate will expose the moon's arc directly onto photographic paper or onto film as Nancy Spencer did in Figure 7.2.

FIGURE 9.14
© Yazu Suzuka, *Ziggurat at Monte d'Accoddi*, Sardinia, 900 × 1125-mm pinhole photograph, 2006.

In 2004, Jonathan Kline from Vermont continued his series of sun-tracking images by photographing sun tracks over large bodies of water. For these beautifully desolate yet warmly reflective images Kline used color chrome film in a Leonardo wide pinhole camera and a 4.0 neutral density filter. In *Lake Haviland* (Figure 9.16), sun and moon tracks are in the frame.

Slavo Deyck from Poland makes *Cyclographs*—a term he has coined for tracings of the Sun (Figure 9.17). He explained the images as

> registered through a pinhole opening in a mechanical disc which moves in regular cycles in a circle. The construction of a camera is a combination of an optical darkroom and a clockwork mechanism. Inside the camera photographic paper has been placed. Cameras modified in this way are then mounted in various sunny places while the image that appears on paper is the result of constant exposure that lasts for days. The disc with the opening is controlled mechanically or manually. The direction of the revolutions which follow the Sun is always opposite to the direction of the Earth's revolutions.
>
> Movement cycles as expressed in the image captions are:
>
> - Daily disc (D)—1 revolution per 12 days
> - Weekly disc (W)—1 revolution per 12 weeks
> - Monthly disc (Mth)—1 revolution per 12 months.[11]

FIGURE 9.15
© Douglas Frank, *Arc*, Oregon, 11 × 14-inch, eight-color Ultrachrome K-3 pigment on archival smooth matte paper, 1989–1991.

Photographing with a pinhole is a way to emotionally remain within the complex present. This is what Mark Dungan denoted in passing as he traveled the roadways of the United States to record "a part of the American landscape that is being lost or forgotton."[12] His choice of material was not a way to attempt to hold onto what he remembered, but a way to remain within its present (Figure 9.18).

Dungan has intuitively enclosed ancient Native-American iconography within a circle. The softness of the figure steps out of the circular hole to speak. It is a primal archetype. Because Dungan's intuitions have made it a figure within a hole, we are instinctively returned to the birth experience, witnessed in the holed stone megaliths in Chapter 1.

It is my theory expressed in many places throughout this book that many pinhole artists are connected to that *transported* birth experience. The circular hole, by necessity, is part of pinhole's fascination (Figure 9.19). Is it all that simple, yet paradoxically complex, because we are all so individual?

It has taken me years to realize some of the differences between instinctive feelings promoted by archetypes, such as the figural pictograph and intuitive ideas connected to them: like photographing a pictograph and placing it within a circular hole. With a shift in visual perception, Dungan's image can be seen as a white sphere rather than as a figural image within

FIGURE 9.16
© Jonathan Kline, *Lake Haviland*, Colorado, August, 2005. Size variable. From the collection of the photographer.

a circular hole. Seen as a sphere, this ancient figure stretches across its surface. We could be looking at the full moon. This altered reality is similar to my image *Grandma Becomes the Moon* shown on the dedication page and again in Figure 9.19. Looking at the moon is always a transportive experience that connects us to birth. The moon is never seen as a hole in the

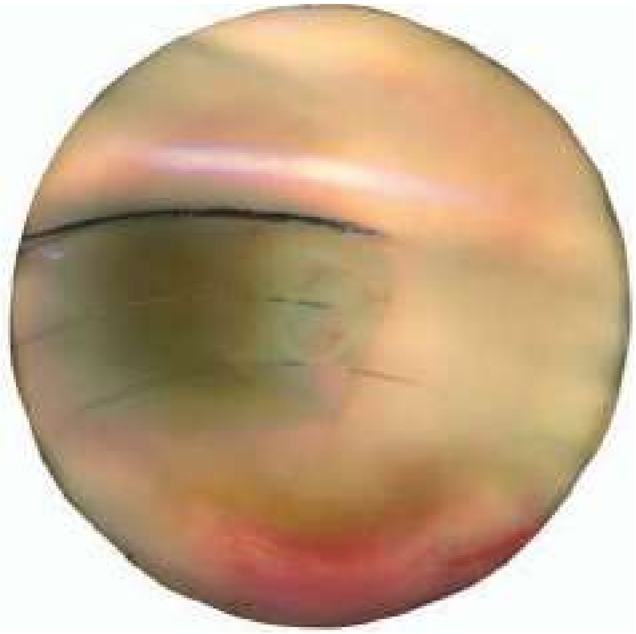

FIGURE 9.17A
Slavo Decyk, *Cyclography* (D), left image of triptych, 60 × 60-cm digital pinhole photograph, 2005. From the collection of the photographer.

