20th Century
Materials, Processes, Technologies

Photographic Process ID Webinar #2

Image Permanence Institute
2017-2018

James and Marjorie Carver
Instant (Diffusion Transfer)
Resources

Web Resources
• Graphics Atlas
  – www.graphicsatlas.org
• George Eastman Museum Photographic Processes Series
  – YouTube
• Lingua Franca: A Common Language for Conservators of Photographic Materials
  – iTunes App
• The Atlas of Analytical Signatures of Photographic Processes

Print Resources
• Twentieth Century Color Photographs: Identification and Care by Silvie Penichon
• Photographs of the Past: Process and Preservation by Bertrand Lavedrine
• In the Darkroom: An Illustrated Guide to Photographic Processes Before the Digital Age by Sarah Kennel
What is a Photograph?

• An Image
  – Light Sensitivity of Chemical Compounds
    • Silver Salts
    • Chromium Salts

• A substrate

Salts (Chemistry): an ionic compound which is made up of two groups of oppositely charged ions (positive and negative)

Scanning electron microscope image of silver bromide crystals
19th C Processes into 20th C

- Collodion POP, 1885-1910
- Gelatin POP, 1885-1910
- Matte Collodion, 1895-1910
- Carbon, 1868-1940
- Gum Dichromate, 1894-1930s
- Cyanotype, 1842-1950
- Platinum, 1880-1930
- Gelatin Dry Plate, 1880-1925

Collodion POP
20th C Processes

- Silver Gelatin DOP, 1890-2000
- Screen Plate, 1907-1935
- Carbro, 1925-1950
- Dye Imbibition, 1945-1990
- Chromogenic, 1942-Present
- Instant (Diffusion Transfer), 1948-2008
Negative

A tonally reversed image on a transparent support.

- Glass plate
- Flexible strip film
- Sheet film

Black and White And Color

35mm negative on cellulose nitrate support
Negative

All light sensitive materials exposed to light through a camera produce a negative image.

More light is reflecting off the light surfaces like the man’s shirt exposing the light sensitive material creating darker hues.

Less light is reflecting off the dark surfaces, like the man’s hair. Little to no material is exposed creating light hues.
Positive Transparency

A positive image on a transparent support

• Lantern slides
• 35 mm slides
• 4x5 or 8x10 transparencies

Black and White
And
Color

35mm chromogenic slide transparency
Print

A positive image on an opaque support

Silver Gelatin DOP
Photographic Printing

Contact print:
The negative is placed in
direct contact with the light
sensitive paper.

The print is the same size as
the negative.

Toned Silver Gelatin DOP
Gelatin dry plate negative
Photographic Printing

Enlargement:

A small negative is placed in an enlarger, the image is projected onto light sensitive paper.

The negative is smaller than the print.
20th C Photographic Materials

Image Material
• Metal, Pigment, Dye

Image Binder
• Gelatin

Primary Support
• Paper, Glass, Plastic

Support Coating*
• Baryta, Plastic

Additives *
• To support, binder

*not always present
Image Formation

Silver Developing Out Process (DOP)

• Black and White, Color
  – Negatives
  – Prints
  – Positive Transparencies

Photography is awesome!
Developing Out (DOP): Overview

- Negatives, 1839-present; Prints, 1900-present
- Short exposure
- Latent image is formed (invisible)
- Silver halide reduced by chemical reaction to silver image particle
- Sensitive to blue, green, and red light after 1906
- Produces large image particles
- Black image colors
Ag⁺ + Cl⁻, Br⁻, I⁻ = AgCl, AgBr, AgI
The Electromagnetic Spectrum

<table>
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<tr>
<th>Gamma Rays</th>
<th>X-Rays</th>
<th>Ultraviolet Rays</th>
<th>Infrared Rays</th>
<th>Radar</th>
<th>FM</th>
<th>TV</th>
<th>Shortwave</th>
<th>AM</th>
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</thead>
<tbody>
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<td>$1 \times 10^{-14}$</td>
<td>$1 \times 10^{-12}$</td>
<td>$1 \times 10^{-3}$</td>
<td>$1 \times 10^{-4}$</td>
<td>$1 \times 10^{-2}$</td>
<td>$1 \times 10^{2}$</td>
<td>$1 \times 10^{4}$</td>
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</tbody>
</table>

