Topics in Photographic Preservation

Volume Thirteen

Photographic Materials Group

The American Institute for Conservation of Historic & Artistic Works

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VOLUME THIRTEEN

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of the American Institute for Conservation Annual Meeting
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COMPILED BY BRENDA BERNIER AND CAMILLE MOORE

AIC

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This volume is dedicated to the enduring legacy of PMG founder, José Orraca (1938-2009).

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8. Please submit articles to the Compilers as *Word* documents via email attachments prior to the deadline of **August 31, 2009.**

FOREWORD

Topics in Photographic Preservation is a biannual publication of the Photographic Materials Group (PMG) of the American Institute for Conservation of Historic and Artistic Works (AIC). It provides a means for exchange of information, experiences, and techniques relating to photographic science, conservation treatment, preventive conservation, and the field of photograph conservation in general.

Topics in Photographic Preservation, Volume Thirteen primarily consists of post prints of presentations given at PMG meetings in 2008 and 2009, with some additional papers. In some cases, authors chose to submit abstracts when full papers were not available. Two panel presentations given during this period are not represented in this volume but merit mentioning. In Denver a panel discussion was presented on the topic of hybrid preservation approaches for image archives. Invited speakers were Stephen Hagel, acmeworks digital film, inc.; Steve Puglia, National Archives and Records Administration; Doug Munson, Chicago Albumen Works; and Caroline Fricke, PhD, The University of Texas at Austin. In Tucson, a panel reviewed the events of the Lewis Hine scandal and reflected on the impact it had on the photography community over the past ten years. Invited speakers were conservators Paul Messier and Valerie Baas; Denise Bethel of Sotheby's; and Andrew Smith of Andrew Smith Gallery.

Articles in *Topics in Photographic Preservation* can vary greatly, from informal tips to detailed research. However, *Topics in Photographic Preservation* should not be considered a substitute for, or an equal to, the *Journal of the American Institute for Conservation* (*JAIC*), the authoritative reference published semiannually by the AIC. Unlike *JAIC*, articles in *Topics* do not undergo a formal process of peer review. Although compilation is aided by a certain degree of uniform formatting, the style of the body of each paper is left largely to the discretion of the authors. Editorial intervention is minimal unless requested by the author.

We sincerely thank the contributors to *Topics in Photographic Preservation, Volume Thirteen* for taking the time to share their research and experiences with the PMG membership. PMG members are urged to consider submitting articles to future volumes so that *Topics* can remain a useful resource for our field.

Brenda Bernier and Camille Moore
Compilers 2008-2009

NPS Service-wide Initiative for the Preservation of Film-Based Media

Theresa Voellinger and Jenny Barton

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado

Abstract

The National Park Service has an estimated 15 million film-based photographic images in the museum collection, many of which are cellulose nitrate, cellulose acetate and color materials. It is well known that these materials are highly susceptible to deterioration when not stored in optimum conditions. However, this deterioration can be slowed by an introduction into cold storage. This talk presented a summary of an ongoing service-side film preservation effort focused on establishing cold storage facilities for all vulnerable NPS film-based collections This project was developed to utilize the best preservation practices while accommodating the uniqueness of the NPS, where collections are managed at 388 individual sites in accordance with a service-wide standard.

The NPS and the Image Permanence Institute worked together to create a web-based survey that all park units were asked to complete on a voluntary basis. This survey information was compiled into usable data that will be used to guide the rest of the project. This talk examined the survey process and the combined effort of many to obtain the best results.

To date, each stage of the project has been met with new and interesting challenges that could not have been addressed without the sharing of knowledge. Beta Testing of cold storage packaging design was performed in conjunction with testing at the Smithsonian Archives. Various packaging systems using the most currently available barrier films were tested for viability and durability. The data was shared and compared between the two institutions to determine the most effective and efficient packaging systems for NPS collections.

Ultimately, the NPS hopes to monitor all their cold storage units throughout the country through one database. This will allow NPS conservators to quickly retrieve data from individual sites to provide technical assistance and promote proper stewardship of film-based photographic collections.

For more information, see the NPS Conserve-o-grams on cold storage that were developed over the course of this project.
http://www.nps.gov/history/museum/publications/conserveogram/cons_toc.html#collectionpreservation

Additional online training is available at:
http://www.nps.gov/history/museum/coldstorage/NPSColdStorage.swf

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A GUIDE TO FIBER-BASE GELATIN SILVER PRINT CONDITION AND DETERIORATION

GAWAIN WEAVER

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado

Abstract

The author presents information from his research "A guide to fiber-base gelatin silver print condition and deterioration" conducted during his 2005-2007 fellowship in the Advanced Residency Program in Photograph Conservation at George Eastman House and the Image Permanence Institute.

The gelatin silver print was one of the most common forms of 20^{th} century visual communication. From the fine arts to journalism to snapshots, gelatin silver prints are present in large numbers in museums, archives, and family photograph albums. Understanding their condition and deterioration at various levels of entry is important for the conservator, archivist, curator, and connoisseur. An understanding of the basic mechanisms of deterioration and their visible results yields great insight into the history of a print. It also brings deeper understanding of how prints should be cared for, and the result of their neglect.

"A guide to fiber-base gelatin silver print condition and deterioration" is a 41-page illustrated guide to how and why gelatin silver prints deteriorate, and includes a 2-page deterioration chart, diagrams, and photographic illustrations of 15 forms of print deterioration. It is available for download as a PDF file from the author's website: http://gawainweaver.com/library/.

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Tip: The Use of Inkjet Copiers to Transcribe Historical Inscriptions

Andrea Youngfert and Brenda Bernier

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado
Presented as a poster at the 2008 Society of American Archivists Annual Meeting in San Francisco, California

Introduction

Preserving information contained in historical inscriptions is a constant need in archival practice, permeating the boundaries of academic, governmental, and scientific institutions. Often many hours and dollars are spent having staff manually copy historical inscriptions from their original enclosures onto new, archival storage materials. And commonly, necessary rehousing projects are indefinitely postponed due to labor cost or fear of transcription error, particularly in cases dealing with technical inscriptions, those that are partially illegible, or inscriptions in a foreign language. By utilizing an inkjet copier, transcription error is eliminated. The overall costs are also greatly reduced, making seemingly impossible projects suddenly much more feasible.

Pilot Project

In a trial project at Harvard University Library's Weissman Preservation Center, a 3-in-1 inkjet printer/copier was used, specifically the Epson Stylus CX6000, to efficiently copy 1,700 historical inscriptions from original negative envelopes onto archival storage enclosures (Figure 1). The 3-in-1 inkjet copier system is commonly used in household printing when connected to a personal computer, but by using the inkjet copier independently, without a computer component, a more user-friendly machine is adapted for streamlined institutional use.

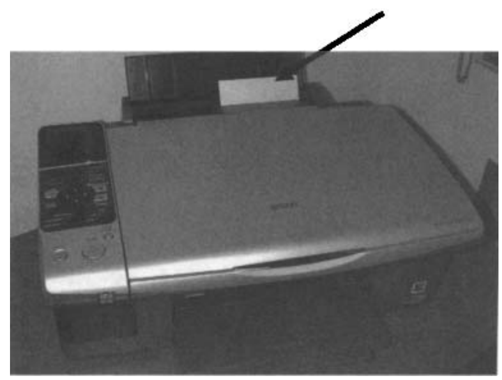

Figure 1. Epson Stylus CX6000 3-in-1 Inkjet Printer/Copier. New archival sleeve seen at arrow.

The 1,700 negative enclosures that were rehoused in this pilot project are from the Philip Beam Negative collection at the Fine Arts Library of Harvard College Library. The collection contains images of various important works of art from around the world. The negatives were previously housed in acidic enclosures, all of which were yellowed and brittle. Each enclosure had important art historical information written on it, including the artist's name, title of work, date, and/or institution where it was displayed.

Most enclosure writing was legible, but others were more difficult to decipher. Usually in rehousing projects such as this, the inscriptions would be copied to the best of the person's ability, with the hope that little transcription error would occur. By implementing the 3-in-1 inkjet copier to physically copy the original enclosure, transcription error is eliminated while also allowing for the preservation of original handwriting and penmanship, which in some cases can give additional information.

Figure 2. Original enclosure on scanning bed, black and white copy on archival negative sleeve in hand

Methods and Materials

First, the original negative envelope was placed on the scanning bed of the 3-in-1 system, face down and in the correct orientation. The "Draft" setting was used to minimize ink use and the 4x5 setting was chosen as the new envelope size on the printer. The new archival enclosure was placed in the feeder. Lastly, the "Copy" button was pressed, and the original enclosure's information was copied onto the new archival envelope, yielding the correct orientation and size. This can be done in either "Color" or "Black and White" depending on the settings chosen (Figure 2). Once the process was established, it only took a few seconds for each enclosure. Again, the printer/copier was used without a computer and no files were saved.

The 3-in-1 system retailed in 2008 for approximately $100, and the pigment-based inks cost another $125. Working with 1,700 enclosures during the pilot project, roughly 7 cents was spent per enclosure on ink, while simultaneously saving approximately 20 hours of labor.

Permanence of Pigment-Based Ink System

Henry Wilhelm has conducted extensive preliminary research on the permanence of various printers and printing inks. His results for the Epson Stylus CX6000 and the Epson DURABrite Ultra pigmented inks can be found on his website at, www.wilhelm-research.com. While other 3-in-1 systems could work equally well for such a project, the CX6000 was chosen because of its relatively low cost, usage of pigment-based inks, and print permanence ratings assigned by Wilhelm. Some of his findings of the printer and ink system that were promising for this application were the light stability, resistance to high humidity, and color balance ratings. Since the original enclosures can be printed in both color and black and white, it was deemed desirable for the color balance to be stable.

Drawbacks and Enhancements

While using this system does save time and resources, there are some drawbacks. Inkjet prints can be water soluble, therefore the water solubility of this ink system was tested before use in this application. We wanted to be sure that both the negatives and the integrity of the inscriptions were not at increased risk should the collection become wet in the future. In our tests, inks did not bleed through the enclosure, so it would likely not transfer to the negatives in a real water event. Also, while there was some minor bleeding, the inscriptions were still completely legible after submerging in water and then allowing to air dry.

When experimenting with the copying of very light pencil inscriptions, there was no way to manually adjust the density on the CX6000 3-in-1 system itself, as was possible with older models. Ultimately density manipulation was achieved through colored filters (available from stage lighting suppliers), which were used between the original and the glass directly on the scanning bed. This offered the manipulation sometimes necessary to achieve a successful copy. Yet, while the original inscription was darkened by the colored filters, so too was the background of each enclosure, causing a darker background tone to be copied overall.

The copier works best on 5x7 or 8x10 archival sleeves, however we have used it on 4x5 sleeves and sleeves that were subsequently cut even smaller. Printing directly on four-flap enclosures was occasionally successful in tests, but proved to be difficult and often wasteful in practice.

Since the time of the original purchase of our 3-in-1 printer (2008) it has become increasingly difficult to find similar printers available on the market. Newer designs tend to have the paper feed tray at the bottom of the printer. This type of feed requires the archival sleeve to travel around more rollers as it is printed, increasing the risk of paper jams and likely making it a poor design choice for this application.

Andrea Youngfert, Conservation Technician for Photographic Materials
Brenda Bernier, Paul M. and Harriet L. Weissman Senior Photograph Conservator
Weissman Preservation Center, Harvard University Library

Acknowledgements

We would like to express our gratitude to our colleagues: former technician Erin Cral, who also worked on the pilot project, current technician Maggie Wessling, who helped perfect the system on other projects, and staff of the Fine Arts Library. We are also very appreciative of the support of the Weissman Preservation Center, Harvard University Library, Harvard College Library, the Andrew W. Mellon Foundation, and Paul and Harriet Weissman.

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History and Stylistic Evolution of Gelatin Silver Developing-Out Paper

Paul Messier

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado

Abstract

Ubiquitous and ordinary, the "black and white" photograph represents one of the most significant, widespread and accessible imaging technologies in history. This success is owed to the rare combination of attributes possessed by gelatin silver developing-out papers. Well processed, and properly stored, a gelatin silver print has outstanding permanence especially as compared to almost any other photographic printing process. Gelatin silver papers have reliable handling properties in the darkroom, allowing quick and large-scale production by amateurs and professionals alike. Capable of subtle manipulations are available in great variety, the paper is a versatile medium for artistic expression, bearing masterworks of modern and contemporary art.

With darkrooms shutting down, photographers, curators, collectors and conservators are being challenged to mark the historic transition away from chemical photography and interpret the gains and losses. Part of this accounting is the growing realization that any understanding of a photographic print must include a comprehension of the historical development, expressive potential and stylistic qualities of photographic paper. This presentation covered the history of gelatin silver developing-out papers from their inception in the late 19th century to present day.

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ADVANCEMENTS IN DAGUERREOTYPE RESEARCH USING CONFOCAL AND ELECTRON MICROSCOPY

PATRICK RAVINES

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado

Abstract

George Eastman House International Museum of Photography & Film (GEH) has been leading a collaborative investigation of the surface characteristics, material science, and the effects of treatments on daguerreotypes. The partners in this collaboration with GEH are: the NanoImaging Laboratory, Center for Imaging Science, Rochester Institute of Technology (RIT); the Foundation Science and Technology Center (now Corporate Engineering & Analytical Science), Eastman Kodak Company; and NanoFocus, AG. This paper presented initial results of these ongoing investigations that are yielding new information on the material nature of the daguerreotype surface.

One of our research efforts has been in the application of the non-perturbing (non-contact, non-invasive and non-destructive) optical and surface metrological techniques such as confocal scanning disc microscopy to daguerreotypes. White light confocal disc scanning microscopy is shown to be a useful technique for examining the 3D ultra-fine structure of the daguerreotype image. This technique provides exceptional submicron data that can be projected into three-dimensional imaging programs to document the daguerreotype surface structure. Examination at this level allows for measuring changes due to environmentally induced deterioration, and provides comparative data before and after chemical and physical treatment (Ravines et al. 2008). Examples of the application of confocal microscopy showed its potential in assisting the conservator to evaluate both daguerreotype condition and treatments performed on the fragile image structure. To date this instrument is proving to be a powerful research tool suited to the investigation of the daguerreotype image surface (Ravines, P., C. M. Wichern & J-j. Chen. 2008).

The second area of our exploration presented the initial stages of an electron microscopic study of modern and historic 19th century daguerreotypes using state of the art field emission ultra-high resolution scanning electron microscopes (FE UHR SEM) with magnifications ranging from 100,000 to 250,000x, focused ion beam scanning electron microscopes (FIB SEM) to cross section daguerreotypes, and transmission electron microscopes (TEM). These investigations are corroborating the metallurgical nature of the silver mercury amalgam image particles firstly done by Swan et al. (1979) and then by Barger and White (1991). The new images are demonstrating for the first time the nano-texture characteristics of the background surface, and that image particles also show an even finer nano-textured surface than the background surface. The daguerreotypes investigated appear to show nano-textured gold-capped silver nodules ranging in size in the tens of nanometers and ungilded smaller narrower nodule boundary regions. These ungilded nodule boundary regions expose silver metal to atmospheric contaminants thereby allowing tarnish to develop. The nano-texture features of the background surface provide

information that potentially explains the occurrence of tarnish as corrosion in the inter-nodular boundary regions on gilded daguerreotype surfaces.

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An Examination of the Short and Long Term Effects of Light Bleaching Silver Gelatin Photographs

Rachel K. Wetzel

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado

Abstract

Light bleaching can often be a successful means of reducing discoloration products in photographic materials, though its short- and long-term effects are unknown. This paper explored the changes that occurred when silver gelatin developed-out photographs that were artificially yellowed by two different methods were subjected to aqueous treatments including water washing, light bleaching and light bleaching with hydrogen peroxide. These samples were evaluated alongside an untreated control to monitor any changes in the strength of the gelatin emulsion, loss of silver density and potential color changes in the light tones and white areas of the photographic image. The samples were evaluated visually and instrumentally after chemical development, after artificial yellowing, after aqueous treatment and finally after artificial aging. The results of the light bleaching treatments were found to vary depending on the type of yellowing that was induced. To further solidify the results, the experiment was repeated on a set of naturally yellowed silver gelatin photographs, which were found to mimic the results of the experimental sample set used in the controlled portion of this experiment.