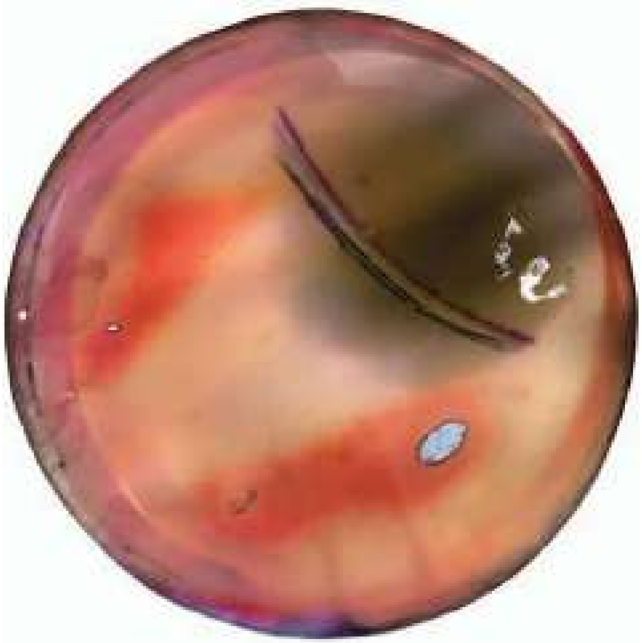

FIGURE 9.17B
Slavo Decyk, *Cyclography* (Mth), middle image of triptych, 60 × 60-cm digital pinhole photograph, 2005. From the collection of the photographer.

FIGURE 9.17C
Slavo Decyk, *Cyclography* (W), right image of triptych 60 × 60-cm digital pinhole photograph, 2005. From the collection of the photographer.

sky—nor is a black hole really a hole in the sky—thus, too, the nonnumber 0 and the letter o are constant points in space.

I have consistently thought that pinhole photography was not really photography at all in the usual sense of photographing what I see. It has more to do with constantly looking within—translating a very selected outside view. Inner reality has always been what I explore

FIGURE 9.18
© Mark Dungan, *Pictograph* (Utah), 2¾ × 2¾-inch Polaroid pinhole photograph, 2001. From the collection at Pinhole Resource.

FIGURE 9.19
© Eric Renner, *Grandma Becomes the Moon*, 20 × 16-inch pinhole photograph, 1976.

and express, not because of time constraints inherent in long exposures, but because the notational picture of time connected to self is a visual archetype for life force.

This concept is expressed in the Julie Schachter image *Lunambulist* (Figure 9.20). It's what's beyond the image that is the reality of the picture.

FIGURE 9.20
© Julie Schachter, *Lunambulist*, 13 × 10-inch pinhole photograph, 1993. From the collection of the photographer.

NOTES

1. A few of the images that seem to accomplish this are Figures 1.39A, 1.40B, 2.21, 2.23, 4.1, 4.20A and B, 4.23J, 5.25, 7.15B, 7.11, 8.5 and many in this chapter.
2. Thomas Bachler, personal communication with the author, 10 February 1994.
3. Karl Marx and Friedrich Engels, *The German Ideology* (parts I and III). Translated and edited by R. Pascal (New York: International Publishers, 1947), 14. Bachler's recent work in progress continues to speak of a collective consciousness; Figure 6.5B.
4. Patrick Poels, "Interview," *Pinhole Journal*, Vol. 10#1 (1994): 24. Poels' work also speaks to a collective consiousness.
5. Patrick Poels, "Interview," *Pinhole Journal*, Vol. 10#1 (1994): 24.
6. Patrick Poels, "Interview," *Pinhole Journal*, Vol. 10#1 (1994): 24.
7. Ilan Wolff, personal communication with the author, 15 June 1988.
8. Sarah Van Keuren, personal communication with the author, 10 November 2003.
9. Jesseca Ferguson, personal communication with the author, 23 February 1994.
10. Bobbe Besold, personal communication with the author, 17 October 2003.
11. Slavo Decyk, "Cyclography," *Pinhole Journal*, 21#2 (2005): 15.
12. Mark Dungan, *Pinhole Journal*, Vol. 19#2 (2003): 2.

