Color Photography

A WORKING MANUAL

Henry Horenstein

Author of the classic *Black & White Photography*

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Henry Horenstein
with Russell Hart
Drawings by Tom Briggs

LITTLE, BROWN AND COMPANY
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A Pond Press Book

First Edition
Fourth Printing, 1999

Library of Congress-in-Publication Data
Horenstein, Henry.
Color photography : a working manual/by Henry Horenstein.
p. cm.
Includes bibliographical references and index.
ISBN 0-316-37317-6 (hc) — ISBN 0-316-37316-8 (pb)
1. Color photography — Handbooks, manuals, etc. I. Title.
778.6 — dc20 93-21445

PRINTED IN THE UNITED STATES OF AMERICA

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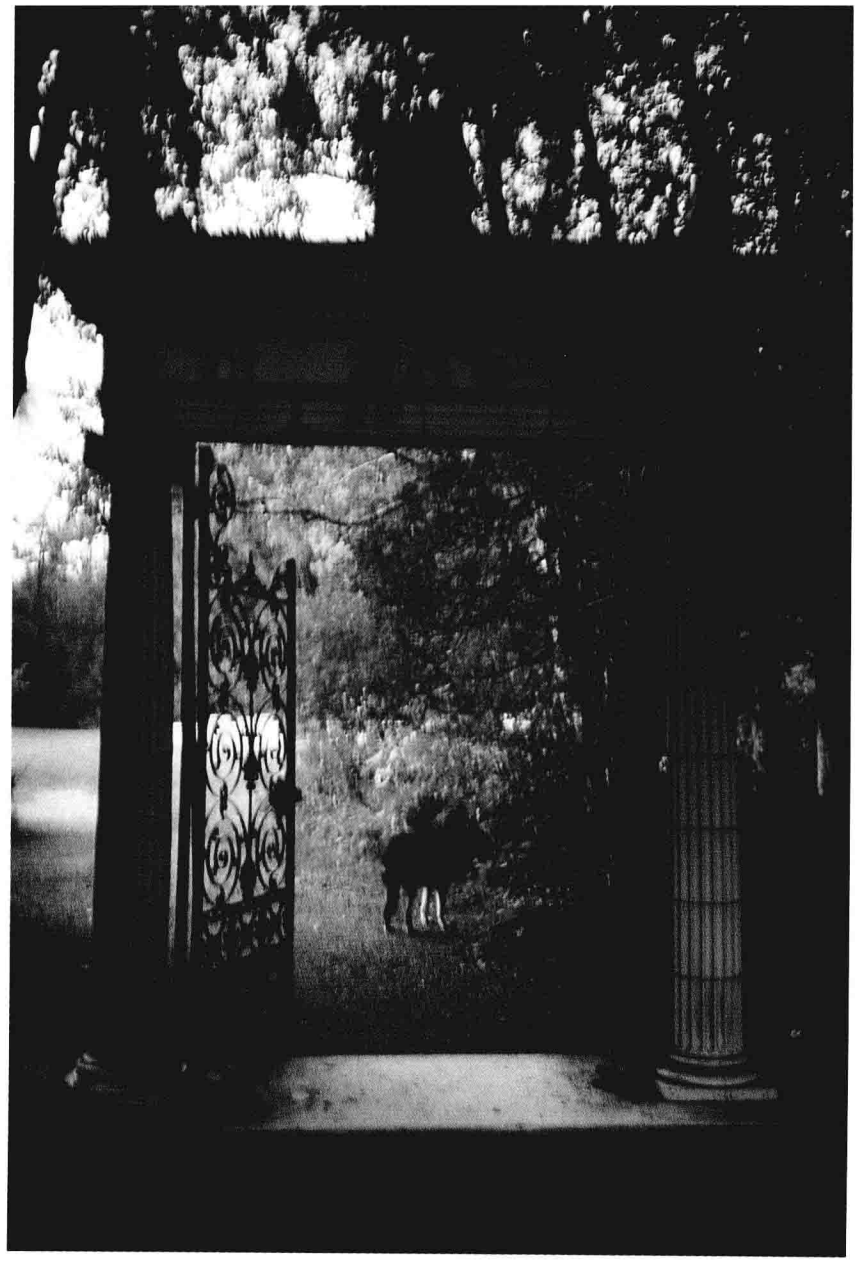
This book is for Paul Krot.

