

CHAPTER 7

THE CYANOTYPE PROCESS



Fig 7-1 here, (Christopher James, Foot of the Pyramid, 1994- toned cyanotype)

OVERVIEW & EXPECTATIONS

The cyanotype, or *Ferro-Prussiate Process*, is often the first technique that any of us learn in alternative process photography. Cyanotype is the proverbial “first kiss” that sinks the hook and makes us fall in love with all of the possibilities to come with alternative process image making... in much the same way that the wet lab darkroom experience did to all of the image makers who had the pleasure of that experience.

The primary reason for this affection is the absolute simplicity of the process and chemistry, and the nearly fail-safe workflow. This is the process that is ideal for both

student and teacher alike as the opportunity of making a great print, and experiencing success the first time it is taught or attempted, is very high. As an example, I always begin a class or workshop with a 9' x 18' cyanotype mural on pre-sensitized fabric. This bonds a class and facilitates the student's experience in making a beautiful giant size mural with nothing more than a piece of prepared cotton fabric, sunlight, themselves as the subject, a hose, an ocean, a stream or plastic trash can filled with water, and a dash of hydrogen peroxide for a cheap thrill finish. In the Cyanotype Variations chapter I will give you a step-by-step guide for making this project work as a class or for a family gathering at the beach.

In this chapter the cyanotype process begins, as always, with a little history to show you where it all came from. I will introduce you to the first woman photographer, Anna Atkins. You'll learn about cyanotype chemistry and how to prepare and use it as a hand-applied UV light sensitive solution to paper and fiber substrates, and how to adjust the cyanotype formula for specific effects and corrections.

Also included is a discussion about alternative substrates, sizing, coating, light sources, exposure, and development in water or acids for additional contrast control. You will also learn about accelerated oxidation, highlight clearing, trouble-shooting, and an abundant number of toning options for the cyanotype...just in case the color blue doesn't seem like the right one for the subject in your print.

This will prepare you for the following chapter, Cyanotype Variations, where you will learn about inter-media applications, cyanotype on fabrics and optional mural materials, cyanotype on glass, Mike Ware's New Cyanotype process, and combination processes with cyanotype. Let's begin!

Fig ICON-1 here, (A Little History)

Fig 7-2, Anna Atkins, Cyanotype Specimen, 1842

A LITTLE HISTORY

The cyanotype, a technique in the *siderotype* family of iron-based photographic processes, was the first simple, fully realized and practical, non-silver photographic process. Discovered by Sir John Herschel (1792-1871) in 1842, just three short years after the “official” announcement of the discovery of photography, the cyanotype provided permanent images in a vast array of elegant blue values. Herschel, by the way, was a British gentleman who coined the now familiar photo-centric words *positive* and *negative*, *snapshot*, and *photography*.

As an aside, there is strong evidence that the Brazilian inventor and artist, Hércules Florence, first applied the word *photographia* to describe his images on silver nitrate coated paper using a camera obscura in 1832–33. Florence’s work was done years after Nicéphore Niepce’s unpreserved *retinas* in 1816, and *Heliographs* in 1826, but several years before Hippolyte Bayard, William Henry Fox Talbot and Louis Daguerre were accepting different levels of credit for the medium’s discovery. There is no evidence that Herschel was remotely aware of Florence’s work, or coinage of the word *photography*.

Fig: 7 – 3 here, Hippolyte Bayard Photogram 1842

Like many educated and erudite gentlemen of his era, Herschel was involved in a great many activities in a universe of disciplines as diverse as science, the arts, literature, travel, and virtually any activity that would raise his stock as a *Renaissance Man* and interesting dinner guest. He was rightfully considered one of the greatest scientific minds in Europe and was renowned for his skills as a mathematician and astronomer, as was his father.

Herschel’s imagination was ignited with the new science of making images with light and chemical reaction and immersed himself in that field of study. Among his photographic discoveries, Herschel developed the Argentotype, in which ferric citrate

iron salts were used to precipitate silver under the influence of ultra violet (UV). These salts were subsequently developed in a solution that included silver nitrate. He also developed a lovely and odd technique described in the Anthotype chapter of this book, that involves crushed flower petals, a little alcohol, and a 2 to 3 week exposure in sunlight... coincidentally, the three key ingredients for an outstanding vacation.

Herschel was a gentleman scientist, and like others within the social circle he traveled in, his investigations were instigated by the concept of experimentation for the love of satisfying puzzling curiosities and for the honor of presenting an important paper or idea to distinguished and scholarly societies. Often, the investigations and ideas had practical applications and I suspect that when Herschel was playing with iron salts, and extracts from the flowers in his garden, that he had no conceptual reference to imagine that making pictures of life in photograms, or with a box of air when employing a camera obscura, would one day be credited as a significant part of one of the most important, and universally loved, forms of expression on earth.

Fig: 7 – 4 here (*Julia Margaret Cameron, Sir John Herschel – 1867 – albumen from glass plate negative*)

Between 1839 and 1842, Herschel conducted hundreds of separate experiments on the light sensitivity of silver salts, metals, and vegetation. A fair percentage of these experiments were dedicated to the idea of making colored photographic images as a way of distinguishing his work from that of his peer, and friend, William Henry Fox Talbot who was successfully making photogenic drawings, and calotypes, in brown. In that quest, he embarked on an investigative mission to discover highly colored dye extracts of flowers from his garden that might show evidence of being light sensitive. This work led to the invention of his charming anthotype process.

Another tangent of Herschel's experimentation dealt with an investigation of potassium ferricyanide. This aspect of his work was greatly augmented by Dr. Alfred Smee's work in electro-chemistry, which led Smee to a refined variation of potassium

ferricyanide, produced through electrolytic oxidation, that he was generous enough to share with Herschel in 1842.

Dr. Smee, in his early 20's at the time, responded to a request from the 50 year old Herschel for "deeply-coloured salts" that might be "bleached" or reduced by light. In reply, Dr. Smee sent a parcel of bright red potassium ferricyanide as well as a new chemical substance he was working with at the time, ammonio-citrate of iron, that had only recently become available to chemists and physicians as a prescription remedy for patients who were in need of an iron-tonic to stimulate physical energy and to correct certain gastrointestinal maladies.

Working with Dr. Smee's chemical gift, Herschel observed that the ammonio-citrate of iron, a.k.a. ferric ammonium citrate, was quite sensitive to sunlight and that exposure to UV rays would reduce the salt of the iron from a ferric iron Fe(3+) state to a ferrous Fe(2+) state. At this point in the process, the newly reduced ferrous irons were free to react with the potassium ferricyanide in the sensitizer.

When a cyanotype sensitizer solution of ferric ammonium citrate and potassium ferricyanide, the two primary chemicals in the cyanotype process, are combined, coated on a paper, and exposed to UV light, they are reduced to ferrous ammonium citrate and potassium ferricyanide, which then forms ferric ferrocyanide... the well-known and insoluble Prussian blue. This vibrant and deep blue colored pigment was synthesized by Johann Jacob Diesbach in Berlin, in 1706, and first used by the Dutch painter, Pieter van der Werff, in 1709, in his painting, *The Entombment of Christ*. The term, Prussian Blue, derived its name from the use of prussic acid and ferrocyanide. *Ferricyanide* is translated as "blue substance from iron" from the Latin *ferrum*, meaning iron, and the Greek word *kyanos*, meaning cyan or dark blue.

Fig: 7-5 here, Katsushika Hokusai, *The Great Wave Off of Kanagawa (Kanagawa-oki nami-ura)*, 1826 (a later example of the use of Prussian Blue)

Herschel's Original Cyanotype Formula

Solution A

20 parts ammonio-citrate of iron (*ferric ammonium citrate*)

100 parts water

Solution B

16 parts potassium ferricyanide

100 parts Water

Mix equal volumes of A and B for sensitizer.

The Cyanotype was popular for a short time and experimented with by many, thanks to a commercially produced Ferro Prussiate 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 used by engineers and builders for the next century.

An odd historical nugget concerning the cyanotype involved Lt. Col. Baden-Powell, founder of Scouting For Boys, a.k.a. The Boy Scouts. Apparently, Baden-Powell mandated that the cyanotype process be used to make stamps and money during the siege of Mafeking in the Boer War between Great Britain and the Transvaal (1899 - 1902). In a modest demonstration of self-importance, he ordered that his own likeness grace the oval-framed portrait in the center of the new currency... normally reserved for the portrait of her Majesty Queen Victoria.

