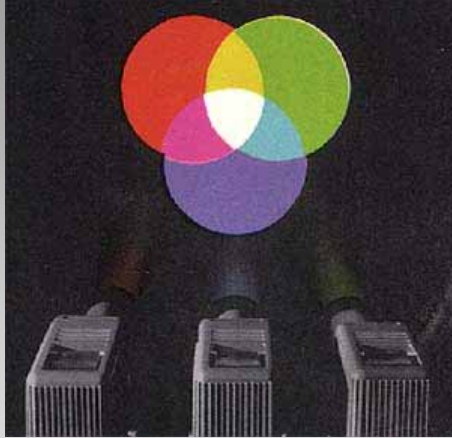
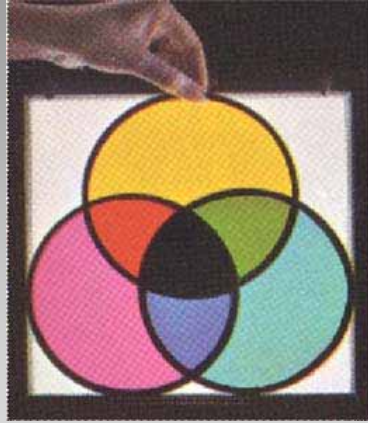


Systems for rendering color

Additive



Subtractive



Main processes for color photography

Additive

- Screen filter

Subtractive

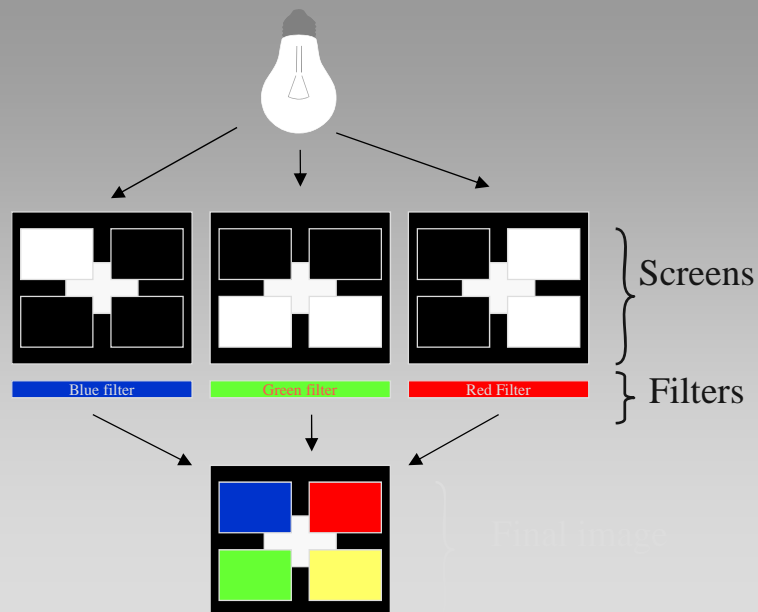
- Assembly
- Dye imbibition
- Chromogenic
- Silver dye bleach
- Dye diffusion transfer

Screen Filter Processes

- Joly 1895
- MCDonough 1897
- Dufay 1905 (Dioptichrome), Autochrome 1907
- Ominicolor 1907
- 1908 Dufaycolor
- Paget 1913
- Agfa color 1916
- Finlay 1929
- Lumiere Filmcolor 1929
- Dufaycolor Motion Picture Film 1935

Additive Screen Filter Processes

Additive Color in Principle





Untitled, John Joly, Screen Plate Process, 1893. *The Art of Color Photography*, John Hedgecoe, 1978, page 253.



Unidentified photographer, John Joly, Screen Plate Process, circa 1893. GEH Collection.



McDonough's additive screen and photograph

The early additive photograph, left, was taken by an American, James McDonough, in 1894, using the regular ruled screen shown $\times 50$, below. In the original picture, the tomatoes were orange-red; but the screen has shifted and this color cannot be reproduced.



James McDonough, screen filter photograph, 1894. *The Book of Color Photography*, Adrian Bailey and Adrian Holloway, 1982, page 20.



Unidentified Photographer, James McDonough, screen filter photograph, circa 1894. GEH Collection.



Unidentified Photographer, James McDonough, screen filter photograph, detail, circa 1894. GEH Collection.



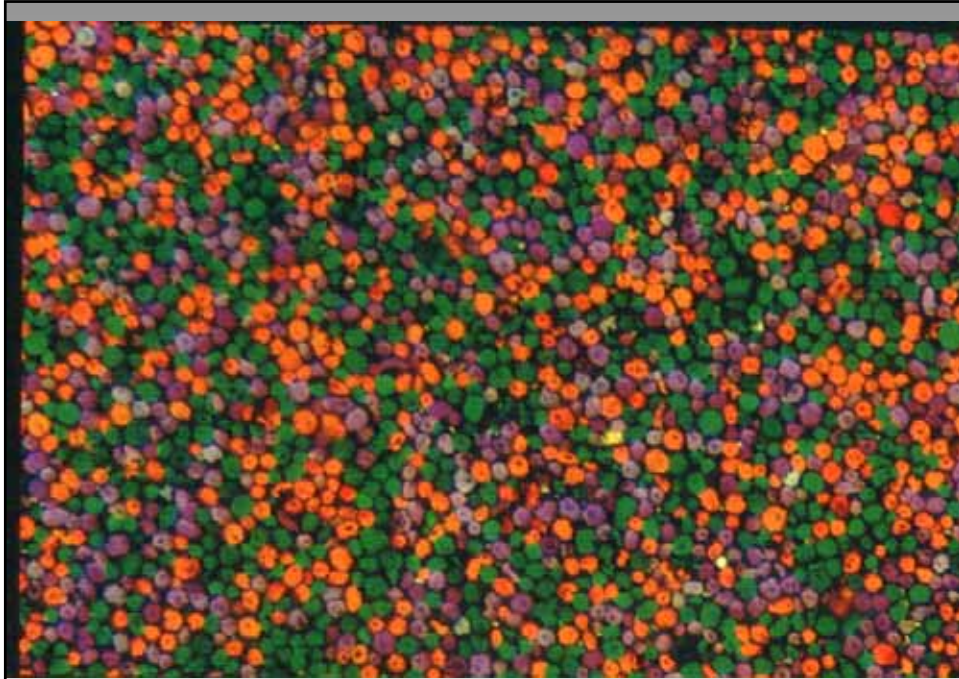
Louis and Auguste Lumiere, Inventors of the Autochrome plate. *Color Photography with the Miniature Camera*, Luis Marden, 1934, page 2.



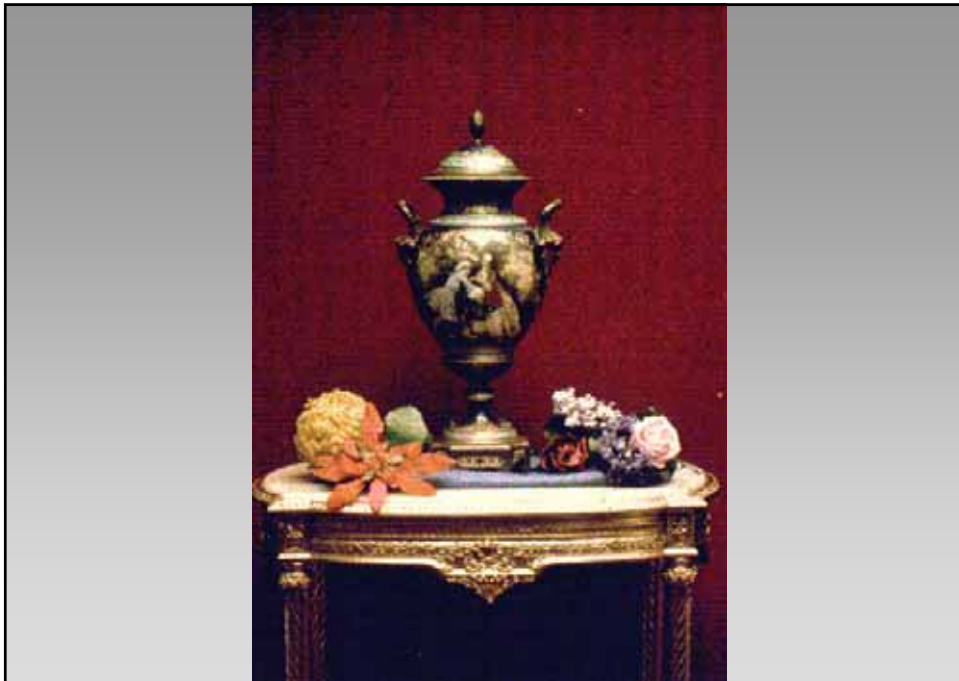
Still Life with Fish, Auguste and Louis Lumiere, 1905. *The Art of the Autochrome The Birth of Color Photography*, John Wood, 1993, page 93.