Ellie Hollinshead, *Jenny at Yaddo.*

Good color photographs aren't always that colorful. This shot was made on a sunny day, but the subject was in the shade, and the resulting colors are low in contrast and almost monochromatic. "I originally wanted to capture the timelessness of the setting," says Hollinshead, a painter by trade. "As I set up the camera, Jenny walked into perfect position below the archway, and that's what made the picture work."



Introduction

Since the great majority of photographs are taken in color these days, it may seem odd to devote an entire book to the subject. Why not simply write a book called *Photography,* featuring mostly color illustrations and focusing on color processes, and leave it at that? Although this reasoning has a good deal of logic, there are in fact many good reasons to make a distinction. While almost all occasional amateur photographers do shoot color, many professionals and fine-art photographers as well as "serious amateurs" (including students and hobbyists) shoot mostly in black and white. And many of these photographers are "colorphobic"—reluctant to work in color or even intimidated by it.

Photography programs in schools and other institutions almost always begin by teaching black-and-white technique. Color is usually treated as a next step, rather than a beginning. As such, there is a need for a color text to guide more advanced students (although this book was written so that anyone with even a rudimentary knowledge of camera and darkroom controls would have no trouble understanding it).

The truth is that color photography is no harder to master than black-and-white photography. Some would say it's easier. Color photography does require some different skills and information, but the fine quality of current films and papers and the high degree of reliable automation provided by modern camera and lab equipment make good color photographs much easier to produce today than they were a few short years ago.

No doubt color photography is a complex subject. After all, it took some of the best scientific minds in the world some 100 years to invent a practical color system. But because you don't need to be one of those scientists to practice this system, I decided to provide a practical manual for the working photographer—something that would lay out the options and controls available to him or her and show what some fine photographers have produced with widely available equipment and the same set of

skills. This book's emphasis, then, is on making better color photographs—not on theory or criticism. As such, it's a logical follow-up to my previous texts, *Black and White Photography: A Basic Manual* and *Beyond Basic Photography: A Technical Manual.*

While this book provides much useful information, keep in mind that good photographers often break as many rules as they observe. Follow the text and try to understand the logic behind the technique, but don't be afraid to take a chance now and then and do things differently.

Color Photography: A Working Manual represents a combined effort by many people over several years, including some fine photographers, teachers, and editors. Russell Hart was my chief collaborator, technically and conceptually. He was responsible for much of the basic research, as well as text accuracy and photo selection. Jim Dow and Lorie Novak also made major contributions in shaping the book, as did Jerry Vezzuso. Readers along the way included John Auer (Agfa Corporation), Valorie Fisher, Allen Hess, Bob Hower, Kim Mosley, Jack Naylor, Elaine O'Neil, Andrea Raynor, James M. Reilly, John Reuter, Monona Rossol, and Jacquie Strasburger. Also making significant efforts were Steve Brettler of E. Phillip Levine Company; John Lane and Rich Ferrari at Polaroid Corporation; Rowena Otremba, Mary Osgood, Tom Warhol, and Brian Jacobson at Zona Photo Labs; Steve Tyminski, Wendy Erickson, and Joanne M. Kirwin at Ilford; and Joe Runde and the Marketing Technical Support Organization at Eastman Kodak.

Tom Briggs of Theurer Design produced his usual stylish and accurate illustrations. Julie Mihaly was the original and primary photography editor. Contributing technical and other research were Alexandra Foley and Richard Maurer. Tracy Hill was instrumental in guiding the book through its myriad stages, as was Megan Doyle.