PINHOLE PHOTOGRAPHY WORKSHOPS

This list is composed of those who offer pinhole workshops:

- Penland School of Crafts
  P.O. Box 37
  Penland, NC 28765
  phone: 828-765-2359
  website: penland.rg
  e-mail: office@penland.org
  A quiet mountain retreat near Asheville, North Carolina.
- f295.org
  website: www.f295.org
  A symposium for pinhole photography in Pittsburgh, Pennsylvania that began in 2007.
- Pinhole Resource
  Route 15, Box 1355
  San Lorenzo, NM 88041
  phone: 505-536-9942
  website: pinholeresource.com
  e-mail: pinhole@gilanet.com
  An unusual high desert spot just below the Gila Wilderness in southwest New Mexico.

GENERAL PINHOLE PHOTOGRAPHY INFORMATION

pinhole.com
Operates Pinhole Visions with an online gallery and information site.

NONPROFIT ORGANIZATIONS

Pinhole Resource
Route 15, Box 1355
San Lorenzo, NM 88041
phone: 575-536-9942
website: pinholeresource.com
e-mail: pinhole@gilanet.com

International pinhole photography archive of approximately 3000 pinhole photographs from artists throughout the world. Pinhole Resource published *Pinhole Journal* for 22 years (1985–2006), back issues are available. Pinhole Resource operates International Pinhole Photography Gallery—the largest and most comprehensive internet gallery of international pinhole photographs. Pinhole Resource sells pinhole cameras, pinholes and zone plates, pinhole books and monographs and sometimes exhibition catalogs, and other products useful to the pinhole and zone plate photographer.

EVENTS

Worldwide Pinhole Photography Day—Thousands celebrate yearly on the last Sunday in April (2008 count was 2630 from 62 countries). Make a pinhole image and upload to the gallery site at pinholeday.org

ONLINE GALLERIES SPECIALIZING IN PINHOLE PHOTOGRAPHY

- International Pinhole Photography Gallery at pinholeresource.com
- pinhole.com
- withoutlenses.com
- www.pinholeformat.com/gallery
- www.latamagica.art.br
- www.pinhole.ru
- www.estenopeica.com
- www.pinholephotography.com.au/html/index.html
- www.linsenfrei.de
- www.stenope.net
- tobbmintfoto.hu/camera_obscura
- www.mhf.krakow.pl/wystawy/otwork/index.htm
- www.pinhole.art.pl

PRIVATE INDIVIDUALS AND SMALL COMPANIES MAKING PINHOLE PRODUCTS

- website: zeroimage.com
  e-mail: info@zeroimage.com
  A site that sells a variety of wooden pinhole cameras from 35 mm up to 4 × 5.

- W. Joseph Christiansen
  P.O. Box 303
  Maplewood, WI 54226
  phone: 414-856-6842
  e-mail: pinhole@centurytel.net
  Pinholes, body caps, Apo II shutter, pinholes, drills, and pin vises.

- Dominique Stroobant
  11 Via Fantiscritti
  1.54033 Miseglia di Carrara
  Italy
  phone: 39-0585-776-288
  e-mail: stroobant@tiscalinet.it
  Lensless Leica pinhole mounts.

- Jay Bender
  19691 Highway 209
  Leavenworth, WA 98826
  phone: 800-776-3199
  website: benderphoto.com
  e-mail: mrbender@benderphoto.com
  Bender view pinhole camera.

- Lensless Camera Mfg. Co.
  809 Lark Drive
  Fernley, NV 89408
  phone: 775-575-5189

website: pinholecamera.com
e-mail: info@pinholecamera.com
Large-format wooden pinhole cameras.

- Jim Kosinski
P.O. Box 540
Cherry Valley, NY 13320
phone: 607-264-3480
website: www.paintcancamera.com
e-mail: merlin@paintcancamera.com
Starlight cameras and Little Merlin cameras made from paint cans.

