

Cyanotype



# The Cyanotype Process

## OVERVIEW AND EXPECTATIONS

The cyanotype (Ferro-Prussiate) is often the first process you will encounter in alternative/non-silver photography. The reason for this is the absolute simplicity of the nearly fail-safe technique and chemistry and the likelihood that you will make a successful print within a short time. This chapter begins with a little history to show you where it all came from, including introducing you to the first woman photographer, Anna Atkins. You'll learn about the chemistry and how to prepare and use it as a UV light-sensitized solution and how to adjust the cyanotype formula for specific corrections. Also included is a discussion about substrates, sizing, coating, light sources, exposure, and development in water or acids for additional control of the process. This chapter also deals with accelerated oxidation, highlight clearing, trouble-shooting, and many toning options for the cyanotype in the event that the color blue just doesn't seem like the right one for the subject in your print. This will prepare you for additional information on cyanotype fabric murals, Michael Ware's New Cyanotype process, and combination processes with cyanotypes.

## A LITTLE HISTORY

The cyanotype was the first simple and successfully realized practical non-silver iron process. Discovered by Sir John Herschel (1792–1871) in 1842, a mere three years after the “official” announcement of the discovery of photography, the cyanotype provided permanent images in an elegant assortment of blue values. Herschel is the same gentleman who coined the words *positive and negative*, *photograph*, and *snapshot*. He is also credited, in 1819, with discovering that a solution of sodium thiosulfate (which he referred to as hyposulfite of soda) had the ability to dissolve silver chloride and what that particular chemical's role might be in permanently fixing a photographic image. This is an important bit of information that he passed along to Talbot. Curiously, Herschel did not officially announce this particular finding until 1839.



Figure 6-1  
**Christopher James,**  
***Self-Portrait with***  
***Pinhole, Maine, 1994***  
(Courtesy of the  
artist)



Figure 6-2

**Julia Margaret Cameron, *The Astronomer* (Sir John Herschel, 1867)**

Julia Margaret Cameron (1815–1879) began her career as a photographer in 1849 shortly after returning to England from India. Her work was centered on the ideals, and allegories, investigated by the Pre-Raphaelites, a group of artists who despised industrialization and yearned for the return of mythic heroes and romanticism. Her style, like this albumen print portrait of Herschel, is an example of the principal innovation she brought to the medium: the close and uncompromising psychology of the subject before her camera.

(Courtesy of the Royal Photographic Society)



Herschel was a very busy gentleman who invented a number of non-silver and alternative photographic processes, including the Argentotype in which iron salts (ferric citrate) were used to precipitate silver under the influence of light and were subsequently developed in silver nitrate. He also developed a charming and odd technique, which is described for you in another chapter, called the *Anthotype*. That process involved using crushed flower petals, a little alcohol, and a 2 to 3 week exposure in sunlight—three of the key ingredients for a nice vacation.

Herschel introduced the Anthotype in a paper modestly entitled, “On the Action of Rays of the Solar Spectrum on Vegetable Colors and on Some New Photographic Processes.” The initial portion of this historic paper concerned itself with the Anthotype, describing the bleaching effect of sunlight on extracted flower juices applied to paper. The second part of his paper dealt with the photosensitivity of ferric (iron in a trivalent state) salts to light and how, on exposure to light, the ferric salts reduced to the ferrous (iron in a bivalent state) state. As a point of information, *valent* is a term meaning “worth, or value”

in scientific terminology. It was this process he named the Argentotype. A short time later, Herschel announced that ferrous salts could also reduce silver to its metallic state and that he had developed a process to show this phenomenon. The Argentotype was later modified as the Kallitype/Van Dyke Process.

Herschel was a gentleman scientist and his investigations primarily revolved around the concept of experimentation for its own sake rather than practical application. Between 1839 and 1842 he conducted hundreds of separate experiments on the light-sensitivity of silver salts, metals, and vegetation, including an investigation of potassium ferrocyanide. This aspect of his work was augmented by Dr. Alfred Smee’s work in electrochemistry, which resulted in a refined version of the potassium ferrocyanide that he was generous enough to share with Herschel. Working with Smee’s chemistry, Herschel continued his experiments with variations of chemical and light reactions. In one such experiment he described a technique in which a piece of paper was coated with a solution of ferric ammonium citrate and exposed to light under a positive image. The exposed paper was then devel-



Figure 6-3  
**Peter Henry Emerson, *Gathering Water Lilies*, 1886**  
 (Platinum print—plate #9 from *Life and Landscape on the Norfolk Broads*)  
 Peter Henry Emerson (1856–1936) said, “... only a vandal would print a landscape in red or in cyanotype.”  
 (Courtesy of the George Eastman House, Rochester, NY)

oped with a potassium ferricyanide solution that resulted in a blue negative. These are the two primary chemicals found in the classic cyanotype formula.

In still another variation, which Herschel named the *Chrysotype*, he sensitized a sheet of paper with ferric ammonium citrate, contact printed and then developed the paper in a weak solution of gold chloride. The ferrous salts, created by exposure, reduced the gold, which then precipitated as a purple deposit over the image in direct proportion to the exposure. If you are interested in trying your hand at Chrysotypes, Dr. Michael Ware has done a lot of work on a more consistent variation of this process that he calls the New Chrysotype.

The Cyanotype was popular for a short time and experimented with by many, thanks to a commercially produced Ferroprussiate Cyanotype paper. The first commercial use of the cyanotype was initiated in 1876 at the Philadelphia Centennial Exposition, and this industrial application heralded the adoption of the process for schematic blueprint drawings that would be used by engineers and builders. There is an odd historical tidbit concerning the cyanotype that involved Lt. Col. Baden-Powell, founder of the Boy Scouts. Apparently, Baden-Powell ordered the cyanotype process to be used to make stamps and money during the siege of Mafeking in

the Boer War (1899–1902) between Great Britain and the Transvaal.

Another person who placed himself into the history of the cyanotype was the outspoken and very curmudgeonly English physician/photographer Peter Henry Emerson (1856–1936), who said “... only a vandal would print a landscape in red or in cyanotype.” Emerson, by the way, spent an important part of his life tormented by the debate between those who believed photography could be distilled into a set of hard and fast rules and those who believed that it was a flexible form of expression and impression. In 1886, Emerson, as a member of the Council of the Photographic Society, began to deliver a series of lectures that defined the correct, *naturalistic*, way to approach the new medium. He trashed image-makers such as Henry Peach Robinson and attempted to define an unassailable position in which a photograph should always aspire to represent an artist’s true aesthetic vision, as in the Impressionist painting movement.

