Photographic LAB HAND BOOK

JOHN S. CARROLL

Fifth Edition

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AMPHOTO
American Photographic Book Publishing Co., Inc.
Garden City, New York

1970 First Edition
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for future expansion.

INTRODUCTION

This volume, the first completely new photographic data book in more than 25 years, is offered to the photographic community to fill a long-felt need. The idea of a master data service is, itself, not new – several are offered, most by manufacturers of photographic products.

The problem is simply that the average photographer does not limit himself to the products of one manufacturer, and when he has to refer to data sheets, and pamphlets issued by the various manufacturers, he finds himself in at least one dilemma. Namely, the format used by different manufacturers differs, and data is offered in a variety of forms, arrangements, and even, in some cases, using different systems of measurement. Film speeds are given in ASA by American manufacturers; foreign makers use BSI, DIN, and sometimes others. Developer formulas make up to quarts, liters, and in some cases, British Imperial pints.

So, then, the first purpose of this volume is to standardize the presentation of photographic information; to make it completely comparable. This is not entirely new, either; it has been done before, with varying degrees of success.

More important, in terms of purpose, is to be sure that the information offered is in such form as to make it easiest to refer to. A book which over-classifies is as bad as one which is insufficiently classified. It should not be necessary to turn pages a dozen times while looking up information on a given make or type of film. One should not have to refer to one section of the book to find the speed of a film, another section for filter factors, a third for flash guide numbers, and a fourth for developing data. This approach may be useful in an encyclopedia, but not in a workbook for practical photographers.

Thus the first and most important difference between this book and all others is that the basic information required by the photographer for any and all sensitized materials is conveniently grouped, mostly in tabular form, using just a single page for each film, plate or paper. If, for instance, you wish to find out how to work with Kodak Plus-X Sheet Film, you will find a data page devoted to this one film; on this page you will find its film speed (ASA), the recommended safelight for loading and processing, a table of filter factors, a table of flash guide numbers, a table of guide numbers for electronic flash, and a table giving the developers recommended.

Manufacturer sections, as such, are neither used nor required. The second section, logically, is devoted entirely to black-and-white films, which includes both sheet, roll films, and 35 mm films.

The third section, arranged in much the same manner covers all the commonly used color films, mainly of American manufacture. Although it might be of some value to the curious to read the data for such minor foreign products as Telcolor, Orwocolor, and so on, we feel that this book is intended for the serious worker, amateur and professional, who wants useful useable information. There is little use in cluttering pages with data about products which can't be bought anyway.

Again, the fourth section is arranged in much the same order; it contains data on all commonly used photographic papers for black and white photography, and a standardized format has been devised so that everything you need to know to use a given paper will be found on a single data page.

As we mentioned previously, each data page contains processing recommendations for that particular film, plate or paper. But these recommendations are only for time of development for one or more recommended formulas. The broad subject of processing is covered in the following two sections.

The section on processing black-and-white films opens with a general formulary; it contains formulas for mixing developers, stop baths, fixing baths, and incidental formulas such as intensifiers, reducers, toners, and so on. This formulary has been very strictly edited; the huge proliferation of published formulas could result in this section running into hundreds of pages, most of them devoted to material of very dubious utility.

The fact is that there has been a very notable change in the entire philosophy of black-and-white photography in recent years. It is now generally appreciated that image characteristics are mostly "built-in" to an emulsion; most of them are almost unaffected by variations in the composition of a developer. With this appreciation, the entire subject of "fine-grain" processing, so popular only a few years ago, has now ceased to have any meaning or even interest. If you want fine grain, you must use a fine grained film; the developer composition has next to no influence on graininess. However—and this is important—the *use* of the developer does have some effect on grain; generally the higher the contrast of the developed image, the grainier, and likewise, the higher the density, the grainier. It is this reasoning that leads to current recommendations for low-gamma processing combined with minimum exposure. The former keeps the contrast down, the latter minimizes density, and a soft, thin negative has the finest grain structure possible with a given emulsion.

Actually, the huge number of negative developer formulas available never did serve any really useful purpose. It has become more and more evident in recent years that this multiplicity of formulas was really only a large number of variations on combinations of a few basic chemicals. The only function of a negative developer is to reduce the exposed grains of silver halide to a metallic silver image, and these hundreds of formulas merely represent many different ways of arriving at the identical end result. If a developer is chosen according to purpose and format, it is obvious that one or two developers for miniature films, a couple for roll films, and two or three for sheet films are all that is really necessary—the remainder merely make for confusion.