Fig: 7 – 6 here, Anna Atkins, Lycopodium Flagellatum 1843 – (cyanotype)

Anna Atkins: The First Woman Photographer

Anna Atkins (1799-1871) has, until recently, been referred to sparingly by traditional photo and art historians in spite of having produced a significant body of photographic work at the very beginning of the medium... to a degree where she could

justly be called the first woman photographer. She constructed wonderful cyanotype photogram images of algae, ferns, feathers, and waterweeds using Herschel's cyanotype invention. The Atkins and Herschel families resided only 30 miles apart in Kent, England, and her botanist father, John George Children, and Herschel were peers and contemporaries. 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' mentor, it is more than probable that she learned the cyanotype process in the Herschel household. If not fact, then at least it's a romantic legend.

Anna Atkins made thirteen known versions of her work titled, *British Algae: Cyanotype Impressions (1843-1853)*. In October 1843 she began publishing folios of her photogenic (photogram) drawings. In 1850, she began to publish more comprehensive collections of her work, completing a three-volume anthology in 1853. These books, containing hundreds of hand-made images, were the very first published works to utilize a photographic system for scientific investigation and illustration. Although Atkins published in 1843, Talbot with his *Pencil of Nature (1844-1846)* publications is usually credited by historians as the first to have achieved this important milestone.

Fig 7-7 here, Anna Atkins - Book Cover- 1843

Note: Sir John Herschel was the former owner of a copy of Atkins' manuscript that now resides in the archives of the New York Public Library. Photographs of *British Algae: Cyanotype Impressions – Part I* was published in October 1843, has 231 photographs, and was dedicated to Atkins' father, John George Children. The manuscript resides in the Spencer Collection – Cat #: 1843 93-440, and can be seen on line at the New York Public Library web site. Other examples of Atkins' work can be found 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. The work also exists in printed form: Aperture published Larry Schaaf's book,

Sun Gardens: Victorian Photograms by Anna Atkins, 1985. Schaaf's beautiful book is out of print, but an Internet search will likely lead to a copy.

HOW CYANOTYPE WORKS

The Process

Cyanotype is an UV sensitive contact printing process that requires, as do most alternative photographic 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 Anna Atkins did with her photograms of ferns.

The blue color of the cyanotype print is the result of the reaction of ferrous ions from 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. It will also fade, like most things left in UV light, if exposed to direct sunlight over a period of time. Should you experience this fading, your image can be restored to its original blue intensity by putting it in a dark environment for a day or two.

Contrary to some teaching, the cyanotype print can be controlled well enough to yield technically exquisite images. Cyanotype prints can also be toned with a vast assortment of toners to provide alternatives to the color blue and many of these toning options are described later in the toning cyanotypes section of this chapter. Cyanotypes are also employed very successfully as first impressions in the gum bichromate or Blue-Van-Dyke processes and can also be used, with excellent results, to delicately intensify shadow details in other processes such as platinum / palladium.

Fig: 7 -8 here (Edward Steichen, Moonrise, Mamaroneck, NY 1904 - Pt and Cyanotype.)

THE CHEMISTRY

Cyanotype Sensitizing Formula

There are two primary chemicals that constitute a traditional cyanotype formula and these are mixed together in equal parts, from A & B stock solutions. Combining Part A - *ferric ammonium citrate*, and Part B - *potassium ferricyanide*, will constitute a working sensitizing solution that may be applied to paper or fabric substrates using a variety of techniques such as painting with a hake, foam, or Richeson synthetic brush... or by spraying or immersion. Neither of these primary chemicals poses a health risk unless you are one of the very rare individuals who have an allergic reaction to the chemistry. Ferric ammonium citrate is often found in iron and vitamin supplements and is mostly just annoying if it becomes humidified and sticky. Potassium ferricyanide is a stable compound that only becomes a risk to your health if it's heated beyond 300°F or combined with an acid... neither of which you will be doing. I will add that in the decades I have been teaching this process, to people of all ages, I have never seen an allergic skin reaction. Stains on hot humid days, yes... but that will wash and fade away in a day.

Part A - Ferric Ammonium Citrate (green type)

In the green powdered state, ferric ammonium citrate (*ammonio-citrate of iron*) is a light-sensitive compound that changes from a *ferric* (iron III) to *ferrous* (iron II) state when subjected to UV light. I refer to this chemical in my classes as the “light-trigger” as it is responsible for the light sensitivity of the sensitizer.

Once mixed into solution it is, depending upon how it is stored, subject to mold growth after a relatively short period of time. This moldy surface skin state is not detrimental to your cyanotype ambitions and can be avoided by adding a drop or two of formalin (formaldehyde), or a crystal of thymol, to the solution. If mold does appear, it is easily strained off by decanting the solution through a coffee filter. In some cases, where the mold has a tangible thickness, it can simply be 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. Regardless of the mold warning, this chemical, mixed into a stock Part A solution, has a reasonable shelf life.

Part B - Potassium Ferricyanide

Potassium ferricyanide is the other half of the sensitizer formula and is responsible for the blue color when combined with the recently converted, under the influence of UV light, *ferrous* ammonium citrate. If the chemical is in good condition it should be a nice orange-red color, sometimes referred to as “ruby red.” 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 in it is bound to the iron atom and is not free to behave as a poison. However, the cyanide part of this chemical has the potential to be released as a hydrogen cyanide gas if it is subjected to a strong acid ... which is, again, something you will not be doing.

Be diligent about avoiding acid contact. You will most likely use everything you mix, but in the event that you need to dispose of this chemical you should adhere to the following: small portions of potassium ferricyanide should be diluted with excessive amounts of water and flushed. The chemical should never be thrown in the trash in its dry, ruby red, out-of-container state as it has the ability to become self-combustible.

Fig: [ICON-3 here](#) (Measuring Chemistry)

Making the Sensitizing Solution

You will need a plastic or glass mixing beaker and two dark glass, or dark plastic, 500 ml to 1000 ml containers for the mixed solutions. Try to leave as little air space as possible in the Stock A & B bottles. The easiest way to introduce yourself to the process is to purchase a pre-measured dry or wet pack Cyanotype Kit from a supplier such as Photographer’s Formulary or Bostick and Sullivan. Honestly though, the formula for this process is so elementary and hazard free that it is a perfect process to make from scratch using raw chemistry while simultaneously teaching yourself to use a gram scale.

The best place to get a digital gram scale is to go to an auction site, such as eBay, and search for a compact digital jeweler's scale... my students jokingly refer to them as dealer's scales. They are very inexpensive, portable, light up in the dark, and are totally simple to use.

If you are frugal and intend to do large pieces or a sizeable print run, keep in mind that kits from any source cost as much literally as a virtual lifetime supply of cyanotype solution made from dry chemicals. Bostick & Sullivan, Artcraft, or Photographer's Formulary will sell the raw chemistry to you. After buying the chemistry in bulk, all you will need is that gram scale and some basic lab equipment. The following is the classic cyanotype sensitizer recipe. With the exception of Dr. Ware's New Cyanotype, which will be discussed in the following chapter, it is considered the standard cyanotype formula.

Standard 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

Fig: 7 - 9 here (*Christopher James, Self Portrait with Pinhole, Maine - 1994*)

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 for quite a while. When mixed together, their shelf life is far shorter. In ideal cool and dry conditions, they may last several weeks. My advice is to mix the two stock solutions together when you intend to use them. The sensitizer is so simple to prepare that there really isn't a good argument for having a combined A & B solution always at the ready.

Sullivan's Cyanotype Sensitizing Formula with Oxalic Acid

Stock Solution A

- 400 ml water (68° F)
- 100 g ferric ammonium citrate (green type)
- 2 g oxalic acid
- Add water to make a total solution of 500 ml

Stock Solution B

- 400 ml water (68° F)
- 40 g potassium ferricyanide
- 2 g oxalic acid
- 0.8 g ammonium dichromate
- Add water to make a total solution of 500 ml

The oxalic acid in this formula assists in keeping highlights clean and bright. The ammonium dichromate has a similar role in the formula but be careful as ammonium dichromate, no matter how little is added to the mix, will have a big impact on the contrast of your tonalities within the print. If I was really concerned about getting higher contrast into my cyanotypes, and the process is going to give you that without too much effort anyway, I would recommend making a higher contrast contact negative using Pictorico Ultra Premium OHP ink jet film or add a few drops of a saturated ammonium dichromate to the first development wash.