Emerson’s idealism came to an abrupt halt in 1890 when Ferdinand Hurter (1844–1898) and Vero Drifffield (1848–1915) announced their method of scientifically measuring the sensitivity of photographic plates involving the measurement of light intensities and resulting densities. In addition, they devised a theory of controlling

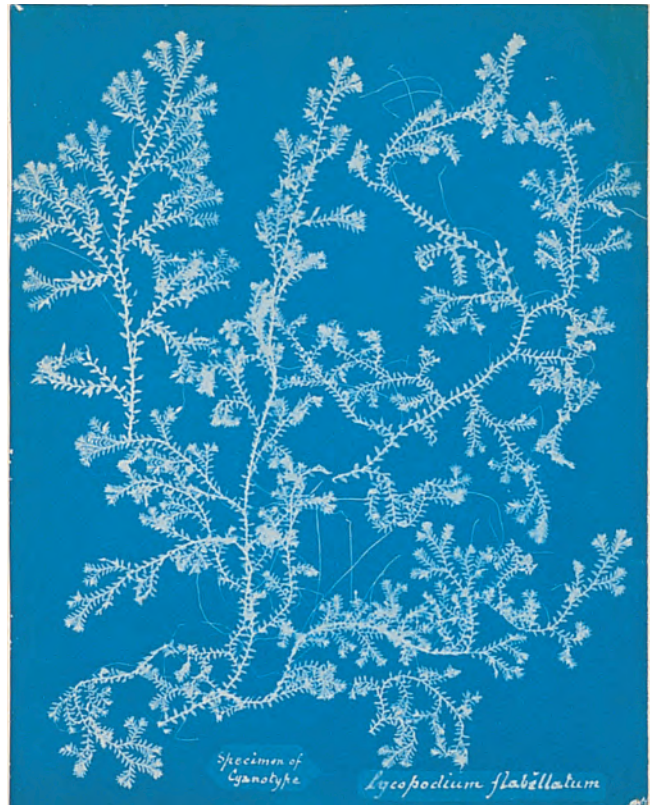


Figure 6-4

**Anna Atkins (1799–1871), *Cyanotype of Algae*, c. 1843**

From the first published book illustrated with photographic images, *British Algae: Cyanotype Impressions* (1843–1853). Atkins was the first woman photographer and presumably learned the cyanotype process from Herschel, who was a family friend.

(Courtesy of the Gernsheim Collection, Ransom Center, University of Texas–Austin)



## Anna Atkins: The First Woman Photographer

Anna Atkins (1799–1871) was the first woman photographer. Referred to sparingly by traditional photo historians, she made beautiful cyanotype images of algae, ferns, feathers, and waterweeds. Her botanist father, John George Children, and Herschel were friends, and the Atkins and Herschel families resided only 30 miles apart in Kent, England. Children was a member of the Royal Society, and when his friend Herschel announced his discovery of the cyanotype (1842) Children quickly passed the news on to his daughter Anna. Although there is no conclusive evidence that Herschel was Atkins's mentor it is more than probable that she learned the cyanotype process in the Herschel household.

Anna Atkins made thirteen known versions of her work entitled *British Algae: Cyanotype Impressions* (1843–1853). In October 1843 Atkins began issuing published folios of her photogenic (photogram) drawings. In 1850, she began to publish more comprehensive collections of her work, com-

pleting a three-volume anthology in 1853. These books, containing hundreds of handmade images, were the very first published works to utilize a photographic system for purposes of scientific investigation and illustration. Significantly, they were initiated and created prior to Talbot's *Pencil of Nature* (1844–1846), a published work that is generally given credit by historians as the first to have achieved this important milestone.

Note: It is believed that Talbot was given an edition, and Herschel's personal copy resides in the New York Public Library. There are examples of Atkins's work at the Harry Ransom Humanities Research Center at the University of Texas, the Getty Museum, and public, institutional, and private collections in the United Kingdom and the United States. If you are interested in seeing this work in printed form, Aperture published Larry Schaaf's book, *Sun Gardens: Victorian Photograms by Anna Atkins*, 1985. The book is out of print but a simple Internet search at [www.bookfind.com](http://www.bookfind.com) or Andrew Cahan at [www.cahanbook.com](http://www.cahanbook.com) will likely lead to a copy.





Figure 6-5

**Betty Hahn, *Iris Variation #6*, 1985**

This piece of Betty Hahn's has always been a favorite example of mine to show students how compelling the cyanotype process can be when mixed with other media—in this case watercolor.

(Photo by Robert Reck/Courtesy of the artist)

the development of the latent image. Emerson, convinced that his beliefs were now in doubt due to this scientific proof, publicly denounced photography as a pure art, but it was too late—many photographers had already become disciples of the pictorialist vision.

## How Cyanotype Works

Cyanotype is an ultraviolet (UV) sensitive contact printing process that requires, as do most all of the non-silver processes, a negative the same size as the final print. Of course you can use transparent, translucent, or opaque objects to make cyanotype photograms as Atkins did.

The blue color of the cyanotype print is the result of the reaction of ferrous ions to the photo reduction of ferric ammonium citrate in combination with potassium ferricyanide. The cyanotype image is highly stable but can

be degraded by something alkaline, such as sodium carbonate or perspiration. It will also fade, like most things, if exposed to strong direct sunlight over a period of time. Should you experience this fading, your image can generally be restored to its original blue intensity by storing it in a dark environment for a short time.

Contrary to popular lore, the cyanotype print can be controlled in process to yield wonderful and technically exquisite images. The prints can also be toned in a wide variety of ways to provide alternatives to the color blue. Many of these toner options are described later in the toning cyanotype section of this chapter. Cyanotypes can also be employed successfully as first impressions in the gum bichromate or Blue-Van-Dyke processes and can also be used to delicately intensify shadow details in platinum or palladium printing. All in all, a versatile and rewarding way to begin learning alternative processes.

## The Chemistry: Chemicals and Sensitizer Formula

There are two principal chemicals employed in the traditional cyanotype formula, and these are mixed together in equal parts to create a working sensitizing solution that will be applied to paper with a brush. They are: Part A, *ferric ammonium citrate* and Part B, *potassium ferricyanide*. Neither of these chemicals poses a serious health risk unless you are one of the very few people who may have an allergic reaction to the chemistry. Ferric ammonium citrate is often found in iron and vitamin supplements and is mostly annoying if it becomes humidified and sticky. Potassium ferricyanide is a stable compound that only becomes a risk if it is heated beyond 300°F or if it is combined with an acid.