On the other hand, there is ample justification for a variety of developers for black and white papers. Variation in formula in the case of papers *can* have the effect of producing a variety of effects, mostly connected with the image tone or color of the silver deposit. On the other hand, paper emulsions always

develop to maximum contrast and there is almost no way in which variation of a developer formula can change the contrast of the final image.

Nonetheless, the number of useful formulas is still limited, and furthermore, there are few photographers today who will waste the time required to mix a developer from its basic ingredients. Many of them merely buy the packaged versions of the same developers—thus the familiar Kodak D-76 Developer is available in packaged form, and all that is required is to mix it with water. Many other numbered formulas are likewise available in ready mixed form. In addition, all the major manufacturers have trademarked developers for which the formulas are not available; examples are GAF's Hyfinol, Kodak's Polydol and Microdol-X, Agfa's Rodinal, and Dupont's 16-D.

Some photographers prefer to use packaged developers made by firms which do not manufacture films, and certain of these products are very popular indeed. For this reason, we have chosen a representative selection of such packaged developers and have given practically complete instructions for their use in this section.

One thing which the reader will find absent in this section is the subject of gamma and contrast index. The reasons for this significant omission are given below, under the appropriate heading.

Corresponding to the section on Black and White Processing is the following section on Color Processing; here, however, no formulas are given since none are available. Instead, we show, in highly condensed form, the recommended procedure for processing those color films and color printing materials, in the appropriate kits supplied by the respective manufacturer. This is necessitated by the fact that color films are still the subjects of patents. Since no two of them can be alike, it follows that each color film or printing medium can be processed only in its appropriate developers. Attempts at processing a color film of one manufacturer in the formulas of another will result only in total failure, and for this reason, no general procedures can be given at this time. With the instructions for the processing of color printing materials will be found some general data on the making of color prints, by reversal from transparency materials, and by straight printing from color negatives. Such processes as trichrome carbro, wash-off relief, etc. are substantially obsolete, and there is no good reason to include such material in an up-to-date manual; all of these antiquated processes are therefore omitted.

Up to this point, the book has been devoted to products and how to use them. The remaining three sections differ in that they contain more general information, useful to photographers in their work, but not necessarily referring to any specific product.

The section on Motion Pictures and Slides covers mainly the mechanical details, often needed and somehow difficult to find when needed. The size and shapes of the actual film formats – image areas, as photographed and projected, for 8mm, Super 8, 16mm, and 35mm, as well as for 2 x 2 and full size slides, are given followed by projection tables for all these different formats. Data on screens and their use, audience arrangements, etc. are given. There is a special discussion on standards for single frame filmstrips; these are widely used in education and industry.

The section on Optics contains, as might be expected, the usual tables and formulas for the use of lenses, calculation of relative aperture and effective aperture, and the use of supplementary lenses for closeup work. However, this section is entirely new in one respect: it contains a discussion of elementary lens design, which leads into lens aberrations, their evaluation and relative

importance. There is a short discussion of computer-designed lenses and the significance of computer design to the working photographer. Reference is made to resolving power, the newer concept of acutance, and methods of lens testing.

The following section is a general data section, containing information which is less directly related to photography, but of considerable value to the working photographer. This includes tables of weights and measures, metric conversions, thermometer scales, specific gravities, and other general information.

Photographic tables in this section include several for flashlamp exposures, a table of film speed conversions, and others. General discussions are included covering such matters as reflected-light, incident-light, and spot-type exposure meters, and the special problem of the built-in exposure meter. There are also tables of filters, darkroom safelights, color temperatures of light sources, and other useful information.

The following section is one on Graphic Arts Materials; like the sections on black-and-white, color, and motion-picture films, it is largely composed of data pages for the particular types of films and papers used in the photomechanical trades. The purpose of this, however, is not to supply data for the use of engravers and lithographers; the presence of this section recognizes that the creative photographer, in his search for exotic effects, often makes use of materials not originally intended for general photography. Therefore, the materials listed, and the data supplied for them, are those which the general photographer would find most useful, and information on their use in photomechanical fields (such as, for instance, exposures through halftone screens) is kept to the minimum.

This section concludes with some directions for the carrying out of procedures having considerable creative potential; equidensity production with Agfacontour film, the making of Tone-Line positives, and the use of color proofing materials for special types of prints, are covered at some length.

The final section of the book is a general alphabetical index, covering the entire contents of the volume. This is a big thing, and would be bigger if we cross-indexed in the manner of many other books. The size and bulk of this index is kept to the minimum by indexing each item only once, as far as possible—that is, for example, a single listing for "Films, black-and-white:" followed by all black-and-white films in alphabetic order. No separate indexing is used for the individual films, otherwise; this would not only hugely increase the bulk of the index, it would actually make things harder to find. The book having also been repaged consecutively, no further section references are required, and there are no longer any sectional indexes.