Janis Owens created the elegant and accessible design. Barbara Jatkola copyedited; Cheryl Brooks provided the index; and Christina Eckerson handled production.

Among the others who helped along the way: Lindley Boegehold, Janet Bush, Bobbi Carrey, Barbara Hitchcock and Nasarian Rohani of Polaroid Corporation, Ellie Hollinshead, Jack and Penny Lueders-Booth, Sylvia Wolf, Janet Zweig, and, of course, all the photographers who allowed me to use their photographs and comments.

I especially want to thank Dick McDonough for having the vision to sign up the book and Mary Tondorf-Dick for her endless patience and encouragement in seeing it through.

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CHAPTER ONE

Origins of Color Photography

The first practical systems of photography were introduced in 1839 with Louis Daguerre's daguerreotype from France and William Henry Fox Talbot's calotype from England. Although these inventions caused a great sensation, there remained a lingering sense of frustration. The first photographs were colored, but they lacked a range of color. They rendered subjects monochromatically, in tones of a single color.

Many of the early pioneers, including Daguerre and Talbot, worked actively on this problem, and some had a measure of success. As early as 1840, the Englishman John Herschel reportedly produced a primitive color image based on the interference principle (see pages 5–6). Around 1850, Frenchmen Edmond Bequerel and C. F. A. Nièpce de St. Victor (whose uncle had made what is generally credited as the first photographic image in 1826) and American Levi L. Hill all reportedly produced color photographs. However, none of these early efforts could be fixed reliably, and the images faded shortly after they were made.

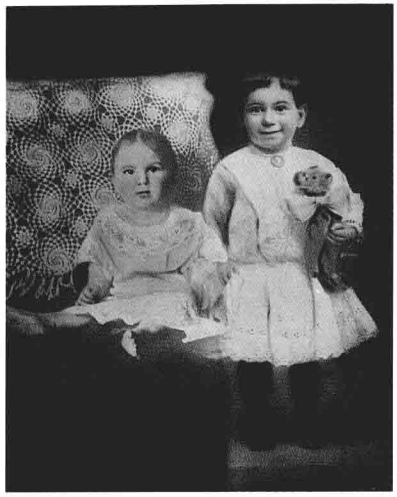
In early photographs color was applied by hand.

Photographers took to adding color to the surface of photographs with pigments, oils, watercolors, and other substances. Examples of this technique date from the very beginning of the medium, and it remained the most popular method of producing color photographs for about 100 years.

Some processes were more suited to hand-coloring than others. Coloring a daguerreotype, for example, required great care and ingenuity because the surface was fragile and smooth. Coloring a paper print, such as a salt or an albumen print, was much easier. Many photographic portrait studios hired colorists, who were often miniature painters—a craft that was being eliminated by photography, which was cheaper and more realistic and required less sitting time.

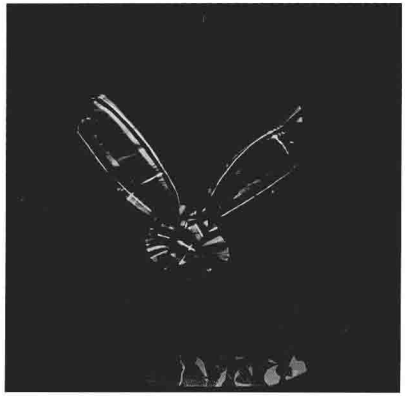
(Opposite)
John Jabez Edwin Mayall, *Portrait of Caroline Greg.*

The fragile quality and nonabsorbent shiny surface of daguerreotypes made them difficult to color. This portrait, taken about 1850, is fully colored; with most daguerreotypes, if color was applied at all, it was in small areas to accent portions of the image.
George Eastman House.



Anonymous, *Sarah and Marcia.*

Applied color remained the most common method for creating color in photographs into the twentieth century. This 1915 portrait was so heavily colored that the original photograph was almost covered.