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FOAM (12), BY ZHANG HUAN: THE TREATMENT OF AN OVERSIZE CHROMOGENIC PRINT

THOMAS M. EDMONDSON

Presented at the PMG session of the 2008 AIC Annual Meeting in Denver, Colorado

Abstract

This work by Chinese photographer and performance artist Zhang Huan required treatment to correct a welt or area of detachment of the photographic print from its mount board. The welt was located in the proper lower right quadrant, and extended nearly 6" into the bottom center image area with about ¼ - ½ " rise. This presentation discusses the treatment process starting with the initial and misleading examination that led to mistaken conclusions regarding the course of treatment, describing the various steps of the treatment and the difficulties and complications that were encountered, and concluding with observations and commentary about the experience. About Huan from 3 Quarks Daily: "In China, people thought I should be in a mental hospital," says Zhan, smiling. "In New York, they understood what I was doing as art."

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Research Themes Explored by the Advanced Residency Program in Photograph Conservation

Stacey VanDenburgh

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract
The Advanced Residency Program in Photograph Conservation (ARP), a collaborative fellowship program at George Eastman House, International Museum of Photography and Film and the Image Permanence Institute of the Rochester Institute of Technology, provided advanced training and research opportunities to five groups of eight fellows for ten years. Primarily funded by the Andrew W. Mellon Foundation in 1999, this unique and ambitious program concluded in August 2009.

When the program began, it was thought that fellows would come to Rochester to study and hone their conservation skills, much in the way doctors complete their education with medical residencies in hospitals. What happened was, in addition to the advanced, post-graduate training, certain important research themes were established early on. Many of these themes were developed further in subsequent cycles. These research topics included characterization, connoisseurship, negatives, daguerreotypes, and conservation. This article provides an overview of the research themes explored by the fellows in their major research projects.

Introduction
The purpose of this paper is to review the research themes explored by the fellows of the Advanced Residency Program in Photograph Conservation (ARP). The program was located in Rochester, New York because this city was the center of the photography industry in the United States for most of the 20th century. Combined with the remarkable collections of photography at George Eastman House, and the resources of Image Permanence Institute (IPI) at the Rochester Institute of Technology, it is no wonder that this is the place where Angelica Rudenstine of the Andrew W. Mellon Foundation selected to locate the program. Of course, the proven excellence of well known educators Grant Romer in the conservation department of George Eastman House and Jim Reilly at IPI helped to ensure the program's location.

Initially, the purpose of the ARP was not to produce important research for the field of photograph conservation, but rather to provide advanced post graduate school training to conservators wishing to pursue a career in photograph conservation. Similar to a medical residency, eight fellows were selected for each two year cycle from a large pool of applicants. Over the first year of the program they followed a curriculum to catch them up on the core knowledge needed by photograph conservators. This curriculum included courses such as historic process workshops with Mark Osterman, preservation and environmental management courses with Jim Reilly and Jean-Louis Bigourdan at IPI, the chemistry of deterioration with Douglas Nishimura, treatment practicum with conservators at GEH and an introduction to the various instruments available for materials analysis, now taught by Greg Smith at the Art Conservation Program at Buffalo State College. Fellows were encouraged to build their portfolio and assist the conservator in charge by treating objects from the museum's collection. The second year of the fellowship was devoted to producing a "Capstone Research Project" in order to give each fellow the opportunity to explore his or her own interests in depth. The fellows were not assigned a given topic, but were encouraged to follow their interests and perhaps be inspired by something they discovered in the collection, through a treatment process or through some experience they were exposed to during the delivery of the curriculum. Now that the fifth and final cycle has concluded, it is clear that many fellows were influenced by the research projects of previous cycles. The research projects of the ARP have not only helped fellows with their careers, but also they have provided funding opportunities and inspiration for new directions for the host institutions and have produced important advancements for the field of photograph conservation.

Illustration number one gives the titles of each capstone research project organized chronologically by cycle and alphabetically by the name of fellow in that cycle. By no means does this list represent all of the research produced by the program, but what was considered to be the most important research project produced by a each fellow. Additional research and process intensives can be found in the portfolios of each fellow in the Conservation Library at George Eastman House. All of the research produced by the ARP can be found on-line at www.notesonphotographs.org. Illustration number two categorizes each project into five topics: characterization, connoisseurship, negatives, daguerreotypes and conservation.

Illustration number one

Capstone Research Projects for Five Cycles

First Cycle 1999-2001
Alexandra Botelho
The Durieu Album: Early Nineteenth-Century French Photographic Techniques and Studies of the Nude
Jens Gold
Investigation of Methods Used to Misrepresent the Conditions and the Age of Photographs
Dana Hemmenway
The Making of a Conservation Database for the Photographs of Hill and Adamson at George Eastman House
Kathrine Kilde
The Photographic Activity Test: What Is It and How Is It Useful?
Tania Passafiume
A Silver Gelatin DOP Sample Book and a Characteristic Catalogue of the Edward Weston Collection at George Eastman House
Klaus Pollmeier
Documentation and Characterization of Photographic Surfaces by Edge Reflection Analysis

Second Cycle 2001-2003
Elena Bulat
Conservation Issues of Paper Stereo Transparencies
Jiuan-jiuan Chen
Edge Reflection Analysis (ERA): A New Technique for Non-contact Texture Analysis of Glossy Surfaces
Kate Jennings
Research into the Conservation of Paper Negatives
Hanako Murata
Secondary Protective Housing System for Daguerreotypes
Sara Shpargel
Environmental Management through the Climate Notebook®: A Case Study on the Process of Achieving Climate Control at George Eastman House
Fernanda Valverde
Guide for Identification and Preservation of Negative Collections

Third Cycle 2003-2005
Corinne Dune
Care of Rare and Unusual Photographs: A Methodology
Lydia Egunnike
Opalotypes: Their Evolution and Care
Lene Grinde
Conservation of Stereo Daguerreotypes
Pip Morrison
The Effects of Solvents on Silver Dye Bleach Materials
Mariana Planck
Preserving B&W Negatives from Physical Damage: Handling Methods and Enclosure Design
Claire Tragni
Use of Ultraviolet-induced Fluorescence for Examination of Photographs
Ralph Wiegandt
Investigation into Traditional and Modern Daguerreotype Housing Systems from a Conservation Viewpoint

Fourth Cycle 2005-2007
Karina Beeman
A Guide for Establishing a Photograph Conservation Laboratory
Luisa Casella
Establishing a Wiki Resource in Fine Photography Connoisseurship and Conservation
Rosina Herrera
Alfred Stieglitz' Lantern Slides: History, Technique and Technical Analysis
Gustavo Lozano
Nineteenth Century Albums & Photo Books: History, Technology and Conservation
Patrick Ravines
Surface Profilometry: a New Approach and Method in Photograph Conservation
Gawain Weaver
Deterioration of Fiber-base Gelatin Silver Prints

Rachel Wetzel
The History of Light Bleaching Techniques Used in Photograph Conservation and the Examination of the Short-Term and Long-term Effects of Light Bleaching Silver Gelatin Photographs
Katharine Whitman
The History and Conservation of Glass Supported and Protected Photographs

Fifth Cycle 2007-2009
Caroline Barcella
Conservation Project of the Manila Daguerreotypes
Valentina Branchini
The Photographs of Alvin Langdon Coburn at George Eastman House
Mirasol Estrada
A Study in Photograph Conservation Problem Resolution: A Conservation Plan for the "Mexican Suitcase"
Alejandra Mendoza
Current Status of Treatment Practices in Photograph Conservation
Anna Michas
An Introduction to the History, Identification and Collectability of Early Postcard Prints
Hyejung Yum
A Brief History of Early Photographic Paper

Illustration number two

Capstone Research Projects Organized by Topic

Characterization
Documentation and Characterization of Photographic Surfaces by Edge Reflection Analysis – Klaus Pollmeier (2001)

A Silver Gelatin DOP Sample Book and a Characteristic Catalogue of the Edward Weston Collection at George Eastman House – Tania Passafiume (2001)

Edge Reflection Analysis (ERA): A New Technique for Non-contact Texture Analysis of Glossy Surfaces – Jiuan-jiuan Chen (2003)

Opalotypes: Their Evolution and Care – Lydia Egunnike (2005)

Use of Ultraviolet-induced Visible Fluorescence for Examination of Photographs – Claire Buzit Tragni (2005)

Deterioration of Fiber-base Gelatin Silver Prints – Gawain Weaver (2007)

A Brief History of Early Photographic Paper – Hyejung Yum (2009)

An Introduction to the History, Identification and Collectability of Early Postcard Prints – Anna Michas (2009)

Connoisseurship

The Durieu Album: Early Nineteenth-Century French Photographic Techniques and Studies of the Nude – Alejandra Botelho (2001)

Investigation of Methods Used to Misrepresent the Conditions and the Age of Photographs – Jens Gold (2001)

The Making of a Conservation Database for the Photographs of Hill and Adamson at George Eastman House – Dana Hemmenway (2001)

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Establishing a Wiki Resource in Fine Photography Connoisseurship and Conservation – Luisa Casella (2007)

Nineteenth Century Albums & Photo Books: History, Technology and Conservation – Gustavo Lozano (2007)

The Photographs of Alvin Langdon Coburn at George Eastman House – Valentina Branchini (2009)

Negatives

Guide for Identification and Preservation of Negative Collections – Fernanda Valverde (2003)

Research into the Conservation of Paper Negatives – Kate Jennings (2003)

Preserving B&W Negatives from Physical Damage: Handling Methods and Enclosure Design – Mariana Planck (2005)

The History and Conservation of Glass Supported and Protected Photographs – Katharine Whitman (2007)

A Study in Photograph Conservation Problem Resolution: The Image Duplication and Preservation Proposal of the "Mexican Suitcase" – Mirasol Estrada (2009)

Daguerreotypes
Secondary Protective Housing System for Daguerreotypes – Hanako Murata (2003)

Conservation of Stereo Daguerreotypes – Lene Grinde (2005)

Investigation into Traditional and Modern Daguerreotype Housing Systems from a Conservation Viewpoint – Ralph Wiegandt (2005)

Surface Profilometry: a New Approach and Method in Photograph Conservation – Patrick Ravines (2007)

Conservation Project of the Manila Daguerreotypes – Caroline Barcella (2009)

Conservation
The Photographic Activity Test: What Is It and How Is It Useful? – Kathrine Kilde (2001)

Environmental Management Through the Climate Notebook®: A Case Study on the Process of Achieving Climate Control at George Eastman House – Sara Shpargel (2003)

The Effects of Solvents on Silver Dye Bleach Materials – Pip Morrison (2005)

A Guide for Establishing a Photograph Conservation Laboratory – Karina Beeman (2007)

*The History of Light Bleaching Techniques Used in Photograph Conservation and the Examination of the Short-Term and Long-term Effects of Light Bleaching Silver Gelatin Photograph*s - Rachel Wetzel (2007)

Current Status of Treatment Practices in Photograph Conservation – Alejandra Mendoza (2009)

Characterization
In the mid- 1990's there was a meeting of photo conservators at the Getty Museum where it was determined that the field needed to characterize the materials of photography much in the way that had been done in other conservation disciplines such as paintings or objects. After all, how can we understand the nuances of the materials we treat if we can not agree on definitions and appearances of the wide variety of objects that we call photographs? Characterization develops a formalized approach to look at photographs.

In 2001, during the first cycle of the ARP, two fellows produced projects that advanced the field of characterization. Klaus Pollmeier's project on the *Documentation and Characterization of Photographic Surfaces by Edge Reflection Analysis* and Tania Passafiume's work on *A Silver Gelatin DOP Sample Book and a Characteristic Catalogue of the Edward Weston Collection at George Eastman House* were very fruitful.

In 2003, second cycle fellow Jiuan-jiuan Chen expanded upon an aspect of Klaus' project and explored *Edge Reflection Analysis (ERA): A New Technique for Non-contact Texture Analysis of Glossy Surfaces*. During this time, perhaps inspired by Paul Messier's impressive collection of photographic paper samples, Jim Reilly started acquiring paper sample books produced by the Eastman Kodak Company. In the third cycle of the ARP, Jim encouraged the fellows to work together on a group research project, which characterized the surface of gelatin silver prints produced by Kodak in the 20th century. The fellows developed a system to document the various sheens and textures of the papers, as well as a means to compare paper cross sections from each paper sample. Work on this project continued mainly at IPI during the fourth cycle with Ryan Boatright, resulting in the creation of the Digital Sample Book, an interactive website where the user can compare various types of photographs and print samples side by side. Fourth cycle fellow Gawain Weaver's project on *A Guide to Fiber-Base Gelatin Silver Print Condition and Deterioration* landed him a position with IPI where he worked with Ryan to develop this website further. This website was improved and developed further into Graphics Atlas www.graphicsatlas.org.

Connoisseurship

This was a concept developed and encouraged by Grant Romer, where one combines the skills of the art historian with the knowledge base and analytical tools of the conservator, thereby gaining a deeper understanding of a photographer's work. So, not only does one examine the biography, provenance, exhibition history, significant collections and references for a given photographer, but also notes the key attributes of the photographer: photographic techniques, significant marks, mounting techniques, conservation issues, and subject series. This approach of truly understanding the fine photograph has become such a way of life at George Eastman House, that it is surprising to meet a researcher who can wax rhapsodic about the symbolism and social context of an image, say something about composition and positive and negative space, but can not identify the process or understand how the deterioration mechanism has contributed to its present day appearance. Many fellows in each cycle devoted their capstone project to this deeper understanding, beginning with Alexandra Botelho's work on the Durieu Album, Dana Hemmenway's work with Hill & Adamson, that finally in the fourth cycle, Luisa Casella thought it would be useful if all of these important observations could be collated on a website, based upon a wiki platform, called the George Eastman House Connoisseurship Resource. This project was so well received at the museum that it inspired a successful proposal to IMLS to develop this website further. So for almost two years now, Sheila Foster and Emily Welch have continued to work on this website, encouraging collaborations with and submissions by scholars and collections outside of George Eastman House. This website is now called Notes on Photographs www.notesonphotographs.org.

Negatives

Great advancements were made in the study of photographic negatives in the ARP, beginning with second cycle fellow Kate Jennings' *Research into the Conservation of Paper Negatives*. Kate had observed a trend in museums and galleries to display these negatives as photographic objects and became concerned with their long-term preservation. Also, in the second cycle, Maria Fernanda Valverde was interested in conservation education. She worked closely with IPI staff to produce a beautiful and informative poster and accompanying booklet, *A Guide for Identification and Preservation of Photographic Negatives.* Third cycle fellow Mariana Planck, who like Fernanda came from Mexico, where they have many thousands of negatives in collections, devoted her research project to *Preserving B&W Negatives from Physical Damage: Handling Methods and Enclosure Design.* Mariana observed and documented hundreds of traditional enclosures before devising her own solution.

Fourth cycle fellow Katharine Whitman went a step further by producing her project, *The History and Conservation of Glass Supported and Protected Photographs.* Kate worked under the supervision of Ralph Wiegandt on the treatment of a seminal historical glass inter-positive image of Abraham Lincoln. Referred to as the Hesler Ayres Interpositive, working on the treatment of this national treasure led Kate to examine the types of glass used in photography. The innovative treatment solution enabled the portrait of Abraham Lincoln to be on exhibit at George Eastman House for bicentennial of Lincoln's date of birth in 2009.

Fifth cycle fellow Mirasol Estrada assisted The International Center of Photography (ICP) with a conservation plan for the long-term preservation and exhibition plan for the so-called Mexican Suitcase, a rediscovered object that contains many tightly wound rolls of 35mm negatives taken of the Spanish civil war by noted photojournalists Robert Capa, Gerda Taro and David "Chim" Seymour. Mirasol worked with Grant Romer and others to design a device that would enable the photographers at ICP to safely unroll the film such that they could be photographed digitally. The device was called the Planar Film Duplicating Device or PFD2, and already there are other photography and film archives that have expressed interest in owning one.

Daguerreotypes

It would be a challenge to study in Rochester with Grant Romer and not learn about daguerreotypes. It is interesting that the field of photograph conservation still does not entirely understand and agree upon treatment regimens and preservation plans for these precious objects created over 150 years ago. In the second cycle, Hanako Murata methodically researched the various historic binding systems for daguerreotypes in her work, *Secondary Protective Systems for Daguerreotypes*. She also researched the efficacy of the commonly used present day binding systems and supports and found that these various systems did not prevent moisture and acidic elements from permeating the package.