Gamma And Contrast Index

For many years, a great deal of emphasis was placed on gamma as a measure of development contrast, and some of the discussion of the subject tended to generate more heat than light. Photographers tended to use gamma in many incorrect ways; often as a measure of negative contrast, or in various attempts to relate the subject contrast, negative contrast, and paper exposure scale into one homogeneous "system". Many such systems have been proposed, few have survived.

The reasons for the failure of these various systems are various, and we should like to clear up the numerous misconceptions which led to some proposals, as well as to evaluate those which show some promise. We cannot, in the limited space available here, explain the fundamentals of sensitometry or do any more than to define gamma as "the slope of the straight line portion (correct exposure portion) of the characteristic curve." For further explanation

of this definition, the reader is referred to any good basic textbook on photography. The following discussion is aimed at the advanced photographer who has some grasp of sensitometry, and who is curious to know why the whole subject of gamma has been de-emphasized in this book.

In general, the entire problem of tone reproduction in the black-and-white photograph is simply an attempt to reproduce the entire scale of brightnesses in the original subject as a series of tones from white, through various grays, to black, on a piece of photographic paper. In the early days of photography, this ideal was attained, if at all, more by accident than by design.

With the introduction of the electronic exposure meter in the 1930s, means became available by which the average photographer could easily measure the brightnesses of the various elements of a given scene. It was found that there was a wide variation in range in given scenes—some having very bright highlight areas and deep blacks in shadow, could have a scale of 100 to 1 in terms of measured brightness. More normal scenes ran about 30 to 1, and some "flat" scenes ran as little as 10 to 1 in brightness range.

Most negative films used in black-and-white photography are easily capable of accommodating subject matter with a 100:1 brightness range. The problem is in getting this range of tones onto the printing paper.

So-called "Normal" or No. 2 papers have a Scale Index of 1.30 which implies a 20:1 exposure range. Extra Soft, or No. 0 papers have a Scale Index of about 1.70, which corresponds to a range of about 50:1; likewise "Extra Hard" or No. 5 papers have a Scale Index of 0.70 or about 5:1.

Some papers, made mainly for amateur photographers, are available in the full range of 6 exposure scale values from No. 0 to No. 5. On the other hand, the papers made for professional use, portrait photography, etc. are often available in a single grade only, generally No. 2 with a scale of no more than 20:1. Obviously, those intending to print their negatives on the latter types of paper are required to make all their negatives to a single range of transmissions, in which the lightest part of the negative transmits no more than 20 times the light which passes through the densest part.

In portrait photography, this is easy enough—the subject can be illuminated by separate light units in such a manner as to establish almost any density range desired in the final negative. In outdoor work, and in other areas where there is little or no control over the illumination or subject matter, the problem is different—another means must be found to control the printing range of the negative.

It was, then, in the 1930s, that certain advanced photographers began to investigate the matter of contrast control in negative processing to better fit the negative to the printing paper. Now, since "gamma" is defined as the slope of the straightline portion of the characteristic curve of the film, it appeared that gamma would be a useful measure of the relation between subject brightness and negative transmission—that is, it would be possible to fit the negative of any reasonable subject matter to any given paper, with mathematical precision, by proper control of negative development.

As an example (and a highly simplified one): it was believed that if a negative were developed to a gamma of 1.0, then the scale of the subject would be exactly reproduced in the negative—that is, a subject having 30:1 brightness range would result in a negative having, likewise a 30:1 scale. Thus, it was said, all you had to do, if you had a 30:1 scene and wanted to print the negative on a 20:1 paper, would be to develop the negative to a gamma of 0.66, and the job would be done.

The system is deceptively simple and speciously logical. In point of fact, it did work to some extent, simply because any system works better than no system at all. In the motion picture industry, where strict control of negative gamma had been enforced for some time because of the problems associated with photographic sound tracks, the photographers found that they could, indeed, measure the various brightnesses in the scene, adjust them with lighting, reflectors, or screens, and predict fairly well the appearance of the final screen image.

But the motion picture industry had both the sensitometric equipment and know-how to measure gamma precisely, and the automated developing equipment to maintain a desired gamma within narrow limits from day to day. This point was overlooked by the mass of still photographers who tried in various ways to adopt gamma control in their daily work. These latter tried to control their development in various free-hand ways, without measuring equipment; they demanded of the film manufacturer (and of the publishers of various data books) that information be provided as to the exact gammas obtainable with various film and developer combinations, at various processing times. Such information was duly provided, with appropriate disclaimers for the inevitable inaccuracies; it was used, unfortunately, by many photographers uncritically and without regard for the exceptions which had been duly pointed out.

