

H A S S E L B L A D<sup>®</sup>



COPYING  
TECHNIQUES

All photography is actually a kind of copying, if by "copying" we mean the depiction of a subject by optical means. Copying is a term used to describe the reproduction of two-dimensional objects.

Copying techniques have mainly been developed in the graphic arts industry and are the basis of the modern printing industry. Photographic reproduction can also serve as the first phase in the process of disseminating a visual or printed message, as information for use on isolated occasions or for teaching purposes. But in addition to being a passive form of photographic reproduction, copying can also enhance a picture's message by altering image contrast or the shape and color of the original. Copying techniques can be used by many different professions with information as a common denominator.

It is usually impossible to satisfy the reprographic requirements of the graphic arts industry except by using special-purpose equipment. But almost all other copying can be accommodated within the framework of a high-quality camera system. The Hasselblad system provides abundant scope for first-class copying work. The system's single-lens reflex design with advanced format interchangeability approaches the flexibility provided by advanced repro equipment.

### The original

The subject in copying is called the original. An original is usually divided up into 3 main categories.

1. Line originals
2. Black & white continuous tone originals
3. Multicolor originals

In principle, line originals differ from continuous tone originals by displaying maximum contrast, i.e. a maximum difference between the intensity of black and white. A continuous tone original has a continuous gray scale (black & white) or a scale of hues of varying saturation (color). These basic differences have a decisive influence on the choice of copying technique.

Originals should generally be flat and smooth and, preferably, have a contrast suitable to

the copying materials used. The quality of the original is decisive to the quality of reproduction results. The graphic arts trade, which often uses copies of originals for printing purposes, prefers to work with a 1:1 scale of reproduction, i.e. natural size. Copying originals 1 1/2 the desired size is also common in that trade. The choice is dictated by technical requirements. But since every copying action entails an image conversion, which must be minimized, it is best to use originals which coincide as closely as possible with the size of the copies to be made.

### Graphic characteristics of the original

The copying technique used depends on an original's graphic characteristics, i.e. the characteristics which assign it to one of the three aforementioned categories. The photographer must be absolutely certain about the factors governing this classification in order to select the best copying technique.

### Line originals

Line originals consist of opaque black lines or dots on a white background. Variations in line density can create a continuous tone effect. Line drawings are made with opaque black ink or India ink. Chalk and pencil drawings should not be processed as line originals, since they may produce continuous tone effects. See below under "Continuous tone originals."

Cover photo: Jens Karlsson  
Photo at right: Lars Gustafsson

*Copying quality largely depends on the quality of the lens used. The Planar lenses feature even illumination and uniform resolution across the entire field, even when used wide open. The 120mm S-Planar lens is also especially designed for close-up reproduction.*



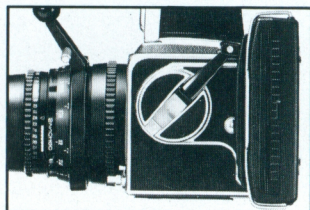




Painting by Inge Schiöler (1908–1971). Göteborg Museum of Art. Photo: Jens Karlsson

*The reproduction of works of art presents two main problems. One involves lighting, whose task is to reveal structural effects. The other involves the correct rendition of a work's original*

*colors when color film is used. The Hasselblad magazine for Polaroid film facilitates fast checks on both these important factors.*



Line drawings should be made on flat, smooth white paper. Matt-surface paper should be used if possible. But lines will tend to fill in and there will be a loss of detail in a copy if the original's surface is too rough.

### **Continuous tone originals**

Continuous tone originals consist of material with a continuous gray scale (black & white) or a scale of color tones (color).

A photographic print used as an original for copying should have normal or slightly less than normal contrast and be made on glossy paper. Yellowed or matt-surface prints make unsuitable originals for first-class copying.

Photographic prints which have yellowed with age or which were toned yellow from the beginning must be regarded as special problems. See the section "Yellowed originals." The original should be as fine-grained as possible unless a coarse-grained effect is desired. The image should be sharp and printed on a softer grade of paper whenever possible. Thus, white areas should be grayish white and no dark area should be completely black. This is because copies tend to be contrastier than originals.