The third cycle began when solutions were being developed for the exhibition *Young America: the Daguerreotypes of Southworth & Hawes.* Many innovations were developed for this exhibit including a unique mounting and lighting system. But perhaps the greatest accomplishment was the development of the preservation package, the work of Ralph Wiegandt, who as a third cycle fellow brought his ingenuity and experience as a skilled objects conservator to the discipline of photo conservation. The preservation package did not allow air and pollutants to enter to compromise the daguerreotype plate. Also, a great contribution was made by third cycle fellow Taina Meller who developed a systematic way to monitor the condition of these precious objects as they traveled from each of the three venues of this exhibit.

In the fourth cycle, Patrick Ravines applied 3D surface profilometry techniques to quantify the surface structure of the daguerreotype.

The awareness raised by these ARP research projects concerning the daguerreotypes of Southworth & Hawes enabled some wonderful objects to come to the lab at George Eastman House for treatment. An example is the Cincinnati Waterfront Panorama by Fonteyn & Porter that is owned by the Cincinnati Public Library, but was languishing in remote storage as the object was considered too fragile for display. This object is a truly a national treasure and was put on display at the Crystal Palace Exhibit in London in 1851. The treatment developed and executed by Ralph Wiegandt, who by now had joined the faculty of the ARP, enabled the Cincinnati Public Library to put this marvelous object safely on display. I should mention that Patrick Ravines and many fourth cycle fellows assisted Ralph with this monumental treatment.

Concurrent to the Southworth & Hawes projects, second cycle fellow Elena Bulat performed a survey of Russian photographs in St. Petersburg led her to conceive of a number of initiatives to help that country preserve its national photographic heritage. After two successful symposia, a two-phased proposal, written by Elena, was granted by the Mellon Foundation to survey the photographs of the State Hermitage Museum. The first part of this grant was to stabilize their collection of daguerreotypes. This historic collection of 83 daguerreotypes either once belonged to the czar or were accepted from aristocratic families during the revolution. With Karina Beeman, Grant Romer traveled to St. Petersburg to educate the conservation and curatorial staff of the State Hermitage Museum about how to care for and stabilize their daguerreotypes and help publish them in a book.

Also during the fourth cycle, fellows Rosina Herrera and Luisa Casella surveyed the photograph collection at the Hispanic Society in New York City. During this survey they made an important discovery of a group of 16 daguerreotypes that are the earliest photographic record of the Philippines and are the only known group of daguerreotypes of Asia, as there are only a few scattered daguerreotypes existing in other collections. In the 1920's these objects were not accessioned into the Hispanic Society's collection since they represented Spanish colonial objects and not items directly from Spain. The Hispanic Society did not have the means to conserve these objects so they came to the lab at George Eastman House at the beginning of the fifth cycle for treatment. The treatment of these objects was started by Rosina Herrera and Karina Beeman. Since fifth cycle fellow Caroline Barcella took charge of the treatment of the so-called Manila Daguerreotypes, it became the subject of her Capstone Research Project. In addition to stabilizing the condition of these daguerreotypes, Caroline perfected a method of creating gilded lines on glass, so she could recreate the passé partout presentations of these daguerreotypes.

Additional grants related to the Southworth and Hawes daguerreotypes were developed by Ralph Wiegandt: a Mellon funded pilot daguerreotype documentation project with the MFA Boston as lead agent and the Metropolitan Museum of Art as collaborators to develop an on-line website to share our collections of Southworth & Hawes daguerreotypes and monitor their condition; a prestigious Save America's Treasures grant to preserve George Eastman House's collection of 1,600 daguerreotypes by Southworth & Hawes, and a Getty Foundation grant for a collaborative survey of Southworth & Hawes daguerreotypes.

Conclusion
There are, of course, many other research directions that could be addressed in this paper. For instance, there were many projects that addressed various aspects of treatment within the discipline of photograph conservation.

The fifth cycle of the ARP ended in August 2009. The conservation department of George Eastman House and the research scientists at IPI will continue to educate photo conservators, researchers, collectors and interested people for years to come.

The research of the ARP did not happen in an insular vacuum that exists only in Rochester, New York. Of course, the faculty and fellows are inspired by trends and the needs of other institutions, collectors and conservators in the field. We actively consult with other institutions and people and share our research findings at conferences, in publications and on-line. The research projects of the ARP have not only helped the careers of the fellows, helped our institutions to better care for photographs, but have also provided the field with many directions for the future.

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CONSERVATION AND DIGITIZATION AT THE BUDDHIST ARCHIVE OF PHOTOGRAPHY IN LUANG PRABANG, LAOS

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ABSTRACT

The Buddhist Archive of Photography is a steadily growing collection of photographs that is based in Luang Prabang, the historic royal city in the heart of Laos. Having recognized that the photographs taken by local monks over the past 120 years form an important part of the cultural and religious heritage of the many Buddhist monasteries within the city, the late Venerable Abbot Phra Khamchan Virachitto founded this archive in 2006/2007. A pilot project and two consecutive Major Reseach Projects of the Endangered Archives Programme of the British Library allowed for the examination of the situation of the many thousands of photographs in the Luang Prabang monasteries, the invitation of a photograph conservator to Luang Prabang to act as a consulting expert in the ensuing conservation efforts, and the establishment of a functioning photograph archive with a digitization program at the monastery of Vat Suvanna Khili. This article describes a survey of the collections in the monasteries, the implementation of improvements in digitization methods and storage facilities, and basic handling and conservation efforts. Local materials and craftsmen were used exclusively for designing the storage enclosures and facilities of the archive, and, with the help of a selected number of young Lao men who had once served as monks and novices, a practical Lao-English dictionary for terms of photograph conservation was established. The outlook lists the challenges that will need to be addressed to maintain this small but important archive in a tropical setting in the future.

INTRODUCTION

Since the summer of 2006, the historic city of Luang Prabang in northern Laos has been witnessing increasing activity in the field of the preservation of photographs. A number of monks and abbots of the many Buddhist monasteries in the city have been taking and collecting photographs for many decades, resulting in a significant but yet hidden treasure trove of the photographic history of Laos. Phra Khamchan Virachitto, highly venerated Abbot of the monastery Vat Saen Sukharam from 1920 to 2007, was one of the most learned and influential abbots in Laos, and he was also the central figure in the ensuing projects that led to the founding of the Buddhist Archive of Photography in 2007 (Fig. 1).

Holding over 20,000 photographs today, the archive covers approximately 120 years of Buddhist photography. Since photography's early times, Luang Prabang, as a royal city, has had an élite of learned people who loved creating and collecting photographs. From his young age, the Venerable Abbot had been one of them, and he was in a position to uphold his collection even during the times when the possession of images linked to the past, royalty, or certain religious practice represented a danger – and when most members of this élite perished or went into exile. The photographs have escaped loss, dispersion and arbitrary destruction that have afflicted many historic collections of photography in South East Asia as a result of this region's extraordinary political and social changes in the 20th century, only because the Venerable Abbot, who for more than 70 years had been a collector of photographic documents, found ways to astutely gather, protect and, for many years, hide the archive from any intrusion and inspection by outsiders.

A particular quality of the material lies in the fact that it offers a view from the inside: all photographs were taken by Buddhist people involved in the ritual life of the city or by monks who documented their own world with a camera. The archive therefore shows a perspective that differs greatly from western ethnographic photography of the past or from the type of photographic reportage we know of today.

Fig. 1. Venerable Abbot Phra Khamchan Virachitto, aged 73, with alms bowl and meditation tent at Vat Pha Pon Pao, 1993. (EAP.A0174, Buddhist Archive of Photography, chromogenic print)

The important and vulnerable material found in the monastery has always been highly endangered. Curiously, the fact that few people know about it represented one of the biggest threats: lay people and monks of the monastery did not know how to deal with the material or how to resist possible commercial interests in the older photographs. The photographs have also suffered from the ravages of a tropical climate and excessive handling over the years.

Aware of the significance of this collection and the imminent dangers facing it, German photographer Hans Georg Berger in 2005 asked the Venerable Abbot to permit him to apply to the Endangered Archives Programme (EAP) of the British Library, London, for funding to protect the photographs from their sure destruction. A pilot project was approved by EAP, and two field research periods (July/August 2006 and January/February 2007) were carried out, during which the situation of the many thousands of photographs was examined, talks were held between the organizers, relevant Lao government agencies, and the monks, and a small team was formed. The pilot project team started to interview the Venerable Abbot on the contents, age, and significance of the photographs during the research periods. He was able to identify most of the depicted persons and readily communicated his knowledge to the members of the team, all of whom were former monks who had been ordained by him. Part of the urgency for this work related to the extraordinary chance to conduct these interviews, since it would be impossible to acquire this contextual information at subsequent occasions.

With the success of the pilot project, EAP awarded funding for a first Major Research Project to Hans Georg Berger that ran from July 2007 to June 2009. As a photograph conservator, I was asked to participate as a consultant in the conservation efforts during the month of July 2007, and I returned to help wrap up the project in June 2009. Shortly before this first project ended, funding for a follow-up EAP Major Research Project was procured by Mr. Berger. This new situation will enable the archive to function and continue to grow until mid 2011.

Apart from securing the original material from loss, theft, and deterioration, the archive has focused on digitization of the photographs as a measure of rescuing at least the images through reformatting. Digitization will also allow for accessing the photographic images without having to touch the originals, many of which are very fragile. Access to the digital images and to information on the archive's holdings will be given through the Buddhist Archive itself, the National Library of Laos in the capital, Vientiane, and the British Library's Endangered Archives Programme in the future. The National Library of Laos, the project's official partner from the side of the Lao government, and the British Library will hold full sets of digital copies and listings of all of the catalogued photographs. The British Library will be responsible for the long term updating of the digital data. A starting point for researchers is the EAP's website at www.bl.uk/about/policies/endangeredarch/homepage.html.

One of the most important aspects of the research project has been the involvement of abbots and monks of the other monasteries; it has thereby found acceptance within the Buddhist community of monks, the "sangha". As it turned out, photographs were present in many monasteries in large numbers; these prints could also be secured. An important outcome of the research has been the preparation of biographies of the collecting monks and abbots and of histories of the respective monasteries. Finally, the images have been and will continue to be used to educate novices and laypeople in Laos on their heritage through a calendar and other planned publications such as schoolbooks.

At the beginning of the pilot project, in 2006, the Venerable Abbot was 86 years old. He hoped that the activity of the research team would enhance the sensibility of local townspeople for the significance of the collection, thereby making it more difficult to neglect or disperse his collection after his death. The Venerable Abbot's own intentions for the future use of the archive match those of the EAP project. On several occasions, he indicated that he had two motivations for the establishment of the archive: to preserve, in highly difficult times, the spiritual strength, uniqueness and beauty of Lao Buddhism for the Lao people of future generations, and to communicate the singularity of Lao Buddhism to people all over the world.

A SETBACK AND AN INCENTIVE

In 2007, I was honored to have an audience with the Venerable Abbot Phra Khamchan on my first day in Luang Prabang. Having been instructed on appropriate etiquette, I sat on the floor of his quarters at Vat Saen as he received my compliments, then he spoke to me through a translator for twenty minutes. Only two hours later, as I was looking through the first boxes of photographs, I was informed that the Abbot had just passed away. The whole town was stunned, and at the same time it was buzzing with energy and apprehension. The room with the photographs became out-of-bounds to aliens like myself, as valuable temple objects were locked away to protect them for the next two weeks, during which hundreds of lay people and monks came to pay their respect to the Abbot. This period ended with a fantastic funerary parade and cremation.

Fig. 2. This building at Vat Khili houses the Buddhist Archive of Photography.

With the collection in Vat Saen inaccessible, but with a strengthened sense of immediacy and importance of carrying out the Venerable Abbot's will to preserve and protect the historic photographs of Luang Prabang Buddhism, we decided to carry on with the project as best as possible: preparing everything so that once the collection became available again, the structure of the archive would be ready for it and work could commence. In the nearby monastery Vat Suvanna Khili the second floor of a building built in a mixture of French colonialist and traditional Lao architecture (Fig. 2) had been assigned to the project as a work space. Meanwhile, the sangha decided to permanently dedicate it to the Buddhist Archive of Photography.

The novices were very curious of our doings, and word spread throughout the monasteries that two foreigners, Mr. Berger and myself, along with three former Lao monks were searching for photographs. As a result, we began to receive photographs of all kinds from a large number of the town's monasteries. At the same time, official contacts were made with the leading abbots, who then granted permission for us to enter the living quarters ("kutis") and other monastery buildings, some of which had not been accessible for more than 20 years. Many of them did contain historic photographs. This was a wonderful development, since it showed us how widespread and common photography was in Luang Prabang. It was also, for all involved, a tribute to the Abbot's endeavor to unite the photographs of the region and protect them from being lost, stolen, or destroyed.

SURVEY OF THE COLLECTIONS

We had decided to schedule my first, one-month trip to Luang Prabang in 2007 at the very beginning of the project in order to acquaint the local team with my suggestions as early in the process as possible. A survey was carried out to find out more about the photographic processes, formats, quantities and conditions of the photographs in the collections of four monasteries of Luang Prabang. The survey was the basis for subsequent decisions on storage needs such as sleeve and box formats, quantity of enclosure materials to be ordered, the configuration of the Excel lists that we used to catalogue the collections, and the teaching of photographic processes to the project staff. With additional information from the ongoing work of the following two years and the growing holdings of the archive, the following summary of the collections as they stand in July 2009 can be made:

So far, photographs and related materials have been collected and examined from 13 monasteries and from two private collectors. While the subject matter ranges from the 1850s to 2009, the earliest prints found are from the 1890s (some photographs are reproductions of older images or paintings). The final number of the photographs in the Buddhist Archive cannot be given yet, since photographs are still being found in a number of monasteries in the city. However, over 15,000 prints were identified, cleaned, registered, digitized, catalogued, and stored in sleeves and boxes during the first two years. The large part are silver gelatin fiber-based prints and chromogenic RC-paper prints. Some silver gelatin RC-paper prints and chromogenic fiber-based prints were also found. Further processes include dye diffusion instant

Fig. 3. An assortment of photographs from the collection of Vat Saen Sukharam

prints, letterpress halftone prints, collotypes, rotary photogravures, and digital prints such as inkjet and electrophotographic laser prints. A few rare processes such as cyanotypes and photographs on porcelain plates were found. Some original paintings and some printed matter (book pages, certificates) were also accepted in the archive due to their contextual relevance. Over 1000 negatives were found; they include silver gelatin on glass and film in various formats. Chromogenic negatives and framed 35 mm color transparencies are also present.

The photographs were found loosely assembled in envelopes, plastic bags, and boxes, stacked in cabinets and in drawers, displayed in frames or albums (Fig. 3). Some individual album pages were simply nailed to the walls of the novices' living quarters. Many of the 35 mm negative strips were in the plastic or glassine sleeves supplied by the photo lab.

General Condition

In general, gelatin silver prints showed deterioration appropriate to their age: signs of use such as tears, folds, fingerprints, and surface dirt, and slight to moderate silver mirroring and fading. Termite and silverfish damage was extensive on these prints, but only seldom found on the chromogenic prints, presumably due to their RC-paper base. Mold growth was also more common on the gelatin silver prints, and it was often found in conjunction with water damage, leading to a powdery and stained emulsion and support. Most of the serious damage was water-related, either through the prints becoming wet or simply being in a humid climate for many years. Chromogenic prints from the 1970s through to the 1990s had suffered moderate to extensive color shifts towards red. Kodachrome and Ektachrome slides in respectively labeled cardboard mounts from the 1970s showed how stable the former can be: while the Kodachromes have only a slight bluish tinge, the Ektachromes have faded severely to a light red.

Frames

In every collection we found photographs in frames on the walls of the monastery buildings. They were, for the most part, in very poor condition, since they have been exposed to light, dust, water, environmental fluctuations, mold, and insects over many years. As a result of prolonged humid environmental conditions or liquid water leaking into the frames, about one third of the framed photographs have become partially adhered to the glass. Often, this problem is also the result of severe buckling of the print and its support and the lack of a window mat or spacers within the frame. Some of the frames had irregular backings: narrow plates of glass were used as a support, and this had caused irregular pressure on the back of the photograph, which in turn led to it adhering to the frame glass. Many of these prints also showed mold damage to the emulsion and the support. In one case, the paper support had deteriorated to the extent that it was impossible to open the frame without causing the disintegration of the paper and thus the loss of the image in that area.