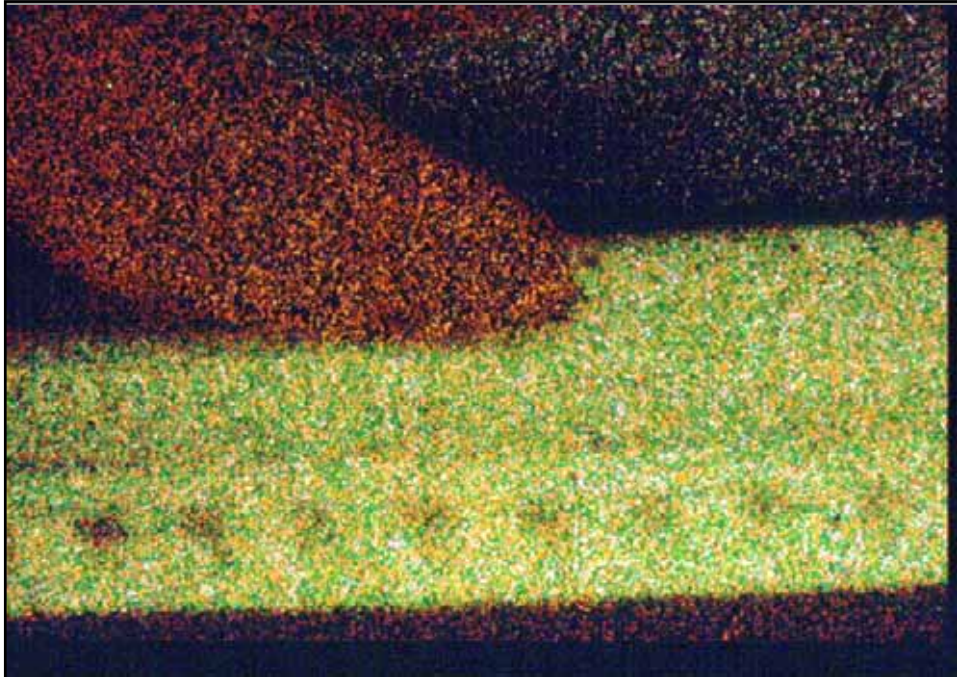
Charles Zoller, Autochrome, ca. 1907. GEH Collection



Charles Zoller, Autochrome, 1907. GEH Collection



Unidentified photographer, Autochrome, ca. 1907. GEH Collection



Unidentified photographer, Autochrome (detail), ca. 1907. GEH Collection



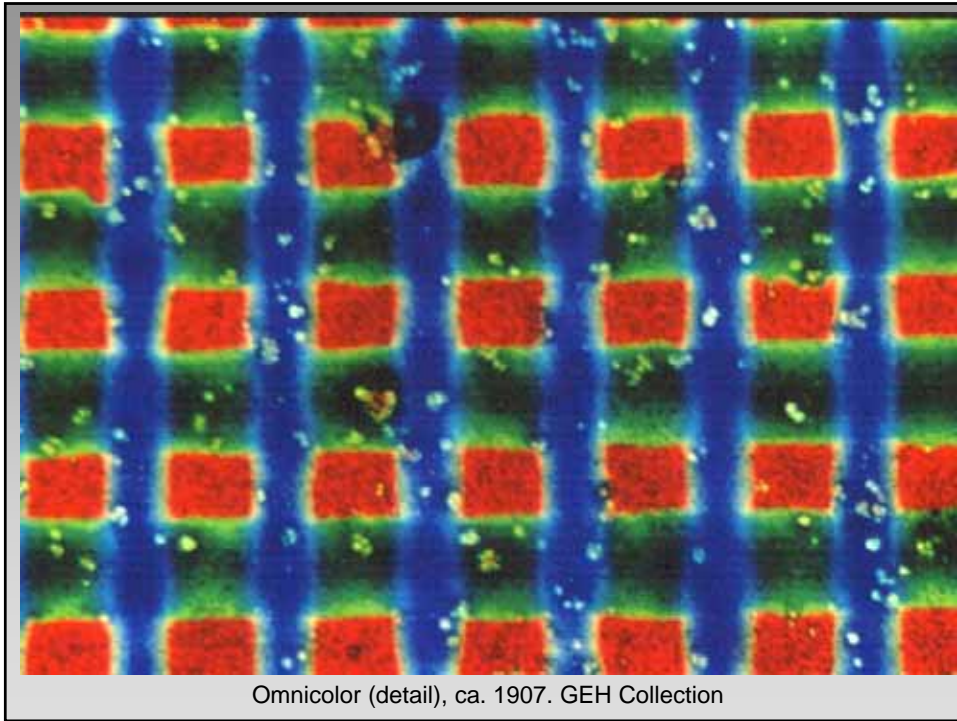
Kitty, Alfred Stieglitz, 1907. *The Art of the Autochrome The Birth of Color Photography*. John Wood, 1993. page 79.



Jean Simpson, Eduard Steichen, October 1907. *The Art of the Autochrome The Birth of Color Photography*, John Wood, 1993, page 83.



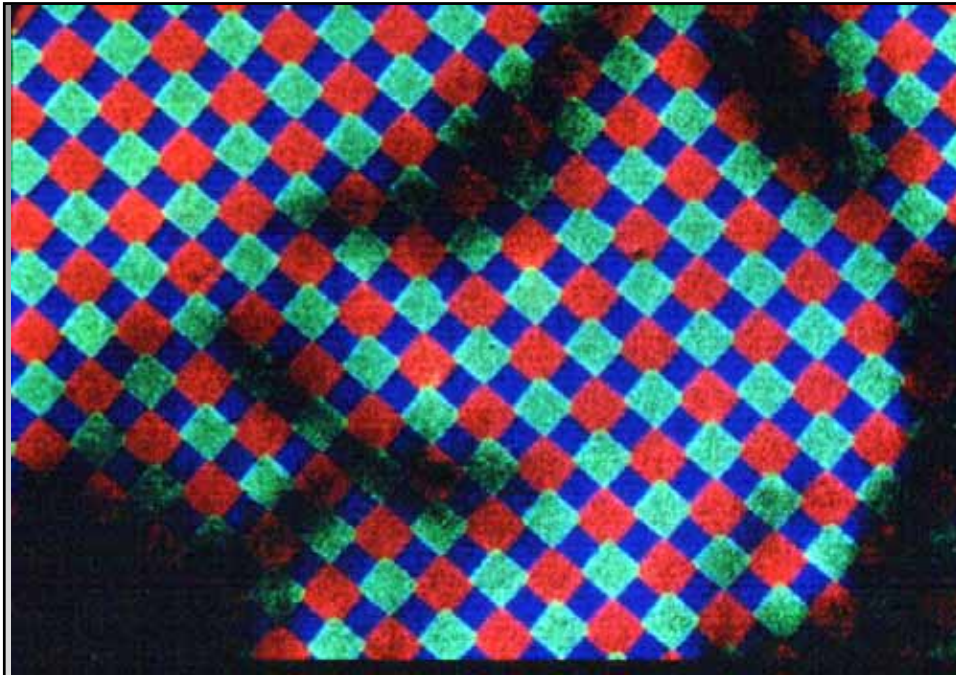
Omnicolor transparency, ca. 1907. GEH Collection



Omicolor (detail), ca. 1907. GEH Collection



George F. Clinton, Paget process, ca. 1913. GEH Collection



George F. Clinton, Paget process, ca. 1913. GEH Collection



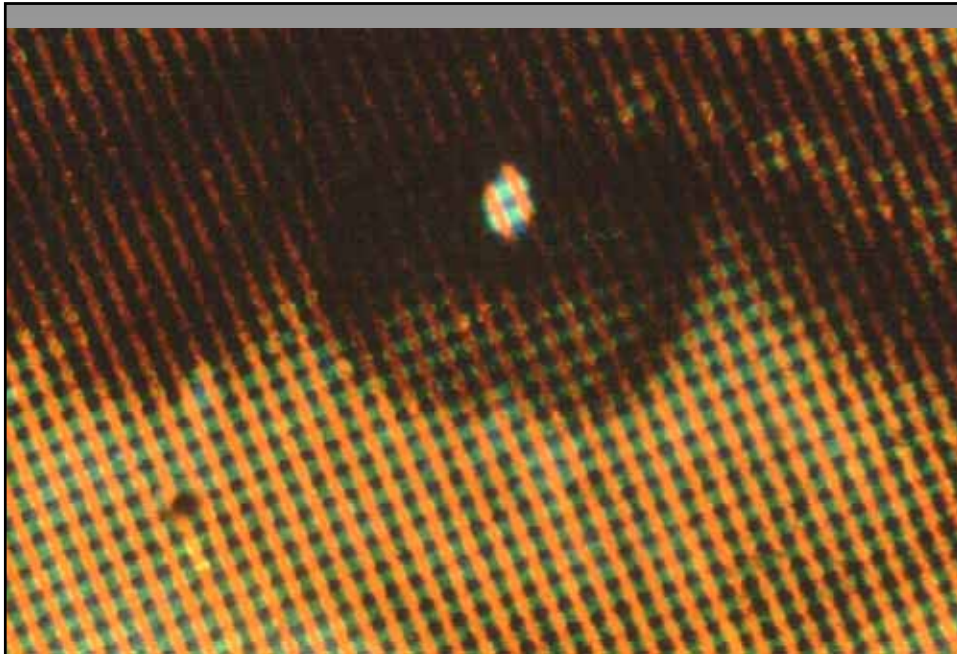
Unidentified Photographer, Agfacolor, ca. 1916. GEH Collection



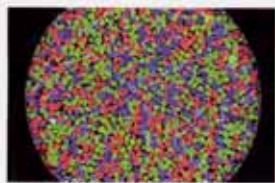
Amateur Photograph, Dufaycolor Process, 1930's. *The Illustrated History of Color Photography*, Jack H. Coote, 1993, page 50.