James Clerk Maxwell, *Tartan Ribbon.*

This re-creation of Maxwell's historic demonstration of additive color was produced with three different black-and-white separation negatives, each shot through a different color filter (blue, green, and red). Cavendish Laboratory, University of Cambridge.

Coloring styles varied widely. Some colorists treated the image faintly—for example, a mild tinting of the cheeks. Others emphasized specific items of clothing, jewelry, or facial features. Some used transparent watercolors; others opted for heavy oils to cover the original image completely.

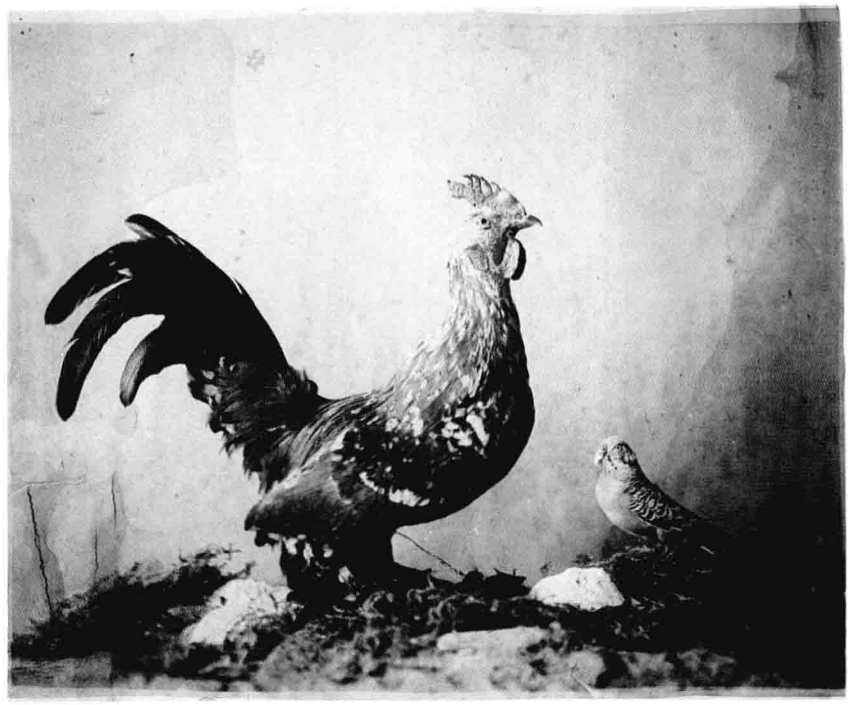
While hand-coloring thrived, the search for a true color photography process continued. One of the most important contributions came before photography was even invented. In 1802, the celebrated British physicist and mathematician Thomas Young suggested that color vision was produced by receptors in the eye responding to various proportions of three colors: blue, green, and red.

In 1861 James Clerk Maxwell, a Scottish physicist, demonstrated Young's theories by photographic means. He made three separate black-and-white negatives of a tartan ribbon. Each "separation" negative was shot through a different color filter. For filters, Maxwell used three glass containers filled with blue, green, and red liquids. He made positive transparencies from each negative and projected each transparency through the same filter with which the original negative had been exposed. When the three images were superimposed, they re-created the original colors of the tartan ribbon.

Maxwell's method of creating color was based on *additive* principles—mixing proportions of blue, green, and red light—and became the basis for the earliest successful systems of color photography. Most current systems use *subtractive* principles, by which color can be created by mixing various amounts of cyan, magenta, and yellow, known as the subtractive primaries. (See Appendix 1 for more on additive and subtractive color principles.)

Subtractive color formation was originally proposed by Louis Ducos du Hauron and fellow Frenchman Charles Cros, who worked independently of each other but announced their findings at about the same time in the late 1860s. Whereas Ducos du Hauron concentrated on practical applications, Cros focused primarily on theory.