None of the frames were sealed on the verso, so that dust and insects were able to enter and cause severe losses and disfiguration of the images. The losses caused by silverfish and other insects will continue unless the prints are unframed and stored safely. The common practice of creating a collage of many small prints in a frame (Fig. 4) is problematic in that some of the pictures invariably fall away from their original location while others adhere to the glass. These factors made it difficult to find a solution that would ensure the preservation of the images while respecting their original order and context.

The abbots expect to re-hang the prints in their original locations following their digitization. For these cases, the replacement of the original photograph with a duplicate would be the most sensible option from the point of view of preservation. It became clear, however, that some of the original photographs will have to be re-framed and re-hung. This is unfortunate in that they will then once again be subject to the agents of deterioration described above. In addition, the risk that they will simply disappear cannot be addressed once they have returned to their original monasteries.

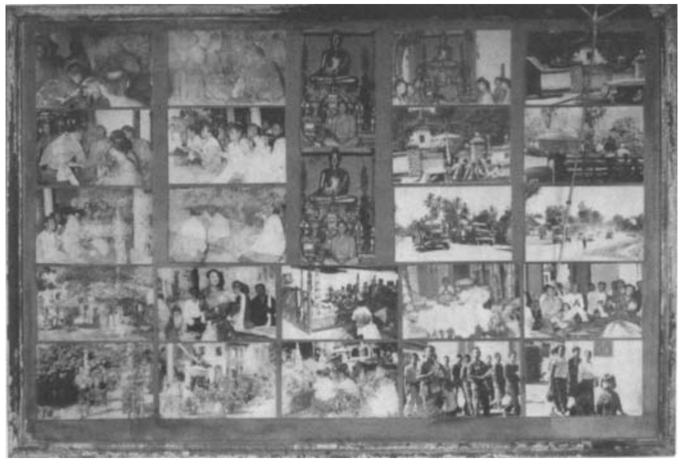

Fig. 4. Frame from Abbot Phra Khamfan Silasangvaro's living quarters at Vat Suvanna Khili

Albums

A variety of albums were encountered. The historic albums have black paper pages and thin glassine tissue as interleaving sheets. Some, more modern, black paper albums, however, have a plastic sleeve that is folded around the outer edge of the sheet, in a manner similar to that of the sticky albums (described below). The photographs are adhered to the pages with an unknown glue, either in the corners or overall. Some of the photographs are loose and easily fall out and become damaged or lost when the album pages are turned. The photographs in these albums are, in general, in good condition.

The PVC-type albums have pages that are made entirely of poly(vinyl chloride). Prints up to 9 x 13 cm are inserted into sleeves on both sides of each page. Almost all of the prints have partially adhered to the PVC. In most cases it was possible to separate the prints by simply inserting a pointed bamboo spatula, but where water had entered the sleeves the emulsion stuck to the PVC so firmly that it could not be removed. This was also the case for the color halftone prints, which had stuck overall to the plastic. Water led to the complete dissolution of the emulsion in some cases. Physical damage occurred where the prints had partially slipped out from one sleeve and into the adjacent one: when the page was flexed the print was creased and the emulsion delaminated.

Small and simple plastic albums encountered in the collections are typical for the 1980s and 1990s. They were generally used for the display of prints of only one film, up to the format of 10 x 15 cm. The pages are simple plastic sleeves (usually cellulose acetate) stapled to the cardboard cover at the spine. Prints are inserted back to back into the sleeves through the open top edge. The cellulose acetate has shrunk and channeled to a great extent in most of the albums, but there was no smell of acetic acid. Many of the prints have adhered to the inner surface of the sleeves, but they were very easily removed.

The sticky albums have cardboard pages that are coated overall with thin, horizontal lines of adhesive on each side. The prints are laid down onto the adhesive and then covered with a plastic sheet, commonly of cellulose acetate. As the albums aged, the adhesive hardened and lost its tack, and the plastic cover often fell loose. The plastic itself seemed to have caused no problems to the prints; on the contrary, the prints were well protected by the acetate sheets. Due to the failing adhesive, however, some prints simply fell out of the albums or could be easily pried from the page surface with a bamboo spatula. A large number of the prints, on the other hand, adhered ever firmer to the pages and could not be removed.

BASIC TREATMENT

During the survey of the collections it became clear that a fair number of the photographs were in very poor condition and would benefit from conservation treatment. The treatment would serve to stabilize the objects to the extent that they could be handled by researchers without being further damaged, and that they would not deteriorate on their own once they had become part of the Buddhist Archive of Photography. Only the most basic treatment was carried out on the photographs, since more difficult, though equally pressing treatments would have required more time and equipment. Conservation treatment will be part of future work within the archive. The following steps were taught to the Lao staff so that they could carry them out on their own:

- Since virtually all of the items were dusty or dirty, it was important to give them a basic surface cleaning before placing them into their new, clean, paper sleeves, boxes, and cabinets. In addition, cleaning is an important prerequisite for high quality digitization. For most of the objects, this step consisted of a simple brushing of the recto and verso surfaces with a clean, soft, wide brush. The brushes had been purchased from a local hardware store. Cleaning of the very dirty items was carried out in a separate area from that of digitization and sleeving in order to avoid contamination. Most of the frames were very dirty; in consequence, they were first cleaned externally near a window in the fore room, then opened and cleaned on the inside as well.
- Superficial mould growth was removed with an Absorene Dirt Eraser sponge, which I had brought to Laos from Germany. Mold that was embedded in the emulsion or support could not be removed by this method, and no disinfection was carried out.
- A full treatment such as mending tears with Japanese paper or lining very fragile prints was not possible in the short period of my stay. For this reason, following their surface cleaning, fragile objects were simply placed in a double sleeve in order to physically stabilize them. The front of the outer sleeve was inscribed in Lao and English with a warning against handling, and the need for conservation was entered into the catalogue so that these items could be identified and retrieved for treatment at a later time.
- Removal of prints from PVC sleeve albums and sticky albums was carried out with fine micro-spatulas, each with different tips, which were carved from bamboo.

CATALOGUING

One of the most important issues to address at the beginning of the project was that of the ordering system for the photographs of the different collections. The hierarchy that was adopted was based on EAP's "Guidelines for Listing Copied Material" (Endangered Archives Programme 2006), and its system was used throughout the conservation, digitization, and storage procedures:

- The Buddhist Archive of Photography is the general entity. It is divided into a number of collections.
- Each collection contains the items from one monastery or from one collector.
- Each photograph is given a unique EAP reference number, which is written in pencil on the verso and on its paper storage sleeve. The reference number contains a code letter for the collection that the photograph belongs to and a four-digit number. This system allows for a large number of further collections to be added to the archive over time.
- The photographs can be further sorted by keywords.

We chose Microsoft Excel for handling the large amount of cataloguing data. Excel is widely used internationally and is expected not to become obsolete in the near future. It works with a very simple table-based system that can be exported into other formats if necessary. The data entry spreadsheets were made with the software's *List* function. This allows for easy sorting and searching, and individual columns can be formatted differently: entries in two columns labeled "Description", for example, can be made in Lao or English script.

The description is one of the most important entries, since it describes the content and context of the image. The information gathered here gives invaluable insight into the history, culture, rituals, architecture, and persons of Lao Buddhism that cannot be found elsewhere. Following the Venerable Abbot's passing, Project Director Khamvone Boulyaphone took over the task of describing the photographs. He had been a monk under the Abbot for many years and knew many of the depicted persons and rituals; today he has become a respected personality within the Luang Prabang community himself. Where there were still open questions, he interviewed other monks and abbots. The descriptions were first written in Lao in order to capture the immediate essence of the photographs; they were later translated into English by archive staff.

For some columns, *dropdown* lists were designed that offer a restricted choice: this was useful, for example, for the columns "Keywords", in which only a pre-defined list of English terms describing the contents of the image (such as "Buddhist ceremony", "Pilgrimage" etc.) were allowed, and also "Original Medium", which contains the photographic process. This feature proved to be especially useful, as it guaranteed that only one spelling was used for the keywords, which did not have to be typed over and over again, a sure source for typographic errors in a language foreign to the archive's Lao staff. This enabled accurate sorting and searching. Excel's *List* function also allows for automatic totaling of the entries. The total number of catalogued items can be found at a glance, and it can also be seen how many of them have or have not been digitized. In the final version of the lists, each item had 15 fields for data entry.

DIGITIZATION

Two methods are currently being used for the digitization of the items in the archive: scanning and digital photography. The small, desktop flatbed scanner can process reflection prints up to approximately 18 x 24 cm. Prints that are larger than this must be digitized with a digital SLR camera. At present, there is no procedure for digitizing negatives or transparencies in Luang Prabang; this task will be addressed in the future. Both of the digitization procedures were adjusted to result in the highest quality possible with this equipment and under the given circumstances. Workflows were standardized so that the results would be as consistent as possible.

The settings in the scanner software were optimized with a Kodak Greyscale Q13 target. The aim was to create a file with a histogram that shows that all of the details of the original have been captured in the digital duplicate. The use of the digital camera for digitizing larger formats was slightly more complicated, as we needed to use natural light for lack of suitable artificial light sources. A simple duplication stage was constructed out of greyboard. Positions for the stage and the camera tripod were marked on the floor with brightly colored tape with so that the set-up would always be reproducible (Fig. 5).

Since the quality of natural light is time and weather dependant and fluctuates greatly in color temperature and brightness, the use of the Kodak Greyscale Q13 is important for the calibration of the digital image. Using the camera's software, the digital images, taken in the RAW format, could be developed to optimize color balance and levels. The settings of the digital camera, the scanner, and the respective software were recorded in detail in a series of protocols, and backups are regularly generated on a number of external hard drives. Preservation copies are saved as uncompressed TIFFs. Access copies are then generated as JPEGs. All photographs were to be digitized in 24 bit RGB, but some black-and-white photographs were scanned in 8 bit greyscale. Some confusion also ensued due to the presence of two different Q13 targets, both of which have slightly different color casts. Despite the known disadvantages associated with these Kodak targets, we decided to continue working with one of the greyscale targets for the second EAP project in order to maintain continuity in our digitization procedures.

Fig. 5. The simple stage setup for digital photography of oversized prints.

STORAGE SOLUTIONS

It was clear that it would not be possible to satisfy the usual requirements for the ideal storage of photographic materials given the circumstances in Luang Prabang. Nonetheless, it was important to keep them in mind as reference. Our goals for storage were set as high as possible for the given situation, but it was important to retain a certain amount of flexibility and inventiveness in our interpretation of the common guidelines. The new storage conditions are a great improvement to the prior ones, and it may be possible at some point in the future to further improve the situation.

Luang Prabang has a year-round tropical climate, with a humid summer and a dry winter. Summer days range from mid 20s to low 30s (°C) and relative humidity values between 70 and 90%. The rainy season (June through September) brings much precipitation and especially high levels of humidity. The first half of the dry season (November through February) is cooler, with temperatures ranging from mid 10s to mid 20s (°C) and RH values between 60 and 75%, while the second half (March through May) can get very hot and dry; it is during this period, especially, that Luang Prabang can become quite dusty as the dry red soil becomes airborne.

The archive's storage room has a number of unglazed windows that have slatted wooden shutters. These allow air to pass through the building at all times. This form of ventilation is advantageous in that it cools down the room and does not allow for areas of stagnant, humid air that might encourage mould growth. At the same time, however, it makes it impossible to control the passage of airborne dirt or influence weather-based fluctuations in temperature or RH.

Since a technical solution to climate control is not possible at this time, we decided to house the individual prints in paper instead of plastic sleeves. Although plastic sleeves made of polyester, polyethylene or polypropylene are chemically inert and give a better protection against handling, plastic has the disadvantage that it is largely impermeable to water vapor. Paper sleeves, on the other hand, allow for diffusion of water vapor throughout the storage units, which may be an important factor in an uncontrolled tropical environment. Many examples of prints that had adhered to their plastic enclosures were found in the collections, and we did not want to duplicate this situation.

The new individual sleeves are stored in paper boxes, which themselves are stored in wooden cabinets. Wood was chosen over metal early on in the project. Although wood is not recommended in climate controlled archives due to its potential for off-gassing acidic fumes that can damage photographic materials, metal poses severe problems in a tropical climate: at constant RH levels over 60%, the development of rust would be the main issue. Even powder-coated metal cabinets may have holes in their coatings. The prohibitive price of well-made, individually modified, powder-coated metal cabinets was a factor as was the fact that they would have to be imported. One of the most important reasons to use wood was that we would continue the tradition of a distinct style of cabinetry found throughout the monasteries, and that we would support local businesses with our orders. The bleak functionality of a powder-coated cabinet would have been out of place within the monastery surroundings.

It was decided very early in the project to use locally available materials for the storage of the photographs in the collections. The following factors were considered:

- Importing papers, boxes, and cabinets from overseas would have greatly increased the budget for the conservation of the collections.
- The papers available in Luang Prabang promised to be suitable, to a large degree, for the storage of photographs. This area of Laos is known for its production of Sa paper, made from the inner bark of mulberry trees growing in the forests in the region. In a process similar to that of the manufacture of Japanese papers, the inner bark is harvested, the fibers are separated, purified and washed with sodium hydroxide, then bleached to various degrees with hydrogen peroxide. The Sa paper sheets are made without any internal sizing. As a result, they are quite absorbent to water, but they proved to be surprisingly strong nonetheless. From the point of view of their composition, these papers are very pure.
- A local factory that that we visited produced eight different grades of Sa paper. The papers were evaluated for their suitability for the storage of photographs by a pH test and a simple lightfastness test. Although a Photographic Activity Test would have been desirable, the expenses and logistics this would have involved were considered inappropriate for this project. The pH of each paper was measured both with an indicator pen and with the cold extraction method (TAPPI 2002); all papers appear to be near pH neutral (pH 7.0, ± 1.0). For lightfastness testing, I placed samples of the papers that I had received in advance behind a window with one half of each sheet covered. Exposure to daylight averaged 12 hours per day. After

ten weeks of exposure there was a slight bleaching effect in the exposed areas. This was evaluated as a positive result, since the inclusion of lignin or other impurities in the papers would have caused the opposite: a yellowing of the paper in light. Only three of eight, the brightest papers with the most uniform formation and smoothest surfaces, were chosen for use in the archive. Upon my return to Luang Prabang in 2009, two years since the boxes and sleeves had been made, I found that only some of the white papers had yellowed and developed foxing.

- It was thought that the use of materials and products from Luang Prabang would not only support the local economy, but also provide the archive with an internal sense of connection to its own basis: the local materials, markets, customs, and culture.

Boxes

Two clamshell-type boxes were developed that would accommodate almost all of the prints found in the collections (Fig. 6). The smaller box is used for vertical storage of prints up to the format 10 x 15 cm; the larger box is for the horizontal storage of prints up to the format 30 x 40 cm. When stored together on one shelf, two boxes of each type match each other in their outer dimensions to save space. Oversize prints will be stored in a wooden flat-file cabinet that will be constructed in the second EAP project.

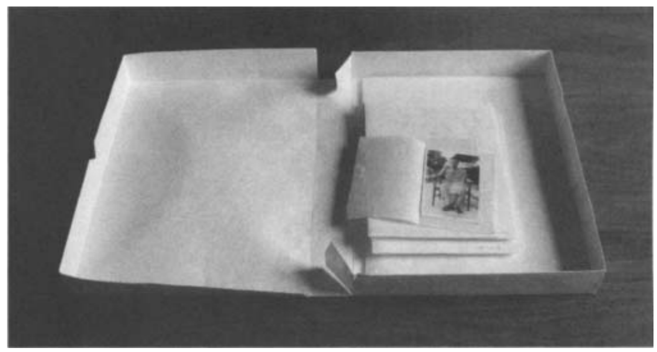

Fig. 6. A large, open spine clamshell box with prints in sleeves.