Standard Working Solution

Mix equal parts of 500 ml of ferric ammonium citrate Stock A and 500 ml potassium ferricyanide Stock B to make a 1000 ml (1 liter) of working cyanotype sensitizer solution. A healthy sensitizer will be clear yellow-green color. This is also the color that your dried paper or fabric should be just prior to printing. If, you notice that the surface of your substrate, paper or fabric is showing uneven blue or grayish-green stained areas, it is likely that your substrate has been fogged or subjected to high humidity or dampness prior to use.

Fig: 7 –10 here (Lisa Elmaleh, Self, Santa Fe, 2006)

A Brief Word About Non-standard Mixes

It is a totally acceptable idea to alter the chemical composition of the cyanotype formula in order to achieve variations in density. I've found that 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 fabrics in the last few years due to the quality of cotton being compromised by additives in manufacturing. If, however, only ferric ammonium citrate is increased you will often experience a "bleeding" of the shadow portions of the print. An increase in only the potassium ferricyanide will result in a print with reduced densities in those same values. This last observation is dependent, of course, on the type of paper you are using and how that paper was made.

Low Contrast - High Contrast Solutions and Controls

Contrast control in cyanotype is, as in almost every alternative process, a case of controlling the tonal values of your contact negative whether it is a conventional silver gelatin film or a digitally produced ink jet film. That said, it is common to experience a fairly moderate loss of tonal gradation during the washing, toning, and drying stages of the cyanotype process. The following suggestions are options you might wish to entertain if your image was made from a negative that was less than perfect for the process and that may be exhibiting problems of too high, or low, contrast for your taste.

A simple solution for reducing contrast is to dilute the standard working sensitizer solution with a small percentage of distilled water. As you dilute the sensitizer, the gradations in the cyanotype print become softer... like adding water to soup. You may also create a lower contrast image by developing out the image in an acidic solution such as a white vinegar concentration described later in this chapter. Another method of controlling contrast is coating your paper, before the cyanotype sensitizer, with one of a variety of weak acid solutions, such as 1% oxalic acid or 1% glacial acetic acid. In most cases, depending on the paper you are using, an acid bath will intensify darks and extend the visible tonal range.

This tonal separation is most noticeable in the lower end of the highlights. Be aware that regardless of the increase in density, this pre-sensitizer acid-wash technique will often flatten the mid-range values and take the thrill out of the highlights by extending the range and lowering the contrast. You can also achieve lower contrast appearance in your image by using direct 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. This observation changes when exposures are made with color layered digital negatives, different intensity light boxes, and open shade outdoor exposures.

This open shade technique, one that I use in many alternative processes, is a really simple solution to increasing contrast. Depending on time of day, with mid-day summer sun being best, perform the bulk of your exposure in open shade until the color of the open areas of the negative begin to turn a silvery gray. Then, to intensify your shadows, continue the exposure in direct sunlight.

*Fig 7-11 here, Christine Baczek - Colorado-Columbine(Aquilegia-coerulea) 2012
(cyan on glass)*

Adding a 1% Dichromate to the Sensitizer for Contrast

A higher contrast solution can be mixed by adding 4 to 6 drops of a 1% solution of potassium or ammonium 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 and highlights, resulting in a far shorter value scale. To make a 1% solution, mix 1 gram of potassium dichromate with 100 ml of distilled water. In my experience, potassium dichromate is less aggressive than ammonium dichromate and allows more control of this technique.

0.2% Potassium Ferricyanide First Bath for Contrast

A solution for achieving greater contrast following exposure is to immerse your exposed cyanotype print in a water bath containing 0.2% potassium ferricyanide... in place of a plain water development bath. This bath is made by mixing 2 g of potassium ferricyanide in 1000 ml of water.

A similar contrast boost effect can be realized by adding a few drops of an ammonium, or potassium, dichromate solution to the initial water development bath. These percentages can range from 1% to 10% and the exact amount that may be effective will depend on the strength of the percentage that you elect to use and the state of flatness in your print... you decide.

Note: Dichromates are carcinogenic and you must take precautions when working with them. Please consult the chemical section for working recommendations.

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, or potassium, dichromate solution and add 10 to 15 drops to a liter of water and process a second test print. Write down the information and record your results. Then, add either more 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.

Fig 7-12, Francis Schanberger, Ginko Photogram Coat, 2005

Double Coating to Increase Density

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. This makes sense depending on the paper you are using. With fibers, immersion works with similar effectiveness. Image density in the darker values is intensified well enough to merit this option simply as a matter of standard practice even when not experiencing exposure problems. Double coating will often mean that your standard exposure time will be a little longer than when you used a single coating. The best option is to make a great negative that is well-matched to the process, double coat a standard sensitizer, and make an exposure in good UV light at the optimum time of day... or use an exposure unit.

Fig 7-13 here, Sarah Van Keuren, Seth Holding Wreath, 1996- (gum over cyanotype)

Coating on Gum Sized Paper to Increase Density

Another option that you might find interesting is to make your cyanotype on a piece of paper that has been sized and prepared for gum bichromate printing, e.g. gelatin hardened with glyoxal. Of course this advice is dependent upon what kind of paper you are working with but is a very good idea if you are intending to follow your cyanotype print with a gum bichromate process and application of colors. In this case, the cyanotype takes the place of your blue gum bichromate pass and gives you a nicely detailed image to register subsequent gum passes on.

THE NEGATIVE

The cyanotype is a contact printing process... like a photogram. 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... success comes quickly, even for the rookie. I really do not have a specific suggestion for a cyanotype negative. I've heard a lot of theories that recommend

using a negative that would print well on a paper grade of 0 to 1 (*indicating a contrasty negative with an average density range between 1.1 to 1.4*) and that this particular type will do well with a standard A & B sensitizing formula. This is true. However, the same success can come from negatives that do not meet this recommendation. My best advice is to make a nice negative with a good degree of tonal personality and learn the process with it. Just a quick reference to the digital and negative chapters... the “less than fussy” personality of cyanotype makes this a great process for learning, in tandem, the production of digital contact negatives. Just be sure to make your negative deep and rich, versus pale and pointless, and you’ll be in good shape. Be sure to check the negative sections in several other chapters including Gum Bichromate, Platinum / Palladium, and the Digital chapter.

PAPER & FABRIC SUBSTRATES

Almost any type of paper or fabric can be used with the cyanotype process. This is entirely dependent upon what your intentions are before and after the print has completed its cyanotype journey. Cyanotypes can be enormously successful when combined with gum bichromate, collage, montage, artist’s books, monotypes, printmaking, painting, paper sculpture, clothing, and installation. One of the primary reasons for this is that it is a very simple process to adapt and that after the sensitizer, all you will really need is water. Those options will determine which surface will be appropriate.

Generally speaking, the best paper to use for a single image will be a quality hot or cold press paper like Arches Platine, Legion Revere, Fabriano Artistico, Lana Aquarelle, Cot 320, Saunders Waterford, Somerset Book, Crane’s Platinotype, or any decent watercolor paper. Watercolor papers of all types work well, as do alternative papers such as newsprint, stationary, inkjet prints, and butcher’s paper. These alternatives to a standard art paper work with varying degrees of success so be prepared to experiment. Try any paper that won’t break apart in water. Try colored papers for alternative toned highlights or try a watercolor paper with vegetable dyes, teas, or coffee before making your cyanotype.

The art papers mentioned are neutral pH (*in the middle of being acidic or alkaline and therefore considered a good bet for an archival rating*) and already have a good sizing built into them during manufacturing. This indicates that they are 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" x 30" Gampi Torinoko and Hahnemühle etching paper that you can purchase by the roll. There are a wide variety of rice papers available at well stocked art supply stores, though I would recommend buying small pieces to test before committing to large amounts. One paper that is fun to work with is a roll paper, 18" x 50 feet, that is simply labeled Oriental Rice Paper for Sumi. The paper is tenaciously strong in water almost to the point of being like fabric.

Generally, sizing beyond the manufacturer's own process is unnecessary for cyanotype and will only be relevant if you intend to extend your ideas with other processes, such as gum bichromate or platinum / palladium. With cyanotype, whether you size or not is really dependent upon 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. Here is a modest list of a few papers that work well with this process. In reality, almost anything will work and some of the best work I've seen has been printed on the pages of the New York Times and road maps.