- Robert Rigby Pinhole Cameras
Store Street, Bollington
Macclesfield, Cheshire
SK10 5PN, England UK
phone: +44 (0)1625 575591
website: www.bobrigby.com
For pinhole cameras at: www.bobrigby.com/brp_products/Misc/pinhole.html
e-mail: info@bobrigby.com

- website: www.holgamods.com
e-mail: info@holgamods.com
A site that sells the pinhole Holga camera.

- website: www.marcus-schwier.de/
phone: 49-171-4903044
e-mail: photo@marcus-shwier.de
For pinhole cameras at www.marcus-schwier.de/Marcus-Schwier/index.htm
A site that sells large-format pinhole cameras.

- website: blackcatphotoproducts.com
The Black Cat Exposure Guide—useful for pinhole.

COMMERCIAL PHOTOGRAPHIC SUPPLIERS CARRYING PINHOLE PRODUCTS

All provide a variety of pinhole products.

- Calumet Photographics
890 Supreme Drive
Bentsenville, IL 60106
website: calumetphoto.com
phone: 800-225-8638
e-mail: wesite@calumetphoto.com
A variety of pinhole products.

- Freestyle Sales Co.
5124 Sunset Blvd
Los Angeles, CA 90027
phone: 800-292-6137
website: freestylephoto.biz
e-mail: info@freestylephoto.biz
A variety of pinhole products.

- Lomographic Society USA
100 Water Street #1008
Brooklyn, NY 11201

phone: 718-522-4353
fax: 718-522-4468
website: lomography.com
A variety of pinhole cameras.

- Monochrom
  Kunoldstr. 10–14
  D-34131 Kassel
  Germany
  phone: 0561-935190
  website: monochrome.com
  e-mail: email@monochrom.com
  A variety of pinhole products.

HIGH TECH SUPPLIERS

- Edmund Scientific Company
  60 Pearce Ave.
  Tonawanda, NY 14150
  phone: 800-728-6999
  website: scientificsonline.com
  e-mail: scientifics@edsci.com
  Tools, optics, and general scientific equipment.
- Lenox Laser
  12530 Manor Rd.
  Glen Arm, MD 21057-9503
  phone: 800-494-6537
  website: lenoxlaser.com
  e-mail: sales@lenoxlaser.com
  Scientific precision pinholes—sponsors a yearly pinhole competition using their pinholes.

GENERAL WEBSITES ON PINHOLE PHOTOGRAPHY

- pinholeresource.com—A nonprofit educational organization that maintains a photographic archive for pinhole photography, publishes *Pinhole Journal*, and sells pinhole cameras, books, and pinhole-related products, lists workshops, and exhibits examples on the website galleries of pinhole images from Pinhole Resource collection.
- pinhole.com—An extensive site founded by Gregg Kemp, North Carolina, that lists news, events, sponsors Worldwide Pinhole Day in late April of every year (images can be seen at pinholeday.org), and runs an online pinhole gallery with changing exhibits, lists resources, and a directory.
- h.webring.com/hub?ring = pinhole—A pinhole photography web ring.
- home.online.no/~gjon/pinhole.htm #—A site by Jon Grepstad.

INDIVIDUAL PINHOLE PHOTOGRAPHERS' WEBSITES

Here are a few of the numerous websites of individual pinhole photographers, listed in order of appearance in this book. It is easy to find more by using Google.

- Dianne Bos: diannebos.com
- Peggy Ann Jones: pinhole.us
- Paolo Gioli: paologioli.it