No thicker board of higher quality was available, so the boxes were made by the Sa paper factory according to our designs. Despite the use of relatively thin paper, these boxes turned out to be quite stable, though not made for transport or for storage of heavy objects. The floor, lid and walls consist of double or triple layers, and the adhesive used was a locally available polyvinyl acetate (PVAC) white glue. We decided against the use of a local rice starch for paste, even though it would have been more suitable in terms of purity and off-gassing, because it would have been very difficult to convince the paper maker to cook the paste regularly, the workers at the factory were accustomed to using the PVAC, and starch would have been a source of nourishment for mould and insects.

Sleeves

Four standard sized sleeves were designed to fit into the two types of boxes. All of the sleeves consist of simply cut Sa paper with a single fold; for reasons of simplicity, purity of materials, and cost, no adhesives were used. The smallest sleeves, made of the thin Sa paper, are for the vertical storage of prints up to 10 x 15 cm. For ease of handling, stiffer inserts are made that are simple U-folds, with a 1 cm wide base strip. Six of these inserts fit into one vertical box, and approximately 14 prints fit into one insert, resulting in a potential total of approximately 84 prints in one box. For a small group of prints that belong together, a simple phase box is made individually. In this case, prints are simply interleaved with a tissue-like Sa paper. Larger sleeves are made from the thicker Sa paper to accommodate prints up to 30 x 40 cm. These are placed in the flat boxes made for horizontal storage. These boxes can hold approximately 50 prints of the format 30 x 40 cm and up to 90 prints of smaller formats.

Cabinets

Four cabinets were made during the first EAP project. Their design is based on that of traditional cabinets found in the temples (Fig. 7). The cabinets were made of tropical rosewood, a heavy and very hard wood found in Laos. In order to avoid the build-up of vapors from the fresh wood, all inside surfaces were coated with a layer of shellac, a good barrier for volatile organic compounds (Tetreault 1999). Depending on the way the cabinets are filled, they can hold up to approximately 120 boxes. To deter mold growth within the cabinets, holes were drilled near the top and bottom of the back panel to ensure adequate ventilation. All of the holes were closed with a finely meshed textile on the inside to ensure that only air, but no insects or dust enter the cabinet. There is also a 4 cm gap between the edges of the shelves and the outer panels of the cabinet. In addition, there should always be a small gap between the boxes on the shelves.

Figure 7. Left: historic cabinet for palm leaf manuscripts. Right: new archive cabinet.

TEACHING

An important part of my work in Luang Prabang was teaching the local staff fundamental skills and a basic understanding of photograph preservation and archiving. We set aside special times for teaching units, and it was critical that each staff member take part in all of the units. At a later point, the individual members discovered their strengths and weaknesses and concentrated on an area most suitable for themselves. The topics of the teaching units were:

- Identification of photographic processes

  Since it was necessary to provide information on the process of each photograph for the records, I used the results of the collection survey to prepare a workshop on the identification of photographic processes. It was first necessary to explain fundamentals of photography. Luckily we had found some unused silver gelatin photographic paper in its original packaging in one of the collections, and with it I could demonstrate how a positive is created by contact with a negative under the influence of light: a negative was placed on the photographic paper, held flat by a sheet of glass, and this sandwich was placed in the sunlight. The image printed out and could be seen as a positive. We had no chemicals to fix the image, but the basic principle of the light sensitivity of photographic materials and positive and negative images could be shown to the local staff, all of whom belong to a generation only familiar with digital cameras and who did not know what a negative was used for. Following this, the characteristics and sensitivities of gelatin films and emulsions were demonstrated, and the processes that had been found in the collections were discussed with examples. Key identification factors were given for each process. One example of (almost) each of these processes was singled out from the collections for a didactic sample reference collection. In addition, a set of identification notes was printed out for reference.

- Basic conservation principles

Whenever we dealt with photographs, frames or albums, I tried to impress upon the staff the importance of conscious and correct archival practice. Principles of cleanliness were discussed. The overall presence of dust and the dirtiness of the prints themselves made the use of white cotton gloves impractical, however. The gloves became soiled and moist very quickly and would then only serve to pass the dirt from object to object. As an alternative, I taught the staff to only handle the prints by the edges and never to touch the surfaces. Large prints were only to be carried with two hands. Prints were only laid down on clean sheets of Sa-paper, since the table-tops were often quite dusty. The avoidance of accidents was also an important lesson; no drinks or other containers containing liquids were allowed on the table if a photograph, frame or album was present.

- Box- and sleeve-making

Although we had the boxes and sleeves produced by the paper factory, it was important that at least one staff member is capable of making boxes and sleeves by himself. For this reason, I taught Somlit Vongsavath how to measure, create right angles, cut, crease and glue Sa-paper. He also learned how to make individual phase boxes for small groups of photographs. The rulers and knives were bought in Luang Prabang; other tools were carved from bamboo.

- Unframing and reframing

Typical framed images were unframed and their components cleaned. The frames themselves were dusted and cleaned with a brush and a moist cloth. The glass was washed in water with detergent; accretions were removed with a razor blade. The photograph was cleaned with a dry brush, but extremely dirty backings without any information on them were discarded. The frame and the glass were labeled with the inventory number of the print. One exemplary photograph was reframed for the benefit of the staff members. The photograph was placed behind the clean glass, a new backing made from thick Sa-paper and a greyboard from Thailand. The backing was fastened with nails. Finally, the back edges were sealed with a gummed paper tape that we imported from Vientiane, the capital of Laos, to keep dirt and insects from entering the frame.

Since the shallow frames used in the monastery collections do not allow for the use of spacers, the photograph was reframed in direct contact with the glass. This is very problematic in that it is quite probable that the image will stick to the glass when it becomes too humid. Every effort is made in the archive to avoid returning framed photographs to the original monasteries, since the chances of their becoming damaged or lost is great. As an alternative, copies of the prints will be made with a donated inkjet printer during the second EAP project. These will be placed in the original frames and returned, so that the originals can be preserved in the archive.

- Workflow

  Tackling a project as large as sorting, cleaning, digitizing, and preserving over 15,000 photographs is quite complex. It was therefore necessary to introduce a simple but efficient workflow that would be rigid but allow a certain degree of flexibility at the same time. We decided upon a permanent order for the scanner and the computers on the table, and boxes were designated for the temporary storage of the photographs as they went through the various processing stages.

CONCLUSIONS AND OUTLOOK

My involvement as a conservator in the establishment of the Buddhist Archive of Photography went beyond the usual tasks of a conservator in a typical institution: next to preservation, handling, and conservation issues, I was also responsible for implementing cataloguing and digitization workflows and teaching fundamentals of photography. In general, I found that much good can be done with very little financial back up, and that working on a shoestring can enhance creativity in problem-solving. Especially in a – for us – foreign setting, making compromises and listening to differing opinions is fundamental in bringing a project to success. Working within a monastery environment also helped open my eyes to the varying significance that photographs can have in different cultures.

Language proved to pose many interesting challenges, since the Buddhist Archive of Photography is of a bilingual, if not multilingual nature. Annotations and inscriptions on the photographs, for example, were found in Lao, Pali (Tham script), French, Khmer, and Thai. Some of the former monks working in the archive had studied in Thailand and were also fluent in reading Pali, and French is common as Laos is a former colony of France. The various scripts make cataloguing the information on the objects quite tricky, however. The language barrier between the Lao and the western staff was also challenging. It soon became clear to me that there was no equivalent Lao vocabulary for a number of terms related to photographic processes and technology that I had been using freely during my stay and, as it turned out, much of what I had been talking about had remained a mystery to the staff. To resolve this situation, we worked together on creating an English–Lao glossary of technical terms relating to photography and archiving. This glossary helped us through the difficulties of communication and proved to be a wonderful source of amusement, understanding, and cultural exchange on both sides.

By means of the implementation of the Buddhist Archive of Photography and due to the mere fact that the prints are being collected and taken care of, the photographs of the monasteries of Luang Prabang have experienced an increase in significance within the monks' community. Their survival over the next decades has become more probable, since they are now less likely to become moldy, dirty, physically damaged, eaten by insects, stolen, or simply lost. A number of questions related to the conservation of the photographs that are in especially poor condition have not yet been properly addressed, however. During my visits to the archive, we decided to simply stabilize the condition of problematic objects as best as we could for the present and plan further trips to Luang Prabang during which urgent conservation treatments would be carried out.

Until then, prints with serious problems receive a special entry in the Excel lists that will enable us to identify them later for treatment. Despite basic stabilization, the long-term preservation of these specific photographs is endangered. The following cases are examples of the dangers and the proposed treatments that cannot be carried out without advanced conservation experience or training:

- Stabilization of physically damaged photographs

  Photographs that have suffered losses through insect infestation, mould, or water damage are currently not fit for handling by researchers. They should be stabilized by lining to Japanese paper or mounting to a rigid support; tears and holes should be mended on a basic level.
- Treatment of photographs damaged by water and mold

  Water is the main source of degradation of the photographs in Luang Prabang. It causes the emulsions to disintegrate, adhere to glass and plastic enclosures, and it encourages mold growth. The affected emulsions are acutely endangered: they need to be disinfected and consolidated if they are to survive the next years.
- Removal of photographs from glass

  This is the main problem with the framed photographs in the collections. Without removal from the glass, these photographs cannot be properly digitized or easily handled. In addition, it will be difficult to deter the adhesion of larger areas of the prints to the glass in a tropical climate. Realistically viewed, prints with large stuck areas may never be able to be removed from the glass, so digitization of the images through the glass, which is often dirty, and storage of the glass with the attached prints may be the only steps we can take at this moment.
- Removal of photographs from albums where necessary

  Some of the albums have served to protect the images inside them; this is the case for the paper albums, for example. Others, however, such as the PVC sleeve albums, have caused further deterioration of the photographs due to their inappropriate materials. This is also the case for some of the sticky albums. Photographs in these albums should be removed from the pages, since their long-term preservation cannot otherwise be assured.
- Solution for digitization and storage of the negatives

  The majority of the silver gelatin negatives encountered were on a cellulose nitrate base. This material is known to be unstable and inflammable. Although self-combustion is not to be expected with the small amounts present in the archive, the nitrate and acetate negatives will surely deteriorate at an accelerated speed in Laos' warm climate. Following their digitization, which to date has not been possible due to lack of equipment, these unique photographic materials should benefit from a separate storage solution.

The overall improvement of the storage conditions of the photographs in the collections of the Buddhist Archive of Photography has been great. The prints and negatives are being digitized and put into an order appropriate to their significance. These first steps will not persevere in the long term, however, if there is no improvement in the external conditions. A photograph that has been cleaned of mold can suffer from a new fungal outbreak as soon as the atmospheric conditions are suitable for this, e.g. warm and moist, which is often the case in a tropical climate. Problems of mold and insect damage can only be controlled by a stable, cool and dry climate. This will most likely only be possible by the implementation of climate control equipment. This step, on the other hand, is only feasible if the storage vault is an interior, closed room either without windows or at least with glazed windows. Therefore, for the preservation of the valuable photographs of the Buddhist Archive of Photography, the involvement of a conservation expert on a long-term basis, the evaluation of the feasibility of long-term climate control, and the implementation of conservation measures for the damaged photographs will need to be considered.

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THE PRESERVATION OF PHOTOGRAPHIC COLLECTIONS IN HISTORICALLY BLACK COLLEGES AND UNIVERSITIES

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Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

In 2007 the Andrew W. Mellon Foundation awarded a grant to the Art Conservation Department at the University of Delaware and Lyrasis to facilitate a three-year project aimed at improving the preservation of photographic collections at Historically Black Colleges and Universities throughout the Southeastern United States. Implementation of the project goals also involved partnerships with the Historically Black Colleges and Universities Library Alliance, the Conservation Center for Art and Historic Artifacts, and the Image Permanence Institute. This ambitious endeavor is ongoing and the goals of this paper are to introduce this unique project, the institutions and individuals collaborating to make it successful.

Before the Civil War, higher education for African American students was virtually nonexistent. Some schools for elementary and secondary training existed however a college education was only available to a limited number of students. Through the support of the American Missionary Association (AMA) and the Freedmen's Bureau, some private colleges and universities for the education of African Americans were established. Between 1861 and 1870, the AMA founded seven black colleges and thirteen teaching schools. In addition to the work of AMA, educational opportunities for African Americans began to change in the years following the Civil War, with the 13th Amendment's abolition of slavery and the second Morrill Act.

The Morrill Land-Grant Act of 1862 gave federal lands to the states for the purpose of opening colleges and universities to educate farmers, scientists, and teachers. Although many institutions were created, few were open or inviting to the African American community, particularly in the South. Representative Justin Smith Morrill of Vermont suggested a solution to this challenge in the second Morrill Land-Grant Act of 1890. This Act specified that states using federal land-grant funds must either make their schools open to both blacks and whites or allocate money for segregated black colleges to serve as an alternative to white schools.

Today there are approximately 110 higher education institutions collectively referred to as Historically Black Colleges and Universities (HBCUs). Though the student bodies at most of these schools remain predominantly black, HBCUs encourage students from different backgrounds and cultures to join their academic communities. These institutions have rich photographic collections that represent the history of the institutions, their students and faculty, an important aspect of higher education in the United States and the history of African Americans.

The Andrew W. Mellon Foundation has been an advocate for both Historically Black Colleges and Universities and the field of photograph conservation for many years. The Foundation's HBCU Program provides grants to private HBCUs that provide an undergraduate liberal arts education. Grants awarded in this program are aimed at supporting HBCUs in areas of their strategic plans, providing resources and professional development opportunities for HBCU librarians, and assisting HBCU faculty members as they revive their curriculum.

For the past 10 years the Mellon Foundation has supported numerous initiatives to advance the field of photograph conservation including educational programs, workshops and reference resources. The Preservation of Photographic Collections in Historically Black Colleges and Universities Project is a special project in which the Mellon Foundation has been able to support both HBCUs and the field of photograph conservation simultaneously.

In January of 2007 the HBCU Library Alliance, a consortium of HBCU library professionals dedicated to fostering the collaboration and strengthening of resources within the HBCU network, conducted a survey of its 41 HBCU members focused on the preservation needs of photographic collections. The survey revealed that only 22% of the institutions had completed conservation assessments of their photographic holdings and only 12% had funds allocated for preservation activities in their annual budget. The distressing results of this survey, along with a previous study conducted by the Mellon Foundation in 1999, led the Foundation to create a steering committee of administrators (see the Acknowledgements section) from the Conservation Center for Art and Historic Artifacts, the HBCU Library Alliance, Lyrasis, the Image Permanence Institute, and the Art Conservation Department at the University of Delaware, to develop and conduct a $1.3 million collaborative project aimed at improving the preservation of photographic collections in HBCUs.

The goals of the project are to provide practical training in photograph preservation, to assist with prioritization of needed projects, to stabilize at-risk collections, to encourage investment in preservation capacity buildings within these institutions, and to inspire future generations to care for photographic collections. Ten HBCUs (see the Acknowledgements section) were identified as the focus institutions for this three-year project. The final phase of this project entails opportunities for sharing resources and conservation knowledge within the broader HBCU network.

The criteria used to identify the focus institutions included consideration of the historical significance and photographic collection size, photographic holdings pre-1950 at risk, adequate staffing and an established administrative infrastructure, and the opportunity to share resources, knowledge and expertise. Additional criteria included selecting a group of institutions that represent a diverse geographic focus, a combination of private and public institutions, and successful involvement in past HBCU Library Alliance initiatives. The project was divided into four Phases.

Phase I of the project was a two-day preservation summit hosted at the University of Delaware (UD) in October 2007. Thirty participants from the ten HBCUs attended the summit. Ten photograph conservation professionals presented lectures and workshops designed to provide practical training in photograph preservation. Lecture topics included, historic and contemporary prints, glass plate and film-base negatives, the Climate Notebook, selecting safe storage enclosures for photographic collections, exhibition parameters, and treatment challenges. Workshop topics included environmental monitoring, the history and identification of photographic negatives and identification of 19^{th} century print processes.

The summit was extremely successful at providing participants with practical training as well as initiating relationships between the HBCU and conservation professionals that would collaborate throughout this three-year project. In a thoughtful thank you note sent after the summit, Elizabeth Wilson, University Librarian at Lincoln University summarized her response to the summit and the fledging project as follows:

> "It is so good to know that now we have help in conserving and preserving our legacy here at Lincoln University, called the "Harvard of the Midwest" from 1923-54 when our scholars were publishing journals, painting wonderful pictures, producing plays, making innovations in agriculture and collecting the treasures of the African American experience in books, photographs and other resources. I have been waiting for this for 23 years. It is such a gift to know the Lincoln University legacy will be preserved and conserved for another 140 years."