### Part A—Ferric Ammonium Citrate (Green Type)

In the green powdered state, ferric ammonium citrate is a light-sensitive compound that changes from a ferric to ferrous state when subjected to ultraviolet (UV) light. Once mixed into solution it is subject to mold growth after a relatively short storage period. This moldy state is not detrimental to your cyanotype ambitions and can be avoided by adding a drop or two of Formalin (formaldehyde) to the solution. If mold does appear, it is easily strained off by decanting the solution through a coffee filter. In extreme cases the mold can be simply skimmed off the top of the solution with a pair of chopsticks. In any event, this mold growth is not something that should cause you to lose any sleep. In hot and humid weather, try not to let the chemical sit out in the open too long before mixing it into solution.

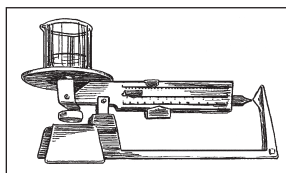
### Part B—Potassium Ferricyanide

Potassium ferricyanide is the other half of the formula and is responsible for the blue color, when combined with the ferrous ammonium citrate. If the chemical is in good condition it should have a nice orange red, sometimes referred to as “ruby red,” color. If it is in bad condition you’ll see yellow lumps and you should avoid using it. Potassium ferricyanide is not particularly toxic because the cyanide group is bound to the iron atom and is not free to behave as a poison. The cyanide part of this chemical

can, however, be released as a hydrogen cyanide gas if it is subjected to a strong acid, so be diligent about avoiding acid contact. Any disposal of potassium ferricyanide should be accomplished by diluting it with an excessive amount of water and disposed of in small amounts over a period of time. Do not throw it away in the trash in a dry state.

### Making a Sensitizing Solution

You will need a nonmetallic mixing beaker and two dark glass or plastic 500 ml to 1,000 ml containers that will hold the mixed solutions. The easiest way to introduce yourself to the process is to purchase a premeasured dry or wet pack Cyanotype Kit from a supplier such as Photographer’s Formulary or Bostick & Sullivan. If you are frugal and intend to do large pieces or a great many prints, keep in mind that kits from any source cost as much as would a virtual lifetime supply of cyanotype chemicals made from raw chemicals. After buying the chemicals in bulk, all you will need is a gram scale and some basic lab equipment. The following is a classic cyanotype sensitizer that, with the exception of Dr. Ware’s New Cyanotype, is essentially identical to the vast majority of published cyanotype formulas.



The Cyanotype  
Sensitizing Formula

#### STOCK SOLUTION A

400 ml water (68°F)

100 g ferric ammonium citrate (green type)

Add water to make a total solution of 500 ml

#### STOCK SOLUTION B

400 ml water (68°F)

40 g potassium ferricyanide

Add water to make a total solution of 500 ml

Parts A and B can be separately mixed in normal ambient light and will work best after a ripening period of 24 hours. The Part A and B cyanotype solutions, if stored separately in dark glass or opaque plastic containers with a good seal, will keep indefinitely. When mixed together, their usable



life is a relatively brief 2 to 3 weeks. The sensitizer is so simple to prepare that there really isn't a good argument for having a combined A and B solution always available.

### Standard Working Solution

Mix equal parts of Stock A and Stock B, that is, 25 ml of Stock A mixed with 25 ml of Stock B to make a 50 ml working sensitizer solution. A healthy sensitizer will be clear yellow-green chartreuse in color. This is also the color that your dried paper or fabric should be just prior to printing. If, after using good chemistry, you see blue or blue-gray at the dry stage it is likely that your paper or fabric has been fogged or the humidity has affected the sensitizer.

### A Very Brief Word About Making Nonstandard Solutions

It is an acceptable idea to alter the chemical composition of the cyanotype formula in order to achieve variations in density, and a few beginning options are discussed below. I have found that greatly increasing the percentage proportions of both the potassium ferricyanide and ferric ammonium citrate to water will result in an increase in the density of the blue. This solution may solve the chronic fading problem that has plagued cyanotype on cotton murals in the last few years, because the quality of cotton has been compromised by additives in manufacturing. If, however, only ferric ammonium citrate is increased you will often experience a "bleeding" of the shadows, whereas an increase in potassium ferricyanide will result in a print with reduced density in those same values. This last observation is dependent on the type of paper you are using.

### Low Contrast/High Contrast Solutions and Controls

Contrast control in cyanotype is, to me, often about controlling the visual associations of lighter to darker values in the negative translation and extending the range of cyanotype tonalities. It is common to experience a fairly significant loss of tonal gradations during the washing, toning, and drying stages, and the following suggestions are options you might take if your image is exhibiting problems of too high or low contrast.

A simple solution to reduce contrast is to dilute the standard working sensitizer solution with a small per-

centage of water. The greater the dilution, the softer the image. You may also create a lower contrast image by developing the image in a white vinegar concentration that is described later on in this chapter. Another method of controlling contrast is precoating your paper with a variety of weak acid solutions such as 1% oxalic acid or a 1% glacial acetic acid. In most cases, depending on the paper you are using, precoating, and drying, an acid bath will intensify darks and extend the visible tonal range. Be aware that regardless of the increase in density, this technique will often flatten the mid-range values and take the thrill out of the highlights. You can also achieve lower contrast appearance in your image by using the sun as your UV source. Cyanotype exposed by sunlight tends to provide a longer tonal range than does a mechanical UV light and thus creates a lower contrast image by a light to dark association.

A higher contrast solution can be mixed by adding 4 to 6 drops of a 1% solution of potassium dichromate to every 2 to 4 ml of the standard A + B sensitizer mix. This modest addition to the sensitizer will often let you print a poorly defined negative, but it may also degrade a portion of the middle tonal values. To make a 1% solution, mix 1 g of potassium dichromate with 100 ml of distilled water.

A similar contrast boost effect can be realized by adding a few drops of an ammonium dichromate solution to the initial water development bath. This percentage can range from 1% to 10%, and the exact amount that can be effective will depend on the strength of the percentage that you elect to use. Begin testing by making a batch of identical exposures through a Stouffer T2115, or equivalent, step-graded transparent scale. Process the first print in plain water as a control. Then make a specific dilute ammonium dichromate solution and add 10 to 15 drops of it to a liter of water and process a second test print. Write down the information, add either more ammonium dichromate or water, and make a third test. Proceed with the testing until you have established a set of working parameters that you can use effectively.