Fig 7 - 14 here, Michele Robins, Tokyo Harbor, 2006 (cyan on map)

- Arches Platine – moderate smoothness, can be delicate, nice finish
- Arches hot press watercolor (take your pick for weight)
- Arches Aquarelle - (best for gum / cyanotype combination printing)

- Bergger COT-320 – a beautiful hot press finish paper for most processes, a bit precious cost wise and lately hard to get
- Buxton from Ruscombe Mills – One of the very best papers for cyanotype and made by Chris Bingham in collaboration with Mike Ware
- Cranes AS 8111 – light weight, kid finish, stationary
- Cranes Platinotype – one of the very best! Smooth gradations, holds up well in water, hot press, works well with many processes
- Fabriano Artistico hot press, works well, rather thick with great surface
- Hahnemühle Photo rag inkjet paper & printmaking paper
- Kozo rice paper - made from mulberries. This is a delicate & translucent paper with a great wet strength. Dry thoroughly to 'rest' the paper before toning
- Stonehenge HP 245 gsm
- Strathmore Bristol - Very smooth surface – BUT...tends to separate and break down in long immersions due to the paper strata employed in the making of Bristol.

Making a Paper Hammock

If you are going to use a delicate paper then you should make a lifting device out of plastic screening for raising and lowering your print in, and out of, the trays. Think of this as a paper “hammock.” To make it, cut a length of plastic window screening and staple it to two wooden dowels at either end of the screening. You’ll be raising and lowering the screening by holding onto the dowels which will drape over the edges of the tray when the paper is at rest in the liquid.

Fig ICON-2 here – (Table Set-Up)

TABLE SET UP FOR CYANOTYPE

Cyanotype sensitizer Stock A & Stock B: (ferric ammonium citrate and potassium ferricyanide)

Plastic beaker for brush application of sensitizer

Pipette for drop count volume

Good quality shot glass for sensitizer drop count

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Clean paper for the table surface coating area
Rag content paper for coating
Richeson synthetic brush or old-school hake brush
Beaker with water for rinsing the brush after coating
Distilled water
Pencil
Hair dryer
Contact printing frame
Negative or photogram materials for contact printing

BRUSHES

There are several ways to coat your substrates with cyanotype sensitizer whether it is paper, wood, fabric, or glass. A total immersion technique is the best method for fabrics, certainly easier than spraying the sensitizer, but requiring a great quantity of chemistry. Still, it's uncomplicated, and if you're mixing from bulk chemistry this will be of little concern to you as it is so economical. Spraying, with a garden type misting bottle, or a used Windex bottle, is a suitable application technique for 16" x 20" and larger paper sheets. I think the best method for paper under 16" x 20" is to coat with a 1.5" to 4" wide Richeson synthetic brush, hake brush, or inexpensive foam applicator.

The foam brush is inexpensive and available everywhere. The hake brush is a traditional Japanese instrument and has been used forever as the brush style of choice for alternative process applications. Both brushes are made without metal *ferrules* (the metallic section that holds the brush hairs to the handle), which may cause problems in a few of the more sensitive alternative processes should metal come into contact with your sensitizer chemistry. Honestly, I've never seen this problem and actually heard of a teacher who coated with a steel wool pad to see if it were true. Apparently everything worked out fine. Within the last few years, I have been using, and teaching, with a beautifully made synthetic brush made by Richeson that is available through better art supplies and on line at www.jerrysartorama.com which I frequent because of their deep discounts on quality brushes, paints, and art supplies.

Hake Brush and Super Glue

If you decide to go the traditional route with a hake brush you will want to take advantage of this advice. Japanese hake or Chinese Jaiban brushes are made of wood and stitched hairs. Some styles are better than others. Be sure to always buy the most expensive you can find. They are desirable for alternative process coating due to their lack of metal ferrule, their long life expectancy, and their aesthetically organic look and feel. The only problem with these lovely brushes is their tendency to shed hairs, as they get older and these show up regularly during the coating. A solution to this shedding problem is simple. When you buy the brush, prepare it for a lifetime of service by running 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 and be careful not to use too much glue. Do not smooth the glue with your finger or you will have “hake finger.”

Fig: ICON-4 here (Hake Brush Icon)

Making A Drop Count & Coating

I like to coat in regular ambient level room light, or if I’m trying to make a lab a bit less uptight, under a few strands of non-blinking red hot chili pepper lights. As an aside, I use the red chili lights for illumination when doing wet plate collodion on the road in the ice fishing tents that serve as my darkroom (*see the wet plate collodion chapter*).

The most economical and efficient method of coating a 16” x 20” piece of paper is to create a drop count with your A & B sensitizer in a heavy duty shot glass using a plastic eyedropper or pipette. If the humidity is in the 50% - 60% range, then you can coat an 8” x 10” paper with approximately 30 – 35 drops of sensitizer solution. In an arid climate, you will need to increase the drop count due to the speed of the drying and the absorption rate of the paper. With cyanotype you can use as much sensitizer as you wish, as it is so inexpensive. Using your eyedropper, squeeze out 30 drops in the shot

glass and be prepared to dump the sensitizer into the center of your paper and to begin coating.

Dampen your brush and blot it dry with a paper towel so that it feels cool to the touch. Empty your shot glass onto the paper and with rapid and very light strokes spread the sensitizer on the paper. Brush vertically until you have coated top to bottom across the width of the paper. Then, change your brush direction to horizontal and repeat the gentle and fast brushing. Be sure to end each brush stroke out of the image area (this is what makes all of those romantic coating edges) and to avoid stopping the stroke short of your goal. Again, apply your sensitizer quickly and evenly using a *gentle* vertical, and then horizontal, stroking technique... brushing with too much energy and pressure will only serve to make your images fuzzy due to the paper fibers on the surface being aggressively disturbed. As well, be wary of leaving puddles of sensitizer on the paper's surface; they will bronze easily during long exposures and clear unevenly in development.

Single coats work quite well if you get the right degree of saturation but I recommend drying the first coat and repeating the application of the sensitizer. The quality and thickness of your paper will determine the degree and amount of sensitizer your paper can accept. As a rule, most quality artist's papers will only require a single coating but a double coating will yield much denser blues. Single coatings are excellent choices if you are intending to do a gum bichromate print on top of your cyanotype or integrate another process with it.

Drying the Paper

Once the paper has been coated well, dry it quickly in the same moderate ambient light that you coated under. You can let the paper dry naturally in an empty drawer or use a hair dryer if you don't want to wait around for nature to do the work. Use a hairdryer on a cool setting to speed up the process and try to avoid excessive heat and focus on the back of the paper rather than the coated front. Drying from the rear of the paper draws the sensitizer into the paper rather than drying it quickly on the surface.

If you are coating a large piece of fabric, versus the easier solution of purchasing your fabric pre-coated from Linda Stemer at www.blueprintsonfabric.com, you will need to hang it on a line, or pin it to a wall, in semi-darkness for the night following the application of sensitizer. Be careful of staining walls and floors, as you will not make people happy if you drip cyanotype sensitizer on anything. Avoid using a clothes dryer for drying a coated fabric... a lesson one of my students learned the hard way at a laundromat in Harvard Square. The heat in tandem with the moisture in the fabric will simply result in a large fogged piece of fabric and the possibility of staining future loads of laundry.

I'll discuss this in the next chapter but a small warning for now... if you introduce water and light to the substrate, such as laying a sensitized fabric on a dew-laden lawn in the summer, the process of development will commence to your likely displeasure. You'll see the result of this warning when your live people-models sweat on the fabric and create really interesting and permanent puddles and stains in the image.

Be sure that the paper is "bone" dry because any moisture in the paper will instigate development during your exposure (*remember, this is a water development technique*) and your image's quality and clarity will be compromised with flat shadows and dull gray highlights. This is especially true when contact printing in sunlight as the heat from the sun drives up the humidity in the contact frame quickly. A bone dry and ready to print cyanotype sensitized paper or fabric will be a light green-yellow chartreuse color. If your sensitized paper, or fabric, is blue-gray rather than chartreuse prior to printing, then you have a moisture problem and the likelihood of a good image, with clean and bright highlights, is slim.

Occasionally you will see a mottling (an uneven coating) on the surface of the support, especially with fabrics. Don't stress about this as the effect usually disappears after the exposure, development-wash, hydrogen peroxide immersion, and dry down. One last thing, try not to touch the print surface before exposure because the oils and

moisture in your fingertips may leave bleach-like fingerprint marks where you touch the surface of the paper.