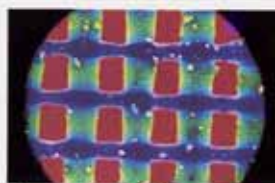
Unidentified Photographer. Dufaycolor. ca. 1935. GEH Collection



Unidentified Photographer, Dufaycolor, ca. 1935. GEH Collection



Autochrome 1907



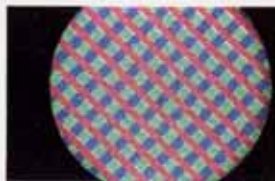
Omnicolore 1909



Paget 1913



Finlay 1929



Dufaycolor 1935



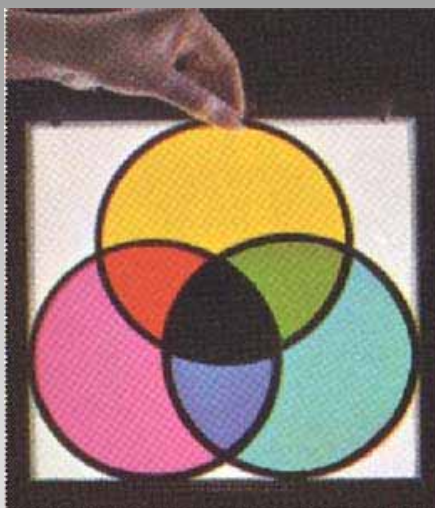
Agfacolor Ultra 1934

Photomicrographs of Patterned Screen-Plates. *The Illustrated History of Color Photography*, Jack H. Coote, 1993, page 54.



Diascope used in the Autochrome Process. *A Half Century of Color*, Louis Walton Siple, 1951, page 38.

Subtractive Color: Based on Combinations of Cyan, Yellow and Magenta Dye



Main processes for color photography

Additive

- Screen filter

Subtractive

- Assembly
- Dye imbibition
- Chromogenic
- Silver dye bleach
- Dye diffusion transfer

Assembly Process

Based on superimposing layers of pigments (and sometime dyes) usually in a gelatin matrix onto a paper final support.

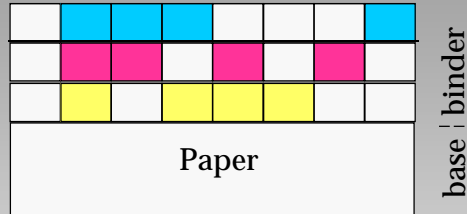
Some key products and dates:

- Tri Chrome carbon 1862
 - Pigments bound in layers of gelatin sensitized with dichromate and hardened by light and developed in water.
 - Duxachrome 1929
- Carbro 1912
 - Pigments bound in layers of gelatin sensitized with dichromate and hardened / “tanned” by contact with metallic silver light and developed in water.
- Dye Toning Process, Chromotone 1935
 - Dyes bound in layers of gelatin mordanted to silver.

Pigment / Assembly

Assembly Cross Section

Successive layers pigmented layers, usually in bichromated gelatin, are applied to a secondary support



Colors rendered in the final image

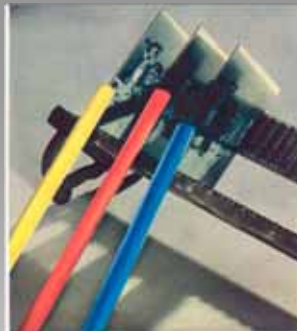
A color palette consisting of eight colored squares: white, black, blue, green, red, yellow, magenta, and cyan.



Louis Ducos Du Hauron 3-color carbon transparency 1879. GEH collection.



Nude, Anonymous, 1925, Belcolor. *Color in Photo: The History of Color Photography from 1861 to 1981*, Josef-Haubrich-Kunsthalle Koln, 1981, page 26.



1. These 1x7 segments represent the strong tints—blue, red, and yellow.

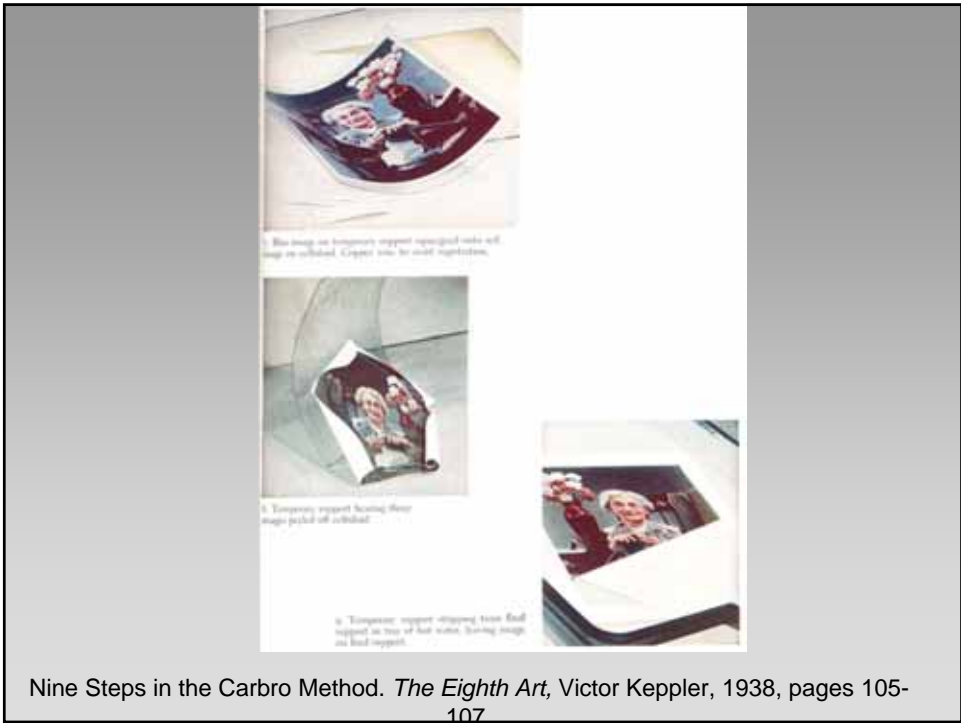


2. These circular photographs made from a set of separate negatives—blue, red, and yellow.



3. These segments Carbro prints in black and white—blue, red, and yellow.

Nine Steps (1-3) in the Carbro Method. *The Eighth Art*, Victor Keppler, 1938, pages 105-107.





Portrait of Enzo Pinza, Nickolas Murray, Carbro (Print), GEH Collection



Construction, Laszlo Moholy-Nagy, 1934. Vivex Print. Color in Photo: The History of Color Photography from 1861 to 1981, Josef-Haubrich-Kunsthalle Koln, 1981, page 35.

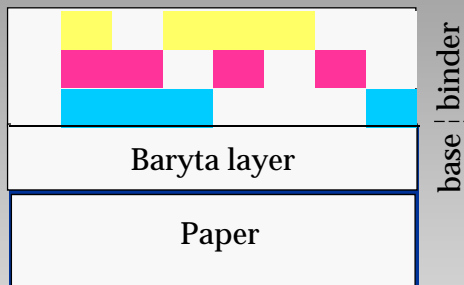
Dye Imbibition

- Hydrotype 1881
- Sanger-Shephard 1900
- Pinatype 1905
- Kodachrome (2-color)
- Technicolor (2 color) 1927 and (3 color) 1933
- Eastman Wash-Off Relief 1935
- ***Kodak dye Transfer 1945***

Dye Imbibition

Dye -Imbibition Process Cross Section

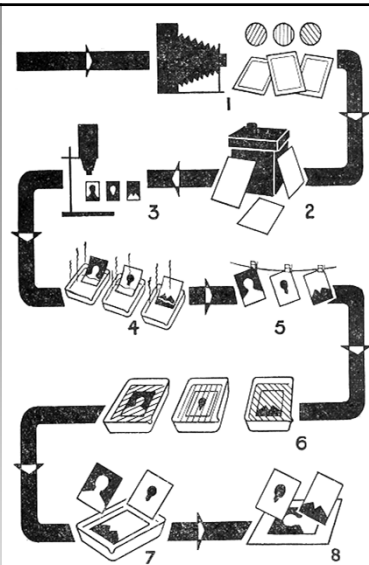
Gelatin layer containing
mordanted dye aggregates