### **Multicolor originals**

#### *Reflected light viewing*

Multicolor originals for reflected light viewing are found in the form of water-colors, pastels, oils, color prints, collages and printed matter. The photographic color print has a tonal range making it relatively easy to copy and is therefore often used when a color illustration is required for a graphic presentation. For technical reasons the contrast of color prints is low. A color print is often used to duplicate originals drawn in color for printed material and advertisements.

Other types of photographic multicolor originals are: 1. black & white prints tinted with translucent colors and 2. black & white prints tinted with opaque colors.

In the first case, the underlying black drawing is often discernible. Type two is more suitable for copying, since the underlying image does not affect color hues.

#### *Transmitted light viewing*

The best and most saturated rendition of color images are provided by translucent originals. There are three main types: 1. original color transparencies, 2. color transparencies made from color negatives and 3. duplicate transparencies.

Assuming the technical procedure is performed faultlessly, the picture viewed by transmitted light generally makes an excellent original for copying.

### **Film material**

In copying, it is more important than in any other form of photography to adapt the film material to the subject. The great dividing line here, as in photography in general, is drawn between color and black & white, even if black & white originals are found on the fringes of color copying in the additive copying method.

On this basis, let us have a look at film emulsions.

### **Black & white negative film**

The photographic industry provides a wide range of different negative films for use in different types of copying work. Generally speaking, the black & white continuous tone original calls for an emulsion with moderate contrast while line originals require a maximum contrast film.

However, it might be appropriate to say a few words about the general properties of negative emulsions with a view to the special requirements of copying.

#### *Color sensitivity*

The color sensitivity of the negative emulsion is decisive, irrespective of the purpose of copying. Negative emulsions are divided into three main categories:

1. *Blue-sensitive* (also called color-blind or process) emulsions render blue an intense black on the negative. This means that blue areas are light in the final copy and red, yellow and green are very dark.
2. *Orthochromatic* films and plates are insensitive to red light. This means that red is

rendered very dark. These emulsions are faster than process films, they are sensitive to a wider range of the light spectrum.

3. *Panchromatic* films and plates are sensitive to all visible colors. They therefore produce a good monochromatic (black & white) image of a color original.

The choice of film type is dictated by the color sensitivity requirements of the black & white copy to be made.

### **Reproduction of detail**

The reproduction of detail often depends on the "brilliance" perceived when the copy is viewed. This "brilliance" is the product of three important image factors: contrast, resolving power and graininess.

Resolving power in most emulsions usually declines as graininess increases. This underlines the importance of using fine-grain emulsions for copying.

Resolving power depends on the properties of the lens and film used, and its visual results are an impression of contrast and sharpness. Resolving power is measured in lines per mm. However, there is no way to make use of such a measurement method in practical photography. That is why attempts have been made to classify resolving power in terms of the "brilliance" with which details are reproduced.

Obtaining objective measurements of resolving power is complicated by the inability of the eye to distinguish more than about 10 lines/mm at a normal reading distance, while the resolving power of film and lenses may exceed 225 lines/mm.

The film manufacturer's information on resolving power should be studied in order to obtain the best results. It will be found that ordinary single-layer films and some multilayer films in the normal speed range will be designated as having "very high resolving power," i.e. from 136 to 225 lines/mm. Process films are said to have "extremely high resolving power" and "extreme contrast." This is not very surprising, since the task of process films is usually to reproduce hairline details.

In view of the present high quality of negative emulsions, the results of the interplay between camera and film will generally depend on the manner in which the photographer uses his equipment and materials.

The following requirements are vital in order to achieve optimum image brilliance and resolution in copying: 1. a clean camera lens of high resolving power 2. accurate focusing 3. a steady tripod 4. normal negatives (not overly dense through over-exposure or over-development) 5. a choice of paper contrast which does not alter original contrast 6. a steady enlarger, a clean enlarging lens and accurate focusing.

### **Color film**

The color film used must be dictated by the color temperature of the illumination in question (daylight, incandescent or electronic flash). Color films are divided into two main categories in respect to color temperature: 1. Daylight type film for exposure in light at about 5700 K. Normal daylight, electronic flash or blue expendable flash can be used with this type of film. 2. Tungsten type film for exposure in artificial light with a color temperature of 3200 K.

The measurement of color temperature makes it possible to ensure that illumination is suitable for a given type of color film. Any difference can be corrected with color correction or light balance filters.

