B A S I C B L A C K & W H I T E P H O T O G R A P H Y

S t e v e n B e r k o w l t z

F I L M

T y l e r S c h o o l o f A r t
U n i v e r s i t y
D e p a r t m e n t o f
A r t & A r t
E d u c a t i o n
T U C C
P h o t o
L a b

FILM and the PHOTOGRAPHIC PROCESS

FILM

composition
- scratch resistant layer, protects the soft gelatin emulsion
- emulsion, a gelatin layer containing light sensitive crystals
- acetate base, a plastic roll to hold the emulsion
- anti-halation coating, prevents reflections from reentering the film

light sensitive crystals
- silver halides, most typically silver bromide crystals
- silver ions, positively charged = missing one electron
- bromide ions, negatively charged = having one extra electron
- free silver ions, not connected to bromide ions
- additional impurities, to help bind free silver ions and electrons

PROCESS

latent image
- photons strike the film, freeing electrons from the bromide ions
- electrons merge with the free silver ions and impurities
- this forms a site which will become visible when film is developed

development
- metallic silver is built up through time around the latent images sites
- fixing with sodium thiosulfite removes the halides not struck by light

IMAGE REVERSAL

the real world
- materials reflect light depending on their structure

the negative
- a collection of silver specks on clear plastic film
- most dense where struck by the many photons
- least dense where few photons have struck
- yielding an image which is light where the source image was dark
- and vice-versa, i.e. a negative image

the positive
- a collection of silver specks on opaque white paper
- basically the same emulsion as on the film
- light in an enlarger is projected through the negative
- the negative acts as a mask allowing some of the light through
- other parts of the light are blocked
- the silver in the emulsion turns dark where struck by light
- yielding an image which is the reverse of the negative, i.e. a positive
- the white paper blends with the black of the silver
- creating a wide range of gray tonalities

LOADING and REWINDING

LOADING

open ____ the camera back
place ____ the film cassette into the back of the camera, nose down
engage ____ the leader of the film with the take up spool
rotate ____ the take up spool backwards
make sure the full width of the film is hooked over the sprockets
advance ____ the film with the film advance lever with the camera back still open
check that the film is advancing properly
close ____ the camera back
leave ____ the rewind crank up a little bit
advance ____ the film another one or two frames
watch for the rewind crank to move
this is your absolute assurance the film is moving through the camera

If there are no pictures on the film after it has been developed it is because of one of two reasons:
there are frame numbers on the film = the film never went through the camera,
but it was properly developed (the frame numbers are exposed onto the film at the factory)
there are no frame numbers = the film was improperly processed

REWINDING

press in ____ the rewind button on the bottom of the camera
this disengages the sprockets that move the film forward
turn ____ the rewind crank clockwise about 31 times
notice ____ when the tensions releases, and a small click is heard
stop ____ rewinding when this happens
the film has disengaged from the take up spool
but has not gone all the way back into the cassette
open ____ the camera back
remove ____ the film cassette from the camera
bend ____ the nose of the film to mark it as exposed
it is also possible to cut off the nose of the film, or write on the cassette
cut ____ the nose of the film off in between the sprocket holes before developing
the film tends to load with less problems if the film is cut between the sprocket holes

It is no tragedy if the film goes all the way into the film cassette, it just means the nose has to be cut off in total darkness.

HOLDING the CAMERA

It is important to hold the camera in a supportive way. This means that if the camera is placed in a vertical (portrait) orientation, the camera should be rotated in a clockwise direction and held from below with the right arm so the right elbow is against one's torso. Otherwise, if the camera is rotated in a counterclockwise direction it is being suspended from above where perpendicular movement can set in and make it extremely unstable.