Contrast can also be managed in other ways. If you let a first coating of sensitizer dry thoroughly and then recoat it with a second application of sensitizer, you will notice a remarkable increase in the density of the darker values. By



Figure 6-6

**Laurie Snyder, *Sun and Pressure*, 1992**

This is a fine example of Laurie Snyder's work in the genre of artists' books. The piece is 15" × 24" when opened and consists of twenty-seven double-page spreads of ink monotypes with cyanotype. It is quarter bound in linen and handmade flax paper.

*(Courtesy of the artist)*

the darker value's association with lighter values, both the contrast and the clarity of the image appear to be enhanced well enough to merit this option when you are experiencing problems. Be aware that the double coating will often mean a longer exposure time. The best option is to make a great negative that can be specifically used for the process.

## The Negative

The cyanotype is a contact printing process like a photogram. As is the case with other non-silver processes, a cyanotype sensitized paper is exposed with sunlight or an ultraviolet (UV) light source and will require a negative(s) that is the same size as your intended print. I have had success with a wide assortment of negative types and can usually get a good-looking print by adjusting the way I work to fit the negative's potential. This is one of the primary

reasons that the process is such a great one to begin learning alternative techniques with, because success comes quickly to the rookie. I really do not have a specific general recommendation for a cyanotype negative. I've heard a lot of advice that recommends using a negative that would print well on a paper grade of 0 to 1 (indicating a fairly high-contrast negative density of about 1.5 to 1.7) and that this particular type will do well with using a standard A + B sensitizing formula. This is true, but the same success can come from negatives that do not specifically meet this recommendation. My best advice is to make a nice negative and learn the process with it.

## Paper and Fabric Surfaces

Almost any type of paper or fabric can be used in the cyanotype process. This is, of course, dependent on what type





Figure 6-7  
**Sarah Van Keuren, Seth Holding**  
*Wreath, 1996*

Sarah Van Keuren made this wonderful cyanotype portrait and then altered its coloration by performing a gum bichromate process on top of it once the cyanotype was finished.  
*(Courtesy of the artist)*

of statement you are going to make or what your intentions are with the print after it has completed its cyanotype journey, that is, gum bichromate printing, collage, painting, paper sculpture, clothing, etc. Those options will determine which surface will be appropriate for you. Generally speaking, the best paper to use for a single image will be a quality hot or cold press paper like Arches Platine, Fabriano Artistico, Lana, Arches Acquarelle, Saunderson Waterford, Somerset Book, and Crane's Platinotype. These papers are neutral pH (in the middle of being acidic or alkaline) and already have a good sizing built into them during manufacturing. They are also specifically made to

withstand the rigors of extended immersion times in liquids.

Other paper options, some of them esoteric, that withstand the rigors of wet processing are those such as the 22" × 30" Gampi Torinoko and Hahnemuhl etching paper that you can purchase by the roll. There are a wide variety of rice papers available at well-stocked art supply stores, and I recommend buying small pieces to test before committing to large amounts. One recommendation that I read about was a roll paper, 18" × 50', that was simply labeled Oriental Rice Paper for Sumi. The paper was tenaciously strong in water almost to the point of

being like fabric. Generally, sizing beyond the manufacturer's own process is seldom necessary for cyanotype and will only be relevant if you intend to extend your ideas with other processes such as gum bichromate. With cyanotype, whether you size or not is really dependent on the original attributes of the paper you buy and what your intentions are. If you feel sizing is called for you can simplify your life by adding a ml or two of liquid gum arabic to each 40 to 60 ml of the cyanotype A and B sensitizer mix. This will help suspend the coating on the paper's surface.

## Coating

There are several ways to coat your paper or fabric. A total immersion technique is the best method for fabrics but uses an awful lot of sensitizer. If you're mixing from bulk chemicals this will be of little concern to you. Spraying is a suitable application technique for large paper sheets but I think the best method for paper under 16"×20" is to coat with a *hake* brush or inexpensive foam applicator. Both brushes are made without metal *ferrules* (the metallic section that holds the brush hairs to the handle), which can cause problems in many of the alternative processes should metal come into contact with your sensitizer chemistry.

I like to coat under a few strands of miniature non-blinking Christmas tree lights, or low level ambient room light. Apply your sensitizer quickly and evenly using a gentle vertical, and then horizontal, stroking technique and be wary of leaving puddles of sensitizer on the paper's surface. Single coats work quite well if you get the right degree of saturation. The quality and thickness of your paper will determine the degree and amount of sensitizer your paper can accept. If your prints are consistently thin, even following extensive exposures, try a second coat once the first one is completely dry. As a rule, most quality artist's papers will only require a single coating

Once the paper has been coated well, dry it in darkness or very low light by tacking it to a wall (be careful of staining the floor and walls), hanging it on a clothesline, or placing it on a drying rack (not one used for black and white print drying). You may use a hairdryer on a cool setting to speed up the process, but be sure to wear a respirator when doing so. When using a hairdryer, avoid



## Hake Brush

Japanese *hake*, or Chinese *jaiban*, brushes are made of wood and stitched hairs. They are desirable for alternative and non-silver process coating due to their lack of metal ferrule and aesthetically organic look and feel. The absence of a metal ferrule is important, because it is often detrimental for any metal to come into contact with an alternative emulsion. The only problem with these lovely brushes is their tendency to shed hairs during the coating. A solution to this shedding is simple. Take your hake brush and run a single bead of Super Glue® along the hairs where they come into contact with the wood handle. Repeat this step along the opposite side, being careful not to use too much glue. Do not smooth the glue with your finger or you will have "hake finger."

excessive heat and focus on the back of the paper rather than the coated front.

Be sure that the paper is "bone" dry because any moisture left in the paper will become an instant developer during your exposure (remember, this is a water development technique), and your print's detail and clarity will be compromised with fog. Do not use a clothes dryer for drying a coated fabric. The heat will be detrimental, and the possibilities of staining future loads of laundry are quite real—which will make you very unpopular at home.

A coated dry and ready to print cyanotype will be a light green-yellow color. Again, if it is blue prior to printing then you may have a chemical or moisture problem. Often you will see a mottling (an uneven coating) on the surface of the support, especially with fabrics, but this problem is often uneventful after exposure and development. Try not to touch the print surface because the oils and moisture in your fingertips may alter the chemical coating in those spots.