Floods must always be used at the rated voltage. The voltage of the power supply should also be checked periodically, since even slight variations can result in a shift in the color temperature of lamp output. Floods also age and usually produce light at the rated color temperature only when new.

Other factors affecting color temperature are the color of the reflector and the color of walls, ceiling and floor which may reflect light onto the original. Thus, the objective should be to carry out copying in a neutral-gray environment so as to obtain well-balanced color reproduction.

Daylight and tungsten type color film is available in reversal and negative versions. The

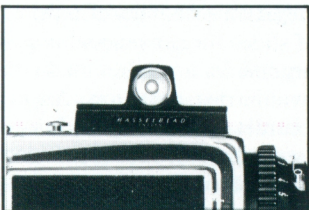


20-juni 1904.

⊗  
 Karl XI:s staty avtäcker. (1905. —)  
 7 sept. 1904.

P.K.

At the Göteborg Historical Museum



The photographer who took this picture in 1904 knew how to guard against distorted building lines. The high camera angle made it unnecessary to tilt the camera upwards, so the

buildings retained their vertical lines. In copying work the film plane and the original must be parallel in order to avoid similar distortion. A spirit level and a set-square are good aids.

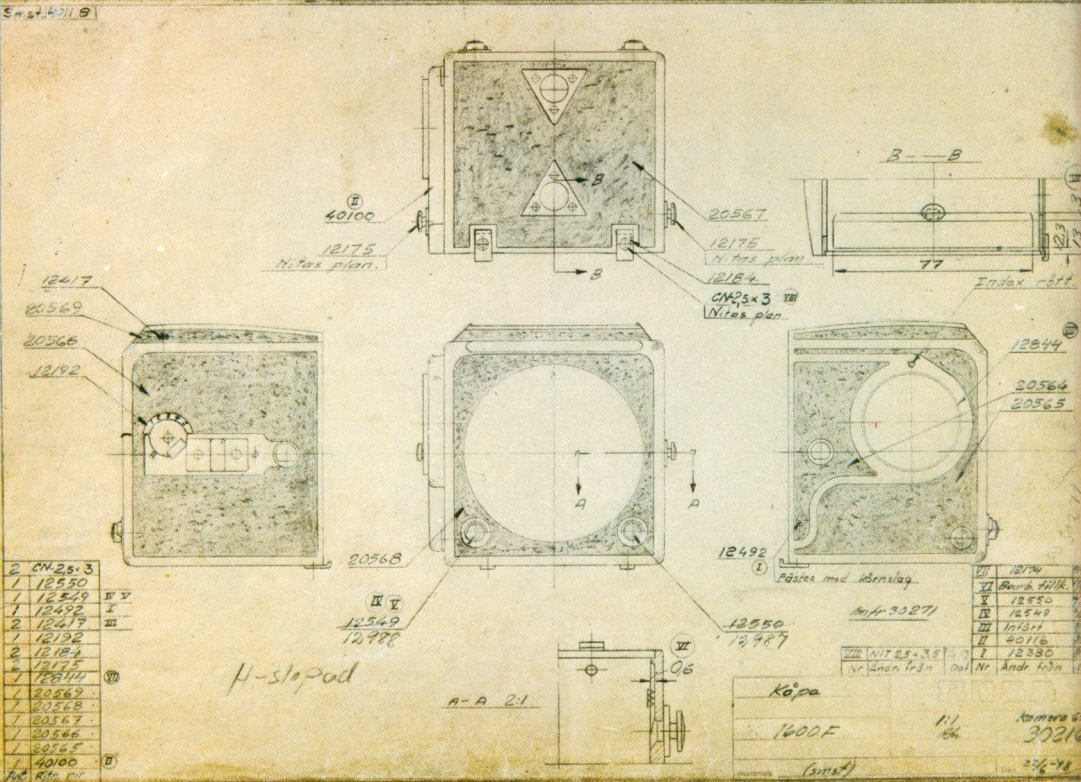
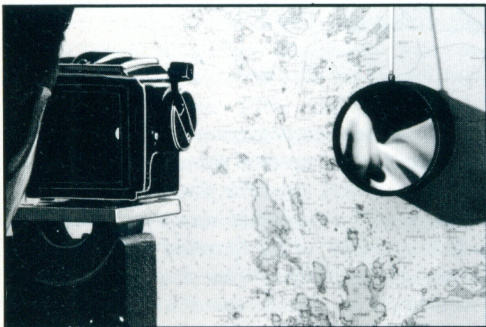