DEVELOPING FILM

Roll _____ film onto reels in total darkness in the Film Loading Rooms or with a changing bag.
Place _____ loaded reels into daylight film developing tank and close lid tightly.
Determine _____ the amount of chemical solution you will need.
20 oz. for 2 reels of 35mm film in a Paterson tank
This is the volume of all other chemical solutions you will use during this process.
Fill _____ a large beaker with the amount of water you will need at the desired *temperature*
This should be between 68-75 degrees Fahrenheit.
All the other chemicals used should be the same temperature!
Dilute _____ the proper amount of stock Edwal FG7 Developer with the water.
A 1:15 parts ratio is the standard for normal development.
Consult the *Developer Mix Chart* above the sinks.
Determine _____ the development time for the your film type at the temperature of your developer.
Consult the *Time/Temperature Chart* above the sinks.
Prewet _____ the film with water of proper temperature for 30 seconds. Drain.
Develop _____ for the determined amount of time.
Start timing as soon as you finish pouring the developer into the tank..
Agitate the tank with rocking motion for the first 30 seconds.
Then agitate the tank 5 seconds every 30 seconds.
proper and consistent agitation is extremely important !
Start _____ pouring out Developer 15 seconds before developing time is up.
Stop _____ the development by *immediately* pouring in water at the same temperature for 30 sec.
Drain _____ and have a beaker of the right amount of water at the right temperature ready.
Fix _____ for 3 1/2 minutes with agitation as described above.
Drain the Used Fix into the Used Fix container.
If there is no Fresh Fix use Used Fix and *save* that after use.
Rinse _____ in Water for 30 seconds.
Hypo-Clear _____ for 2 minutes with agitation.
Drain the Used Hypo-Clear into the Used Hypo-Clear Container.
If there is no Fresh Hypo-Clear use Used Hypo-Clear and *discard* when finished.
Wash _____ film for 5 minutes in film washing tube.
Photo-Flo _____ for 30 seconds. Drain but do not rinse off.
Remove _____ excess liquid from film with a squeegee or fingers wet with Photo-Flo.
Cut _____ film 15 frames back from the *last frame* on the roll. Do not cut off the head or tail.
Hang _____ up each piece of film to dry in Film Dryer with a clip on the end to weight it down.
See detailed instructions on the dryer.
Dry _____ film in preheated dryer for about 7 - 10 minutes.
Do not leave your film out in the open for very long. Dust is your worst enemy.
Cut _____ into strips of five frames each when film is dry.
Include the leader at the beginning of the roll to give you a five frame length strip.
Avoid having fewer than 3 negatives together.
Slide _____ the strips into plastic Negative Files using the light table.
Insert the film with the emulsion side down and the frame numbers in proper order.
Never touch the emulsion side of the film.
Negatives are fragile and will scratch easily.
Insert _____ negative file into loose leaf notebook.
Insert _____ contact sheet for the roll of film into loose leaf book, behind the negative file page.

NEGATIVES: Exposure & Evaluation

EXPOSURE *Expose for the Shadows*

The density of the negative in the shadow areas (thinnest) is controlled directly by exposure.

The most accurate method of determining exposure when shooting is to meter for the shadows and then underexpose by two stops.
Close the lens down or speed the shutter speed up, either of which will yield less light.
BIG NUMBERS yield little light.

DEVELOPMENT *Develop for the Highlights*

The density of the negative in the highlight areas (densest) is controlled by development.

Because of this, the development times given are only recommended starting points which can be adjusted according to how and what you shoot.
The contrast in a negative is defined as the difference between the shadow and highlight densities. Longer developing times will make the highlights more saturated while changing the shadows only a little. This expands the contrast range.
Development, therefore, directly controls the contrast in negatives.
The amount of agitation can also alter the contrast range, more agitation yielding higher contrast, yet too much can cause streaking. This is why it is important to keep your agitation technique consistent.

EVALUATION

- Look at the thinnest shadow areas.
  If there is enough information to render details in the shadows, the negative is properly exposed.
  If the film is clear in the shadow areas, the negative is underexposed not enough light.
  If the film is too dense in the shadow areas, the negative is overexposed too much light.
  note: This will vary for each frame on a roll until you become consistent with your exposure technique

- Now look at the densest highlight areas of a negative that is properly exposed according to the shadows.
  If there is enough information to render details in the highlights, the negative is properly developed.
  If the film is not dense enough in the highlight areas, the negative is underdeveloped
  - not developed long enough.
  If the film is too dense in the highlight areas, the negative is overdeveloped
  - developed too long.

VARIATIONS

The longer you develop film the larger each individual silver crystal will become. This makes the grain structure more prominent and the photographs will appear more contrasty.
A similar effect is created by developing film at a higher temperature.
Conversely, if you deliberately overexpose you film, you can develop it for less time giving you smaller grain yielding more detailed images.