Colors rendered in the final image

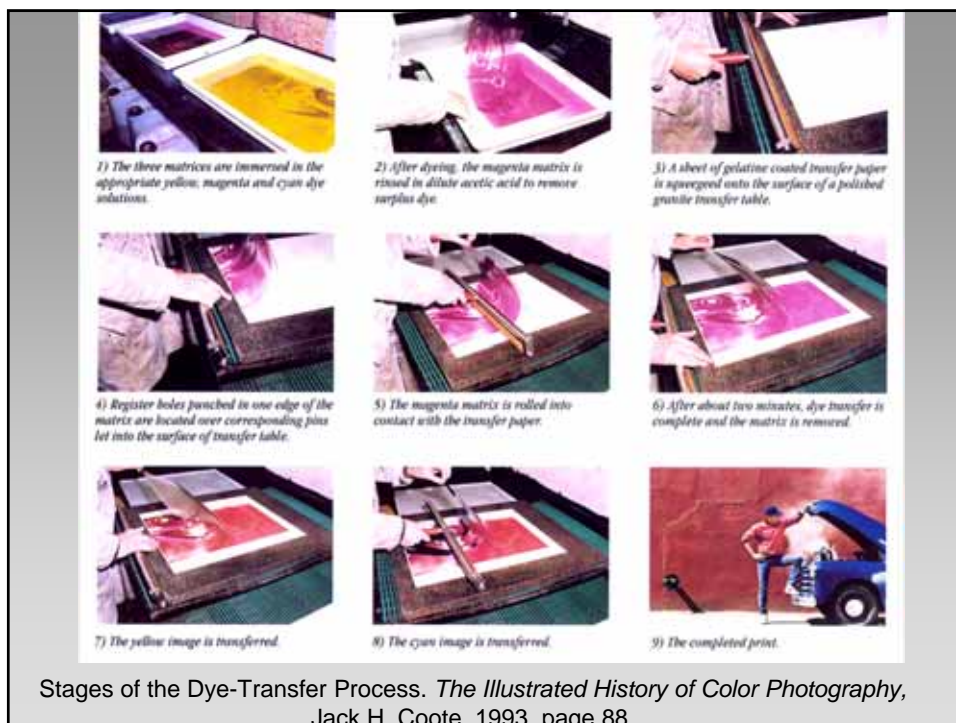
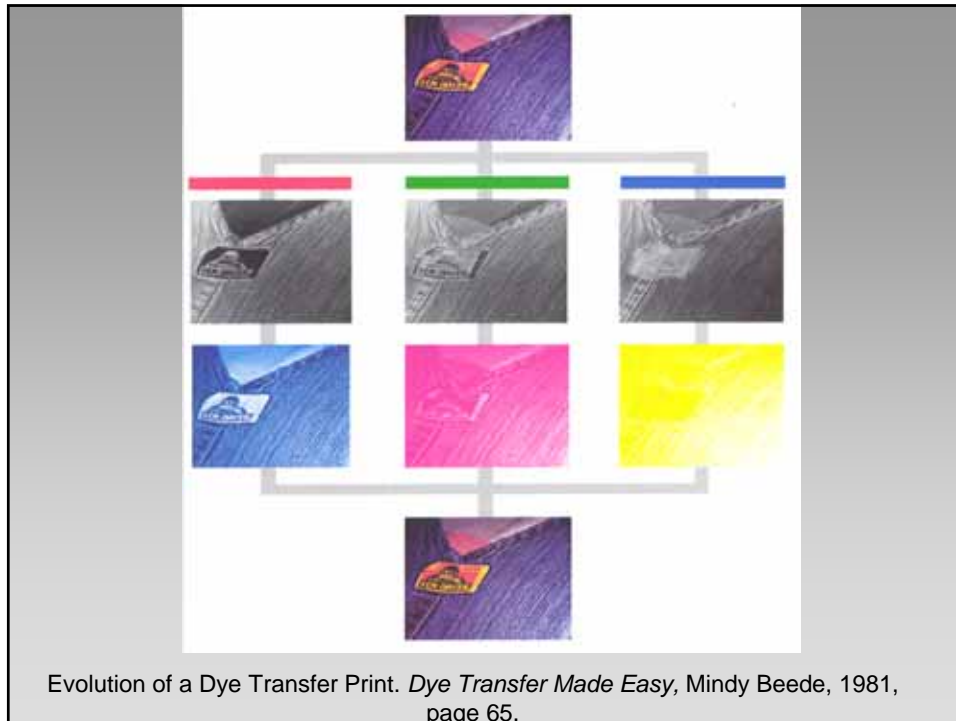


Phil Conday, Eastman Wash-Off Relief Process, 1939. *Color in Photo: The History of Color Photography from 1861 to 1981*, Josef-Haubrich-Kunsthalle Koln, 1981, page 101.



Outline of steps of Dye Transfer process. 1 Expose three negatives in turn through red, green, and blue filter. 2 Develop the three negatives. 3 Expose matrices, one from each negative. 4 Process matrices (develop, rinse and fix, hot water wash, chill). 5 Dry matrices. 6 Dye matrices after expanding. 7 Pass matrices in turn through the acid rinses. 8 Transfer dye image from each matrix in turn to transfer paper.

Outline of Dye Transfer Process. *Amateur Dye Transfer Colour Prints*, Viscount Hanworth, 1955, page 11.





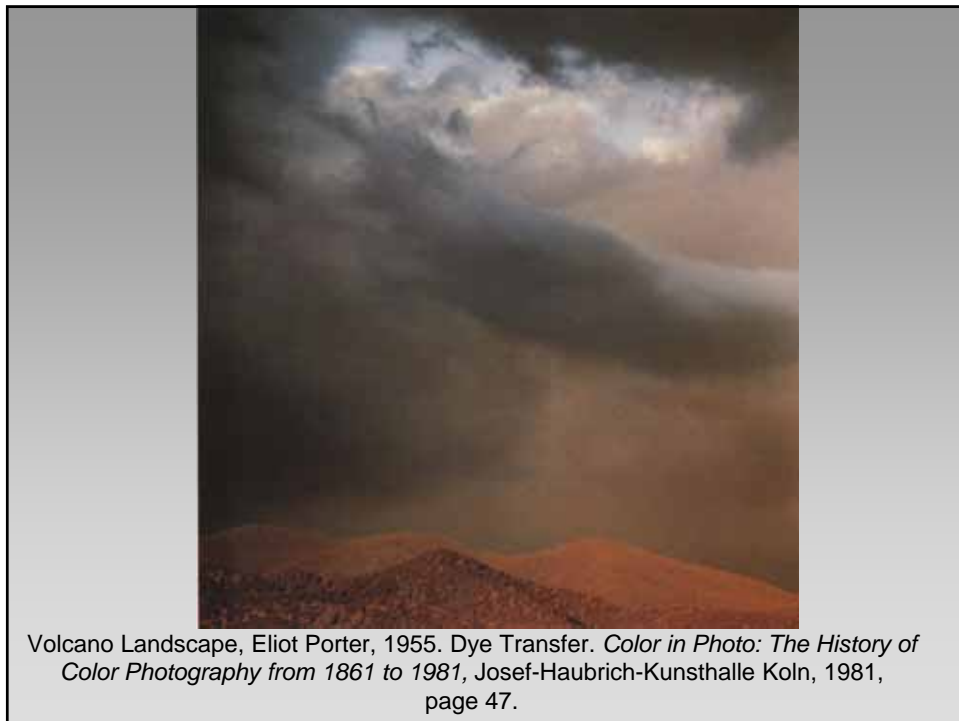
Dye Transfer Print Made from Separation Negatives Exposed in a Mikut Color Camera.
The Illustrated History of Color Photography, Jack H. Coote, 1993,
page 105.



Hoedt Studio, Dye Imbibition. GEH Collection



Hoedt Studio, Dye Imbibition. GEH Collection



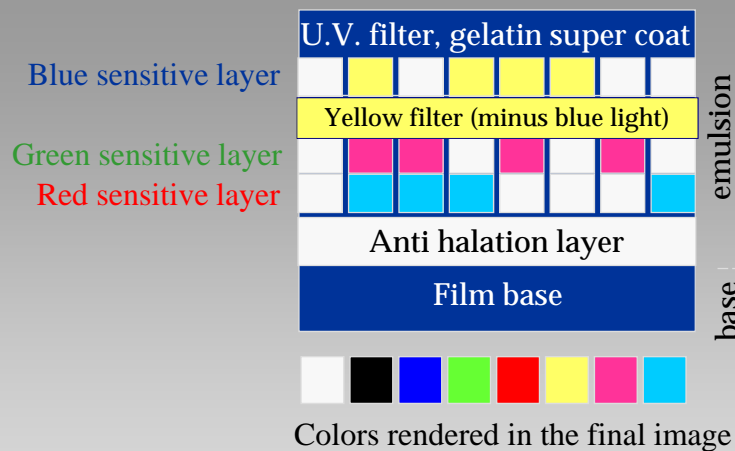
Volcano Landscape, Eliot Porter, 1955. Dye Transfer. *Color in Photo: The History of Color Photography from 1861 to 1981*, Josef-Haubrich-Kunsthalle Koln, 1981, page 47.