The second phase of the project required six expert conservation consultants (see the Acknowledgements section) from the collaborating organizations to visit the ten HBCU sites and collaborate with staff to evaluate the photographic preservation needs and priorities at each collection. Each of the conservation consultants was accompanied by a conservation graduate student (see the Acknowledgements section) to assist with the on-site consultations. Students from New York University, Buffalo State, the University of Delaware, and the University of Texas participated in the consultation visits and also attended the preservation summit held at UD. During the on-site visits the consultants examined as much of the photographic collection materials as possible. After examining the collections the consultants met with staff to discuss collection needs and preservation priorities. Following the on-site visit the consultants prepared assessment reports that listed suggested preservation projects for the institutions' collections. This information was then used by each institution to identify and implement preservation demonstration projects costing up to $60,000. The cost of these projects was supported by the original grant awarded UD and Lyrasis.

Sara Norris of the University of Texas noted of her experience in the project:

> "The great thing about the HBCU project was knowing that I could really make a difference. Thanks to the funding available to each participating institution, my

recommendations were more than just advice; they were real options that could prolong the lifespan of irreplaceable collections."

Phase III of this project is currently in progress and began in June of 2008. This phase includes three parts: an environmental monitoring program supported by the Image Permanence Institute (IPI), a re-grant program, and the completion of demonstration projects. During this phase of the project the ten institutions are using the practical training and advice they've received to complete preservation projects that will improve the condition of their collections.

In some instances the conservators that initially conducted the conservation consultation visits have or will soon return to their partnering HBCUs to provide additional training and assistance with the demonstration projects. Each institution proposed unique preservation projects based on the individual needs of their collections. The third phase of this project has empowered the custodians of these valuable collections to make positive changes regarding the long-term care and preservation of their photographic materials.

The final phase of the project hopes to provide information and inspiration to additional HBCU institutions. One component of this phase was a daylong preservation summit for 70 HBCU library and museum professionals hosted in Charlotte North Carolina in conjunction with the HBCU Library Alliance's annual meeting in October 2008. A second component is on-site consultations with IPI staff at each institution to review a year of environmental data and develop strategies for improvement.

The success of this project depended on the work of many individuals and the support of several institutions, most notably the Andrew W. Mellon Foundation for providing the funding needed. The partnerships involved have led to collaborations and knowledge exchange that will carry beyond the three-year time period of this particular project and beyond the 10 focus institutions. The impact of this project will continue to benefit the individuals and the collections involved, inspire the next generation of conservators, archivists and curators that will care for these collections and others, and positively impact the preservation of our photographic heritage.

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Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

Photograph Preservation Institute in the Middle East: *Lessons in Priorities*

Nora W. Kennedy and Debra Hess Norris

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

The 2009 Middle East Photograph Preservation Institute was four years in planning, but achieved all goals laid out in the initial 2005 funding proposal to the Getty Foundation. This article addresses the workshop content and challenges in bringing this two-week educational initiative to fruition while providing guidance for the organization of professional workshops outside of the United States and especially in politically unstable regions of the world. This workshop serves as a model for other international initiatives primarily aimed at the preservation of our global photographic heritage.

Introduction

In 2004 Debra Hess Norris proposed the idea of organizing a Middle East-wide workshop on the preservation of photographs to her long-time colleague and collaborator, Nora Kennedy. Despite a wealth of photographic heritage dating from the early nineteenth century to the present, there are no formally trained photograph conservators in the Middle East. Norris and Kennedy had organized over twenty workshops of various kinds during the previous decade, so this seemed like a natural progression. Kennedy was born and raised in Lebanon, and the notion of making even a small contribution in recognition of the richness of culture, depth of history, and generosity of spirit in the Middle East was immediately attractive. In addition, the world political situation dictated the need for and enormous value of some immediate, positive American interaction in this part of the world.

The Middle East Photograph Preservation Institute (MEPPI) was finally realized in January 2009, following four years of planning. The workshop took place in Beirut, Lebanon, fulfilling the goal to introduce and advance the practice of photograph preservation throughout the Middle East. The two-week institute strengthened photograph conservation in the Middle East by initiating new collaborations among related professionals and by disseminating and sharing the most current photograph preventive conservation knowledge, as well as making some information available in Arabic. An excerpt from the 2005 proposal to the Getty Foundation is included below:

> "Following completion of this two-week institute, expected competencies for all participants will include:
>
> - A basic familiarity with the fundamental physical and chemical properties of photographic print and negative collections and the causes and mechanisms of their deterioration.
> - A basic knowledge of the technological developments of photography in the 19th, 20th and 21st centuries with special focus on albumen, silver gelatin, chromogenic, and digital print materials, and glass plate and film base negatives.
> - A familiarity with the history of photography with a special focus on the development of the medium in the Middle East.

- A basic understanding of and appreciation for issues relating to preventive care and photographic collections, including appropriate environmental conditions, handling and maintenance procedures for storage; exhibition and display parameters and monitoring techniques; integrated pest management; and emergency preparedness, mitigation, and response.
- A basic knowledge of best practices in photograph preservation and digitization.
- An understanding of the importance of risk assessment and preservation prioritization within a collection and the need to balance preservation and access.
- Hands-on experience with basic handling, cleaning and stabilization procedures.
- A familiarity with and understanding of the need for and the meaning of a professional codes of ethics.
- The ability to prepare brief written collection condition assessments to assist with funding for collection materials in urgent need of preservation.
- Knowledge of issues relating to personal health and safety in the work place, especially as related to the access and use of film base negative collections."

This Institute could not have taken place without very generous support from the Getty Foundation and Andrew W. Mellon Foundation, the collaboration of the Arab Image Foundation in Beirut, the welcome and cooperation of the American University of Beirut, the commitment of the invited guest lecturers, and the enthusiasm and dedication of the wonderful participants.

Hisham Abdel Hadi (amateur photographer)
Not always on a camel also on the BMW, Jericho, Palestine, 1963
Collection: Abdel Hadi family, Copyright © Arab Image Foundation

An additional goal was to engage with caretakers of photograph collections across the Middle East. Working with the Arab Image Foundation staff, we identified potential participants from many countries representing significant collections. Generous funding was offered to cover transportation, housing and per diem expenses for collections care managers, curators, librarians, and caretakers of public collections. While interest in the goals and purposes of our proposed educational institute was clear, political unrest, the uncertainty of travel in this region, and other pressing professional and work-life demands presented organizational challenges. In the end, we were enormously pleased by those professionals who did participate, representing Lebanese, Palestinian, Syrian, Jordanian, Iranian and Egyptian collections.

The Middle East is a region of the world where preservation activities to date have been focused on the considerable archaeological heritage. At present, only some institutions—primarily universities—have recognized the importance of the photograph in recording the history and culture of what is a rapidly vanishing way of life. Preservation professionals and conservators are rare in many of these countries. Those who are active tend to focus on architecture and archaeological artifacts, making the availability of information on the preservation and care of photographs difficult to access. Prior to the Getty-funded Institute, no literature existed in Arabic on this topic. One of the great achievements of the workshop, in addition to forming a close network of like-minded individuals, is the availability of an on-line publication in Arabic on the preservation of photographs. This Institute is the first, but substantial step in many steps toward the awakening of awareness and the building of infrastructure to preserve the important photographic heritage in the region.

First Steps

The start of the planning included locating a partner in the Middle East to help coordinate and plan, and then obtaining funding to support the venture. Contact was made with the Arab Image Foundation (AIF), a not-for-profit organization based in Beirut, Lebanon, and responsible for the collection and preservation of the photographic heritage of the Middle East and North Africa from the early nineteenth century to the present. Through its diverse set of activities – exhibitions, publications and videos – the AIF aims to encourage critical approaches to reading and interpreting photographs and therefore seemed ideal partners in this endeavor. Zeina Arida, AIF Director, and Akram Zaatari, Lebanese video artist and curator, met with Norris and Kennedy in New York in late 2004 while there to open an exhibition at the Grey Art Gallery, New York University. Arida and Zaatari were immediately enthusiastic about and supportive of the joint venture.

Camille el Kareh: [Self-Portrait] Zghorta, North Lebanon, 1920 Collection: AIF / Mohsen Yammine, Copyright © Arab Image Foundation

A proposal was drafted with the input of AIF staff and submitted to the Getty Foundation for review. This proposal included funding for eight international experts to provide lectures and demonstrations; travel expenses for an estimated twelve participants from throughout the Middle East; funding for notebooks of articles, some literature and other supplies; and the rental of a facility for two weeks. Beirut, Lebanon, was chosen as the workshop site due to its central location within the region, the ready availability of facilities and amenities, the large number of local collections and, most important, the presence of the AIF headquarters there. We were fortunate that the Getty Foundation understood the importance and far-reaching impact of this endeavor and generously provided full funding for the project.

The Arab Image Foundation

The close collaboration of the Arab Image Foundation (AIF) was vital to the success of the Institute. As part of its mission, AIF identifies and makes contact with organizations and individuals with collections of photographs from the Middle East. These established networks formed the basis from which we were able to identify potential participants for the workshop from the region. The Foundation translated and distributed questionnaires designed to better understand photograph collections' size, type, and preservation challenges. This survey provided information critical to the planning of the Institute curriculum.

In addition, the Arab Image Foundation made all on-site arrangements flawlessly, from the hotel reservations to the meeting rooms at the American University of Beirut (AUB). The AIF also organized and administered daily ground transportation for participants and speakers as well as catered coffee breaks and the opening dinner. Two public lectures – offered by Norris and Kennedy and designed to engage the broader community in the conversation surrounding the value and importance of photograph preservation - were planned and promoted by the AIF. They printed and compiled the notebooks of articles provided to them in PDF format. These became essential resources for the participants. Toolkits were also provided complete with Hake brushes and a watercolor brush, vinyl erasers, cotton gloves, nitrile powder-free exam gloves, a Cretacolor Monolith Woodless Graphite Pencil 6B, a University Products Humidity Indicator card, a bone folder, a #2 Caselli spatula, some tweezers, a fiberglass retractable tape measure and a Radio Shack 30x pocket magnifier with light.

Preservation workshops organized outside the United States mandate an on-site host. Our situation was most fortunate in that the Arab Image Foundation has strong organization and active networks in place, and that the implementation of such workshops—though never before on this scale—is fundamental to their mission.

American University of Beirut

We had two offers for hosting sites in Beirut, the American University of Beirut and the *Université Saint-Joseph.* We deeply appreciate the proposed collaboration of both these institutions. We ultimately chose the American University (AUB), which proved to be extremely accommodating in providing a spacious classroom fully equipped with all necessary equipment and materials, a lecture hall for the public presentation, and a wonderfully landscaped campus to experience during sunny January lunch breaks. Beautifully situated in "Ras Beirut" (the "head" of Beirut—a tip of land projecting into the Mediterranean), the AUB is located on a hillside with striking plantings and frequent vistas over the ocean. The busy streets outside the campus are alive with eateries that provide quick and nutritious lunches and snacks for students and our participants alike. The meetings were held in West Hall, named after Robert Haldane West, a professor at AUB from to 1883-1906 and the grandfather of conservation scientist Liz West Fitzhugh. Coffee breaks were held on an upper floor with a large stone balcony, surrounded by huge banyan trees — a lovely place to refresh and network.

The Participants

We were extremely fortunate in the selection of participants for the Institute. The group chosen was energetic and dedicated, and immediately interacted positively and enthusiastically with one another. We had fourteen full-time participants and eight visitors. We were pleased that five countries were represented, including Egypt, Iran, Jordan, Lebanon, and Syria. Among the colleagues from Lebanon we had representation from the Palestinian and Armenian communities as well. There had been some interest from colleagues in Turkey, but in the end the two potential candidates were unable to attend.

The participants varied greatly in their familiarity with photography, its history and technology. The majority had little to no information about preservation of photographic materials. Most are in some way responsible for photographic collections, though the majority shoulder many other responsibilities as well. Included among the participants, for example, were librarians, catalogers, archivists and curators. Ola Seif from the American University of Cairo (AUC) cares exclusively for a photograph archive, but the majority is responsible for mixed collections containing photographs, books, manuscripts, and maps. Rana Andari from the National Museum of Lebanon is an archaeologist by training, but has been responsible for the organization, cataloging, and scanning of the substantial collection of negatives housed at the Beirut Museum. These collections bear important documentation of the many archaeological excavations carried out in the region. The photographers tended to turn their cameras on the peoples, landscapes, and architecture surrounding the archeological sites, so the record of the Middle East at that time period is quite complete, if undiscovered. Andari has many responsibilities at the Museum; her time focused on photograph conservation is limited. Levon Nordiguian is an archaeologist with a passion for and commitment to the wonderful collection of negatives and prints he informally oversees at the *Université Saint-Joseph*. Nordiguian creates exhibitions and has published a number of books featuring the images made or collected by the Jesuits from the University over many decades. When the group visited this collection, Levon impressed us with incredible images of local customs and dress, building styles, and aerial photography, as well as some absolutely pristine nineteenth-century Bonfils images of Egyptian monuments.

Levon Nordiguian showing negatives from the *Université Saint-Joseph* collection. Image © Nora Kennedy

Yasmine Eid El-Sabbagh and her assistant Fadi Soleiman came to the MEPPI with laudable qualifications and goals. El-Sabbagh was raised and educated in Europe, but has family in the Middle East. While in photography school in France, she called photography companies for donations of disposable cameras and started a children's photography program in one of the many Palestinian refugee camps in Southern Lebanon. El-Sabbagh now lives in the Borj al-Shamali refugee camp where she continues to work with children and photography and to assist in finding funding to provide higher education for many young people in the camps. She has extended her photography project to encompass one of archiving the few family photographs rescued by families fleeing armed conflict. El-Sabbagh and Soleiman speak with people in the camp about the proper care of their treasured photographs. These images are scanned to form an archived record of life in the Palestine - a living memory of much that is now lost. The MEPPI was critical for Fadi and Yasmine in providing preservation information for them to share with the Palestinians and in helping to ensure the preservation of the digital scans they are carefully creating and maintaining.

Participants examine negatives during an identification session. Image © Nora Kennedy

The task of locating institutions with collections of photographs and the individuals with responsibility for them was greatly facilitated by the Arab Image Foundation and the many contacts they had made since their establishment in 1996.

Nevertheless, there were gaps such as Jordan, Iraq, and Turkey, where we started without any leads on collections or individuals to contact. Additional connections were sometimes established through conservation networks or Middle Eastern friends and organizations. Our Jordanian representative for example, Dr. Atef Shiyab, Director of the Museum of Jordanian Heritage, Yarmouk University, Jordan, was suggested by a Jordanian student completing his studies in Australia. He was referred by one of his professors who we happened to meet at the September 2008 ICOM-CC meeting in New Delhi, India. This was one of the more circuitous and exotic, but nevertheless fortuitous connections.

Contacts made with the Director of the National Library and Archives in Baghdad, Iraq, revealed that this institution lost all of its photographic materials to bombings, fire, and/or theft during the American invasion of the country and subsequent chaotic conditions. In spite of this, we would like to involve Iraq in future initiatives as we hope that their photographic collections will be built anew with international contributions. Two participants from Turkey—one a private collector who was to pay his own way and one an assistant professor at Marmara University, were not able to participate. We broke our stipulation of full attendance during all nine days of the Institute for our Syrian representative, Martine Gillet from the *Institut Français du Proche-Orient* in Damascus, who at the last moment was able to attend for only two days. This proved to be a wise decision as during this brief time period Ms. Gillet managed to speak in-depth with each of the other participants, to establish connections, and eagerly took in information from lectures which was clearly of great import to her and her collections. She will be a valuable asset moving forward into future initiatives and collaborations.

THE PROGRAM

The program was designed in part based upon the results of the collections questionnaire collected from all potential participants at the start of the planning phase. A draft of the program was made and circulated among the primary speakers as well as Arida and Sawaya from the AIF well in advance of the Institute, and refinements made. Care was taken to tailor the topics, commencing with the fundamental concepts and building to more sophisticated applications. The emphasis was always on the practical as we knew that budgets and staffing for the preservation of photographic collections tended to be minimal or non-existent.