- Carlos Jurado: zonezero.com/exposiciones/fotografos/jurado
- Wiley Sanderson: galaxymall.com/art/artphotography/360.html
- Ruth Thorne-Thomsen: www.laurencemillergallery.com/thomsenexhibition.html
- Adam Fuss: artnet.com/artist/6627/adam-fuss
- Sarah Van Keuren: schmidtdean.com/svk.html
- Martha Casanave: marthacasanave.com
- David Plakke: davidplakke.com
- Marcus Kaiser: www.artnews.info/artist.php?i=1522
- Thomas Bachler: thomasbachler.de
- Bethany de Forest: pinhole.nl
- Scott McMahon: scottmcmaonphoto.com
- Jeff Guess: jeffguess.com
- Robert Mann: thencamenow.com
- Franz John: f-john.de
- Willie Anne Wright: willieannewright.com
- Abelardo Morell: abelardomorell.com
- Ilan Wolff: ilanwolff.com
- Nancy Spencer and Eric Renner: pinholeresource.com
- Nilu Izadi: nilufar.co.uk
- Shi Guorui: chinesecontemporary.com
- Legacy Project: legacyphotoproject.com
- Larry Bullis: flickr.com/photos/bow-zart
- Dana Day: danadayphoto.com
- Donna Fay Allen: lightpainter.tripod.com
- Oscura: www.vuesimprenables.com
- Zernike Au: zeroimage.com/gallery
- Edward Levinson: edophoto.com
- Thomas Mezzanotte: historiccamera.com
- John Kimmich Javier: www.uiowa.edu/~journal/faculty/kimmich.html
- Jay Bender: jaybender.com
- Matt Abelson: abelsonscopeworks.com
- Meiko Tadokoro: www5a.biglobe.ne.jp/~m-tado/
- Ian Paterson: www.ian-paterson.com
- Jane Alden Stevens: janealdenstevens.com
- Joakin Eneroth: joakineneroth.com
- Walter Crump: waltercrump.com
- Craig Barber: craigbarber.com
- Brice Bischoff: bricebischoff.com
- Jaroslaw Klups: www.asp.poznan.pl/eng/tea/klups.html
- Roger Sayre: rogersayre.com
- Victoria Cooper and Doug Spowart: www.home.aone.net.au/greatdivide
- John Ashburne: www.flickr.com/photos/jfa/show/
- Michael Wesely: wesely.com
- Thomas Micklin: tmicklin.com
- Jürgen Königs: tkellner.com/index.php?id=1552
- Herbert Böettcher: boettcher-photography.de
- Rebecca Sexton Larson: sextonlarson.com
- Jesseca Ferguson: pinholeformat.com/Jessecagal1.html
- Bobbe Besold: bobbebesold.com
- Yasu Suzuka: pgi.ac/content/view/115/29/lang,en
- Jonathan Kline: bennington.edu/acad_fac_klinej.as
- Slavo Decyk: free.art.pl/solaris/decyk.htm
- Mark Dungan: www.art.usu.edu/department/faculty/dungan.php

A short list of other pinhole websites:

- Thomas Kellner: tkellner.com
- Justin Quinell: www.jquinnell.fsnet.co.uk
- Philippe Moroux: www.xs4all.nl/~moroux/
- Erin Malone: erinmalone.com
- Diana Bloomfield: www.alternativephotography.com/artists/diana_bloomfield.html
- Barbara Ess: www.curtmarcusgallery.com/artists/artists_detail.asp?artistID=10
- Mabel Odessey: www.mabelodesseypinholephotography.com
- Udo Beck: www.udobeck.net
- Volkmar Herre: www.edition-herre.de
- Jan Kapoor: www.jankapoor.net/Gallery.html
- Darius Kuzmickas: kudaphoto.com
- Steve Irvine: www.steveirvine.com/pinhole/index.html
- George L. Smyth: glsmyth.com/Pinhole/Images/PinholeImages.htm
- Massimo Stefanutti: www.massimostefanutti.it
- Justin Quinell: www.pinholephotography.org
- Robert Kosara: kosara.net/photo/lochlomo.html
- Yann de Fareins: www.yann-de-fareins.com
- Nissa Kubly: nissakubly.com
- Norma-Louise Thallon: www.normathallon.com/gallery.html
- Wanda Scott: www.wandascott.com
- Catherine Rogers: catherinerogers.com.au
- Angie Buckley: www.angiebuckley.com
- Bill Wittliff: www.library.txstate.edu/swwc/wg/artist/billwittliff/default.html
- Guillermo Penate: ca.geocities.com/penate@rogers.com
- Doug Bardell: www.cyberbeach.net/~dbardell/pinhole.html
- Thomas Hudson Reeve: www.papercams.com/gallery/photos.html
- Thorsten Berndt: www.bauwagenkamera.de
- David Balihar: www.pinhole.cz/en
- Dan MacCormack: www.dan-maccormack.net/
- Bernhard M. Hartmann: www.bernhardhartmann.de
- Jens Titus Freitag: www.jens-titus-freitag.de
- Denis Farley: www.denisfarley.net
- Jochen Dietrich: http://jochendietrich.kulturserver-nrw.de
- Lucy Clink: http://www.chronosroma.net/clink/foto/start.html