Chromogenic (dye coupler): some major products

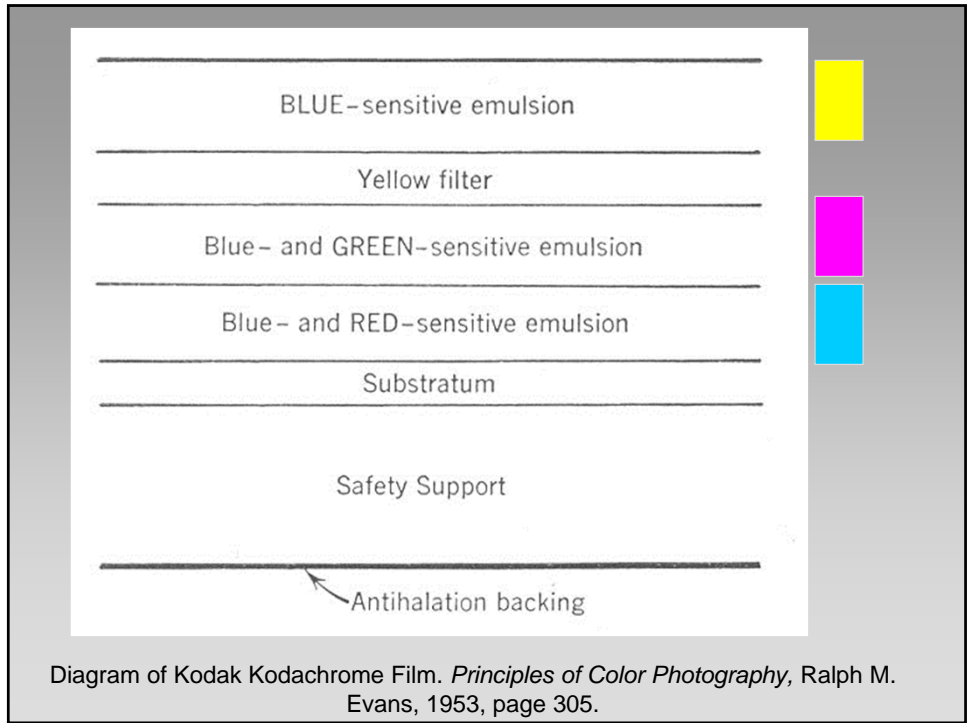
- Kodachrome 1935
- Agfacolor 1936
- Kodacolor 1942
- Agfa / Ansco Printon 1945
- Ektachome 1946
- Ektacolor 1949

Chromogenic

Chromogenic Processes - Cross Section



The diagram shows a simplified structure for a color transparency. Negatives often use a similar layer sequence while prints typically have the cyan or magenta layers on the top and the yellow layer on the bottom.





Kodachrome, 1936. 50 Years of Color Photography, Manfred Heiting, 1986, page 20.



Agfacolor, 1936. 50 Years of Color Photography, Manfred Heiting, 1986, page 13.



Bempohl Nature Color Camera, 1930. *Color in Photo: The History of Color Photography from 1861 to 1981*, Josef-Haubrich-Kunsthalle Koln, 1981, page 31.



Pavelle Color laboratories, Feeding an exposed roll of Printon into processing system, 1950's. *A Half Century of Color*, Louis Walton Siple, 1951, page 158.



MINICOLOR (Kodachrome prints), 1940's. GEH Collection



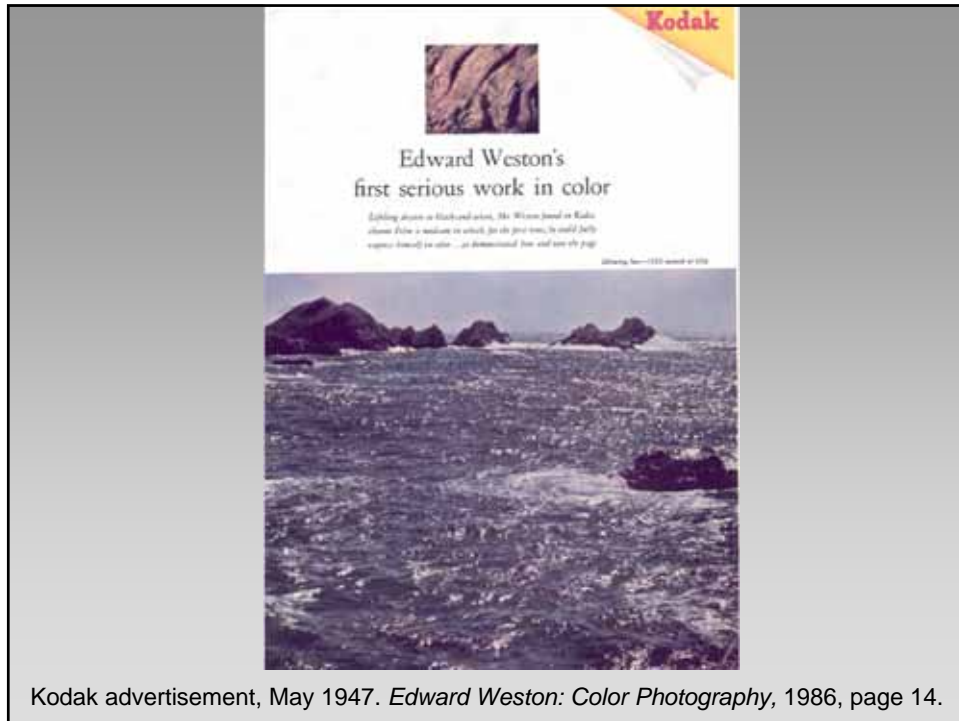
Color print made in the Paville Color laboratories on Ansco Printon, 1950. *A Half Century of Color*, Louis Walton Siple, 1951, page 158.



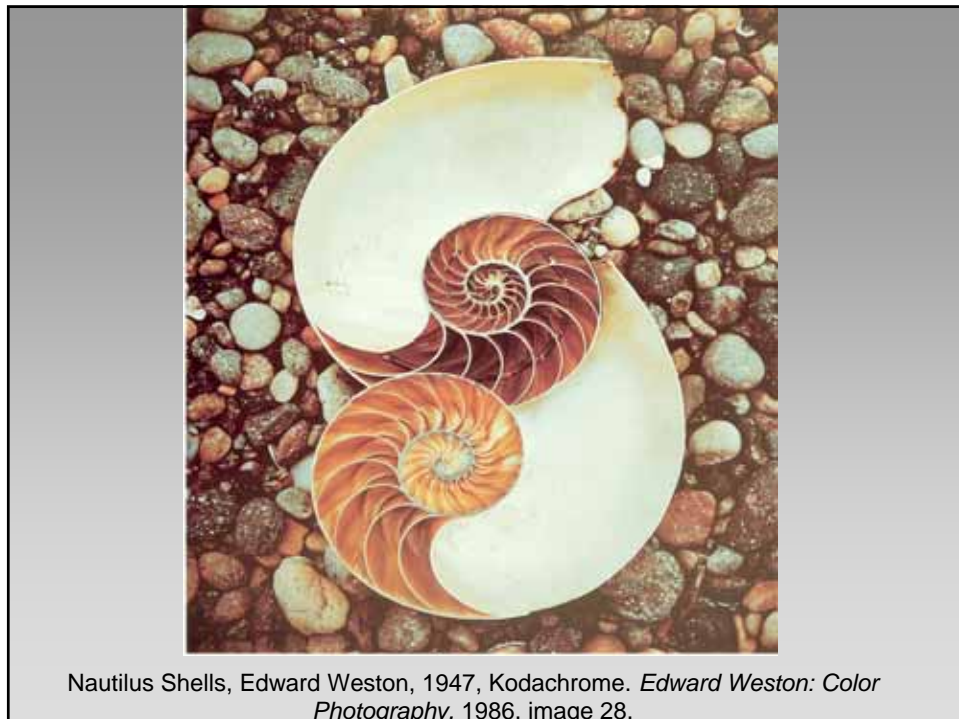
Walter Benser, Agfacolor-Recolor, 1937. *Color in Photo: The History of Color Photography from 1861 to 1981*, Josef-Haubrich-Kunsthalle Koln, 1981, page 139.



Late Evening, Monument Valley, Utah, Ansel Adams, 1950. *Ansel Adams in Color*, Harry M. Callahan, 1993, page 105.



Kodak advertisement, May 1947. *Edward Weston: Color Photography*, 1986, page 14.



Nautilus Shells, Edward Weston, 1947, Kodachrome. *Edward Weston: Color Photography*, 1986, image 28.