Fig: 7 - 15 here, Betty Hahn, Iris Variation #6, 1985

LIGHT & EXPOSURE

A Few Words About the Sun

Unless you are totally compulsive about controlling every aspect of alternative process exposures... a futile ideal perhaps... I will recommend 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 or a philosopher, the sun provides the most efficient and least expensive means of exposing your contact negatives in printing frames. However, very serious alternative process printers swear by UV exposure units because they provide 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 get printing outdoors in the sun with friends. Secondly, in the summer your exposure times are short and pleasant 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. Simple observations of the changes will give you a lot of information as alternative process sunlight exposures are often best determined by this evaluation method rather than by a set time. When you think that you are close to being done, it's 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 any printing out processes such as Ziatype, albumen, salt, and argyrotypes.

Of course there are variables with the sun that you will not find with a UV exposure 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 in. Printing on a winter's day in Dublin, 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 outstanding. Use the winter to enrich your life with other interests or make (*see Appendices*) or buy a UV exposure unit. I think the best home unit to buy is made by Jon Edwards at Edwards Engineered Products (www.eepjon.com). You can also buy plans if you are handy with tools. Don't waste your time with filtered "black-light" tubes like the ones that I lit my room with in college... the type that made Jimi Hendrix posters become animated, because they are very inefficient exposure sources. You may, however, successfully use an unfiltered, UV tube as several of my students have done when making portraits at night with wet plate collodion. Another option could be a 1000-Watt BLB Metal Halide Light.

Fig 7-16, Emily Barton, Self Portrait, Cambridge, 1987- (toned cyanotype)

Another Kind of Sun: The 1000 – Watt BLB Metal Halide Light

If you really want to simplify the whole process then you can purchase a 1000-Watt metal halide light source... called BLB, or black light blue. These light sources are strong, full range, effective, reasonably priced, dependable, long-lived, quick (average exposure for cyanotype is 8 minutes) and make excellent prints.

One example of this type of light source would be the 1000-Watt Metal Halide Maximizer Grow Light System from www.hydroponics.net. The set up includes a bulb, ballast, reflector and socket assembly. The Maximizer reflector is constructed of brushed aluminum with a bright white finish on the inside. The reflector measures 21" long x 17" wide x 7-1/2" tall. The Maximizer reflector has a unique adjustable light pattern to customize the spread of light and the average exposure time will be 8-12 minutes.

Metal halides emulate mid-day summer sunlight and contain all the wavelengths of the visible spectrum. To plants this means quality simulated sunlight and photosynthesis at a level much higher than that which fluorescent lamps can achieve.

The unit runs about \$250., and is more than adequate for your UV needs. The one possible drawback will be the law enforcement surveillance helicopters hovering over your studio primed to seek out high-efficiency grow lights and people who experiment with indoor agriculture.

***Fig: ICON 5 here** (Contact Printing Frame Icon)*

Exposing a Cyanotype

When your coated and sensitized substrate is completely dry, place your negative or photogram material directly in contact with the coated side of the paper and double check to see that it will read correctly (right-reading) when it is completed. The negative that you use will work very well if it has an average negative density range of 1.1 to 1.5.

Be aware that you will be losing a considerable amount of density in the wash development stage so it is somewhat important that your highlights are able to print well before the shadows totally block up from exposure. Making a simple test strip with the negative that you've selected is probably an excellent strategy and one that will save you a lot of time and frustration.

Next, holding the top of your negative and coated paper with thumbs and index pointer fingers, smoothly flip the pairing into the contact printing frame face down 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 contact printing frame during the exposure if you wish to check on your progress without losing registration. Once the negative and sensitized paper are positioned correctly in the contact frame, close up the frame and flip it around to see if you've lined everything up nicely. If so, it is time to go out into the sun, or into a UV light unit, for the exposure.

The most common problem in cyanotype printing is under-exposure, where the highlights and middle values wash out in the water development. It is never a question

of whether they will wash out but *to what degree*. I know this seems pretty obvious, but depending on the density of your negative, you will have a short or a long exposure, with denser negatives taking more time than thinner ones as the UV light needs to penetrate the negative in order to have an effect upon your sensitized coating. Printing with a thin negative is almost hopeless as the overall density of the final print will usually kill the contrast. Printing with a bulletproof dense negative is equally complicated but the odds are better. As I said earlier, it's hard to fail with this process but the negative quality will determine a lot. In summer sunlight, at mid-day, an exposure might last anywhere from 10 to 20 minutes. If it is early or late in the day, be prepared for a lengthy exposure that might take as long as 45 minutes. This last sentence is a good argument for having a UV exposure unit but it is an option that lacks romance. Just saying...

Fig: 7 - 17 here, Cynthia Batmanis, Melancholy, 2009 (toned cyan)

Testing Your Exposure Visually

There are several ways to test your exposure while you're making a print. When I am teaching an alt pro workshop how much fun it is to make cyanotype murals in the sun, I always use the students as photogram objects on a 9' x 18' piece of cyanotype sensitized fabric. During the exposure I periodically lift a shoe, or an arm, to check on the comparative densities of the exposure in progress. Checking under fingers doesn't do much for you in humid and hot weather as the sweat from the fingers pre-develops the cyanotype material. By looking at the unexposed areas under an opaque object I am able to see what the base sensitizer (that green chartreuse color) is doing in comparison to the open exposure areas with nothing blocking the sunlight. I am looking for the uncovered areas of the fabric to turn a silvery greenish-gray.

Fig: ICON 6 here, (Checking Exposure)

In a contact-printing frame, I will often place a small opaque object on the glass so that it covers a separate swatch of sensitized paper that I have added to the bottom of the paper during coating. By quickly lifting the opaque object I can determine how far

along the exposure is and how long I have before the processing stages will begin. As you will discover, overexposing a cyanotype is a difficult thing to do.

A quick test strip can be easily home-made by coating a piece of paper with the sensitizer, drying it completely, and placing a negative in contact with the coating. Put the sensitized paper and negative in your contact frame and lay a series of opaque strips over the coated test piece. These strips can be removed from the frame, one at a time, at predetermined intervals and then processed for the information. The exposure is long enough that you can do the process tests, or prepare your next paper, while you're making the exposure!

You can also use a transparent step wedge, like an inexpensive Stouffer Strip, 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 time will be. Be aware that cyanotype print values will darken over a period of 24 hours as the print oxidizes. You can accelerate this oxidization by immersing the washed print in a weak solution of hydrogen peroxide.

Fig 7-18, Brenton Hamilton, Gardener - 2004-05- cyan & paint

Cyanotype is a printing-out process, so you can examine your exposure as you go, providing you are using a hinged contact printing frame. In a pre-development examination of the exposure, I like to see highlight detail that is a great deal denser than I would be happy with in a finished print. Occasionally I want my deepest shadow areas to have a nearly solarized look where the density has begun to reverse itself and is transforming to a lighter, almost metallic, negative gray.

In particular, I watch the coated borders surrounding the image area that are wide open to the exposure. More often than not, the best cyanotypes will be realized

when the outside borders have converted from the original yellow-green of the sensitizer to a silvery greenish-gray. Another general piece of information is that thicker papers, and double coatings, often take a little longer to expose than do thinner papers and single coatings. Always write down your exposure time on the paper so that you can evaluate your progress over the course of a printing session.

Split Exposure to Increase Shadow Details

One additional technique that you may wish to apply to your knowledge of exposure is a split exposure technique. When you are halfway through your pre-determined UV exposure time, suspend the exposure. Then, take the printing frame and its contents into a low level light environment and wait for 15 – 30 minutes before going back for the rest of the exposure time. This interrupted printing results in noticeably better shadow details and separation without losing highlight or D-max integrity. If you are looking for more sophisticated levels of value in your cyanotype images this is a good technique to try. My friend, Mike Ware, suggested that this technique may allow for a greater degree of print-out, which may be slow to build, and therefore more self-masking.

Fig: ICON 7 here, (Sink Set-Up)

SINK SET UP FOR CYANOTYPE

Tray #1: Initial wash development / running water. You may substitute the sink with the ocean or a flowing river.

Tray #2: Hydrogen Peroxide 3% (a splash) in a liter of water for instant oxidation, dry-down, and wow-factor.

Tray #3: Final wash – in running water.

Post Final Wash Suggestions

If you are in an area where the water has a lot of chlorine in it, or is very hard, it is a good idea to soak your finished prints in a bath of distilled water for 10 minutes or so. This will help prevent grayish highlight fog after dry down.

If your highlights are fogged, try taking a small pinch of sodium carbonate (laundry detergent at times) and mix that up with a liter of distilled water. This will help clear the highlights. Watch carefully... the highlights clear visually first... but the mid tones shortly thereafter. You need to remove the print from the sodium carbonate solution before it reaches the stage you desire. Sodium carbonate is an alkali and it's going to continue its bleaching action in the rinse water, taking some time to clear it out of the paper.