FILM - Speed, Grain & Contrast

SPEED

Film speed is a rating of how quickly film emulsion responds to light. A somewhat arbitrary system of numbers is used to label the film speed in "stops" of light. Just as one *f*/stop on a lens lets in half or twice the light of the next stop, so does one stop of film speed represent either half or twice the sensitivity to light of a particular emulsion. In other words, film rated at ASA200 requires only half as much exposure as ASA100 film to produce negatives of the same density. Film is usually designated in one/third stops as follows:

25 32 40 50 64 80 100 125 160 200 250 320 400 500 640 800 1000 1280 1600

These numbers are usually preceded by the letters ASA, which denotes the American Standards Association, who came up with the numbers in the first place so a standard could be set between numerous film manufactures. People will refer to a specific film as ASA 125 film, and so on. The European community uses a different set of numbers but their relative placements on the chart are the same. That system is called DIN numbers.

In actuality the film speed listed on the label of the film is a recommended film speed rating. The manufacturer will also recommend several developers and starting point developing times for that film at that rated speed. You may vary from these recommendations by either rating the film at a different Exposure Index, and may accompany this by altering the developing time. see: *Push and Pull Processing* page. The results you get are not right or wrong, but different. Each alteration yields a different look. The easiest way to get a handle on what these different looks may be is to understand how film works and what the variables are.

GRAIN

Film emulsion is made up of a collection of silver bromide crystals. "Grain" is a name for the appearance of the structure of these crystals after the film has been developed. Fast speed films have larger grain, while slower speed films have smaller grain. Variations in grain size and structure have numerous repercussions.

Sensitivity - The larger the grain the more quickly the emulsion will respond to light. Larger crystals are more likely to be struck by photons of light, resulting in increased sensitivity. Conversely, smaller grain takes more time to respond to the same amount of light.

Resolution - The larger the grain, the fewer the number of silver crystals there are per unit area, resulting in lower resolution. This means faster film with larger grain will make images that are less sharp and have less detail. Slower film emulsions have grain that is much smaller and tighter yielding far more definition.

Appearance - The larger the grain, the more visible it will be, and the more textural an image will appear. Some people exploit this characteristic to create very grainy photographs which have a very graphic quality. Smaller grain better approximates a truly continuous tone image, and looks closer to the way our eyes perceive the world. Some photographers go to extremes to get as small and as tight a grain structure as possible, in search of the "perfect" image. These two extremes are merely a matter of differences in taste.

CONTRAST

The definition of contrast is the difference in tonality between the brightest highlight and the darkest shadow in an image. There are ten stops of difference in most films, ranging from totally clear to dense black. These are sometimes called zones, to accompany the Zone System, a very exacting means of determining exposure and development for individually processed pieces of sheet film used in view cameras.

Higher contrast levels accompany faster emulsion speed and its inherently larger grain structure. However, contrast levels are more directly controlled by other factors.

Exposure - During short exposures only the top layer of silver bromide crystals in the emulsion are struck by photons of light. As more and more photons are allowed into the camera, crystals that are suspended further down in the gelatin get exposed. This creates a layering effect and the highlights build up and become very dense. Since the crystal in the shadow areas are so far apart, this layering does not have much visual impact in the clearer parts of the negative.

Development - Development is the process of building up metallic silver onto the crystals in the emulsion that have been struck by light. The longer a piece of film stays in the developer, the greater the amount of deposited silver. Since the crystals are much closer together in the highlight areas, the visual impact is much greater.

Film Curves - The measurement of density in the shadow versus the highlight areas are known as film curves. These curves graphically indicate the significant amount of difference that both exposure and development have on both ends of the tonal scale.

Compression and Expansion - It is possible to measure the overall tonal range of the subject and express that range in terms of stops of light. One can then develop the negative so that the tonal range is compressed or expanded to fill the entire tonal range potential of that film. With this kind of control over tonality, exposures can be made for special effects and photographs with restricted tonal range. In addition, objects of a particular luminance can be "placed" in a specific tonal range on photo paper.

CHOOSING FILM

BALANCING

The choice of film to use in a particular situation is a balance of aesthetics and technology.