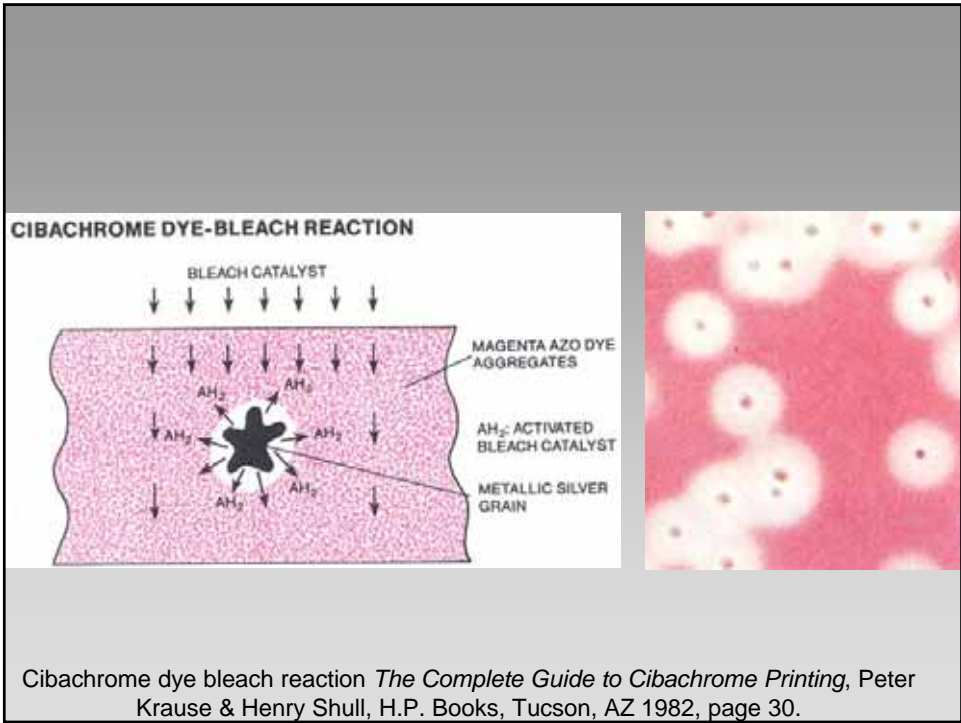
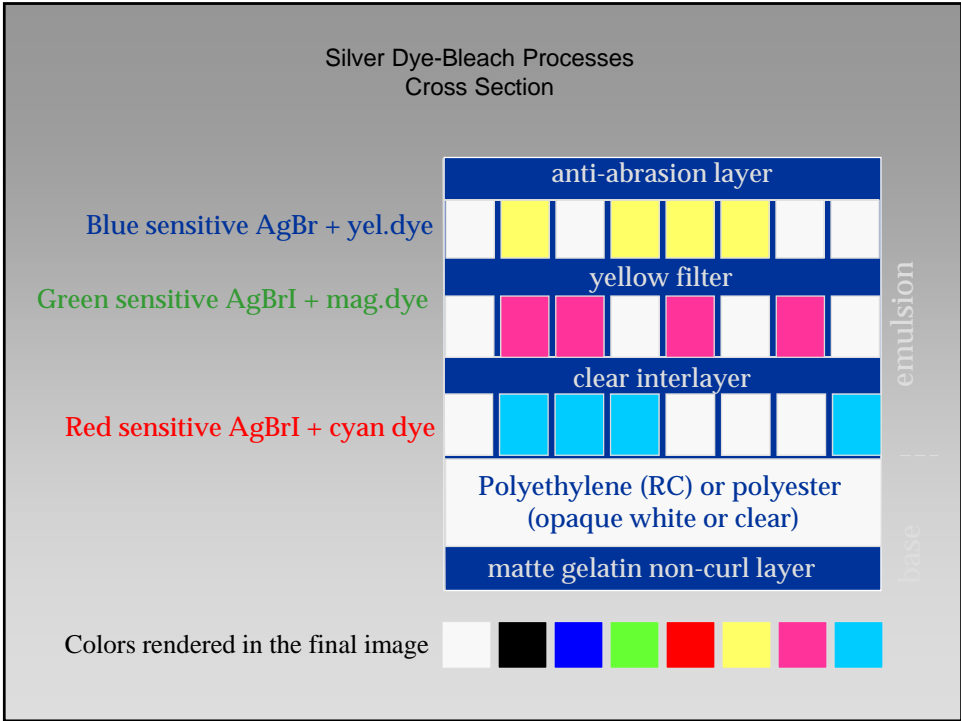


Brett, Edward Weston, 1947, Ektachrome. *Edward Weston: Color Photography*, 1986, page 24.

Silver Dye Bleach

- Christenson 1918
- Gasparacolor 1933
- Azochrome 1940
- *Cibachrome 1963 (Ilfochrome 1991)*

Silver Dye Bleach





Wittmer, Albert, Azochrome (print) ca. 1940. GEH Collection



First Cibachrome Print, Dr. Armin Meyer, 1959. *The Illustrated History of Color Photography*, Jack H. Coote, 1993, page 184.



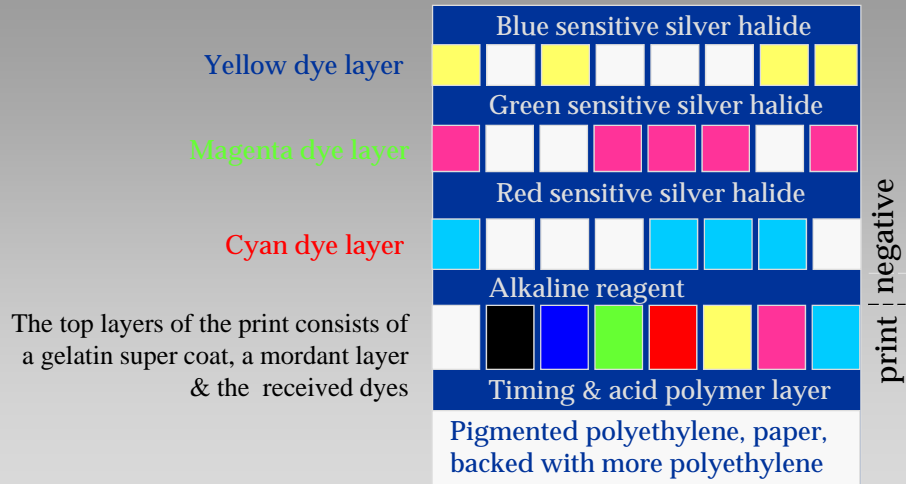
Ciba-Geigy, Photokina, Cibachrome, 1963. *The Illustrated History of Color Photography*, Jack H. Coote, 1993, page 185.

Dye Diffusion Transfer

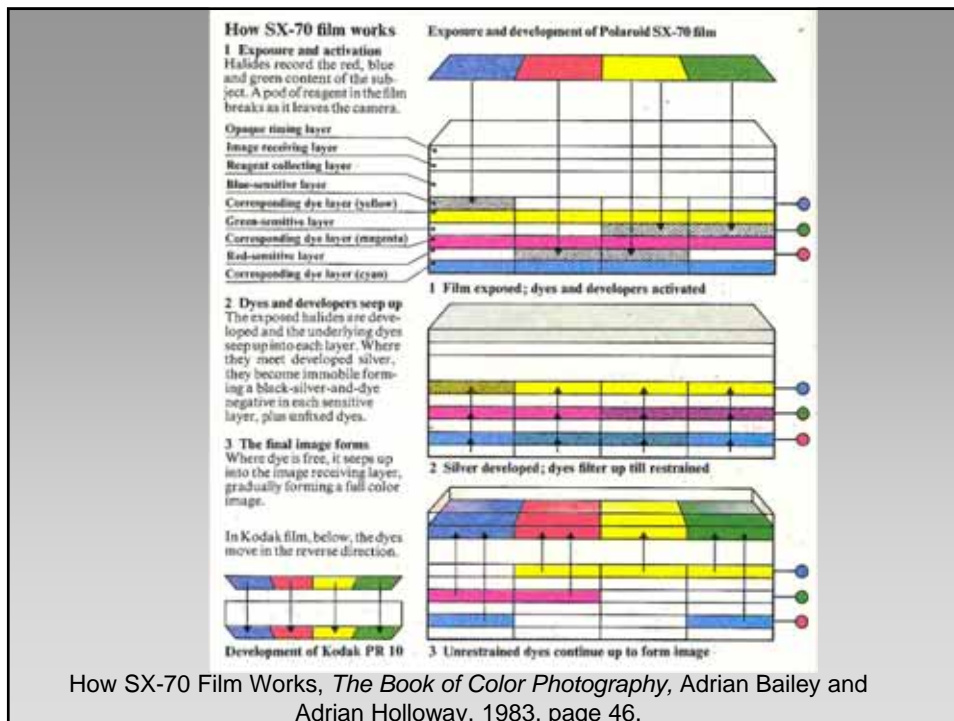
- *Polaroid Polacolor 1963*
- *Polaroid SX-70 1972*
- Kodak 1976
- Kodak Ektaflex 1981