Wavelength (in meters)

Visible Light

4 x $10^{-7}$ 5 x $10^{-7}$ 6 x $10^{-7}$ 7 x $10^{-7}$

Wavelength (in meters)

High Energy  Low Energy

The Electromagnetic Spectrum
Silver Image Formation

\[
\text{Ag}^{+} + [\text{Na}^{+} \text{Cl}^{-}]_{\text{aq}} = \text{AgCl} \quad (s)
\]
Silver Image Formation

\[
\text{Ag}^+ [\text{O}_2]^- + [\text{Na}^+] [\text{Cl}]^- = \text{AgCl}_{(s)}
\]
Silver Image Formation

3D Model of AgBr

2D Model of AgBr

Actual AgBr crystals

Illustration of AgBr crystals
Silver Image Formation

2AgBr (s) + Light = Latent image
Silver Image Formation

Development
- Reduce exposed silver halides to silver image particle

Fix
- Break up unexposed silver halides

Wash
- Remove broken silver and halide ions
- Remove fix chemical
Silver Image Formation
Silver Image Formation

During development, the exposed silver halide is chemically reduced to silver metal.
Silver Image Formation

Image material and formation influences image tone

Large, filamentary silver image particles = Black image tones
Calming Manatee

http://calmingmanatee.com/30
Materials: Silver Gelatin DOP

- Image: silver
- Binder: gelatin
- Support: paper
- Support coating: baryta or polyethylene
Untoned Silver Gelatin DOP

- Black image tone
- Continuous in tone

50x magnification
Continuous in Tone vs Patterned

Continuous in tone

Patterned

50x magnification
Toned Silver Gelatin DOP

- Sulfur Toning
  - Silver converted to silver sulfide
  - Brown image tones

- Selenium toning
  - Silver converted to silver selenide
  - Purple/red image tones
Toned Silver Gelatin DOP

Sulfide and Selenium toning

These prints were toned successively in the same toning bath containing a mix of polysulfide toner and selenium toner. The selenium slowly depleted resulting in stronger sulfide toning of the last prints.
Silver Image Deterioration

- Image fading
- Change in image tone
  - brown, yellow-brown
  - Silver mirroring
Silver Gelatin DOP

Modifications:

• Image tone
• Base tints
• Surface Characteristics
DOP: Surface Characteristics

Thickness of the baryta

Thin Baryta

Semi-Matte Sheen

Paper fibers visible 50x magnification
DOP: Surface Characteristics

Matting agents

Textured
50x magnification

Matte Sheen
DOP: Surface Characteristics

Applied texture

Semi-matte sheen
DOP: Surface Characteristics

Surface sheen characteristics: Matte to Glossy
Silver Gelatin DOP

Modifications: Dyes

- Added to make paper brighter (OBAs)
- Added to binder, baryta, paper support to alter the color of the highlights

Imaged with daylight balanced lighting

Imaged with UV light
Color Photography

Color photography is an illusion

• The image is composed of additive or subtractive color elements, which the eye blends together to produce full color.

George Seurat, *A Sunday on La Grande Jatte*, 1884
Additive Color

Mixing Red, Green, Blue light = White

Viewed with transmitted light
Screen Plate: Autochrome

- **Type:** transparency
- **Image:** silver and dyed potato starch grains
- **Binder:** gelatin
- **Support:** glass or plastic
- **Support coatings:** varnishes

50x mag
Screen Plate: Autochrome

- Transparency
- Patterned image structure
  - Random additive color dots (dyed potato starch)
- Glass or plastic support
Subtractive Color

Combining Cyan, Magenta, Yellow = Black

All other color processes

• Subtractive color
  – Cyan, magenta, yellow
  – Superimposed to produce full color
Color Assembly

Processes:
• Carbro
• Dye Imbibition
• **Separation negatives**
  – 3 silver gelatin DOP negatives
  – Each exposed through a red, green, or blue filter
  – Record of the red, green, blue light

• **Subtractive Color**
  – Separations used to print cyan, magenta, yellow images

• **Assembly**
  – 3 color images superimposed to produce full color image
Color Assembly
BLUE RECORD NEGATIVE
YELLOW PRINTER
PRINT EXPOSURE RATIO 1.0
CHROMATONE
DEFENDER PHOTO SUPPLY CO. INC.