Like Maxwell, Ducos du Hauron made three separate exposures on different pieces of black-and-white film through blue, green, and red filters. He made positives from these, then stripped off the positive emulsion and applied pigments to them using gelatin coatings. For the pigments, Ducos du Hauron used the complements of the filters through which he had shot the negatives. For the negatives made through exposure to the blue filter, he applied yellow pigment; for



Louis Ducos du Hauron, *Rooster and Parrot.*

Du Hauron's main photographic contribution was in demonstrating how color could be created by subtractive means, mixing cyan, magenta, and yellow dyes, as in this 1879 still life. Although additive principles were used to make most of the successful early color photographs, subtractive methods eventually prevailed. Virtually all color materials today are based on subtractive principles. George Eastman House.

green he applied magenta; and for red he applied cyan. The gelatin absorbed the pigment of each in proportion to the density of the negative.

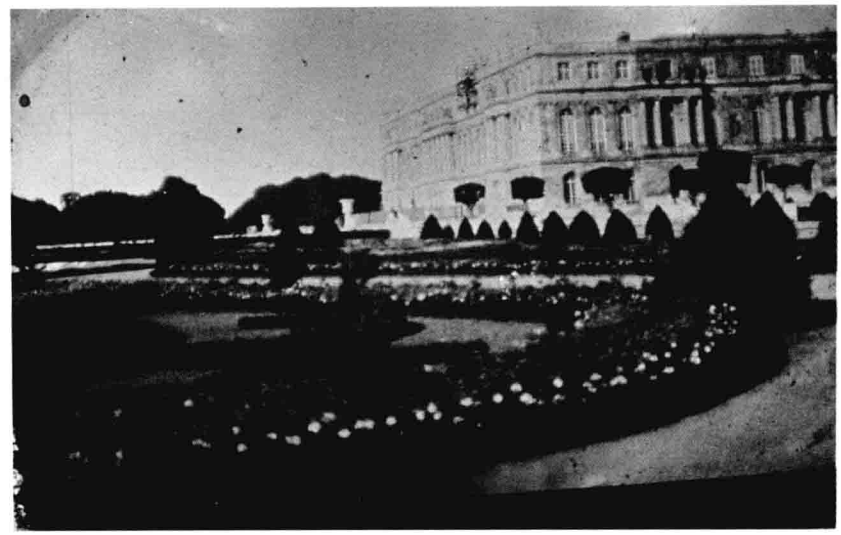
Ducos du Hauron thus produced the first examples of color photographs created by subtractive means. His methods were highly influential and spawned many important color processes over the years, including carbro, dye transfer, and Fresson.

Early subtractive processes were impractical.

Unfortunately, early subtractive color processes were clumsy and slow. They required photographing the same subject three times on three separate plates. Exposure often took many minutes, due to the density of the filters and the slow emulsions of the period, which made photographing live subjects virtually impossible.

Not all early color photography research concentrated on additive and subtractive principles. Some of the most promising work was based on interference principles, which produced color through the chemical response of a silver chloride emulsion to reflected light waves, much the same way color is produced on oil slicks or in mother-of-pearl when viewed at a certain angle.

A French physicist and Nobel Prize winner, Gabriel Lippmann, came close to success with his interference efforts. The process he



Gabriel Lippmann, *View of Versailles.*

Lippmann created highly accurate color photographs using the interference principle, which involved reflected light waves. His efforts were promising, but the results could not be adequately fixed and were difficult to view. This 1900 landscape is one of a very few remaining examples. George Eastman House.

introduced in 1891 produced remarkably natural colors, but he was not able to solve many of the problems that had plagued earlier interference experiments, including long exposures and awkward viewing methods.