Photo: Jens Karlsson

The Hasselblad linear mirror unit for copying work is more sophisticated than the spirit level. It is used when parallel alignment between the film plane and the original must be exact. By using the linear mirror unit, parallel accuracy can be adjusted to less than  $2/160^\circ$  (2 minutes of an arc).



purpose of the copying governs the choice of color film. Reversal film produces transparencies. Duplicate copies are obtained by making copies of the slide original itself. With negative color film the original can be reproduced in any quantity desired by making prints from the negative or copies of a print. Reproductions of slides for subsequent copying or color enlargements are often made on an especially low-contrast emulsion. An increase in the contrast of the copied image must always be expected. It is a good idea to study film specifications before undertaking a color copying assignment.



### Equipment and techniques

The following points are essential to good copying, irrespective of the nature of the original:

1. A flat original
2. Original parallel to the film plane
3. Accurate focusing
4. A suitable original
5. Uniform lighting appropriate to the original
6. Correct exposure
7. Correct development

### Positioning the original

A vertical camera set-up is preferable for originals up to about 12"×16" (30×40 cm). Larger originals should be wall-mounted. This calls for a horizontal camera position. A firm material such as fiberboard makes a suitable backing for the original. Magnetic attachment to an iron plate is another method. A matt finish applied to the backing prevents extraneous reflections from this source. Originals in poor condition can be pressed against the backing with a sheet of heavy plate glass. The best backing is provided by a professional vacuum easel.

### Alignment

In order to eliminate perspective error, the camera's film plane must be parallel to the original. A spirit level and a ruler are traditional aids in attaining parallelism.

A clever Hasselblad accessory, the linear mirror unit, facilitates accurate alignment.

The linear mirror unit provides parallel alignment between the original and film plane with an accuracy of less than 2 minutes of an arc (2/60°). It consists of a lens flange mirror and a reflecting mirror located at the film plane. An enlarger or special copying stand, which is often combined with lighting units, can be used for copying.

Parallel alignment of film plane and original is an absolute must. Film flatness is well-satisfied in the Hasselblad film magazines. For more exacting applications there is a Hasselblad cut film adapter and holder which fit all Hasselblad camera models. This acces-

sory makes it possible to use all the special-purpose emulsions available for cut film and plates.

### The camera and focusing

The camera and accessories are subject to severe demands apart from the need for film flatness. The focusing screen must be fine-grained and be fitted with a device, such as a microprism spot, to facilitate exact focusing. The camera must be capable of double extension, for example, providing a 1:1 scale of reproduction and be available with a lens suitable for copying purposes.

A complete array of close-up equipment (described in greater detail under "Close-up copying") is available for the Hasselblad 500C/M.

All lenses for the Hasselblad 500C/M are suitable for copying work. However, the Hasselblad system has a special purpose lens, the Carl Zeiss 120mm f/5.6 S-Planar, for scales of reproduction from 1:2 to 1:10 in an ordinary copying set-up. This lens was especially designed to provide the finest possible results at the aforementioned reproduction scales, unlike the other Hasselblad lenses which were designed for maximum performance when focused on infinity.

The S-Planar also has high modulation transfer values within the range encompassing low line density to 20 lines/mm. It provides a brilliant corner-to-corner image. Optimum correction is obtained at f/11. At this aperture the center of the field displays a value for modulation transfer function which can otherwise only be obtained in an ideal situation using an absolutely faultless optical system.

This optic combines the outstanding reproduction of ordinary Zeiss lenses at long lens-to-subject distances with the special properties called for in a first-class copying lens.

### Correct lighting

In assessing a lighting situation, it is important to keep in mind the importance of the lamp-to-subject distance and the general principle that "light intensity declines by the



square of the distance." Variations in lamp age also produce variations in light output. Therefore, no specific lighting principles can be given to cover every situation.

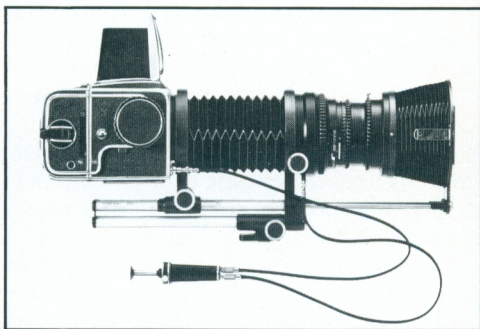
### **Some general advice on lighting**

One to four photofloods are used for most copying assignments.