Let us look at some of the reasons why the system of predicting the final print from the brightness range of the original and the negative gamma, did not work.

To begin with, the fact that a given subject may have a brightness range of, say 30:1 does not mean that the image at the film plane of the camera will have the same range; in point of fact it seldom if ever does. The problem is that a certain amount of light is scattered by the glasses of the lens; furthermore, some of the excess image which spills over the film and strikes the walls of the camera is reflected in random directions and some of this light ends up on the surface of the film. This effect is summed up under the name of "camera flare" and can be very serious indeed.

It takes only a very small amount of flare light to degrade the contrast of an image quite seriously. As an example, let us take a typical subject—arbitrarily, let us say that the shadows are receiving one unit of light, the highlights 30 units. That is, the subject has a brightness range of 30:1. But suppose that as a result of internal reflections in lens and camera, 1 unit of light is added, uniformly over the entire image. The result of adding 1 unit of light over the image is to increase the shadow illumination: $1 + 1 = 2$. Likewise adding 1 unit of light to the highlight, we have $30 + 1 = 31$. But now, our image instead of having a range of 1:30 has a range of 2:31 or only 1:15½. In short only 1 unit of flare light has cut the contrast of the image almost in half!

So, then, if we assumed a subject brightness range of 30:1 and developed the negative to a gamma of .66, to fit it to a 20:1 paper, we would find our negative actually has a range of a bit more than 10:1. It would be far too flat for printing on this paper, and in fact, we should have developed it to a gamma of a bit more than 1.3 to make it print properly on a Number 2 paper. This is, admittedly, an extreme case, but one which occurred often enough in practice to cast some doubt on the validity of the whole method. The only reason the situation was not even worse than this was that there were two other sources of error, and they tended in some cases to cancel each other.

One source of error, and probably the biggest, was simply that the average photographer did not really know what gamma he was developing to. True, he

did have various complicated charts, diagrams, etc. all of which purported to tell him that if he developed Brand X film in Brand Y developer for 7 minutes at 68 F, his negative would have exactly .65 gamma.

Actually, it was nearly certain that no matter how carefully he followed these directions, he would get some other gamma, and the error was likely to be a very large one. First of all, gamma is very sensitive to the conditions of development; variations in agitation alone can account for large differences in the contrast of the final negative. Then, too, the temperature control of an ordinary developer tank in the average darkroom is a pretty freehand sort of thing, nor can most low priced thermometers be depended on for accuracy much better than ±2 or 3 degrees. Then, too, there are variations in development rate from one batch of film to another, while chemical mixing, the alkalinity of the water used, and other factors all have their influences.

All things considered, even with the big, thermostatically controlled developing machines used in the motion picture industry, a gamma specification of .65 means only that the negative is likely to be developed somewhere between .63 and .67—in short the second decimal place is quite uncertain. Without such advanced equipment, it is doubtful that gamma .70 is likely to mean much more than a range of from .6 to .8 and such variation is sufficient to make the whole subject of negative control by variation of gamma meaningless.

One more point, commonly overlooked but of great importance, is that the term "gamma" means only the slope of the straightline portion of the characteristic curve. In earlier photography, exposures were commonly kept quite full to secure ample shadow detail, and the films of that period had rather short toe sections anyway. Today's films, on the contrary, usually have a long, sweeping toe; in addition, the photographer is encouraged to keep his exposure to the minimum to avoid graininess. This results in a large part of the image tones being recorded on the toe of the curve, where gamma is meaningless.

Recently, a new concept, that of "Contrast Index", has been introduced to provide a means of measuring the range of an image when it had been exposed using a large part of the toe of the characteristic curve. While thi. concept is a useful one, and certainly does give a better picture of the effective contrast of given negatives, it is not, apparently, any more controllable by normal darkroom procedures than is gamma.

Some eminent photographic teachers have been espousing a system in which the brightness range of the subject is expressed in terms of a few discrete steps of brightness; the student is then expected to run tests with his own camera, exposure meter and processing equipment, to determine a few developing times which will compensate for subjects differing by one, two or three steps in overall scale. Inasmuch as this system depends on individual calibration of equipment and method, it is workable—it automatically compensates for camera flare, thermometer errors, variations in agitation, etc. The concept of gamma or Contrast Index does not even enter into this system, and it thus avoids the pitfall of attempting to control with mathematical exactness a process which is far from exact.

However, there is some doubt as to whether even this simplified method of negative control is either necessary or desirable. While all this experimenting has been going on, two major changes have taken place in photography, and these seem to have eliminated both the need for and the possibility of exact negative control.

Take possibility first. All systems of matching negative to subject and paper obviously depend upon being able to develop each negative individually,