Figure 6-8  
**Stacia Smith, *Something in Blue*, 1999**  
 (16" × 20" Cyanotype)  
 (Courtesy of the artist)

## A FEW WORDS ABOUT THE SUN

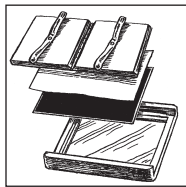
Before we begin exploring all of the alternative processes that follow in the book I want to mention the sun as the best light source you can use for contact printing. Unless you are working in a cold and dark climate most of the year, in which case you might think about becoming a poet, the sun provides the most efficient and least expensive means of exposing your contact negatives in printing frames. However, serious or cold climate based alternative process printers swear by a UV exposure unit because they feel it provides a consistent and controllable light source year round.

Why is sun best? It's free, really bright, and nothing can come close to the good feeling you'll have sitting around outdoors printing with your friends and family. Remember them? the people who have missed you all of those years while you've been in the darkroom? Secondly, in the summer your exposure times are short and pleas-

ant, and it is easy for you to monitor your progress. Outside, the light is bright enough to read the exposure of your edges and their density. Simply observing the changes will give you a lot of information because alternative process exposures are easily determined by this evaluation method. When you think that you are close to being done, it is a simple matter of picking up the frame and moving into a shaded area to check on the details of shadows and highlights. This is especially true with processes such as POP, salt, and Ziatype.

Of course there are variables with the sun that you will not find with a UV printer unit. The time of year, time of day, humidity level outside, and overall atmospheric conditions will all have something to do with your exposure. A misty and foggy day that makes you squint your eyes will often be an ideal one to print. Printing on a winter's day in New Hampshire, where I have my studio, will often be frustrating due to the low position of the sun and the dryness of the air, but the other nine months of the

year are great. Use the winter to enrich your life with other interests or make (see Appendices) or buy a UV exposure unit equipped with daylight tubes. Do not waste your time with filtered “black-light” tubes like the ones that make Jimi Hendrix posters come to life because they are very inefficient exposure sources. You may, however, successfully use an unfiltered UV tube.



## Exposing the Cyanotype

When your coated and sensitized paper or fabric is completely dry, place your negative in contact with the coated emulsion and double check to see that it will read correctly when it is completed. The negative that you use will work very well if it has an average negative density in the range of 1.4 to 1.6. Be aware that you will be losing a considerable amount of density in the wash and development stages, so it is important that your highlights are able to print. Next, load the negative and coated paper into your contact frame so that the negative is next to the glass of the contact printer and the coated paper is behind the negative. Be sure that the hinge part of the frame back straddles the negative/coated area so that you can undo one side of the frame during exposure if you wish to check on your progress without losing registration.

The most common problem in cyanotype printing is underexposure, where the highlights and middle values wash out in the water development. It is not a question of whether they will wash out, but to what degree. Depending on your negative, you will have a short or a long exposure, with darker negatives obviously taking more time than lighter ones. In summer sunlight, a short exposure might last 1 to 3 minutes, and a long one up to a half an hour. It is generally a good idea to make a test print.

There are several ways to test exposure time during the exposure. When I am teaching a workshop class how to make cyanotype murals in the sun, I often use the students as photogram objects on a sensitized bedsheet. During the exposure I periodically lift their fingers to check on the comparative densities. This allows me to see what the base emulsion is doing in adjacent comparison to the open

exposure next to the student's finger. Unless they are sweating a lot, this is a good method of calibration. In a contact printing frame, I often place a small opaque object on the glass so that it covers a separate swatch of emulsion that I had added to the bottom of the paper during coating. By quickly lifting the opaque object I can determine where the exposure is and how long I have before the processing begins. As you will discover, overexposing a cyanotype is a difficult thing to do.

A test strip can be easily made by coating a piece of paper with the sensitizer, drying it completely, and placing a negative in contact with the emulsion. Put the sensitized paper and negative in your contact frame and lay a series of opaque strips over the coated test piece. These strips will be removed, one at a time, at predetermined intervals and then processed for the information. You can also use a transparent step wedge for this task, but I feel the negative's information from the test is often more important than how many gradations you might achieve with it. When the test exposure is done, process it in tap water until the whites have cleared and there is no evidence of yellow in the wash water. Then quickly blow-dry the strip, and you'll get a rough idea of approximately what the best exposure will be. Be aware that cyanotype print values will darken over a period of days as the print oxidizes. You can accelerate this oxidization by immersing the washed print in a weak solution of hydrogen peroxide.

Cyanotype is a printing-out process, so you can examine your exposure as you go, providing you are using a hinged contact printing frame. I generally like to see, in a predevelopment examination of the exposure, highlight detail that is a great deal denser than I would be happy with in a finished print. Occasionally, I want my deepest shadow details to have a nearly solarized look (the density has begun to reverse itself and is transforming to a lighter, almost metallic-negative-gray). I also watch the outside-coated borders that have no negative covering them. Often the best cyanotypes will be realized when the outside borders have reversed themselves to a near silver-gray. Another general piece of information is that thicker papers often take a bit longer to expose than do thinner papers. Always write down your exposure time on the paper so that you can evaluate your progress over the course of a printing session.



Judy Seigel has suggested a technique where the exposure is stopped halfway through the exposure and then resumed to completion after a wait of several minutes. She reports that this interrupted printing results in noticeably better shadow details and separation without losing highlight or D-max integrity. I haven't tried this technique in a formal experiment yet, but Judy's suggestions are always worthwhile, and this may be another good control option to use.

## Development: Water or Acid

Traditionally, the cyanotype is developed out in a water bath. This is the least complicated step possible and is the preferred development by most everyone who works with the process. The one shortcoming of water development may be a moderately limited tonal scale.

An alternative development process, one that often produces a longer tonal scale, is the use of diluted acidic solutions such as distilled white vinegar or acetic acid. The nice part of this alternative is that the tonal range of values will be extended without having to lengthen the exposure. The downside is that by trading for a longer tonal scale you will often lose on the comparative highlight to shadow contrast in the print. You might think of an acid or vinegar development bath as one that turns the cyanotype into a soft graded paper.

The simplest solution to begin experimenting with would be household white vinegar, which is generally the equivalent of a 5% concentration of acetic acid. White vinegar can be used straight from the bottle or diluted with water to give you more flexibility. In its pure state, it is worth about 2 to 4 levels on a step table. Here are a few signs to look for if you decide to use vinegar as a development option.