When only a single lamp is used (an emergency measure only), this lamp must be

*Photo: Jens Karlsson*

*The lens-to-subject distance often varies when works of art are copied. The bellows extension, used with the 135mm S-Planar, opens up new opportunities for reproduction from 1:1 (21") to infinity.*



aimed so that the original lies within 30° of the lighting axis. The most uniform illumination with a minimum of reflections should be strived for.

Illumination of the original with two lamps is most common. One good rule of thumb in the first set-up is to aim the lamps so that they form an angle of about 60° to the lens-to-original axis. The major risk involved in both 1 and 2 lamp set-ups is that specular reflections may easily be produced by originals with rough surfaces, such as oil paintings. Reflections of this type have a degrading effect on the film image.

A 4-lamp set-up provides the best lighting, one lamp at each corner of the original. A 4-lamp set-up is almost a must in the reproduction of non-translucent color originals and difficult black & white continuous tone originals.

The Hasselblad lens series can handle any demand imposed on lenses by copying techniques. The S-Planar and the 38mm f/4.5 Biogon are also characterized by a complete absence of vignetting.

The uniformity of illumination can be measured with a photoelectric exposure meter or be determined by a simple, visual means. A pen is placed at the center of the original and a visual assessment is made of the shadows cast by the lamps. Lamps are shifted until they cast shadows of uniform darkness on all sides of the pen.

Floodlamp reflectors should have a matt-white finish.

The Hasselblad ringlight, which provides shadowless lighting, is a useful source of light when copies have to be made and a stationary set-up is out of the question. A neutral density filter can be used if flash intensity is too great at the working distance.

### **Correct exposure and development**

Careful exposure is vitally important in all copying work.

A combined electronic exposure meter/timer, which can be adjusted for exact exposure times, is a wise investment for work with a stationary set-up.

An ordinary exposure meter reading from a neutral gray card over the original can produce satisfactory results when only occasional copying is carried out. White card measurements can also be used instead. The proper setting can be approximated by dividing the film's tungsten speed rating by 5 and setting that number on the exposure meter dial.

This procedure works well with both continuous tone and colored originals.

### **Exposure of process film**

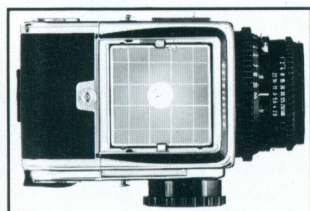
Negative film for the copying of line originals is still supplied without any information on its speed. The correct exposure must therefore be determined by trial and error. The following procedure is suitable: Place a sharp, clean original, such as a page of text printed on good quality paper, on the easel instead of the original. Focus. Then make a series of test exposures on the same film to be used for the copy, i.e. a high-contrast colorblind film. Bracket your exposures in a suitable series, such as 5, 10, 15, 20, 25 and 30 seconds. Test exposures are separated by using a taped-on black paper mask which is shifted after each exposure so as to uncover fresh film in each test exposure. These test exposures can be made on a strip of film, cut from the film to be used, instead of wasting a whole sheet. The developed film will display six different exposures. Pick the one giving the best reproduction. The following factors should be kept in mind when assessing the best exposure:

- black areas should be almost too dense to transmit any light,
- black areas should not display any pinholes or dust spots,
- transparent areas should be clear and unfogged,
- text lines should be as sharp as in the original,
- text lines should not be thicker or thinner than in the original.

It is very important to learn to distinguish a correct exposure from over or underexposure when copying line originals.



Photo: Francis Y. Duval



*Parallel alignment between the film plane and the original is not the only thing important to accurate reproduction. The Hasselblad has a simple accessory, the interchangeable checked*

*focusing screen with central grid. This screen makes it easy to check the image's geometric features and also facilitates accurate focusing.*

Lieber Gustav!

Ich danke Dir herzlich für Deinen lieben Brief. Ich teile Dir mit, daß ich heute, den 26. I., die farbige Photographien aus der Weltraum in Ordnung erhalten habe. Sie sind wunderschön. Sie haben mir große Freude gemacht, und bilden herrliches Material zu den Vorträgen.