WEBSITES DEVOTED TO PINHOLE PHOTOGRAPHERS FROM INDIVIDUAL COUNTRIES

- www.latamagica.art.br
- www.pinhole.ru
- www.estenopeica.com
- www.pinholephotography.com.au/html/index.html
- www.linsenfrei.de
- www.pinhole.art.pl
- www.stenope.net
- tobbmintfoto.hu/camera_obscura
- www.mhf.krakow.pl/wystawy/otwork/index.htm

RECENTLY PUBLISHED BOOKS

- Baltrusaitis, Jurgis, *Anamorfosi* (Milano, Italy: Adelphi, 1990)
- Bibliotheque Municipale Lille, *Stenopephotographie* (Lille, France: Bibliotheque Municipale Lille, 2000)

- Cavaso del Tomba, *L'esperienza del Paesaggio*, pinhole images by Massimo Sordi (and three lens photographers) (Treviso, Italy: Biblioteca Comunale, 1994)
- China Pinhole Photography Art Committee, *Chinese Pinhole Photography* (Shenzhen, China: Decentmate Printing), 2006
- Dietrich, Jochen, *Cine-Teatros de Portugal* (Leiria: Portugal, Teatro Jose Lucio da Silva, 1998)
- Edgerton Jr., and Samuel Y., *The Heritage of Giotto's Geometry* (Ithaca, New York: Cornell University Press, 1993)
- Hammond, Mary Sayer, *The Camera Obscura* (Ann Arbor, MI: UMI, 1986)
- Hockney, David, *Secret Knowledge* (New York: Viking, 2001)
- Kofman, Sarah, *Camera Obscura: Of Ideology* (Ithaca, NY: Cornell University Press, 1998)
- Königs, Jürgen und Heinz Pramann, *Aspekte 2003* (Kreuztal, Germany, 2003)
- Knuchel, Hans, *Camera Obscura* (Ennetbaden, Switzerland: Lars Müller Edition, 1990)
- Leeman, Fred, *Hidden Images* (New York: Harry N. Abrams, Inc. Publishers, 1976)
- Oakes, John Warren, *Minimal Aperture Photography* (Lanham, MD: University Press of America, 1986)
- O'Brien Renee C, *The Post-Romantic Vision of Contemporary Pinhole Photographers* (Ann Arbor, MI: UMI Dissertation Services, 1998)
- Olpe, Peter, *Schachtelkameras* (Stuttgart, Germany: Lindemanns Verlag, 1995)
- Oscura, *Mali Photos: Sténopés d'Afrique* (Paris: Atalante, 2001)
- Photo Poche, Le sténopé (Paris: Actes Sud, 2007)
- Pirenne, Maurice, *Optics, Painting, and Photography* (Cambridge, UK: Cambridge University Press, 1970)
- Picarsic III, Michael, and Lorraine Vullo, *Recrudescence* (Pittsburgh, PA: Rivers of Steel National Heritage Area Publishing, 2005)
- Renner, Eric, *American Disguise* (San Lorenzo, NM: Flying Monkey Press, 2007)
- Shull, Jim, *The Hole Thing* (Dobbs Ferry, NY: Morgan & Morgan, 1974)
- Smith, Lauren, *The Visionary Pinhole*, (Layton, UT: Gibbs M. Smith Inc., 1985)
- *Zwischenzeit-Camera Obscura im Dialog* (Stuttgart, Germany: Lindemanns Verlag, 1993)