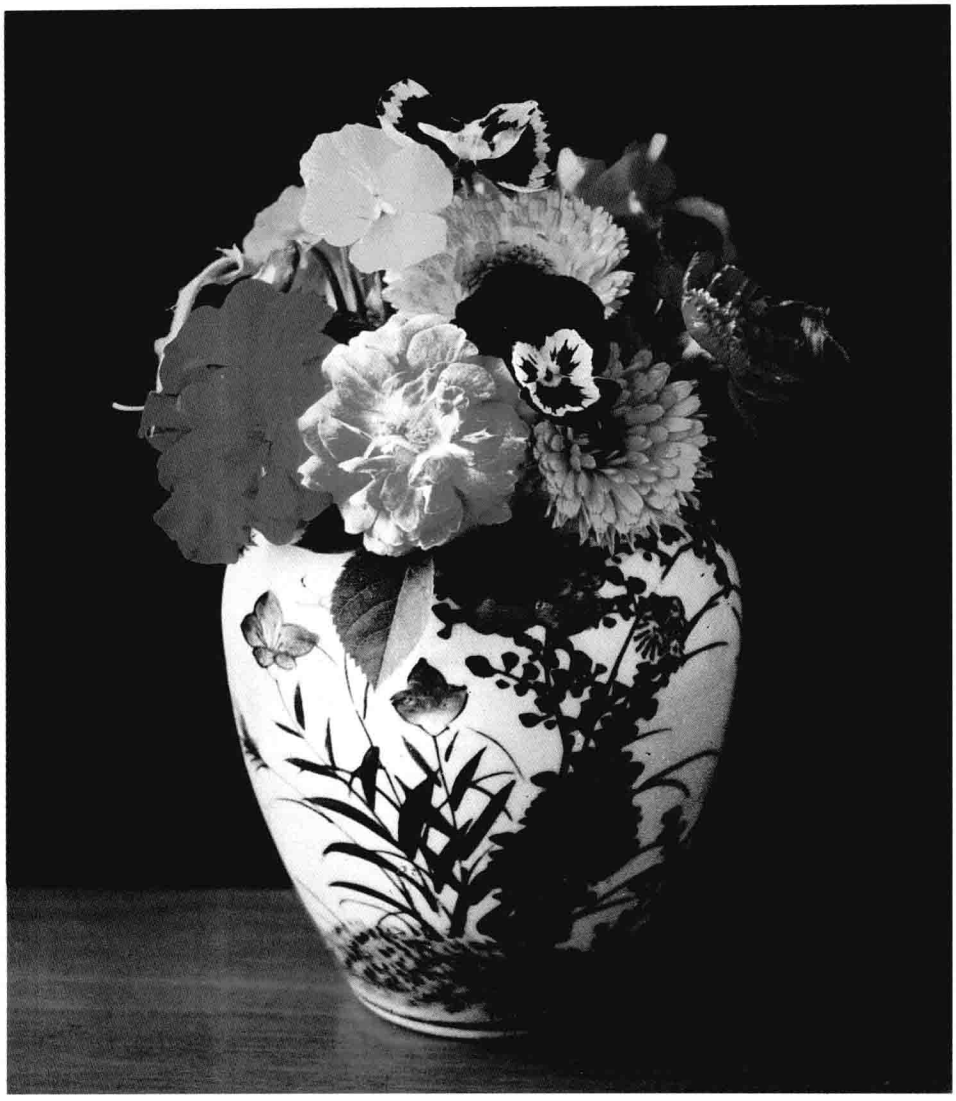
Meanwhile, research in additive color continued with inventions from Frederick Ives, an American printer, beginning in 1892. Ives produced color separations with light entering a camera and bouncing off various reflective surfaces into three separate channels through either a blue, green, or red filter. He later introduced the Kromskop for viewing color stereo images and the Projection Kromskop for color lantern slides.

(Opposite)
Frederic Eugene Ives, *Flowers in Vase.*

Ives was an important figure in the history of color photography, contributing a three-color additive process as well as research in subtractive color that helped lead to the development of Kodachrome. This 1896 still life was created with three positives made from separation negatives, one each taken through a blue, green, and red filter. The positives were superimposed and viewed together through a stereo viewer. (The original was a stereo image.) George Eastman House.