Technically, if you need to shoot at high shutter speeds to capture motion, or are merely shooting in low light, then you will probably use a faster speed film. This will enable you to use faster shutter speeds without sacrificing all your depth of field. Just realize that you will get more noticeable grain in your photographs and they will not be as sharp or as detailed as if they had been shot with slower film.

If you are deliberately after a chunky, contrasty, graphic look, you will also select faster speed film and perhaps play with push processing the film by deliberately underexposing it and subsequently overdeveloping it. Developing at higher temperatures will also help achieve this look.

see: *Push and Pull Processing* page, *Alternative Films* page

Aesthetically, if you are after a lot of depth of field, you probably will want very fine detail to go with it. To get the detail you would use slow speed film and shoot at small apertures. This situation will cause you to lose a lot of light, however. To compensate for this you can put your camera on a tripod and shoot at a much slower shutter speed. In general slower films will give you the sharpest and most detailed negatives with a wide range of subtle tonal differences.

In the beginning of your photo experience it is good to use both types of film to see just how they affect the nature of your images. If after a while you find yourself gravitating toward one style or another, then you can begin to use one type of film more than another. Just make sure not to lock yourself into too narrow a style. Consistency is valuable, constipation is painful.

GRAIN SHAPE

For many years film emulsions have been made with a round grain pattern. Recently, the Kodak T-Max black and white films have borrowed from color technology and now incorporate tabular grain. This shape yields greater sensitivity to light without a corresponding increase in size and therefore, noticeability.

FILM FORMATS

Moving to a larger film format, from 35mm to 2 1/4" for example, does not alter the grain. It merely gives you more surface to work with. Therefore a larger film format will give you more detail only because it is larger. You can put more words on a larger piece of paper can't you?

A larger negative needs to be blown up less than a smaller negative to reach the same print size. Therefore, an 8" x 10" print from a 2 1/4" negative has smaller grain than a print from a 35mm negative because it is not enlarged as much.

ALTERNATIVE EXPOSURE and DEVELOPMENT TECHNIQUES

PUSH-PROCESSING *underexposure and overdevelopment*

It is possible to deliberately underexpose your film and then compensate by overdeveloping it.
The result is high contrast, fat grain and no shadow detail.
The effect is dramatic, but can be gimmicky if not properly considered.

What actually happens is the film does not really receive the amount of light necessary to render a properly exposed negative. Thus there will be no details in the shadow areas. When the film is overdeveloped the grains of silver that have been struck by light will be greatly enlarged, making the highlight areas of the negative appear relatively normal.

Some people like this look and use it deliberately. Some people are forced to use this technique, such as dance photographers, because there is never enough light, always too much movement and deep depth of field is needed to get all the dancers in focus. Through time, however, so many dance photographers have used this technique that up-and-coming dancers now ask specifically for "contrasty, grainy photographs" like the professionals have.

ASA 400 film can be pushed 1 stop to EI 800 or 2 stops to EI 1600.
A 3 stop push to EI 3200 is possible but not recommended.

Developing times are increased by 50% per stop using normal developer.
Higher concentration dilutions of developer can be used, such as Edwal FG7 at 1:3 dilution, if you do not want to stand around developing film for two hours. This dilution yields excessive grain and *no* shadow detail.

High-energy developers such as Ilford Microphen are also available which will give you a less extreme negative.. (necessary if you want to go the ASA 3200 route)
«see *the Push-Processing cookbook style instructions on the Film lab wall*»

"PULL" PROCESSING *overexposure and underdevelopment*

Although not a term used by the photo world in general, "pull" processing seems an applicable tag for the technique of deliberately overexposing film and then compensating by underdeveloping.
The result is negatives with lower contrast, smaller grain and bright highlights.

What actually happens in this situation is too much light hits the film and the highlights get over saturated. Yet when the film is underdeveloped the grains of silver remaining small and do not overlap, which keeps the highlight areas from blocking up. At the same time the film renders more subtle gradations in the tones near the shadow end of the negative.

This technique will produce brilliant highlights, allowing you to print the rest of the picture darker while maintaining white whites.

ASA 400 film can be "pulled" 2 stops to EI 100. Kodak Tri-X works the best in this situation.