Tamara Sawaya shows works from the Arab Image Foundation Collection. Image © Nora Kennedy

A final copy of the Photograph Preservation Institute schedule is included at the conclusion of this article. The printed schedule served as the backbone of presentation order, but we did make adjustments in times and programs to accommodate needs as we went along. Goals of the curriculum included an introduction to the technical history of photography, image formation and deterioration, degradation mechanisms and causes. Emphasis was placed on hands-on workshops for the identification of photographic processes, examination of examples of different forms of deterioration, and diagnosis of their likely causes. Practical preventive strategies were emphasized in ameliorating conditions for the damaged photographs using low cost solutions. Disaster planning and response came alive through the recovery of a variety of photographs from a staged "water incident".

Guest speakers included colleagues from conservation, conservation science, and art history. Issam Nassar provided an illuminating talk on the evolution of photography in the Middle East, wonderfully illustrated with many historic images. Nassar is assistant professor of Middle East history at Bradley University in the United States as well the Assistant Director of the Institute of Jerusalem Studies in Palestine and has published numerous articles on the history of photography in the region. Bertrand Lavédrine joined us from the *Centre de Recherches sur la Conservation des Collections* in France where he serves as Director. Lavédrine covered image formation and deterioration mechanisms, aspects of preventive conservation, environmental assessment and control, all in a very lively fashion, where possible illustrating concepts with entertaining examples. Lavédrine, Norris and Kennedy worked collaboratively with the participants on hands-on practica for process identification. When Franziska Frey, Professor at the School of Print Media at Rochester Institute, was unable to travel to Beirut at the last minute, Martin Jürgens, in private practice in Germany, valiantly stepped and presented the lectures Frey had sent as well as incorporating his own excellent lectures and practica on the preservation of digital media and digital prints. It is clear that future workshops will have to emphasize this area as the scanning of collections is a technology that is being eagerly embraced. Akram Zaatari, a video artist and curator in Beirut and one of the founders of AIF, brought us into the world of contemporary art, with a special focus on the use of historic and contemporary images in a variety of art projects.


Kennedy discusses housing materials and designs with participants.
Image © Debra Hess Norris

A session on fundraising addressed strategies and approaches. This was let by Arida and Norris, but participants contributed enormously to a comprehensive list of promising agencies and individuals in the Middle East and beyond that may support photograph preservation initiatives. Advocacy for the collections was emphasized as a first step in raising awareness of the richness and importance of visual cultural heritage. Professional networks were fostered at the onset of the Institute – a primary and vital goal. Middle Eastern culture is very sociable and friendly, so the friendships and professional relationships that emerged during the two weeks of study flourished rapidly.

Challenges

There were numerous challenges to the realization of the Institute. Not the least of these is the notable political instability in the region. Kennedy's first research trip to the Lebanon was interrupted by the Israeli bombardment of the country. This planning trip was made successfully the following summer (July 2007), but there followed a period of political instability within Lebanon itself. Just the week prior to the January 2009 program, war began between Gaza and Israel, causing some uncertainty in our minds -- but none in those of our hosts -- about the wisdom of proceeding. The fact is that in this part of the world this type of uncertainty is a reality that simply exists. Flexibility must be a part of any plan made. And indeed we all felt strongly that proceeding with cultural events in a time of conflict is a form of resistance to war.

While the MEPPI participants are among those select individuals in the Middle East who clearly recognize the importance of photography in the preservation of cultural heritage, photography is a very recent phenomenon and generally not a cultural heritage preservation priority. Collections in the Middle East tend more often than not to be in private hands. There is not the same tradition of collecting photographs in national institutions that exists in other parts of the world.

There is an acute lack of trained and educated conservators and preservation professionals in the area of libraries and archives; most conservation practitioners are focused on the care of archaeological records and historic monuments. Training of conservators is generally achieved through apprenticeship or internships in Italy and other European countries. This lack of paper and photograph conservation education and training must be addressed by the Arab Image Foundation and other cultural and higher education institutions in this region and globally.

Samar Mikati Kaissi and Debra Hess Norris discuss with participants photographs from the Jafet Library special collections at the American University of Beirut. Image © Nora Kennedy

Identifying collections of photographs and those responsible for their care was another challenge. The Arab Image Foundation had a great many contacts from the outset and worked hard to expand and strengthen these. Our list grew as a result of these efforts. Unfortunately, some on our approved list of participants were ultimately unable to come due to difficulty in travel and the inability to leave work for a prolonged period. The MEPPI has been an exceptional first step and we are confident that from this small group of individuals, more will be inspired to join the collaboration.

We had thought that language would be a challenge, however, in the end we did not require a professional translator. Most participants were comfortable with or at least had adequate comprehension of English. Occasionally, our Jordanian colleague and some of our Lebanese-Palestinian participants required translation during more technical lectures. Two individuals had excellent comprehension of English, but would ask questions or request occasional clarification in French. A future workshop in Egypt or Jordan may require simultaneous translation, something that will add to the expense of the workshop, but also will transform the timing of scheduled topics as well as interpersonal exchange between invited speakers and participants.

FUTURE DIRECTIONS

On the final day of the Institute the group gathered to create a list of future directions. This included small and large initiatives, as well as immediate and long-term goals within individual institutions and the region at-large. We are all eager to take advantage of the considerable energy and momentum generated by this lively meeting of like-minded professionals.

Antonio: *Fez, Morocco*, (dates unknown)
Collection: AIF / A. Tazi
Copyright © Arab Image Foundation

While a detailed discussion on future directions may be found in the upcoming preprints of the International Institute for Conservation meeting to be held in Istanbul in September 2010, some of the immediate institutional goals include efforts to review and amend existing preservation policies and procedures, establish priorities for preservation based on new-found knowledge from the Institute, monitor storage environments, prepare and institute basic disaster plans, and to promote the importance and value of collections within and outside the institutions. Basic disaster preparedness is not established in many collections. Some institutions, like the National Museum of Beirut, are well versed in war-time emergency preparation and have clearly established guidelines for various danger levels. During the workshop, the National Museum instituted their first level of alert after hearing that rockets had been shot from southern Lebanon into Israel. Unfortunately these emergency "drills" take place all too frequently.

Participants suggested offering regular informal meetings to share preservation challenges and activities, strengthen professional networks, and build capacity and expertise. MEPPI participants were equally encouraged to share their preservation knowledge with affiliated groups such as photography clubs, students, and other community organizations. Participants were eager to work together on exhibitions and to pursue opportunities for collaborative fund-raising for this and other initiatives, including the testing of storage materials, ordering bulk supplies, and sharing environmental monitoring expertise. All of these, and the many other possible future directions proposed, involve an implicit promotion of the value and importance of photography in the Middle East.

Finally, over the long term it is essential to hold similar institutes in other regions of the Middle East. During MEPPI, offers of future host training sites were made for Jordan, Occupied Palestine, and Egypt. These are being pursued with hopes of holding the next workshop in Egypt in 2011.

Lessons learned from this endeavor include the necessity of flexibility in planning and scheduling due to inevitable political uncertainties in a part of the world that tends to be a good deal less stable than one would like. Collaboration and partnership with a local institution or organizations is absolutely essential to the success of any workshop or meeting. MEPPI was successful in meeting the needs of the individuals and collections in good part due to the collections survey distributed early on in the process. Preliminary visits to many institutions also helped to form a clearer picture of the collection preservation needs. The practical focus of the two weeks held the participants' interest and clearly directed the contact to tangible day-to-day applications. And finally, the greatest outcome may be the establishment of friendships and professional collaborations between all the participants.

Participants and organizers of the *Middle East Photograph Preservation Institute*, Beirut, Lebanon, January 2009.

We are enormously grateful to the Getty Foundation, the Andrew W. Mellon Foundation, the Arab Image Foundation, and the American University at Beirut for their support of this transformative initiative that has generated considerable good will and new-found knowledge, expertise, and confidence surrounding the preservation of photograph collections in the Middle East.

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Schedule for the Photograph Preservation Institute

Organized by Photograph Conservation at The Metropolitan Museum of Art
and the Art Conservation Department at the University of Delaware
in Partnership with the Arab Image Foundation

Hosted by the American University of Beirut

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DAY ONE: Tuesday, January 6th, 2009

9:00	*Registration and Coffee*	*All*
9:30	Welcome	Arida, AUB representative
9:45	Outline of the goals of the workshop Introductions of all faculty and participants	Norris & Kennedy
10:00	Introduction to the Arab Image Foundation Mission statement, collections. Collecting photographs in the Middle East	Zeina Arida
10:30	General Overview of photo process history Structure of photographs	Debbie Norris
11:00	*Coffee Break*	
11:30	Introduction to how photography entered the Metropolitan Museum and how it exists there in many forms	Nora Kennedy
13:00	*LUNCH*	
14:00	Looking at photographs: tools for handling and identification	Nora Kennedy
	Refreshment Break	
16:00-17:00	Overview of the silver processes: Salted paper, albumen, printed-out and developed-out photographs	Debbie Norris
20:00 - 22:00	*Formal Dinner*	*All*

DAY TWO: Wednesday, January 7th, 2009

9:00	The History of Photography with a Focus on its Development in the Middle East	Issam Nassar
11:00	*Coffee Break*	
11:30	15 minute informal presentations by three participants on their collections.	Three Participants
12:30	*LUNCH*	
14:00	Scientific Principles of Image Formation and	Bertrand Lavédrine

	Image Structure in Silver Photographic Processes	
14:30	Risk Assessment and Deterioration Processes of Photographic Image (final image, binder, support)	Bertrand Lavédrine
15:30	*Refreshment Break*	
16:00	*Practicum:* Identification of silver images	Kennedy, Norris, Lavédrine
Evening Public Lecture ***Debbie Hess Norris:* Caring for Your Family Photographs** 19:00 AUB Reception		

Day Three: THURSDAY, JANUARY 8TH, 2009

9:00	Materials for Preservation (from furniture to individual housings) Recommendations, Standards and Testing (theory and practicum)	Bertrand Lavédrine
11:30	*Coffee Break*	
12:00	Overview of Negative Materials	Debbie Hess Norris
	Identification of Negative Materials	Norris, Kennedy
13:00	*LUNCH*	
14:00	Overview of other photographic processes to include: cased images, and non-silver processes (platinum, cyanotype, pigment processes, some photomechanical)	Nora Kennedy
15:00	*Practicum:* Identification and examination of cased images, non-silver images, silver images, and negatives	Norris, Lavédrine, Kennedy
15:30	*Refreshment Break*	
16:00-16:40	15 minute informal presentations by three participants on their collections	Three participants

DAY FOUR: Friday, January 9th, 2009

9:00	Overview of the Primary Color Processes with emphasis on chromogenic	Nora Kennedy
10:00	Identification of color *(or not!)* and review of other process identification	Norris, Kennedy
10:30	*Coffee Break*	
11:00	Environmental Assessment and Practical Control Measures Including Cold Storage	Bertrand Lavédrine
11:45	*Practicum:* Analyzing Environmental Data	Bertrand Lavédrine
12:30	*LUNCH*	
14:00	Cold and cool storage in practice (small to large systems, bagging, monitoring tools, costs of each application)	Lavédrine, Kennedy, Sawaya

15:00	Mitigation from airborne contaminants and light monitoring	Bertrand Lavédrine
15:45	*Refreshment Break*	
16:00-16:40	15 minute informal presentations by three participants on their collections	Three participants
Evening Public Lecture ***Nora W. Kennedy*: Issues in Contemporary Photography** 19:00 AUB		

Saturday, January 10th, 2009

Optional Tour to Baalbek, Anjar

Sunday, January 11th, 2009

Optional half day tour to other historic sites in Lebanon

DAY FIVE: Monday, January 12th, 2009

9:00	Emergency preparedness and response	Debbie Norris
10:00	What Conservation Treatment Can and Cannot Offer	Nora Kennedy
	Examination of Photographs in Need of Treatment	Kennedy & Norris
11:00	*Coffee Break*	
11:30–12:20	15 minute informal presentations by three participants on their collections.	Three participants
12:40	*Lunch*	
14:00-17:30	***Field Trip:* Collection to View Range of Collection Materials; Storage, Exhibition and Study Areas. *Université Saint-Joseph***	**Levon Nordiguian**

DAY SIX: Tuesday, January 13th, 2009

9:00	Discussion of Surface Cleaning and Stabilization of recovered and air-dried materials *Practicum*	Kennedy & Norris
10:30	*Coffee Break*	
11:00	*Practicum:* Continuation of the above	Norris & Kennedy
12:30	*Lunch*	
14:00	Prioritization for Preservation: Balancing Collection Preservation and Access	Debbie Hess Norris

	Surveying Collections Resources for Preservation Assistance	
	Storage Practices: materials and designs for enclosures and furnishings	Nora Kennedy
15:30	*Refreshment Break*	
16:00	15 minute informal presentation by one participant on their collection.	A Participant
16:30	**Visit to the Jafet Library, AUB to view Range of Collection Materials, Storage**	**Samar Mikati Kaissi**

DAY SEVEN: Wednesday, January 14th, 2009

9:00	Future Directions in the Production and Exhibition of Arab Photography	Akram Zaatari
10:30	*Coffee Break*	
11:00	Exhibition of Photographs Diffusion of Images and Public Relations	Nora Kennedy Debbie Hess Norris
12:30	*LUNCH*	
14:00	Fundraising, Raising Public Awareness Resources for Preservation	Debbie Hess Norris
15:30	*Refreshment Break*	
16:00-17:00	*Practicum:* Creation of housings for photographs (four-flap folders, L-board housings, 3-folders, and other options) *Practicum:* Attachment methods for photographs (hinges, paper photo-corners, etc.)	Nora Kennedy Debbie Hess Norris

DAY EIGHT: Thursday, January 15th, 2009

9:00	*Best Practices for Digitization* Test driving the technology— from input to output How to make digital files last— metadata, digital preservation	Martin Jürgens (Franziska Frey)
10:30	*Coffee Break*	
11:00	*Hands-on exercises on quality and quality control of digital images* Quality control, workflows, tools, guidelines	Martin Jürgens (Franziska Frey)
12:30	*Lunch*	
14:00-17:30	***Field Trip:* Collection to View Range of Collection Materials; Storage, Exhibition and Study Areas**	**Arab Image Foundation with Zeina Arida & Tamara Sawaya**

DAY NINE: Friday, January 16th, 2009

9:00	*Digital Print Media* How do digital prints fit in the bigger picture? Digital print processes Materials for digital prints	Martin Jürgens (Franziska Frey)
10:30	*Coffee Break*	
11:00	*Digital Print Media* Stability and testing of digital prints Practical preservation measures	Martin Jürgens (Franziska Frey)
12:30	*Lunch*	
14:00	*Practicum:* Identification of Digital Print Media	Martin Jürgens
15:30	*Refreshment Break*	
16:00	*Practicum:* Identification of Digital Print Media	Martin Jürgens
	Future Directions for Preservation of Photographs in the Middle East	*All*

Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

Working with Large Photographs at the J. Paul Getty Museum

Sarah Freeman and Marc Harnly

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

The care of large photographs presents a wide variety of challenges to conservators. In 1997, the J. Paul Getty Museum (JPGM) made a change in collecting practices and began to acquire large format contemporary photographs. In 2007, *Recent History: Photographs by Luc Delahaye* was the first exhibition to consist entirely of large contemporary photographs. The exhibition was a collaborative project with the artist and museum staff, which required investigations into mounting techniques and materials, framing methods, and gallery display options. Some of the practical information gathered and lessons learned are presented in this article. An updated, previously published table detailing large-scale rigid support materials and a new table on adhesives available for mounting large works have been included.

Introduction

The collection of photographs at the JPGM was established in 1984. In the twenty-five years since its inception, the collection and its associated exhibition program has experienced rapid evolution and growth. At present, the Getty Center for Photographs within the Museum consists of over 7000 square feet of gallery space permanently dedicated to the continuous display of photographs. At any one time, there are now as many as 300 photographs on display.

Recent History: Photographs by Luc Delahaye, an exhibition consisting of ten chromogenic photographs ranging in dimension from 5 x 7 to 6 x 10 feet, opened in 2007. Readying the prints for exhibition was the charge of conservation, a task made more complicated by the fact that there were five owners of the ten prints, including the artist. Equally important, Luc Delahaye was committed to being an active part of the installation process and worked closely with conservators to mount and frame the exhibition.