GREEN RECORD NEGATIVE
MAGENTA PRINTER
PRINT EXPOSURE RATIO 1.0
CHROMATONE
DEFENDER PHOTO SUPPLY CO. INC.

RED RECORD NEGATIVE
BLUE-GREEN PRINTER
PRINT EXPOSURE RATIO 0.8
CHROMATONE
DEFENDER PHOTO SUPPLY CO. INC.
Carbro

- Separation negatives used to print 3 silver gelatin prints
- Dichromated gelatin sheets squeegeed in contact with prints
- Gelatin hardens where it is in contact with silver metal
- Unhardened areas remain soluble and are washed away
Carbro

- Type: print
- Image: pigment
- Binder: gelatin
- Support: paper
- Coatings: baryta
- Additives: matting agents
Carbro

- Differential gloss
- Pigment particles (continuous in tone)
- Misregistration

50x Magnification
Dye Imbibition

• Separation negatives printed onto printing matricies
  – Matrices: dichromated gelatin on plastic support
  – The gelatin hardens where it is exposed to light
  – Unhardened areas remain soluble and are washed away
• Matrices dyed, cyan, magenta, or yellow
• Dye is transferred to receiving paper
Dye Imbibition

- Type: print
- Image: dye
- Binder: gelatin
- Support: paper
- Coating: baryta
Dye Imbibition

- Misregistration
- Continuous in tone
- Diffuse image
Integral Tripack

• Processes:
  – Chromogenic
  – Silver Dye Bleach
  – Instant Color (Dye diffusion transfer)

• Chemistry
  – Red, green, and blue light sensitive silver gelatin layers (separations) are superimposed on a single support.
  – Cyan, magenta, yellow dye is also in corresponding RGB layer
Chromogenic Image Formation

- exposed silver salts reduced to silver metal
Chromogenic Image Formation

- the dye couplers react with the oxidized developer
- dye couplers form dye clouds where silver is present
Chromogenic Image Formation

- Silver chemically removed
Materials: Chromogenic

- Type: print, negative, positive transparency
- Image: dye
- Support: paper, plastic
- Binder: gelatin
- Coatings (prints): baryta, resin coated
Chromogenic

- Continuous in tone (10x)
- Image Grain (50x)
  - Dye clouds
- Backprint or Back stamp
Chromogenic

- Highlight yellowing
- Color Shift
- Fading
Silver Dye Bleach Image Formation

- exposed silver halide reduced to silver metal
Silver Dye Bleach Image Formation

- dye around silver is bleached
- Silver chemically removed
Materials: Silver Dye Bleach

- **Type**: print, positive transparency
- **Image**: dye
- **Binder**: gelatin
- **Support**: plastic, RC paper
Silver Dye Bleach

- Continuous in tone (10x)
- Image grain (50x)
  - Bleach halos
- Black borders
- Plastic or RC support
Instant (Diffusion Transfer)

- Type: print
- Image: silver, dye
- Binder: synthetic polymer
- Support: paper, plastic
Diffusion Transfer & Dye Diffusion Transfer

- Continuous in tone
- Backprint
- Remnants of adhesive along borders
Instant (Internal Dye Diffusion Transfer)

- Continuous in tone
- White plastic frame with reagent pod
- Backprint
Survey & Thank You

Thank you!

• National Endowment for the Humanities Division of Preservation and Access
• The Andrew W. Mellon Foundation

Next Webinar

• Wednesday, November 8, 2:00pm EDT
• 21st Century Materials and Technologies

Survey!

• A brief survey will appear at the end, please give us feedback!