RECENTLY PUBLISHED MONOGRAPHS

- Babcock, Jo, *The Invented Camera* (San Francisco, CA: Freedom Voices, 2005)
- Bachler, Thomas, *Arbeiten mit der Camera obscura* (Stuggart, Germany: Lindemanns Verlag, 2001)
- Barber, Craig, *Ghosts in the Landscape: Vietnam Revisited* (Umbrage Editions, 2006)
- *Barbara Ess* (New York: The Queens Museum of Art, 1993)
- Baril, Tom, *Botanica* (Santa Fe, NM: Arena Editions, 2000)
- Bos, Dianne, *Son et Lumiere* (Kamloops, BC, Canada: Kamloops Art Gallery, 2002)
- Derleth, Günter, *Venice* (Zurich: Edition Stemmle, 1997)
- Eakin, William, *Monument* (Winnipeg, Canada, 1997)
- Eneroth, Joakim, *Without End* (Stockholm, Sweden: Tryckindustri Information, 2003)
- Ess, Barbara, *I Am Not This Body* (New York: Aperture Foundation Inc., 1990)
- Felten-Massinger, *Caravanna Obscura* (International Relations Commissariat of the French Speaking Community Wallonia-Brussels, 2004)
- Fuss, Adam, *Pinhole Photographs* (Washington, DC: Smithsonian Institution Press, 1996)
- Harding,Thomas, *One-Room Schoolhouses of Arkansas as Seen Through a Pinhole* (Fayetteville, AR: University of Arkansas Press, 1993)
- Königs, Jürgen, *Triviale Objekte* (Keuztal, Germany, 1995)
- Königs, Jürgen, *MessergabelschereLicht* (Kreuztal, Germany, 2001)
- Kuzmickis, Darius, *Camera Obscura* (Las Vegas, NV: Kuda Editions, 2005)
- Kuzmickis, Darius, *Ocean Pinholes* (Las Vegas, NV: Kuda Editions, 2006)
- McMahon, Scott, *Suspended Passages* (Philadelphia, PA, 1995)

- Morell, Abelardo, *A Camera in a Room* (Washington, DC: Smithsonian Institution Press, 1995)
- Morell, Abelardo with Luc Sante, *Camera Obscura* (New York: Bulfinch Press, 2004)
- Morell, Abelardo, *Abelardo Morell* (London: Phaidon Press, 2005)
- Olpe Peter, *Die Lochkameras von Peter Olpe* (Basel, Switzerland: Steiner AG, 1993)
- Olpe Peter, *Die Lochkameras Funktion und Selbsbau* (Stuttgart, Germany: Lindemanns Verlag, 1993)
- *Paolo Gioli, Volti Attravers/Tokyo 1996* (Milan: Folini Arte Contemporanea, 2007)
- *Paolo Gioli* (Tavagnacco, Italy: Art&, 1996)
- *Paolo Gioli: Gran Positivo* (Firenze, Italy: Alinari, 1991)
- *Paolo Gioli: Obscura* (Milano, Italy: Electa, 1991)
- Paterson, Ian, *Le jardin du Luxembourg* (Paris, France: Museum Carnavalet, 1990)
- Pirilä, Marja, *The Eyes of the Fingertips Are Opening* (Helsinki, Finland: Musta Taide, 1993)
- Pirilä, Marja, *Camera Obscura, Interior Exterior* (Helsinki, Finland: Musta Taide, 2002)
- Quinell, Justin, *Mouthpiece* (Stockport, England: Dewi Lewis Publishing, 2006)
- Spencer, Nancy, and Eric Renner, *On Deaf Ears* (San Lorenzo, NM: Flying Monkey Press, 2008)
- Spencer, Nancy, *Under the Blue* (San Lorenzo, NM: Flying Monkey Press, 2008)
- Spencer, Nancy, and Rebecca Wackler, *Flight* (San Lorenzo, NM: Flying Monkey Press, 2008)
- Tadokoro, Meiko, *Mellow Light and Slow Time* (Tokyo, Japan: Ondori-Sha, 1998)
- Thorne-Thomsen, Ruth, *Within This Garden* (New York: Aperture Foundation, Inc. and Chicago: The Museum of Contemporary Photography, Columbia College, 1993)
- Thorne-Thomsen, Ruth, *Postais Dun Sono* (Vigo, Italy: Do Trinque, Centro De Estudos Fotograficos, 2000)
- *Vera Lutter* (Kunsthalle Basel, Switzerland, 2001)
- Wesely, Michael, *American Landscape* (München, Germany: Verlag walter Storms, 2000)
- Wittliff, Bill, *La Vida Brinca* (Austin, TX: University of Texas Press, 2006)