Developing time can then be reduced by about 30%, which doesn't sound like much but will do the trick.

ALTERNATE FILMS

SLOWER EMULSION FILMS

have smaller grain structure, which reacts more slowly to light.
Kodak Plus-X - ASA 125 Ilford PanF - ASA 50 Kodak TechPan - ASA 25
all can be developed in Edwal FG7 at the same developing times for Kodak Plus-X on wall chart
TechPan can also be developed in Technidol LC developer for extremely fine grain and high detail.
Technidol is available in small packets dispensed by the lab monitors from the office.

aesthetic considerations -
the smaller grain provides enhanced detail.
your images will have less contrast.
therefore these films are great for images which have a lot of texture and definition.
slower film speed means shots require more light
this means you will either have to open up your aperture or slow down your shutter speed
since one uses slow speed to get more detail, you will probably not want to loose your depth of field
i.e. you will be taking shots at slower shutter speeds,
which means you will probably need a tripod or some other way to stabilize your camera.

VERY FAST EMULSION FILMS

have larger grain structure allowing faster reaction to light.
Kodak 2475 Recording film - ASA 1000 Kodak T-Max 3200 - ASA 3200
Recording film has very pronounced grain and can be developed in Edwal FG7
T-Max should be developed in Kodak T-Max developer in the silver jug under the developing sink.

aesthetic considerations
these films are designed to give reasonably good negatives in low light situations
or shots where you need both a lot of depth of field and a fast shutter speed.
the grain is much more apparent in an enlarged print.
your images will have considerably more contrast.
some people like the stylistic look of chunky grain and high contrast.
if this is you goal you may prefer to push process ASA 400 film rather than use these films.

TECH PAN - *film from heaven or film from hell*

Kodak Tech Pan film rated at ASA 25 and developed in Kodak Technidol LC developer
will give exceptionally fine grain and remarkable detail.
Tech Pan can, however, be thrown to the other side of the spectrum by shooting it at ASA 200 and developing in Kodak Dektol paper developer for 3 minutes at 68 degrees.
yes – Dektol, the stuff that you use to develop your RC prints, located in the left hand storage vat behind the main darkroom sink, diluted 1 part developer to 2 parts water.
This method of shooting gives outrageous contrast and highly stylistic negatives.
an extensive list of processing possibilities is included with each roll of film.
This is very unusual film which changes considerably depending on the lighting conditions. Try some test shots to see if you like what you get, or don't get, as the case will be with all of your shadow detail!

E X P E R I M E N T !!

AVAILABLE B&W FILMS

SELECTED FILMS

brand	name	speed	grain	characteristics
AGFA	Agfapan 25	25	extra fine	
	Agfapan 100	100	fine	
	Agfapan 400	400	moderate	
ILFORD	Pan F	50	extra fine	higher red sensitivity
	FP4 plus	125	fine	
	HP5 plus	400	moderate	good for fine grain pushing
	Delta *	400	fine	sharp as ISO 100 film
KODAK	Tech Pan *	25-200	ex. fine to coarse	enhanced red sensitivity
	T-Max 100	100	extra fine	great shadow separation
	Plus-X	125	very fine	
	Tri-X	400	moderate	great for pulling or pushing
	T-Max 400	400	fine	not good for pushing
	Recording 2475	1000	coarse	high red sensitivity
	T-Max 3200	3200	moderate	better than pushing Tri-X
	High speed Infrared *	50	coarse	sensitive to invisible infrared
FUJI	Neopan 400	400	fine	excellent sharpness
	Neopan 1600	600	moderate	less blue sensitivity

the EVOLUTION of FILM

It was not until the end of the nineteenth century that chemistry had progressed enough to make the projected light images of the camera obscura permanent. It had been noticed as early as the seventeenth century that certain chemicals change their composition when exposed to light. The trick was to stop the alteration at a certain point and make the new material insensitive to light.

Joseph Niépce created the first permanent photographic image in 1826 using bitumen, a kind of asphalt, dissolved in lavender oil. The bitumen struck by light hardened and the still soft, unexposed bitumen could be washed away with more lavender oil creating a crude image with a reasonable range of tonalities. Shortly thereafter, in both England and France, two separate processes were devised to produce a much more sophisticated product. In 1829 Louis Daguerre became a partner of Niépce and continued his work after his death in 1833.