If you are considering applying a toning process to your cyanotypes, it is a good idea to complete your wash and re-wet the prints 24, or more, hours later to begin your toning experiments.

Fig 7-19 here, Alexander Hartray, Kiss, 1986 (toned cyanotype)

DEVELOPMENT: WATER OR ACID

Traditionally, the cyanotype is developed out in a running water bath. This is the least complicated step possible. Simply set up a deep tray, fill it with water under a tap or with a hose and immerse your exposed paper when you're ready to see what it looks like. The one shortcoming of water development, say if your negative isn't perfect, may be a limited tonal range primarily in the highlight end of the scale. Remember, this is not a particularly sophisticated technique when compared to most other alternative process options, and a full range of values, from light to deepest detailed shadow, are often difficult to achieve. Of course your tonal scale is dependent on more than your water development but there are remedies to this normally restricted range of tonalities that go beyond your negative.

An alternative development process, one that often produces a longer tonal scale, involves using varying concentrations of acidic solutions made up of water and distilled white vinegar. I haven't played with other types of vinegar so these recommendations are going to be restricted to white. Other acids that work well would range from a simple squeezed lemon and water bath to options including acetic acid, citric acid, or nitric acid, which works best of all but is a most unpleasant ingredient to work with... I would stay with the simple acids. The nice part of this optional method of development is that the tonal range 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 highlight to shadow contrast in the print. You might think of an acidic 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... the equivalent of a 5% concentration of acetic acid. White vinegar can be used straight from the bottle or diluted with water for 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 and Citric Acid Recipes

- **White vinegar out of the bottle:** A significant increase in the range of values (2 to 4 steps) but a decrease in the contrast. This might be a good formula for negatives that are hopelessly too high-key. A hydrogen peroxide "oxidation-hit" following development 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. Accelerated oxidation with 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 oxidation adds a little intensification to the blue.

- **Vinegar and water 1:5:** A pretty decent range in the additional step values and the highlights are better. Decent *maximum density* equal to the other prints in the test sequence and the hydrogen peroxide has a modest effect.

- **Citric Acid:** A 1% solution of citric acid, 10 g per liter of water, will behave like a 1:2 water to vinegar concentration. Be careful, if you don't remove every trace of the acid from your print it will fade. Be sure to wash your print thoroughly.

If you are using Mike Ware's New Cyanotype Process, explained shortly, the effects of vinegar development are less distinct. However, this fact is somewhat irrelevant if you are using Mike's formula that has a longer and similar tonal scale and a softer look to the overall image. Mike's process does, in fact, employ an acid development that softens contrast.

Fig: 7 - 20 here, Vincent Carney, Graffiti I (cliché verre cyanotype)

Acid Post-Development Bath for Additional Tonal Range

Still another option for additional tonal range when developing cyanotypes is the technique of rinsing your cyanotype print in a very mild acidic bath following the regular water 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 post-development bath of 4 to 5 drops of hydrochloric acid per 1000 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.

Fig: 7 – 21 here (Brooke Williams, Self with Family, Jamaica, 1987)

THE BIG THRILL

Immediate Oxidation and Gratification

If you are a creature who requires instant gratification, and we all do from time to time, try this! After the first development wash, remove the print from the water and add a splash of drugstore grade, 3%, hydrogen peroxide to the water bath. This is the same solution that you put on cuts to prevent infections. It is not the solution that beauty salons use to turn hair different colors. That is a 33% solution and not something to which you would want to subject your new cyanotype print.

After you add a splash of hydrogen peroxide to your tray of water, about a liter will do, re-immerses the print and watch the blues turn an immediate, and intense, deep blue. This action causes the highlights to appear super white because of their new-found relationship to the suddenly very enhanced and dark blues. This intensification “trick” is everyone’s favorite moment in the process.

Fig 7-22 here, Catherine Jansen, The Blue Room, 1991.tif

What is happening before your eyes is really quite simple. You are accelerating the oxidization of the iron in the print, a process that would have happened naturally without your assistance in 24 to 48 hours. The eventual final densities, with or without the thrill, will be the same. Hydrogen peroxide can be used immediately after the yellow has been washed out of the print. You can mix it casually and without fear; after all, this solution is used to clean wounds and as a mouthwash. Don’t forget the washing stage after your moment of being thrilled.

CLEARING HIGHLIGHTS

A 1% - 5% Oxalic Acid Bath for Clearing Highlights and Stains

Immersing a completed cyanotype print in a 1% - 5% solution of oxalic acid can aid in clearing the highlights in your print if that is a problem that needs to be corrected. To make a 5% solution, mix 5 grams of oxalic acid with 100 ml of water. This bath is particularly successful for spotting blue stains out of highlight areas.

Take all necessary precautions when using oxalic acid because it is toxic. Oxalic acid's primary role in your life is likely to be as a cleaning and bleaching agent... especially for the removal of rust-laden iron deposits. In alternative processes, oxalic acid is also used as a reducing agent in the platinum / palladium process. The principle toxicity risk when using oxalic acid is kidney failure, which may cause precipitation of solid calcium oxalate, the main ingredient of kidney stones. That said, be careful and wear nitrile or safety examination gloves and eyewear when using this chemical.

Fig 7-23 here, Grace Huang, Portrait of Stefanie, 1989

Sodium Carbonate Bath for Reducing Density

As mentioned a bit earlier, if you find that you have significantly over-exposed your cyanotype, a difficult thing to do most of the time, you may want to try this last gasp remedy as a fix because it works really well. Take 1000 ml of water and add a “pinch” of sodium carbonate and stir thoroughly. Immerse your wet, over-exposed cyanotype into the solution and agitate gently for a few seconds. Then move to a clean water tray and wait for the results. If nothing happens, repeat the process but leave the print in the sodium carbonate a little longer. Eventually, your print will begin bleaching. Sometimes a lovely yellow split tone will form between the highlights and the shadows. Watch out 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 idea, 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 with your over-exposed print, save it for another day and try a Blue-Van-Dyke print or print a gum bichromate on top of it. One thing alternative process artists have in common is

willingness and enthusiasm for making great work out of absolutely failed prints simply by extending their life with additional experiments.

Fig: 7 -24 here, (Lucy Soutter, Harvard Diptych, 1990)

Cyanotype Fading

Some papers that you might consider for your cyanotype work, which includes nearly every variety you can imagine, are buffered with a mild base or alkali such as chalk / calcium carbonate. (See *Chemistry Appendix A*) This is not unusual for any material that may end up being considered as archival. On occasion, the manufacturer of the paper does not provide this information so you may be inclined, especially if the print is going to be collected, to test the pH of the paper yourself ... as any alkali will cause a cyanotype to fade. You can buy an inexpensive pH-testing pen, like a highlight marker, from Light Impressions, Talas, or similar store. There is more information about paper in the Paper chapter in this book.

Fig 7-25, Amanda Bross - What To Wear, 2001 - cyan & VDB

CYANOTYPE TONING

Basic Cyanotype Toning Options

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 with other media and its stunning simplicity. The following are some formulas for changing the color of your 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, as reducing agents are common in the step sequences. Many of the following formulas utilize sodium carbonate or ammonia, which will reduce print density if the solutions are too strong.

Note: These toning suggestions are essentially variations on the theme of alkaline hydrolysis of the Prussian blue followed by the formation of ferric tannate or gallate that

becomes a new color palette. They are interesting to play with and modify. Unfortunately, they almost always result in finished prints that look more vibrant when wet than when dry.

Fig 7-26, Cierra Butler - Rebirth_2011(Pd-cyan)

A word of encouragement... many times the formulas will not work as you want them to due to water types, contamination, time of year, and an assortment of other things. Take these formulas with a proverbial large grain of salt 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 toners. Besides, what have you got to lose? The process is simple, inexpensive, and accidents often become individual and unique techniques. Become famous for your failures!

There is the issue of permanence to consider. The cyanotype, in a pure Prussian blue state, and handled correctly, is very permanent and one of the most stable of all alternative processes. Toning changes the chemical composition of the cyanotype image and it is debatable if all of these formulas can be described as “permanent.” I have found virtually no deterioration in the images I toned carefully with a variety of toners over the last 30 years. However, this is not the case with images “performed” during group toning demonstrations, where inadequate washing times between steps are often the rule... especially with sodium carbonate.