- ◆ **White vinegar out of the bottle:** A significant increase in the range of values (2 to 4 steps) but a relative decrease in the contrast. This might be a good formula for negatives that are hopelessly too high-key. A hydrogen peroxide "oxidation-hit" will have little effect on this straight vinegar developed print.
- ◆ **Vinegar and water 1:1:** Some of the image's highlight crispness begins to return without a loss in the step table. Hydrogen peroxide has a negligible effect in deepening the blue in the print.
- ◆ **Vinegar and water 1:3:** A 2 to 3 step increase in mid-tone values, better highlight detail, and the hydrogen peroxide adds a little "intensification" to the blue.
- ◆ **Vinegar and water 1:5:** Still a pretty decent range in the additional steps and the highlights are better. Decent D-max (maximum density) equal to the other prints in the test sequence, and the hydrogen peroxide has a modest effect.

Using Mike Ware's New Cyanotype Process, explained later, the effects of vinegar development are less distinct. That fact is somewhat irrelevant if you are using Ware's formula, which has a longer and similar tonal scale and a softer look to the overall image. Ware's process does employ an acid development that has a softening impact on the contrast.

## Acid Postdevelopment Bath

Another alternative in developing cyanotypes for additional tonal range is a technique of rinsing your water-developed print in a mild acid bath following the development. Adding this acid bath step will often result in an intensification of the darker values while reducing the lighter ones. Traditional manuals, such as the *Kodak Encyclopedia of Practical Photography*, suggest a postdevelopment bath of 4 to 5 drops of hydrochloric acid per 1,000 ml of water for a few minutes. I have also heard of cyanotype artists who use weak solutions of citric acid, both chemical and natural, in this step. For fun, try squeezing a few lemons into a water bath and note the effect. You will likely see a bit of clearing and a marginal intensification of darker values.

## Washing and Oxidization

After exposure and development, wash your developed cyanotype print in running water for 5 to 15 minutes or until the highlights have cleared to white. You should no longer see any yellow-green coloration in the water. Shorter washing times may leave ferric salts in the paper. Too long a washing time will cause both fading, through a pigmentation loss, and a decrease of highlight details in the print.

If you need instant gratification, try this: After the first wash, remove the print from the water and add a splash of drugstore grade hydrogen peroxide to the water bath.

Figure 6-9

**Laurie Snyder, *House Books #1-#4*, 1995**

This image, which is in color and a great deal larger in its original form, illustrates Laurie Snyder's *House Books* #s 1-4. This is a wonderful example of making the pages for an artist's book in an alternative process and then constructing the book. Laurie's installed piece is 85" × 60" and is composed of accordion fold books with hard covers.

*(Courtesy of the artist)*



Reimmerse the print and watch the blues go to an immediate and intense deep blue. This action causes the highlights to appear super white because of their relationship to the dark blues. This intensification “trick” is everyone's favorite. Really, though, all that is happening is that you are accelerating the oxidization of the iron in the print that would happen naturally in a few days without this step. Don't forget the wash stage after being thrilled.

## Clearing Your Highlights

A 1% to 5% solution of oxalic acid can be used (1 to 5 grams of oxalic acid to 100 ml of water). This solution is particularly successful for spotting blue stains out of highlight areas. Take all necessary precautions when using oxalic acid because it is toxic.

If your print is overexposed (which is pretty hard to do), mix up a solution of sodium carbonate, approximately a pinch to 1,000 ml of water, and immerse your image in it until it begins to fade. Watch for the first signs

of yellow. Too strong a concentration or too long in the sodium carbonate solution will have a serious bleaching effect. If you feel you went too far with this, you can consult the toning section for techniques on where to go next. Tannic acid would be a likely option. If you opt to do nothing at all, save your overexposed cyanotype for a Blue-Van-Dyke print or a gum or simply throw it out and do a new one.

## Toning the Cyanotype

There will be times when you simply do not want a blue image but still want to use the cyanotype technique due to its flexibility and simplicity. The following are some formulas for changing the color of cyanotypes once they have completed the final wash. In general, it is a good idea to overexpose your prints if you intend to tone them. Many of the following formulas utilize sodium carbonate or ammonia, which tend to radically reduce print density if the solutions are too strong.





Figure 6-10  
**Brooke Williams, *Self with Family, Jamaica, 1987***  
 (Cyanotype mural)

Brooke made this mural piece while she was a student of mine at Harvard. The work documents a personal and family experience while visiting Jamaica. The cyanotype prints have been toned with tannic acid to convert the blue, and the writing around the outside of the six panels, containing quotations from Brooke's journals and the writing of Marcus Garvey, is made on acetate and contact printed.

(Courtesy of the artist)

These toning suggestions are essentially variations on the theme of alkaline hydrolysis followed by the formation of ferric tannate or gallate that forms the new color palette. They are interesting to play with and modify and almost always look better wet than when dry.

A word of encouragement—many times the formulas will not work as you want them to due to water types, contamination, time of year, etc. Take these formulas with a grain of salt (sorry, bad pun) and adapt them to your own aesthetic. Very often, during workshops, I will simply pour and sprinkle formulas together to reinforce the idea that the results from these toning suggestions are not set in stone, either alone or in combination with other ton-

ers. Besides, what have you got to lose? The process is simple, inexpensive, and accidents often become individual and unique techniques.

There is the issue of permanence to consider. The cyanotype, in a pure Prussian-blue state and handled correctly, is permanent and one of the most stable alternative processes. The toning steps change the chemical composition of the cyanotype image, and it is occasionally questionable if all of these formulas can be described as “permanent” after the fact. I have found virtually no deterioration in the images I toned with tannic acid over 20 years ago. This is not the case with images done during group toning demonstrations, where inadequate washing times between steps are often the rule.

It is a good idea to *dry* your cyanotype prints before toning them and to let them oxidize for a day or so. This

Figure 6-11

**Grace Huang, *Portrait of Stefanie*, 1989**

Grace Huang, a classmate of Stefanie London's, made this portrait of her in cyanotype and split-toned it with sodium carbonate.

(Courtesy of the artist)



step gives the coating a chance to *harden*. After they have been dried, you should rewet them to tone. This soaking stage will allow the toning solutions to cover and penetrate the paper's fibers more completely and makes for a smoother-looking tonality in the print. The formulas given are equivalent in ratios, and you may feel free to modify the amounts in order to adequately cover the size of your prints.

### The Big Thrill

Hydrogen peroxide (3% drugstore grade) added to water will seem to super “intensify” the blue in your cyanotypes. The actual effect is simply an accelerated oxidation of the iron. This intense blue will occur eventually, given time, in any well-processed cyanotype. Hydrogen peroxide can be used immediately after the yellow has been washed out of your print. Mix it casually and without fear, because this chemical is used to clean wounds and as a mouthwash.