Dye Diffusion Transfer

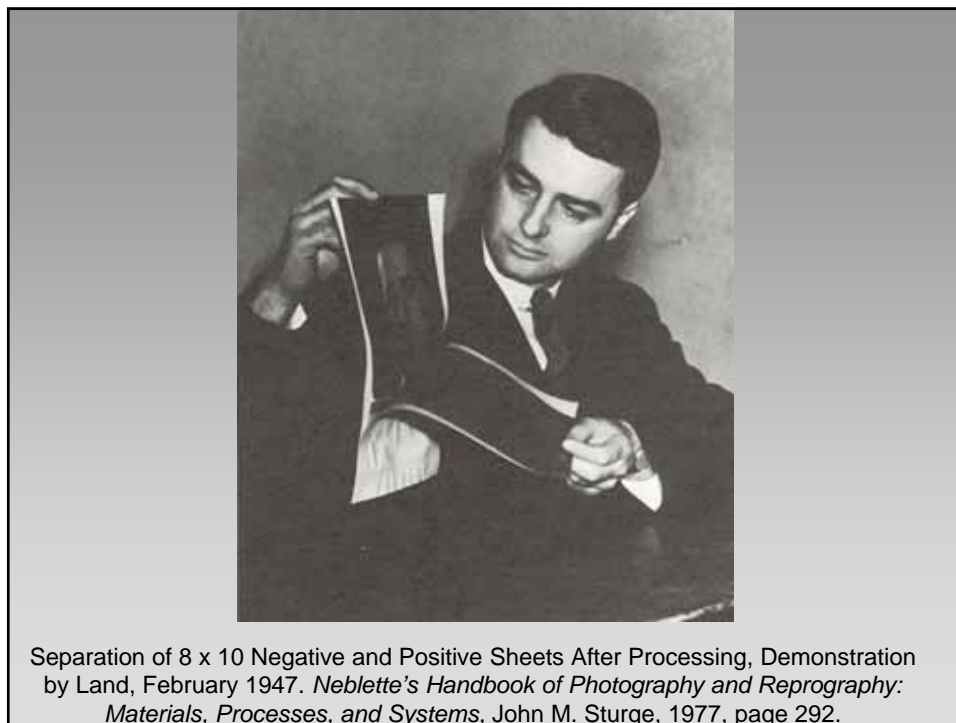
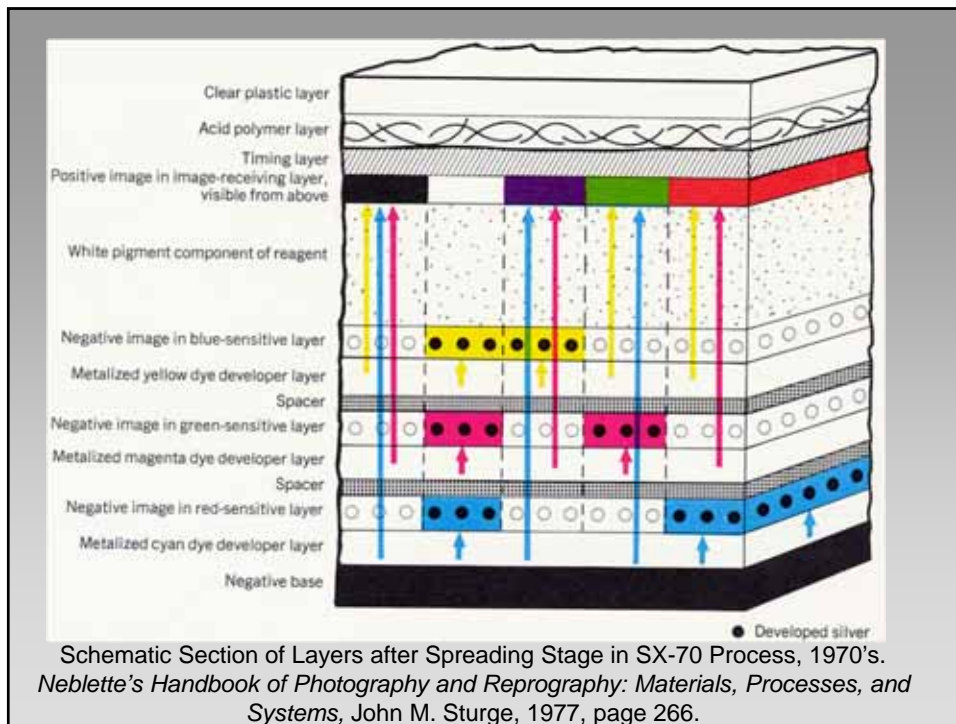
Dye Diffusion-Transfer Processes – Cross-section

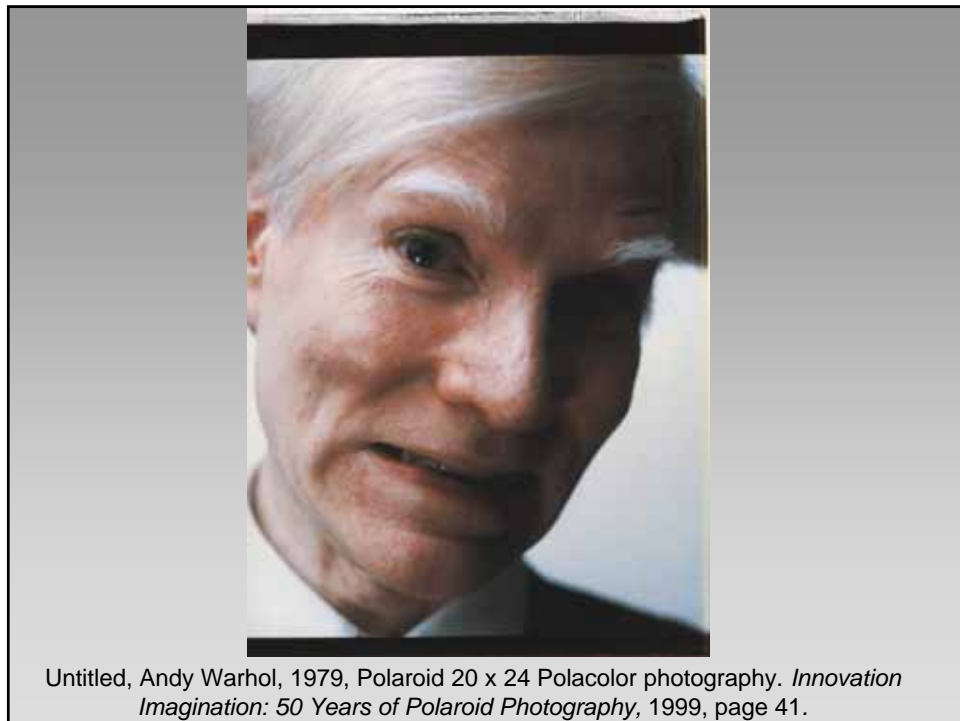
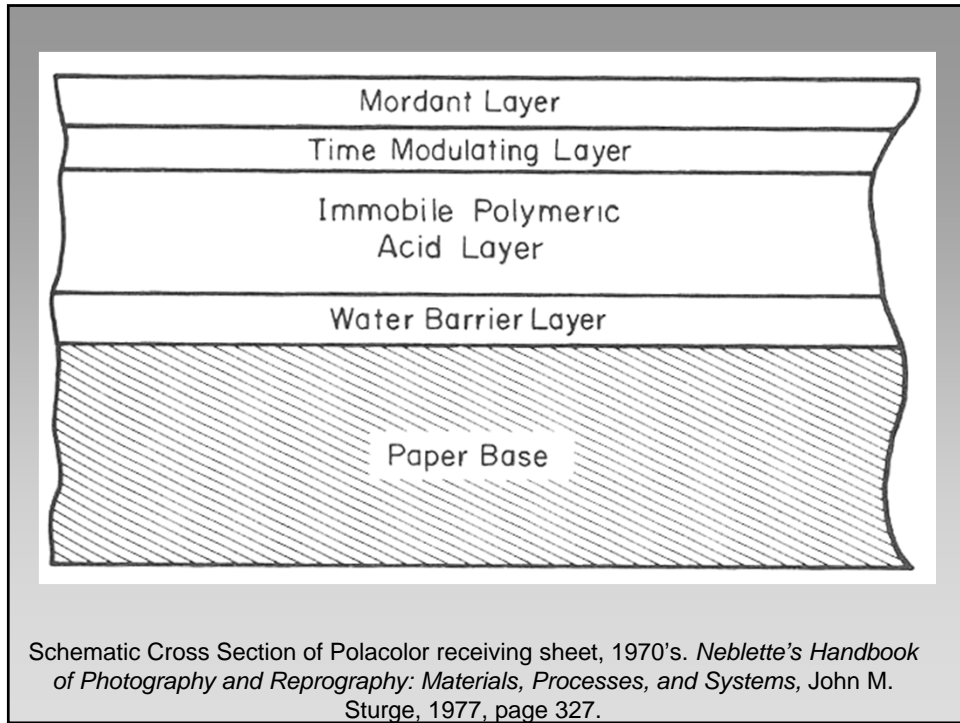


The diagram shows a simplified structure for a Polacolor print



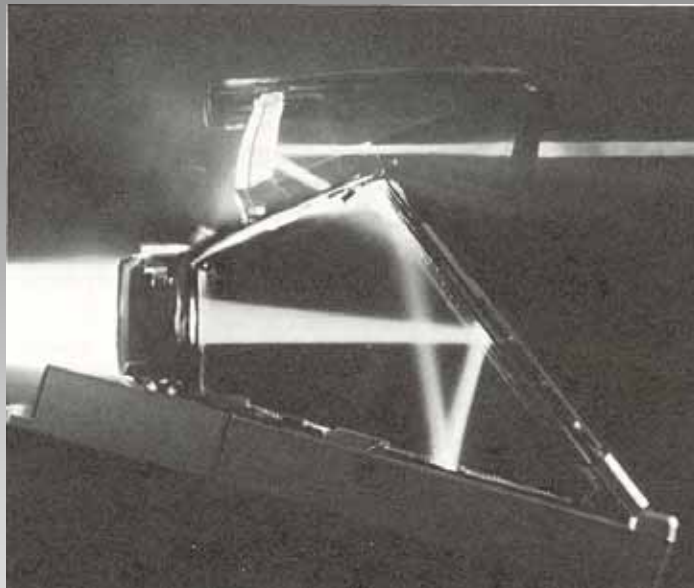
How SX-70 Film Works, *The Book of Color Photography*, Adrian Bailey and Adrian Holloway, 1983, page 46.