It is a good idea to *dry* your cyanotype prints before toning them and to let them oxidize and age for a day or two. After they have been dried, you should re-soak them before toning. 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. Please feel free to modify the amounts in order to adequately cover the size of your prints.

Fig 7-27, Sam Wang, Night Bloomer, 2010 (PdCy5)

Removing Blue: Getting Yellow

Many chemicals will alter the intensity of the blue, and change the values of the whites in your cyanotypes. As previously mentioned, hydrogen peroxide, oxalic acid, nitric acid, and sodium carbonate will all cause the blues to change, as will solutions of chlorine bleach, sodium sulfate, sodium silicate, tri-sodium phosphate, sprays of bathroom cleaner, and commercial laundry soaps. You may elect to apply these selectively with a paintbrush or make up diluted baths to alter entire prints.

For example, to make a yellow and white print, make a solution of trisodium phosphate in a ratio of 1 tablespoon to every liter of hot water. Dissolve the trisodium phosphate in hot water in a plastic tub or tray, and then immerse the overexposed cyanotype in the solution until it fades to yellow. Rinse the print with running water for 30 minutes, or if using fabric, run the material through a cold wash cycle without soap. If you then immerse the print in a bath of warm Red Zinger tea the resulting image should be permanent and may remind you of a Hippolyte Bayard Direct Positive print of the windmills.

Yellow / Blue Split Tones

This is a very simple adaptation of the above and seems to work best in the city where there is a good deal of iron, from old pipes, in the water supply. Allow the overexposed and washed print to age for a day or two. Re-soak the print and immerse it in a hydrogen peroxide bath for a minute or so followed by a 20-minute rinse. Then, place the print in a very weak solution of sodium carbonate (a pinch between thumb and forefinger to a 1000 ml of water). Immediately transfer it to a fresh water bath to observe the changes. To achieve the split, allow the changes to occur in the wash water. After you are satisfied, wash the print well for 20 to 30 minutes.

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. Don't be in a hurry here, I remember overnight soaks in this solution yielding some pretty intense blacks. Using a solution of tea as a toner is a nice way to have the image 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 with less tannic acid in them does not work as well. However, if you boil onionskins, and reduce the liquid a bit, and then soak the cyanotype in it for a while, you can get a lovely bronzing effect.

Fig 7-28 here, Linda Stemer, Grey Feathers (toned cyanotype)

Warm Grey Toner

This is a sequence developed by Linda Stemer of www.blueprintsonfabric.com. Make a very strong cyanotype exposure. Age it for 24 hours. Then iron the fabric on a high heat while misting it with a vinegar solution (you'll have to guess). This will cause the print to fade to a dull blue. Then make up a strong green and black tea solution and stain the print. Next, make up a mild borax solution and immerse for a short time. Then rinse and re-iron a final time.

Anthotype Toner Options

Just as boiling the onionskins will give you a reduced solution that will tone your paper, other options exist that are detailed in the Anthotype chapter. Solutions such as beet root and black current extracted juices will stain papers as will wine, turmeric, and some deep green vegetables.

Brown toning #1

Part A:

- 6 to 12 ml non-detergent, household strength, ammonia added to 1000 ml of water (you may have to modify this percentage as the effect will be dependent upon your exposure)

Part B:

- 60 g tannic acid added and mixed well and added to 500 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. It smells like instant iced tea mix so it isn't an unpleasant task. Immerse the washed and wet print in Part A until it starts to exhibit signs of fading to pale. Rinse the print for 15 minutes. Then, transfer the print 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 discoloration.

Black Toning # 1

The success of this toner is not guaranteed. Sometimes it rocks, sometimes it doesn't. Immerse the print in a solution of Dektol (this is a black and white paper developer from the days of the wet lab). 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, rinse the print for several minutes in water and then immerse it in a solution of tannic acid mixed to 50 to 100 grams per 1000 ml of water. You should see a smoky black color within 5 minutes. Wash the toned print for 20 to 30 minutes.

Fig 7-29, Janet Matthews_ All Through - gum over cyanotype

Eggplant / Red / Black Tones

Age your cyanotype print for 24 hours and re-soak before beginning the toning sequence. Use the Black toning #1 procedure and after the final wash, immerse the print in the strong Dektol solution again.

For reddish-rust tones, wash the print in a light sodium carbonate bath (a pinch to a liter of water). I've made violet by making an ammonia bath solution consisting of 250 ml ammonia to 1000 ml water. Play around with this and see what happens.

Black Toning #2

- **Part A:**

6 drops concentrated nitric acid * added to 1 liter water

(Never add water to acid!)

- **Part B:**

55 g sodium carbonate added to 640 ml water

- **Part C:**

55 g gallic acid added to 640 ml water

- Begin by immersing the washed and wet cyanotype print into Part A (nitric acid) for 2 minutes. Be careful and use tongs or nitrile gloves and wear eye protection.

- Then rinse the print for 10 minutes in running water and transfer it to Part B and leave it in this sodium carbonate solution until the image disappears and then miraculously reappears as a very light orange image.

- Then, rinse the print for 10 minutes and transfer it into Part C where the black tones should become evident.

- Finally, wash the print for at least 20 to 30 minutes. Your tones may be in the gray to black area depending upon the original density of the exposure. Print accordingly.

Nitric Acid

Note: Concentrated 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. When toning you can always work with a larger volume of more dilute acid for safety.

Fig 7-30 here, Grace Huang, Thesis, 1989 - toned cyan

Blue / Gray Split Toning:

This recipe is similar to Black Toning #2.

Age your cyanotype print for 24 hours and re-soak it before beginning the toning sequence. Then, mix a solution of 6 drops of nitric acid in 1000 ml water and immerse your print in it for 2 minutes.

Wash the print for 10 minutes. Then, immerse the print in a weak (*a pinch to 1000 ml of water*) sodium carbonate solution until a yellow split occurs.

Then wash the print for 10 minutes. The next step is to mix up a tannic acid solution of 50 g to 1000 ml water and immerse the print in it until a blue / gray split appears. Finally, wash the print well for 15 to 20 minutes.

Rose Toning:

Follow the directions for the Blue / Gray Split Toning. After the last step in that sequence, immerse the print in a light sodium carbonate solution (*a pinch to 1000 ml of water*) until the image becomes rose colored and then wash the print for 20 minutes.

Green Toning

Age your cyanotype print for 24 hours and re-soak before beginning the toning sequence. This toner is a bit complicated if you don't have proper ventilation and I absolutely do not recommend attempting it unless you can tone outdoors or under a serious chemical lab hood. Under no circumstances should you try this formula with children nearby. The reason is that sulfuric acid was appropriately named "oil of vitriol" back in the long ago by the Sumerians... for a very good reason.

Be really careful with the sulfuric acid and be sure to note the strength of it before opening the bottle. Prepare a 1% solution of sulfuric acid. Photographer's Formulary has

a 48% solution that they can ship but you're going to need to fill out government paperwork and the shipping will be expensive. Best bet is to be in a university setting and to make friends with the chemistry people. While you're there, use their chemical hood to mix this up. To make a 1% solution you need to add 1 ml of the concentrated acid to every 100 ml of distilled water.

Note: although this rule doesn't apply to all acids it is better to be safe than sorry so **REMEMBER: always add an acid to water** ... not the other way around as it may splatter upon contact.

You're going to need at least 500 ml of solution to immerse the print. Again, you can always work with a larger volume of a more dilute stock acid for more safety. When your acid bath is prepared, immerse your print until you like the color you see. A caveat ... this toner doesn't always work and I can't explain the reason since I don't particularly enjoy working with sulfuric acid and haven't done enough personal testing to sound intelligent about it. Wash the print afterwards for 20 to 30 minutes.

Fig 7-31, Peter Lindstrom_15_Walk With Me_No3_2011(gum over cyan)

Greenish-Blue Nickel(II) Sulphate

This is a formula from my friend, Mike Ware, and although I've never performed this toner I am including it because it looks interesting. Keep in mind that it is as equally dangerous as the sulfuric acid green toner formula. In truth, if you really want a green tone on your cyanotype I would recommend doing a normal cyanotype and then following it with a gentle green (oxide of chromium green is a good choice) pass using the gum bichromate process. It will look nice, be consistent in its green tones, and is safer than the other green options. In any event, here's Mike's suggestion.