### Removing Blue: Yellow Toning

There are several chemicals that will alter the intensity of the blue in your cyanotypes. As mentioned, hydrogen peroxide, oxalic acid, and sodium carbonate will all cause the blue to change, as well as solutions of chlorine bleach, sodium sulfate, sodium silicate, trisodium phosphate, and commercial laundry soaps. You may mix solutions of these chemicals and apply them selectively to remove areas of blue, and in some cases you can alter the entire color of the print or fabric in complete baths.

For example, to make a yellow and white print, make a solution of trisodium phosphate in a ratio of 1 tablespoon to every quart of water. Dissolve the trisodium phosphate in hot water in a plastic tub or tray, and immerse the cyanotype in the solution until it fades to yellow. Rinse the print with running water for 30 minutes, or run the fabric through a cold wash cycle without soap. The resulting image will be permanent.



## The Basic Tea Toner

Buy some basic and inexpensive household tea (tannic acid) and make a very strong solution in hot water. Immerse your print in it until you have the desired tonality. Using a solution of tea as a toner is a nice way to create a duotone image. The print's highlights exhibit a pleasant tan color while the blue takes on a slightly warmer hue. If you don't want any blue, just go through the yellow toning stage with trisodium phosphate and then move on to the tea toning. Using green and herbal teas without tannic acid in them does not work as well.

## Brown Toning #1

### PART A

28 ml nondetergent, household strength ammonia added to 240 ml of water

### PART B

14 g tannic acid added and mixed well and added to 750 ml of water

Tannic acid mixing takes a little patience because it does not dissolve readily in water. Break up the clumps and keep stirring until the chemical is in solution. Immerse the washed and wet print in Part A for a few minutes or until it becomes pale. Then rinse the print for several minutes and transfer it to Part B for the conversion to brown. In all of the toning formulas, too short a rinsing time between stages is the primary culprit in the discoloration of highlights and paper base white.

## Black Toning #1

Immerse the print in a solution of Dektol. The stronger the Dektol solution the more intense the goldenrod color that will present itself to you. When the blue is almost entirely bleached out and converted, rinse the print for several minutes in water and then immerse it in a solution of tannic acid mixed to 30 to 50 g per 1,000 ml of water. You should see a smokey black color within 5 minutes. Wash the toned print for 15 minutes.

## Eggplant/Red/Black Tones

Use the black toning #1 procedure and after the final wash immerse the print in the strong Dektol solution again or in an ammonia bath solution consisting of 250 ml ammonia to 1,000 ml water.

## Black Toning #2

### PART A

3 drops nitric acid\* added to 1 liter water

### PART B

14 g sodium carbonate added to 160 ml water (5.3 oz)

### PART C

14 g gallic acid added to 160 ml water

Begin by immersing your washed and wet print into Part A (nitric acid) for 2 minutes. Then rinse the print for several minutes, transfer it to Part B, and leave it in the solution until the image disappears and then reappears as a very light orange image. Then rinse the print for several minutes and transfer it into Part C, where the black tones should become evident. Finally, wash the print for at least 15 minutes.

## Blue/Gray Split Toning

Allow the cyanotype to age for a day or two and then rewet the print. Mix a solution of 3 drops of nitric acid in 1,000 ml water and immerse your print in it for 2 minutes. Then wash the print for several minutes. Next, immerse the print in a weak (a pinch to 1,000 ml of water) sodium carbonate solution until a yellow split occurs, and then wash the print for several minutes. Mix up a solution of tannic acid of 25 g to 1,000 ml water and place your print in it until a blue/gray split appears. Finally, wash the print well for 15 to 20 minutes.

## Red Toning

Follow the directions for the blue/gray toning. Immerse the print in a light sodium carbonate solution (a pinch to 1,000 ml of water) until red and then wash the print for 10 minutes.

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\*Nitric acid is not a chemical to take lightly. This is evident as soon as you take the plastic top off the bottle and see the white vapors rising toward the ceiling. Please do not be casual with this chemical. Be sure to read about it in the chemical section in the Appendix and wear proper protective lab gloves and a mask when working with nitric acid.



Figure 6-12

**Judy Vejvoda, *Goddesses Pantry*, 1992**

Judy, who is now a teacher, was a student of mine and later in the graduate program at UNM with Betty Hahn where she made this 40" × 70" construction of toned cyanotype images and mixed media on paper.

*(Courtesy of the artist)*

### Eggplant Black #1

This is a very casual kitchen formula when you don't have a gram scale.

#### PART A

1 to 2 tsp sodium carbonate (very flexible) stirred into solution in 1 quart water

Be aware of how much sodium carbonate you use in Part A. You may find that 1 to 2 tsp is far too strong a mix for your prints. If this is the case, then either make a new Part

A with a pinch of sodium carbonate or add more water to the solution.

#### PART B

4 to 10 Tbs tannic acid added and mixed really well into 1 quart water

This tannic mix is much stronger than you may need to get the job done but I have found it works for me, so include it in this formula. If you find it is too strong for your prints then simply reduce the amount of tannic acid in the Part B formula.





Figure 6-13

**John Wood, *Hands, Beaver Pond, Windmill and Yellow*, 1990**

This piece by John Wood is from his Colorado Series. It is a great example of mixing the attributes of cyanotype and monoprint.

*(Courtesy of the artist)*

Dry your prints for a day or two and rewet them in a water bath. Begin by immersing your wet print into Part A for a very brief time. The sodium carbonate decomposes the iron blue quite quickly, so watch it closely. I like to slip the print into this solution and immediately remove it to a water bath for the bleaching effect to take place. Generally, this stage is pretty flexible and the less iron blue that decomposes, the greater the possibility of a split toned image. You may find, as I have, depending on the water, that as little as a pinch of sodium carbonate will work well. Next, rinse the print and immerse it into Part B for as long as you want to. The greater the time and concentration of tannic acid, the deeper the color. Be aware that at some point, the highlights will begin to stain. Wash the print for 15 minutes and hang to dry.

### Violet Tones #1

This formula is occasionally successful. Prepare a weak borax (commercially available in the supermarket) solution and immerse the print in it until you see a color change that pleases you. The concentration of the borax to water is flexible, and you should play around with it. This particular toner often looks good in the wet state but has a tendency to flatten out after drying. Water type will play a role in determining the degree of violet you might get.