Daguerre announced his new *daguerreotype* process on January 7, 1839 to the French Academy of Sciences. This process produced one-of-a-kind images on sliver plated copper sheet that had sharply defined details and within fifteen years as many as three million daguerreotypes per year were being produced in the United States alone.

Henry Fox Talbot announced a wholly independent solution to the same problem on January 25, just two weeks after Daguerre, to the Royal Institution of Great Britain. Although not the first to make the discovery, his process is actually the father of that which is used today. Talbot called his products *calotype*s, or "beautiful impressions". The basic complaint with this procedure was that although the images were reproducible, their paper base made them far less sharp than the daguerreotype.

Better chemical compounds continued to be developed including wet plate collodion process that Matthew Brady, the famous documenter of the Civil War used. This process required that an entire darkroom accompany the photographer. When collodion was coated on a glass plate a negative image was formed from which positive prints on albumen coated paper could be made . If the glass plate was backed with black material an ambrotype was created, which resembled a daguerreotype. Collodion coated onto a black plate produced a direct positive image called a tintype that was very inexpensive and became extremely popular for the average American.

In 1881 two new inventions revolutionized the photographic process. One was the development of a gelatin base in which to suspend the light sensitive silver salts. The second was the process of putting the emulsion onto rolls. George Eastman formed the Eastman Kodak company and developed a much simpler camera to hold these new rolls of film. In 1888 the Kodak camera was introduced, which came loaded with enough film for one hundred exposures. The camera was small enough to be hand held and the emulsion was fast enough to take exposures at 1/25th of a second. When all the film was exposed the camera was sent back to the factory. Finished prints were returned to the user along with the camera reloaded with new film. George Eastman and the Kodak camera put photography into the hands of everyone with the slogan, "You press the button, and we do the rest".

MODERN FILM

BLACK & WHITE FILM

The black and white film that we use today is not unlike the early dry plate process. The new emulsions respond much more quickly to light, are much finer in texture, and are now applied to a flexible acetate base. Black and White film does not recognize color information, rendering only the brightness of objects using very small dots of metallic silver which appear black in color. These silver crystals are so small and uneven in texture that these photographic images are called "continuous tone". When placed on white paper, what appears to be a full range of grey intermediate tones is perceived.

COLOR FILM

In 1935 Kodak produced Kodachrome film that produced full color transparencies and introduced Kodacolor negative film in 1941. Both films consisted of three layers of silver based emulsion sandwiched together each sensitive to a particular band of frequencies, namely red, green and blue- the primary colors in additive color theory. Each band is developed as usual and then the silver is replaced with colored dyes to produce either color slides or negatives. The negatives in turn are used with enlargers that can control three colors of light, in this case cyan, magenta and yellow- the primary color in subtractive light theory. These complementary colors are used to produce full color prints often called color coupler prints or simply C-prints. The newest color films employ a tabular grain structure which is now starting to find its way into black and white film design.

Another process called Cibachrome, a direct positive print medium based on the destruction or removal of color dyes rather than the build up of them, actually creates a more stable and more sharp image than the chromogenic materials from Kodak. It is, however, more expensive and more dangerous than Kodak Ektaprint paper and chemicals.

POLAROID INSTANT COLOR

In 1962 Polaroid gave the world "instant" photographic imaging. The negative and positive photographic materials are packaged together and when the film was pulled from the camera after each exposure, the developing and reversal processes are initiated. When the materials are pulled apart in about one minute a finished positive image is had. This technology has since been surpassed with a more automatic process employed in the SX-70 camera and film, introduced in 1972.

CHROMOGENIC B&W FILM

With the loss of interest by the general public in photographs that are "merely" black and white, and the proliferation of quick processing shops, it has gotten increasingly more difficult to get black and white film processed. In response to this situation Ilford has created a chromogenic film called XP-1 which only contains the colors black and grey. It can be developed in standard C-41 color chemistry at a quick print store, and when printed as standard color film monochromatic prints with a slightly toned appearance are produced. This makes black and white photography as quick and convenient as color, if you do not mind having no control over what is happening in your 3 1/2 x 5 inch prints, and do not mind paying as much as for color processing.