Immerse the cyanotype in a 5-10% solution of a nickel(II) salt (e.g. the sulphate, chloride or nitrate) for an hour or so. The colour shift with nickel(II) salts is rather slight - towards a more greenish-blue. This treatment has the beneficial effect of making the

cyanotype much more resistant to alkaline hydrolysis. There may be some loss of image density in this bath so the cyanotype needs to be heavily printed. N.B. Nickel(II) salts are listed carcinogens. Consult the MSDS for this chemical before playing with it.

Eggplant Black #1:

Dry your prints for a day or two and re-soak them in a water bath. Then begin by immersing your wet print into the first tray of sodium carbonate for a very brief time. In this first tray, you only need a pinch of sodium carbonate in liter of water to make an active solution. Be aware of how much sodium carbonate you use, as very light dilutions are best. You will want the bleaching effect to be slower rather than immediate. The sodium carbonate acts on 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. Attention to this will help with possible staining in the highlights later. Try a test piece of cyanotype. If it bleaches too quickly, then make a more dilute solution by adding more water.

For the second tray, mix 10 tablespoons tannic acid into a liter of water and stir for a while. This tannic mix may be much stronger than you need to get the job done but it works for me. If you find it is too strong, and you see evidence of staining, add water to the solution. You might also try a bath of oxalic acid after you wash the print for a while. The greater the concentration, and time of immersion, the deeper the color. The darks are beautiful but the highlights get hammered and will turn a sepia tone most of the time if the immersion is too lengthy. If you are seeking an image effect that feels like the Stone Age... this is your toner. Wash the print for 20 to 30 minutes when it's done with its chemistry journey.

Fig 7-32, xtine Burrough_ the-sky-is-the-limit_2009

Violet Tones #1

Prepare a weak borax 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. This leads to the suggestion that it might be a good base for a first pass with gum bichromate. Water type will play a role in determining the degree of violet you might get. A caveat; often this lovely violet will revert back to the original cyanotype blue in a few days so don't be upset if that happens. If you really like the violet, take a picture of your print for posterity when it's wet and then let it dry, possibly send it through a gelatin glyoxal hardening sequence and do a violet gum bichromate pass over it.

Violet / Gray Tones #2

You can occasionally get the violet / gray shift by making a solution of 5 g of lead(II) 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 20 minutes. Be cautious of the lead acetate because it is not one of the harmless chemicals.

As an aside, ancient Romans often used lead acetate, or Salt of Saturn, as a sweetener and made syrup by reducing grape extract in lead pots to make syrup they called *defrutum*. Overuse of *defrutum* led to lead poisoning and this may explain some historically odd behavior by ancient Romans. That said, 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 and cleaner highlights.

Violet / Gray Tones #3

Make up the same 5% solution of Lead(II) acetate that is described in Violet / Grey #2 but this time adjust its pH to 7.5 to 8 by adding a little ammonia to it. You can use a standard pH test strip to check on the degree of alkalinity. If you see a precipitate, pay it no mind as it can be filtered off easily.

This solution will create a very nice violet- blue in 1 to 2 minutes. The color is permanent and stabilizes the Prussian blue against light fading. Keep in mind that lead(II) acetate is a seriously toxic heavy metal salt.

Violet Tones #4

Age your cyanotype print for 24 hours and re-wet before beginning the toning sequence. Prepare a tray with a liter of water and to this add a splash of household ammonia. Stir the ammonia into solution and immerse the wet print. You will get an immediate violet image that is really quite lovely.

Don't admire the color for too long a time as it will begin to fade away. Remove the print before you get to the point where you love it and place it in a tray of warm water. Wash for 20 to 30 minutes and hang to dry. Enjoy it for a short time... it will not be permanent.

Fig 7 - 33 here (Willis Odundo making his cyanotype, 2006, Kageno Kids, Kenya)

Fig: 7- 34 here (Willis Odundo, Cyanotype Bouquet, 2006, Kageno Kids, Kenya)

Purple - Brown Toning

Mix up a *hot* solution of tannic acid at 70 grams to 1000 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 10 to 20 minutes. If you like the color, simply complete the wash stage and don't do any additional toning. If you wish to go on to the purple-brown, immerse the print in a caustic potash solution made with 15 grams of caustic potash to 1000 ml of water until the desired color is achieved. After toning, wash the print well for 20 to 30 minutes.

Purple – Brown Toning #2 (Ware Option)

Begin by soaking the print as you would all cyanotypes that you are interested in toning. Once soaked, immerse the print in a 1% ammonium hydroxide until the blue is a pale yellow. You can also use the more standard sodium carbonate... 5% solution or a more casual pinch to a liter of water. Interesting split tones can be seen if you don't take this stage to a total pale yellow bleaching. Then, rinse the print for a minute in fresh water and continue by immersing it in a 1% solution of acetic acid. This bath neutralizes the alkali from the ammonium hydroxide or sodium carbonate. Rinse the print again for a minute.

To tone the print, immerse it in a 1% tannic acid solution for 10 minutes and finish by washing the print in running water for 30 minutes.

Gray to Reddish Tones

Mix up a solution of 48 g of copper nitrate dissolved in 100 ml of distilled water. Then, 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 20 to 30 minutes.

Eggplant Black Toning with Dark Cyan

Begin with a dense and over-exposed cyanotype. Age your cyanotype print for 24 hours and re-soak before beginning the toning sequence. Immerse the print in a very weak sodium carbonate dilution (a pinch of sodium carbonate to 1000 ml of water) until the lightest highlights open up. Immediately move it to a wash tray for 10 to 15 minutes.

Then, immerse the bleached print in a strong tannic solution, 100 grams to a liter of water, for another 5 minutes and wash the print again for 10 minutes. Return the print to the weak sodium carbonate bath and a lovely rose color will appear. You may stop here if you want and rinse for 20 to 30 minutes.

However, if you want the eggplant black with deep cyan then take your print, after it has rinsed, following the last sodium carbonate bath, and immerse it in a tray

with a small amount of ammonia to a liter of water. Observe the changes and stop it when the color you want is reached. Finally, wash the print well for 20 - 30 minutes.

Fig 7-35 here, Christina Anderson, Traffic Jam, 2009 - (gum over cyanotype)

Violet – Black Toning

Age your cyanotype print for 24 hours and re-soak it before beginning the toning sequence. Mix up a weak solution of sodium carbonate consisting of a pinch of the chemical to a liter of water and immerse the print until it has turned a pale yellow. Wash the print for 10 minutes. Then, mix a solution of 8 g of gallic acid, 0.5 g of pyrogalllic acid, and 1000 ml of water and immerse the print until the desired color is reached. Wash the print for 15 to 20 minutes and hang to dry.

Red-Brown Toning

Age your cyanotype print for 24 hours, re-soak it thoroughly, and then immerse it in a solution of non-detergent (also known as non-sudsy) household ammonia and water, mixed in solution at approximately 32 ml to 1000 ml of water until the print turns a violet color. Wash the print for 15 minutes and then immerse it in a strong solution of tannic acid and water (50 g to 500 ml water) for 5 to 10 minutes.

After the tannic acid bath, wash the print for 5 minutes. If you like the brown color, stop the process at this point and wash for 20 to 30 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 20 minutes. If you decide to get more of a good thing at this point, and repeat the sequence, you will get mud.

Dark Blue / Blue Violet / Rose Split

Follow the directions for the rich red-brown toner. After washing, 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 20 minutes.

Fig 7-36 here, Tasha Lewis, Octopus # 04 - 2009 (cyan on fabric)

Black Toner Using Silver Nitrate, Fumes of Ammonia & Ferrous Sulfate Developer

From *Anthony's Photographic Bulletin*, 1901, page 444: To get the desired black color, bathe the print in distilled water and then immerse it in a 2% solution of silver nitrate. After the bleaching of the image, re-wash the print in distilled water and dry it. Following drying, expose the print to the vapors of ammonia for a short time and develop it in a solution of oxalate of iron (ferrous sulfate developer as used for wet plate collodion). You'll have to experiment with the dilution, as Anthony's Photographic Bulletin was rather unspecific on this point as it was with washing times.

LAST WORDS

In great portions of this book I am very specific about formula. However, the toning segment in this particular chapter is intentionally non-specific as toning is a subjective exercise and the variables are many. As I wrote to a professor in Fresno, CA, one try at conducting a toning session in a group and you will see that no two prints will behave the same after the first print enters the final rinse. You almost have to have separate trays for each student to be 70% accurate from one print to the next.

Toning cyanotypes, or any other alternative process is about play and encouraging imagination and experimentation... about being an artist... not about having exact answers to every problem. As Winston Churchill put it, "Success is the ability to go from one failure to another with no loss of enthusiasm."