The Ives color process required the use of an ingenious but bulky and awkward camera. Nevertheless, versions of his process (variously called the three-color or color-separation process) remained in use well into the twentieth century, primarily because they were well suited for making photoengravings. A last notable refinement, the Devin One-Shot, was introduced as late as the 1940s.

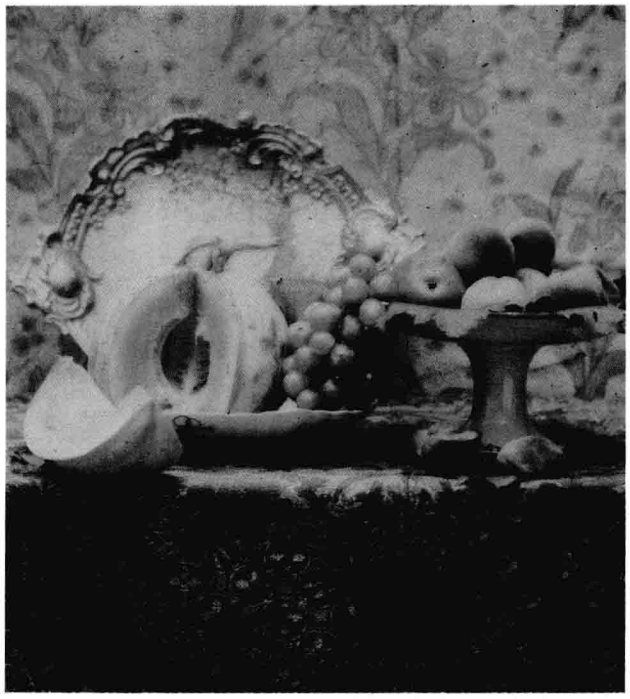
Additive screen plate processes represented the next generation of color photography. The first breakthrough came in 1893 when John Joly, an Irishman, introduced a system that exposed a single plate of black-and-white film through a "taking screen" of microscopic lines of blue, green, and red dyes. The resulting black-and-white negative was printed onto another plate to produce a positive sheet of film. The positive reproduced the color of the original subject when seen

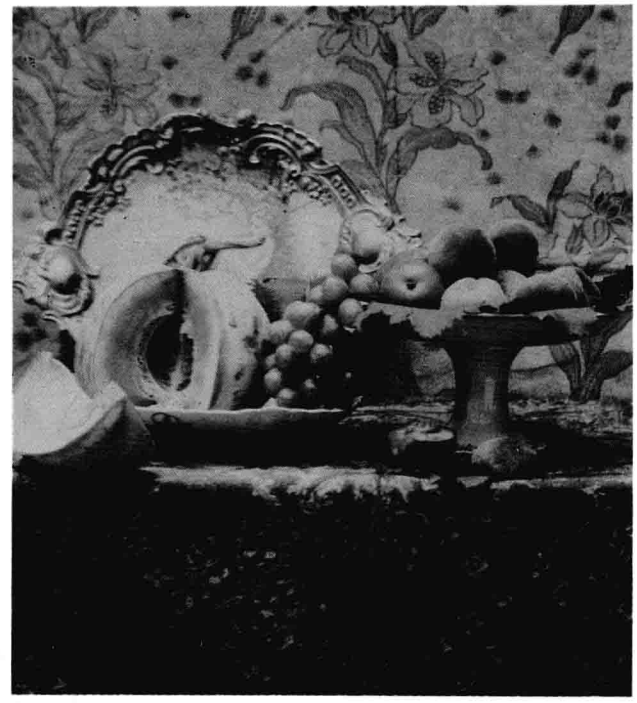


Blue Filter

Green Filter

Red Filter





Auguste and Louis Jean Lumière, *Still Life of Fruit.*

The Lumière Brothers were innovators in color photography, experimenting with many different processes before introducing Autochrome, the first commercially viable color process. This stereo image from about 1899 was created using gum bichromate, which was popular with fine-art photographers around the turn of the century. The color was applied by hand using individual layers of an emulsion consisting of gum arabic, potassium bichromate, and colored pigment. George Eastman House.