Diese Sorgen um unseres Leben hat mich ergriffen. Bis jetzt geht es noch. Du kennst mein Motto: Immer mit dem Lächeln! Ich bin glücklich, daß ich meinen Hasselblad habe, der läßt mir auf alles vergessen.

Ich bin froh, daß Sie alle gesund sind, daß Sie die Grippe nicht getroffen hat. Ich und Magda, wir sind beide krank gewesen, wir mussten über Weihnachten liegen, und bis jetzt sind wir immer noch nicht in Ordnung.

Ich freue mich schon auf den Frühling und auf das große photographieren. Ich habe viele Pläne, und möchte sie alle erfüllen.

Bei uns im Photoclub gibt es nichts neues. Von meinen Kammeräden soll ich viele Grüße übermitteln.

Ich danke Dir noch einmal und grüße Dich und Deine Familie herzlich.

Dein  
Karel + Magda

### Correct exposure

Negative areas should be either completely black or completely transparent. Image edges should be sharp and image proportions should coincide with the original's.

### Underexposure

Underexposure occurs when film exposure has been too brief. Dark areas in the negative display poor density, even when transparent areas are clear. A positive made from such a negative produces a "bleeding" image.

### Overexposure

The opposite effect produces darkening of areas which should be transparent. A positive made from such a negative displays a loss of fine detail, an especially fatal error in the reproduction of classical typefaces.

You should also know that symptoms resembling under or overexposure may arise if the developer was too cold or improperly mixed, if the development time was wrong, if the film was exposed to flare from dirty lens elements or if it was fogged by safelights or reflections. An exhausted fixer or the absence of a stop bath may also cause fogging which could be confused with incorrect exposure.

Pinholes are another common fault when the darkroom is dusty and the relative humidity

too low. The film then attracts dust. Dust particles on the film then produce minute shadows during film exposure. Shadowed areas receive no light and result in unexposed spots on the film. A negative with pinholes can be placed on a light box and spotted with red opaque and a fine-pointed brush or mapping pen.

### Exposing continuous tone and multicolor originals

Correct exposure and lighting are especially critical in the copying of continuous tone and multicolor originals. The copy negative must be able to produce the same tonal values as in the original. A neutral gray scale should be used as an aid in satisfying these requirements. The gray scale should be positioned at the edge of the original and photographed along with it in the same lighting. After development, the gray scale record on the negative should be the same as the original gray scale. In specially critical applications coincidence can be checked out with a densitometer. Gray scales vary in size and gradation. Kodak has gray scales in two sizes, 18 cm and 35 cm. The scale chosen is determined by the size of the original. Both scales feature ten steps with density increasing from 0.00 to 1.90. Each step on the scale is marked and is easy to check. Kodak scales also have color scales in the subtractive primary colors. Checking out the appearance of these colors, illuminated by neutral light, on the focusing screen makes it easy to determine if a copied slide has acquired any off-colors during copying. If the copied color fields and gray scale agree with the original fields and gray scale, the exposure was correct.

Polaroid film has also become a convenient aid in checking out copying set-ups. Exposures can be made on this film before a big copying job is started to provide fast information on the accuracy of exposure, lighting and alignment. A Hasselblad film magazine is available for Polaroid film (color or black & white). This magazine is up to the same high standards of excellence as the other Hasselblad film magazines.

Photo: Jens Karlsson

*Originals consisting of finely drawn lines often require special films. The magnifying hood, focusing screen adapter, rapid-winding crank and the extremely high-resolution 100mm Planar lens are some of the items in the Hasselblad system which make copying work easier.*



## Paper

The paper used for prints should be chosen to suit the purpose of the copying job. If the idea is to produce fine detail, the copy negative should only be printed on white, glossy paper. The use of too high a paper contrast counteracts previous efforts in the copying process to minimize graininess.

Unless otherwise required, the finished print should be an exact reproduction of the original.

## The final negative

Once the correct exposure has been determined on a test strip, a whole sheet of film can be exposed. A good line negative is then guaranteed. Notes should be kept on the procedure used (e.g. film type, exposure, developer, developing time etc.) when a satisfactory negative has been obtained. Excellent negatives can then be produced from all line originals of the same size without further test exposures using such a standardized set-up. Always try to use the same  $f$ /stop and the same lamp-to-subject distance for all originals.