RECENT SELF-PUBLISHED BOOKS AND MUSEUM/GALLERY CATALOGS

- Bachler, Thomas, *Bon Voyage!* (Kassel, Germany, 1999)
- Thomas Bachler, *Pixel Trees* (Dresden, Germay: K4 galerie, bei den Autoren, 2007)
- Bos, Dianne, *10 Countries* (Toronto, Canada, 1999)
- de Forest, Bethany, *Pinhole Pictures 1991–2002* (Amsterdam, The Netherlands, 2003)
- Freitag, Jens Titus, *Wintermärchenmaschine* (Friedrichsthal, Germany: Otto-Weil-Kunstpreises, 2001)
- Herre, Volkmar, *Mit Licht gemalt* (Stralsund, Germany: Edition Herre, 1998)
- Herre, Volkmar, *Licht im Dunkel* (Stralsund, Germany: Edition Herre, 2000)
- Herre, Volkmar, *Erinnerungen Des Lichts* (Stralsund, Germany: Edition Herre, 2001)
- *International Pinhole Photography Exhibition* (Santa Fe, NM: Center for Contemporary Arts of Santa Fe, 1989)
- John, Franz, *Military Eyes* (Berlin, Germany: Galerie Schüppenhauer, 1999)
- Jones, Peggy Ann, *Oracular Orifices* (Costa Mesa, CA: Orange Coast College, 1991)
- Kellner, Thomas, *Deutschland Blick nach Drauben* (Seigen, 1998)
- Kellner, Thomas, *11-Loch-Arbeiten* (Gummersbach, Germany, 2000)
- Königs, Jürgen, *Lochkamera- und Slit-scan Fotografien* (Düdelingen: Galerie Nei Liicht 1996)
- *La Camara Ciega* (Sevilla, Spain: Museo de Arte Contemporaneo Sevilla, 1988)
- Lawrence, Donald, *The Underwater Pinhole Photography Project* (Gallery 44, Gallery ConneXion, Dalhousie Art Gallery, Richmond Art Gallery, Toronto, Canada: ABC Artbooks Canada, 2002)

- Lopez, Luisa, *Au Bord de L'Irreel* (Bruxelles, Belgium: Musee de la photographie a Charleroi, 2002)
- Odessey, Mabel, *Games and Ritual* (Labrugiuere, France: Edite par, 2000)
- Padula, Warren, *Inferno: Shopping in America* (Sag Harbor, NY: 1996)
- *Paolo Gioli* (Firenze, Italy: Alinari, 1991)
- *Paolo Gioli—Senza obiettivo* (Siena, Italy: Protagon, 2002)
- Pelzie, Sarah, *The Salton Sea Viewed Through A Pinhole* (Culver City, CA, 2001)
- Pippin, Steven, *Discovering the Secrets of Monsier Pippin* (Limoges, France: Limousin, 1995)
- Sarachek, Jett Ulaner, *Pinhole Photographs* (Allentown, PA, 2002)
- *Senza Obiettivo* (Siena, Italy: Protagon, 2002)
- Stevens, Jane Alden, *Tears of Stone* (Cincinnati, OH, 2004)
- Stölben, Frank, *Camera Obscura* (Aachen: Suermondt-Ludwig-Museum, 1996)
- Van Keuren, Sarah, *A Non-Silver Manual*, Third Ed. (Philadelphia, PA, 2003)
- Wesely, Michael, *Photographie 1978–1995* (Müchen: Monographienreihe, Förderpreise, 1995)
- Wesely, Michael, *Camera Obscura* (München, Germany: Neue Galerie Dachau, 1994)
- Wolff, Ilan, *Camera Obscura at Work* (Seyssel, France: 1998)
- Wright, Willie Anne, *My Lenseless Imaging* (Richmond, VA, 2003)
- Zhan Zhou, *Pinhole Photographs* (Shenzhen, China, 2006)

PINHOLE NOONMARKS, PINHOLE PERSPECTIVE DEVICES

- Chiarini, Armando, *La Meridiana della Basilica de S. Petronio in Bologna* (Bologna, Italy, 1975)
- Field, J. B., *The Invention of Infinity* (Oxford, UK: Oxford University Press, 1997)
- Heibron, J. L., *The Sun in the Church* (Cambridge, MA: Harvard University Press, 1999)
- Hockney, David, *Secret Knowledge* (New York: Viking Studio, 2001)
- Kemp, Martin, *The Science of Art* (New Haven, CT: Yale University Press, 1990)
- Mancinelli, Fabrizio, and Casanovas, Juan, *La Torre dei venti in vaticano* (Vaticano, Italy: Libreria Editrice Vaticana, 1980)
- Schiavo, Armando, *La Meridiana di S. Maria degli angeli* (Roma, Italy: Istituto Poligrafico e zecca deeo stato, 1993)
- Steadman, Philip, *Vermeer's Camera* (Oxford, UK: Oxford University Press, 2001)

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INDEX

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