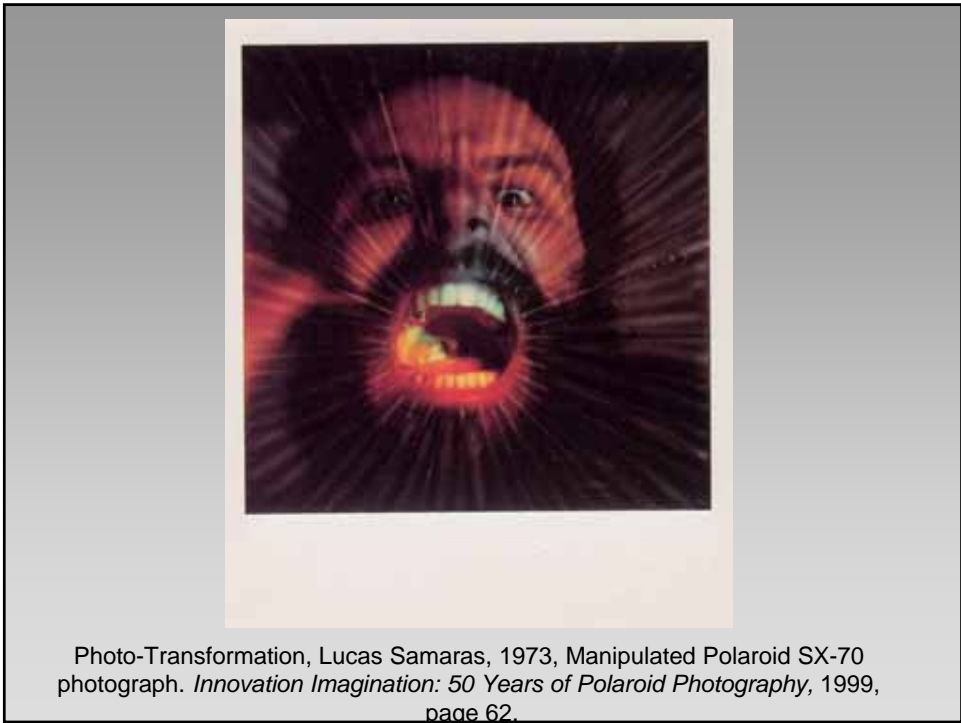
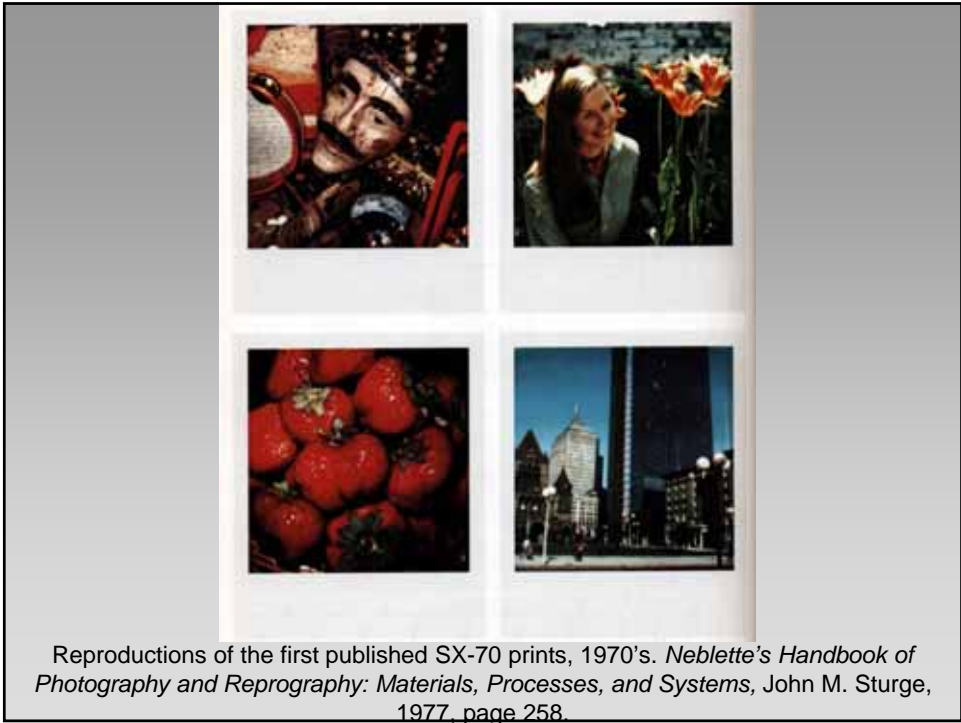






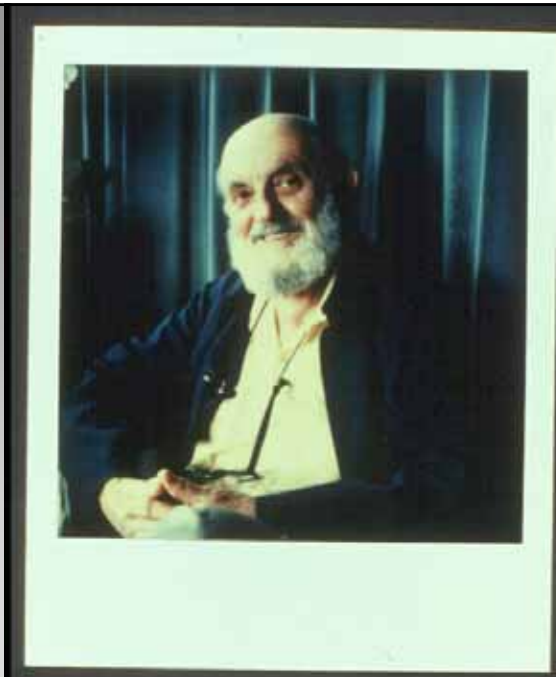
Chow, William Wegman, Polaroid, 1980. *Photography in Boston: 1955-1985*, DeCordova Museum and Sculpture Park, 2000, page 115.







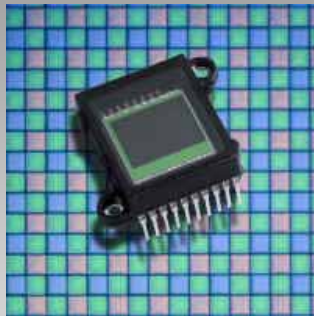
Imogen and Hermiane, Pembroke Studios, London, 30th July, 1982, Polaroid SX-70 composite. *Innovation Imagination: 50 Years of Polaroid Photography*, 1999, page 73.



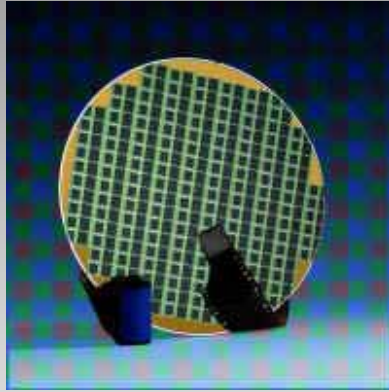
Condax, Philip, Polaroid SX-70, Portrait of Ansel Adams. GEH Collection



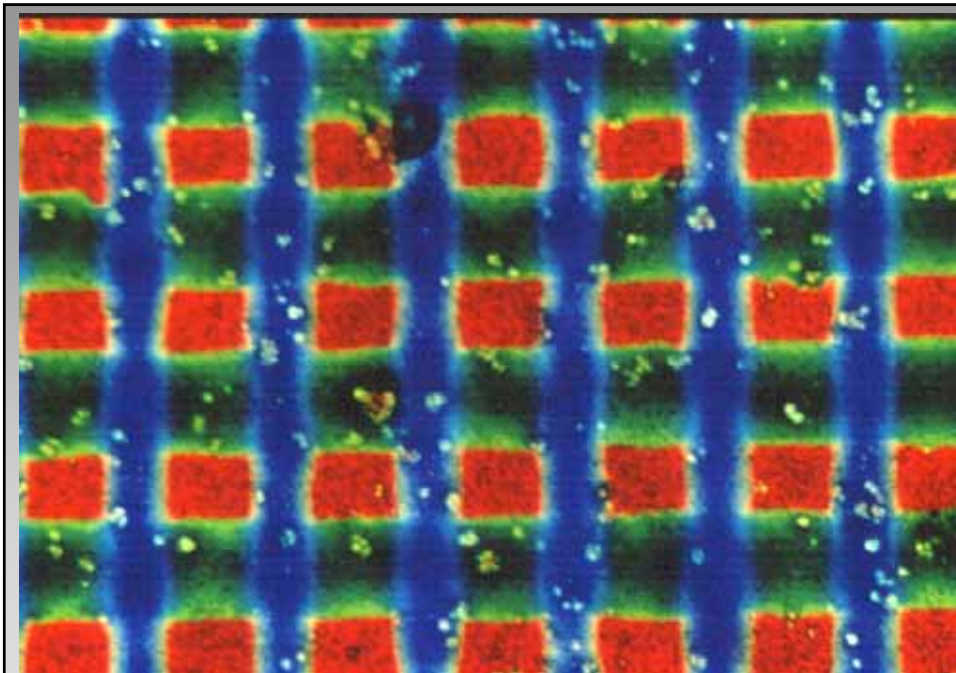
Sony Mavica MVC7000P Electronic Still Camera, 1991. *The Illustrated History of Color Photography*, Jack H. Coote, 1993, page 231.



CDD sensor with Bayer filter



CDD sensor with Bayer filter



Omnicolor (detail), ca. 1907. GEH Collection