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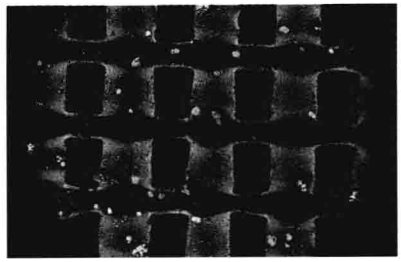

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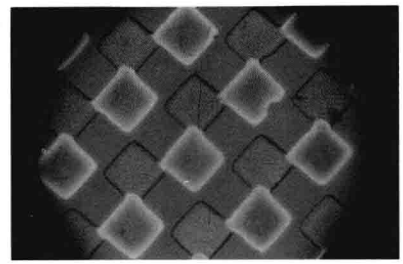

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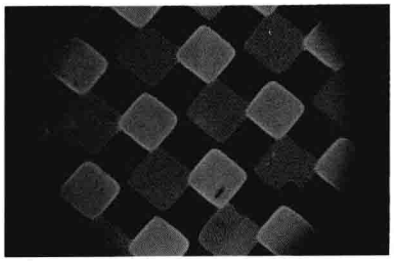

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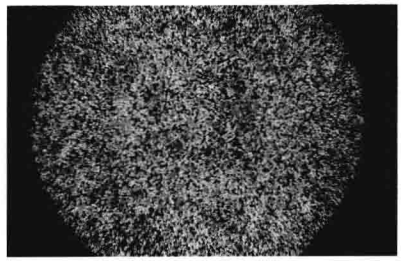

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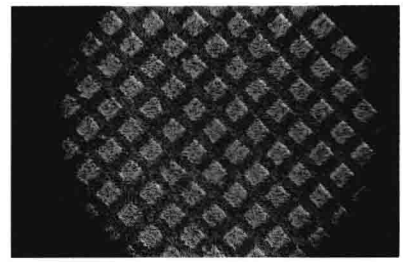

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Autochrome was the first and best known commercial additive screen system. However, several manufacturers later introduced their own additive screen materials. The screen patterns from different manufacturers, six of which are illustrated here, varied widely from regular to random. (1) Autochrome (1907) (2) Omnicolor (1909) (3) Paget (1913) (4) Finlay Color (1929) (5) Agfacolor Ultra (1934) (6) Dufaycolor (1935)
R. C. Smith, *The Illustrated History of Color Photography* by Jack Coote, Fountain Press (England).

The first successful color product, Autochrome, used a screen built into the film to create color.

through a "viewing screen" that lined up with the original taking screen.

Like so many early color methods, Joly's screen process was awkward and slow. Also, the color was poor, and the image was often out of register; it was difficult to line up the taking and viewing screens with precision.

Still, the Joly process was widely imitated and improved upon, most notably by the Lumière brothers, Frenchmen well-known for their innovations in motion pictures. In 1907, they introduced Autochrome, a one-plate additive process that eliminated the need for separate taking and viewing screens.

Autochrome is generally considered the first commercially successful color process. It used different-colored starch grains to filter light, but the construction of the color filters was a limiting factor. Spreading the grains evenly over the film surface was a problem, causing grains of like colors to clump together. Even though the grains were extremely small, about 4 million to the square inch, Autochromes often displayed random blotches of blue, green, and red.

Also, the filters sometimes overlapped, with reds merging into greens and greens into blues. The effect diluted the quality of the

Charles C. Zoller, *Child and Nurse.*

Autochrome was the first widely used color photography process. Its characteristics included muted colors and a pointillist texture resulting from the random patterns of starched grains that helped create the color. Zoller, who was based in Rochester, New York, was one of Autochrome's most prolific practitioners, producing thousands of images, including this one taken in 1920. George Eastman House.