### Violet/Gray Tones #2

You can occasionally get the violet/gray shift by making a solution of 5 g of lead acetate in 100 ml of distilled water. Immerse the print in this solution until you see a color that you like, then wash the print well for 15 to 30 minutes. Be cautious of the lead acetate because it is not one of the harmless chemicals. Do not dispose of lead acetate down the drain and continue to reuse the toner formula until it doesn't do anything anymore. It is possible to continue this formula by immersing the print in a bath of citric acid following the wash. This bath will result in a very deep blue/violet according to those who use it.

### Yellow/Blue Split Tones

This is very simple toner and seems to work best in the city, where there is a good deal of iron in the water supply. Allow the exposed and washed print to age for a day or two. Rewet the print and immerse it in a hydrogen peroxide bath followed by a 15-minute rinse. Then place the print in a very weak solution of sodium carbonate (a pinch between thumb and forefinger to a 1,000 ml of water). Immediately transfer it to a fresh water bath to observe the changes. Allow the changes to occur in the wash water rather than the sodium carbonate to achieve the split. After you are satisfied, wash the print well for 15 minutes.

## Purple–Brown Toning

Mix up a *hot* solution of tannic acid at 70 g to 1,000 ml water. To this solution add a drop or two of pyrogalllic acid. Then immerse the print until the blue turns to a lilac color and rinse the print for 5 to 10 minutes. If you like the color, simply complete the wash stage and don't do any additional toning. If you wish to go to the purple–brown, immerse the print in a caustic potash solution made with 15 grams of caustic potash to 1,000 ml of water until the desired color is achieved. After toning, wash the print well for 15 minutes.

## Gray to Reddish Tones

Mix up a solution of 48 g of copper nitrate dissolved in 96 ml of distilled water. Add 5 drops of household ammonia and mix it well into solution. Immerse the print until the desired color is achieved and wash the print well in running water for 15 to 20 minutes.

## Black Toning #3

Immerse the print in a strong tannic concentration for 5 minutes and then wash for 5 minutes. Then immerse the print for very brief time in a weak sodium carbonate dilution and immediately move it to a wash tray for 5 minutes. Go back to the strong tannic solution for another 5 minutes and wash the print again. Then immerse the print in a hydrogen peroxide bath (casual dilution) for a minute, rinse the print, and return to the tannic bath for the black. Finally, wash the print well for 15 to 20 minutes. This formula has worked very well about 50% of the time and will occasionally result in paper base staining.

## Violet-Black Toning

Mix up a moderately weak solution of sodium carbonate as in previous formulas and immerse the print until it has turned a pale yellow. Wash the print for several minutes and then mix a solution of 8 g of gallic acid, 0.5 g of pyrogalllic acid, and 1,000 ml of water rinse and immerse the print until the desired color is reached. Wash the print for 15 to 20 minutes.

## Red-Brown

Immerse an aged and wet cyanotype print in a solution of nondetergent household ammonia and water, mixed in solution at approximately 8 ml to 250 ml of water until the print turns a violet color. Wash the print for 10 to 15 minutes and then immerse it in a strong solution of tannic acid and water (25 g to 500 ml water) for 5 to 10 minutes. Wash the print for 5 minutes after the tannic acid bath. If you like the brown color, stop the process at this point and wash for 20 minutes. If you feel like going on, immerse the print in a strong solution of sodium carbonate until a deep red-brown appears and then wash the print well for 15 to 20 minutes.

## Dark Blue/Blue Violet/Rose Split

Follow the directions for the rich red-brown. Quickly immerse the print in the strong tannic acid again and then wash the print for 5 minutes. Then immerse the print in the gold/borax toner formula used for salted paper toning (400 ml distilled water, 3 g borax, 6 ml 1% gold chloride) until you see the split. Finally, wash the print for 15 to 20 minutes.



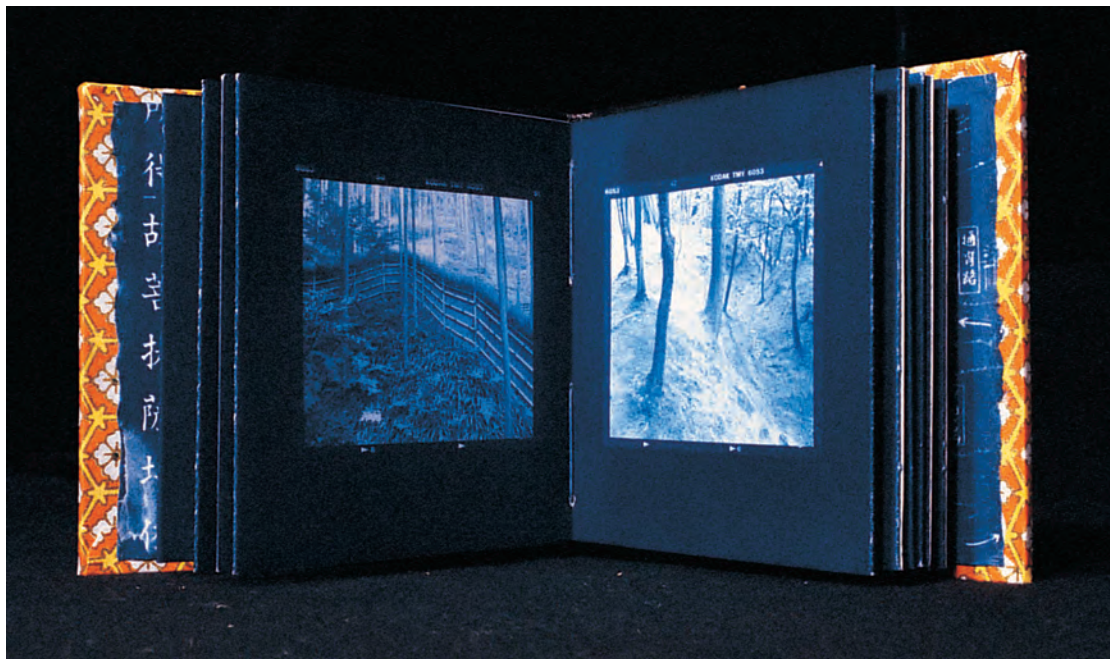


Figure 6-14

**Phoebe McCormick, *Shinto Views***

Phoebe, who races motorcycles, makes artists' books, and teaches at the Art Institute of Boston, works with a vast assortment of processes and materials in the translation of her intentions. *Shinto Views* is a handmade book with cyanotype images that capture the essence of her experience in Japan.

*(Courtesy of the artist)*