An unusually large original may sometimes call for a longer lamp-to-subject distance in order to obtain uniform lighting. The standard exposure must be increased when the lamp-to-subject distance is increased.

Exposure must also be adjusted for varying degrees of enlargement or reduction according to the following table:

a change in size causes a change in exposure to	4	5 1/2	10	16	23	sec.
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at the follow- ing percent of the original size	(1:1)					
	25	50	100	150	200	
	reduction		enlargement			

## Poor originals

It is sometimes necessary to work with poor-quality originals whose fine detail is difficult to reproduce.

## The original has gray lines and text instead of black, i.e. poor contrast

A normal exposure produces fogging of transparent areas on the negative. Try a shorter exposure.

## Yellowed originals

Expose through a yellow filter. Increase the exposure 2 1/2 times in white-flame arc lighting or 1 1/2 times in incandescent light.

## Dirty originals

Clean the original as much as possible. This will make for a cleaner negative requiring less retouching. The negative can only record what the lens sees, including dirt. Erase pencil marks and fill in broken lines. Paint over India ink, splash spots with white opaque. But remember never to do this without the permission of the original's owner. He might like the original the way it is.

## Close-up copying

All photography at distances inside the closest focusing distance engraved on the lens is generally called "close-up photography." The Hasselblad system features a number of useful accessories, such as close-up lenses, extension tubes, a bellows extension, ringlight etc., all making it possible to combine routine photography at normal shooting distances with close-up photography. Every one of these accessories can also be used for copying when the original is very close to the lens. Technical procedures for the use of these accessories are described in detail in another booklet in this series, "Close-up Photography." In general, the same technical procedures also apply to close-up copying.

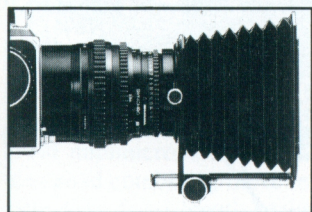
## Lighting a close-up original

The previous demand for even lighting across the surface of the original also applies in close-ups. A special problem may arise in the use of lamps at extremely close lamp-to-subject distances: shadows may then be cast onto the original by the lens barrel. The solution lies in the use of a ringlight whose flash





Photo: Jens Karlsson



*Extension tubes are often necessary when photographing coins. As is the case with a.o. shiny objects, precautions have to be taken against reflections. These reflections can be reduced*

*by using the Hasselblad Professional lens shade or polarizing filter.*

tube encircles the lens and produces almost shadowless lighting. The ringlight in the Hasselblad series can be triggered at half power by means of a special device if over-exposure is otherwise unavoidable. This is a better solution than the use of neutral density filters which introduce additional optical components into the light path. Accurate focusing is especially critical in close-up copying.

The ringlight produces flat lighting. When the surface texture of an original is to be reproduced, as when examining a paper sample or copying an oil painting, the original must be lighted so that a relief effect is created. Side-lighting is the answer here and calls for a special technique.

### Focusing

Focusing is vitally important in close-up copying. The lens should always be focused wide open and then checked stopped down to the working aperture so that focusing errors are eliminated. This apparently fussy procedure is necessary because certain shifts in focus may occur which can not be alleviated by depth-of-field, which is always at a minimum at these lens-to-subject distances even when the lens is fully stopped down. The working aperture should be the one providing maximum resolving power.

If a fixed 1:1 scale of reproduction is desired for a special purpose, all focusing should be made with the rear focusing knob of the bellows extension when this accessory is used.

In order to eliminate camera movement, exposures should be made with light, i.e. an enlarger timer is used to regulate the lighting duration of copying photofloods when the camera is set up with an open shutter in a dark room. Obviously, this does not apply when using electronic flash.

### Special-purpose lens for UV and IR copying

UV and IR photography encompasses special-purpose copying fields covering the spectral range from 215–400 millimicrons (ultraviolet) and 900–1000 millimicrons



*The 105mm Zeiss UV-Sonnar is a special-purpose lens intended for use within the UV-range of the spectrum. However, the lens features exceptional correction making it possible to use it in both visible light and in the IR-range.*

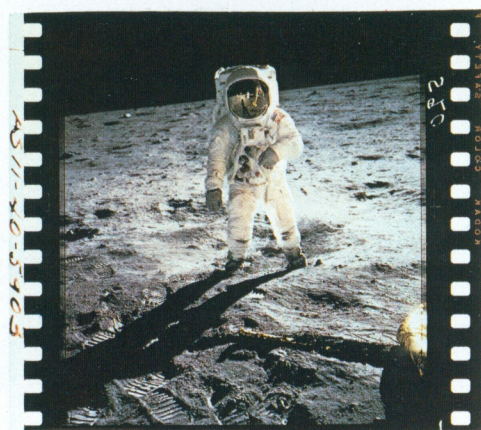
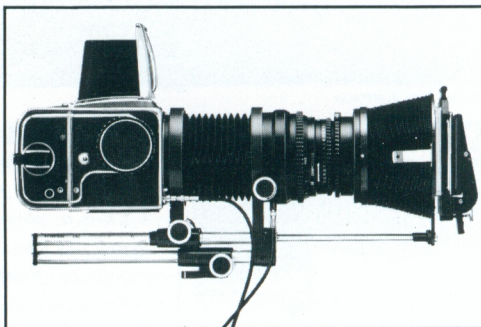


Photo: NASA

*The Hasselblad transparency copy-holder, plus the bellows extension and one of the high-quality reproduction lenses, is an excellent aid in the copying and duplication of color transparencies. Electronic flash is the light source.*



(infrared). The technique used is similar to that used in conventional copying and is usually applied to laboratory photography of two-dimensional objects for the purpose of analyzing structures invisible to the naked eye.

### Ultraviolet (UV)

UV photography is mainly based on the fluorescence of various substances, i.e. the ability of an object to emit radiation at a wavelength greater than that of the radiation with which it was irradiated. When certain substances are irradiated with ultraviolet light (radiation at a wavelength shorter than that of visible light), they emit a visible glow. This glow is usually blue or greenish-yellow and can be photographed with ordinary copying equipment. The light source must be fitted with a UV filter screening out visible light. A special lens is required for the best results, since ordinary glass absorbs UV radiation. The Hasselblad series features a special-purpose optic of this type, the Zeiss 105mm f/4.3 UV-Sonnar, whose quartz construction makes for high production costs.

### Infrared

The use of the infrared part of the spectrum for photographic reproduction is allied to UV photography. The infrared range lies beyond the red end of the spectrum and mainly consists of heat radiation perceived by the skin but invisible to the eye. Modern infrared emulsions are available in both black & white and color and can be used for a variety of applications, such as the analysis of documents, works of art, materials etc.

However, infrared photography usually requires focusing compensation. The new Zeiss 250mm f/5.6 Super-Achromat for the Hasselblad is an optical sensation in many respects because no focusing compensation need be made for infrared. But that is not all. It is also specially designed to provide perfect correction for chromatic aberrations from 400 to 1000 millimicrons and is the first lens ever designed combining these features.

The long focal length makes the lens espe-

cially useful for color copying at long lens-to-subject distances, as in the analysis of ceiling paintings and other inaccessible pictures.

This lens can be said to provide the solution to many complicated copying problems in technical fields with heavy demands on accuracy.

### Reproducing transparencies

Using the Hasselblad bellows extension and transparency copy-holder, it becomes easy to copy transparencies or make duplicates from reversal or negative color film. Uniform, high-intensity illumination, easy to adapt to film properties, is one of the advantages in using this set-up. The bellows extension and copy-holder also make it easy to correct color balance or to crop the image on the slide. The scale of reproduction and sharpness can be accurately determined on the focusing screen.

Note that the  $\pm 1/2$  f/stop exposure latitude of color film is narrower than the latitude of black & white film. This increases the risk of exposure error. But these accessories open up new opportunities to obtain revitalized, sensational color reproductions from transparencies otherwise too dull for further use.

### Copyright restrictions

The right to copy artistic works and photographs is limited by international agreements via the Universal Copyright Convention to which most major countries are signatories. The purpose of the convention is to coordinate the various national systems of legislation on the protection of creative material. Contracting nations are required to take all necessary action in order to provide adequate and efficient legislative protection of the rights of all creators and assignees of literary, scientific and artistic works. This means that the copying of such works must always take place within the framework of national legislative restrictions.

In any case, it is advisable to get acquainted with existing regulations and with any conditions attached to copyrighted material before a copy is put to use.

H A S S E L B L A D<sup>®</sup>



*Photo: Bob Lehmann*

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