When work began on the project, several variables were in place: one print had just been acquired by the Museum and like two other prints lent by Delahaye, it arrived rolled and unmounted; two additional prints belonging to Delahaye were shipped mounted but unframed; four were framed, but unsatisfactorily, so they required reframing; and one was framed properly, but eventually required reframing when the decision was made to glaze each print with non-reflective acrylic (Tru Vue Optium).

From the beginning, Delahaye expressed strong opinions on the mounting, framing, and display specifications for the exhibition. Because several of the ten prints would potentially be acquired for the collection by the end of the exhibition, there was a responsibility to insure the prints were mounted and framed with the most reliable materials and techniques possible. It was necessary to balance this responsibility with Delahaye's intentions and working techniques.

Beyond the scope of what most artists would prepare, Delahaye provided us with a mockup of his desired framing and mounting system, complete with four pages of instructions and a detailed list of the materials that should be used. Delahaye's specifications were extremely thoughtful, but the curator and conservators of the exhibition felt some improvements could be made that would enhance the appearance of the images, increase the safety of the framed package, and ultimately prolong the life of the prints.

Mounting

Methods for partially attaching the prints to rigid supports were considered, but Delahaye was adamant that his prints be mounted overall to a rigid support to achieve a desired smooth flat surface. The type of mounting substrate and adhesive used was not a concern for him. Once the overall mounting criteria were set, the decision was made to outsource the mounting to a mounting studio (Weldon Color Lab, Los Angeles) with a successful track record working with fine art prints.

To aid in our decision of the rigid support and adhesive to be used, we began with three already existing studies of these materials:

1. Table on rigid supports for oversized works of art on paper created at the Fine Arts Museums of San Francisco by Michelle Facini and Stephanie Lussier while working with Debra Evans; published in the AIC Book & Paper Group Annual 22, 2003
2. Table on rigid supports created by Sylvie Penichon; published in IIC's Bilbao Congress in 2004
3. Chapter dedicated to plastic lamination and face mounting of contemporary photographs in PMG's *Coatings on Photographs* written by Sylvie Penichon and Martin Juergens in 2005

An updated Facini and Lussier table is reproduced here in Table 1. Table 2 is a compilation of manufacturer's specifications of cold mount adhesives. Ideally materials to be used for prints in the Museum's collection are based on independent analysis. In this case, due to time constraints for the Delahaye exhibition, the choice of materials was based on product specifications, discussions with technical support of product manufacturers and recommendations of colleagues.

Delahaye favored aluminum as a mounting substrate because of its availability in large sizes and its comparatively low cost. Following the inquiries into substrate options, it was agreed that anodized aluminum would be acceptable for the prints. Anodized aluminum is oxidized electroplated metal. Many metals are structurally weakened by corrosion, except for aluminum, which is strengthened through anodizing. The process involves placing a sheet of aluminum into a chemical acid bath. The aluminum becomes the positive anode of a chemical battery and the acid bath becomes the negative. The electric current passes through the acid and results in the formation of a thin layer of oxidized metal on the surface. This layer is an extremely hard, stable substance called anodized aluminum.

Aluminum is easy to find in varying thicknesses at dimensions smaller than 4 x 6 feet. Larger sheets at specific thicknesses, however, require orders to be made several months in advance. Anodized aluminum of this size is even more difficult to buy and must be ordered six to twelve months in advance. In this case, the aluminum was shipped out-of-state to Arizona to be anodized. Aluminum sheeting this large is considered an industrial material. It is typically not packed to prevent scratches or dents during shipping and handling so repacking was necessary. Each sheet was carefully inspected and cleaned before mounting. Cleaning consisted of polishing surfaces and removing fingerprints with ethanol.

As evident in the Table 1, there is a wide variety of large rigid supports other than aluminum available commercially. Each material has advantages and disadvantages. Aluminum composites, comprised of two thin sheets of aluminum that sandwich a polymer gel interior, (often polyethylene) can have very smooth surfaces and excellent rigidity. The addition of the gel interior reduces the overall weight considerably. Dibond is an aluminum composite we seriously considered for the Delahaye project but large sizes wider than 60” could not be obtained in time for the mounting process. Other prints in the collection have been mounted to Dibond with excellent results.

Delahaye provided Material Safety Data Information on the product he uses in Paris called Permacolor PT2113, manufactured and distributed by Mactac. It is also distributed in the US, but only available on 60” rolls, which were too narrow for seamless mounting of the Delahaye prints. In considering other alternatives, some adhesives of acceptable quality and dimension were found to be unstable at lower temperatures, precluding the long-term cold storage envisioned for the works. We selected an acrylic emulsion adhesive intended for face mounting of prints (Viewbond distributed by Quality Media Laminate Solutions) for this project. Available in 72” rolls, the adhesive met our requirements for cold storage and chemical stability. Many conservators and mounters prefer the acrylic adhesives used for face mounting because they are generally perceived to be of better quality. They are often formulated with UV inhibitors, have a nearly neutral pH and can be used at room temperature for mounting sensitive material like artwork.

The mounting system commonly used for large format materials in commercial studios is a roller laminator system. Roller laminators can be used with heat for thermal plastic adhesives or without heat for cold laminate or pressure sensitive adhesives. The roller laminator and the materials that are used in face mounting and lamination of photographs are often the same materials used for back mounting to substrates.

Framing

Framing systems for large photographs need to provide adequate protection and support, which can be a challenge when balanced with aesthetic requirements. Delahaye, like many other contemporary photographers, preferred a minimal frame profile, as evidenced in the mock-up he provided us. It was unknown to us at the time that the prints made for the exhibition were larger than any Delahaye had made to date. The frame design he provided had actually only been used for smaller prints. Upon closer examination of the design it became clear that some modifications were necessary. The oak frames were given slightly greater depth and poplar strainers were added to help prevent torque of the frames during handling. Seamed aluminum composite (Dibond) backing boards were also added. Even with these additions, the frames did experience some dimensional torque during handling. Plans to fabricate a handling frame for each print now in the collection are being considered. Altogether, seven of the ten prints received new frames, and the remaining three were retrofitted to accommodate a thicker glazing than originally presented in the mock-up.

The decision was made by the artist, curators, and conservators to use nonreflective museum acrylic glazing (Tru Vue Optium). We encountered some unforeseen problems with this product at larger dimension, which included bowing and the presence minor imperfections inherent from the production process that would normally be cut away with smaller sheets. We were able to resolve some of the planar distortion by switching to a single sheet of 6 mm thick glazing rather than 3 or 4 mm sheets we use for smaller works. The imperfections in the glazing were nearly invisible in the gallery. The manufacturer continues to work to resolve this problem. It has been suggested that we consider invisibly securing the glazing to the top of the frame, possibly with screws, to reduce sagging and bowing, but we have not attempted this modification yet.

To maintain an airspace between the glazing and the print surface, Delahaye's system utilized a wooden spacer. The spacer was to be placed directly in contact with the print surface, and adjacent to the lip of the frame. The direct contact was a concern, but one that was not adequately addressed during the planning of the exhibition. As a temporary measure, the wood spacer surfaces were coated with a clear matte acrylic sealant and the frame packages were left unsealed to allow air exchange. These spacers will be changed in the future. One possible alternative under consideration is to digitally scan the wooden spacers and print archival inkjet reproductions, which will then be adhered to the visible side of acrylic spacers.

Display

As with all other aspects of his work, Delahaye had definite ideas on lighting his photographs. The Center galleries are lit with Sylvania 60 watt quartz halogen flood lights mounted on a track system. Delahaye was concerned that the warm tone of these lights in combination with what he felt was a slightly warm tone in the non-reflective acrylic glazing would not be suitable for his prints. To solve this problem, at Delahaye's suggestion, Edison Price daylight blue filters were placed over the gallery lights. These filters have since been used with other contemporary color works on display. At Delahaye's request the light intensity was increased from our standard 5.0 fc level to 9.0 fc and the lights were focused on the images, which created a more dramatic effect. These lighting measures resolved most of the issues for the artist and the curator, and still fell within the Museum lighting policy. Lenders to the exhibition agreed to allow the increase in light exposure.

The ten prints ranged in weight from 100 to 375 lbs each. They were moved in a custom designed handling cart, which kept the frames vertical. Lifting the pictures required the use of hydraulic lifts and several preparators. The smaller prints were hung on wooden cleats. Frames that arrived without cleats were hung with wall blocks. L-brackets were added along the base of the frames to help prevent movement in the event of a major earthquake.

Conclusions

The collection of large format contemporary photographs requires the development of new strategies to mount, frame, glaze, and display prints. At the J. Paul Getty Museum the exhibition *Recent History: Photographs by Luc Delahaye* was successfully presented, but required compromises to be made by the conservators, curators and artist due to the demands of the exhibition schedule. Such exhibitions of large photographs require extensive planning, even when the number of objects is relatively low. The experience of the Delahaye exhibition led to updates of existing research on the materials available for mounting and framing large photographs; a new compilation of information on mounting adhesives; and an understanding and appreciation of the inherent complexities of framing, mounting, and displaying these works. The framed Delahaye prints will be retrofitted to improve the quality of the spacer, mitigate the slight bowing and sagging of the glazing, and provide more stability against torque during handling. As discussed, a variety of methods and practices that will meet these goals are under consideration.

Standards and practices for the collection of large photographs within the Museum, including the establishment of long-term preservation measures, have been established. Installation and handling procedures have been reviewed and updated. Paper conservation will make every effort to secure reliable qualitative information on any material used in association or direct contact with artwork. Absent that, the appropriate analysis, such as the photographic activity test (PAT) or Oddy test, for archival quality will be conducted in-house. Samples of all of the materials used are retained on file by conservation along with testing results and supplier details, which are all subject to continual update as product formulations change.

Areas in need of further research in the photographs conservation field were identified. Independent qualitative analysis of commercial adhesives and supports for large photographs, with the eventual establishment of standards for these materials is essential to insure the long-term preservation of these works. An investigation into the effects of long-term cold storage on large photograph mounting systems is needed.

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J. Paul Getty Museum

TABLE 1. RIGID SUPPORTS FOR THE MOUNTING OF LARGE-SCALE WORKS OF ART ON PAPER*

Supplier and/or Manufacturer	Product Name	Price per Sq. Foot/USD	Thickness		Weight Lbs/ Sq. Ft.	Largest Panel Available
			mm	inch		
Alcan Composites USA Inc. **Alusuisse Composites, Inc.** P.O. Box 507 208 W. 5th Street Benton, KY 42025 Phone: 800-626-3365 Fax: 502-527-1552 www.alcancompositeusa.com	**Alucobond® Material** Two skins of coil aluminum .020", with a polyethylene core. All material supplied with a mill edge. (www.alucobondusa.com)	6.14	3	1/8	.92	5 x 16 ft 1.5 x 4.8 m (custom to 30 ft)
		6.75	4	3/16	1.12	
		7.40	6	1/4	1.49	
	Dibond® Material Two skins of 0.012" coil aluminum with a polyethylene core. Finished with a baked-on polyester paint. Bendable.	2.59	2	1/16	.60	4 x 10 ft 1.2 x 3m
		2.96	3	1/8	.79	5 x 10 ft 1.2 x 3 m
		3.46	4	3/16	.98	4 x 8 ft 1.2 x 2.4 m
	Foam-X® Recovery Lightweight foam board with two clay-coated paper skins and an extruded polystyrene center.	1.10	4	3/16	.149	4 x 8 ft 1.2 x 2.4 m (custom widths and lengths available)
	Gatorfoam® Lightweight foam board with a polystyrene core and patented wood veneer laminate face and back. Available thickness in inches: 3/16, 3/8, ½, ¾, 1, 1 ½, 2.	1.18 1.81	4.10 10 12.7	3/16 3/8 1/2	.247 .296	5 x 10 ft 1.5 x 3 m
		2.06 2.21 3.25 3.93	19.0 25.4 38.1 50.8	¾ 1 1 ½ 2	.277 .370 .449 .513	
	Gatorplast® High impact polystyrene facers laminated to a strong extruded polystyrene center.	1.00 1.40	4.0 12.7	3/16 ½	.204 .257	4 x 8 ft 1.2 x 2.4 m
Archivart® A Division of Heller & Usdan, Inc. 7 Caesar Place Moonachie, NJ 07074 Phone: 800-804-8428 Fax: 201-935-5964 Email: sales@archivart.com	**Aluminum/Aluminum Honeycomb Panel** Aluminum honeycomb, aluminum face material with polyurethane adhesive. Basswood edges.	37.45	14.2	9/16	.8	Supplier will customize panels to size
	Fiberglass/Aluminum Honeycomb Panel Aluminum honeycomb, fiberglass face material with polyurethane adhesive. Basswood edges.	42.80	12.7	1/2	~1.2	Supplier will customize panels to size
		43.87	15.8	5/8	~1.2	
		44.94	25.4	1	~1.2	

Supplier and/or Manufacturer	Product Name	Price per Sq. Foot/USD	Thickness		Weight/ Lbs./ Sq. Ft.	Largest Panel Available
			mm	inch		
Archivart® A Division of Heller & Usdan, Inc. 7 Caesar Place Moonachie, NJ 07074 Phone: 800-804-8428 Fax: 201-935-5964 Email: sales@archivart.com	**Tycore® Mounting Panel** Acid-free, buffered paper, honeycomb, PVA adhesive.	3.71	12.7	1/2	.19	4 x 8 ft 1.2 x 2.4 m
		5.38	19.0	3/4	.33	3.3 x 5 ft 1 x 1.5 m
	Honeycomb Core Core structure without covering skins made from acid-free, lignin-free chemical pulp. Neutral pH. Unexpanded: 60 x 12 in / 5 x 1 ft / 1.5 x .3 m. Expanded: 48 x 192 in / 4 x 16 ft / 1.2 x 4.8 m.	.06	11	7/16	.06	4 x 16 ft 1.2 x 4.8 m
Coroplast®, Inc. 4501 Spring Valley Rd Dallas, TX 75244 Phone: 800-666-2241 Fax: 972-392-2242 www.coroplast.com	**Coroplast®** Extruded twinwall plastic sheet products based on a high impact polypropylene copolymer. (Archival Grade). Available thickness 2, 3, 4, 5, 6, 7, 8, 10 mm.	.31	4	3/16	.16	Standard sizes Up to 6 1/2 x 8 ft Length determined by handling and shipping limitations.
		.63	10	3/8	.41	
Laminators Incorporated 3255 Penn Street Hatfield, PA 19440 Phone: 877-OMEGA-77 Fax: 215-721-4669 www.signboards.com	**Alumalite™** Aluminum composite panel with a high density corrugated plastic core (polyallomer). Both sides are faced with .016 inch finished aluminum.	2.96	6	1/4	.78	5 x 10 ft 1.5 x 3.6 m
		5.18	10	3/8	.99	
	D-Lite™ Aluminum composite panel with a high density corrugated plastic core (polyallomer). Faced on the front with .016 inch, polyester painted aluminum and on the reverse with painted aluminum of same thickness or a lighter gauge.	2.65	3	1/8	.53	4 x 10 ft
	Econolite™ Aluminum composite panel with a high density corrugated plastic core (polyallomer) faced with .016 inch finished aluminum and a lighter gauge backer.	2.56	6	1/4	.64	4 x 10 ft 1.2 x 3 m
		3.75	10	3/8	.84	4 x 8 ft 1.2 x 2.4 m
	Omega Bond™ Aluminum composite panel with solid polyethylene core, faced on front and back with aluminum with factory-baked white	4.15 one side painted 4.68 both sides painted	3	1/8	.83	4 x 8 ft

Supplier and/or Manufacturer	Product Name	Price per Sq. Foot/USD	Thickness		Weight/ Lbs./ Sq. Ft.	Largest Panel Available
			mm	inch		
	polyester paint finish.					
Laminators Incorporated (Cont.) 3255 Penn Street Hatfield, PA 19440 Phone: 877-OMEGA-77 Fax: 215-721-4669 www.signboards.com	**Lumi-Lite™(Omega Lite)** Offer a highly decorative, strong and durable surface finish for exterior wall surfaces. Composed of a polyallomer, corrugated core between two finished aluminum sheets, these panels are non-absorbent, water-insensitive, and easy to maintain.	4.44	6	1/4	.78	4 x 8 ft
		4.69	10	3/8	.86	4 x 10 ft (5 x 12 ft and custom)
	Pro-Lite™ Aluminum composite panel with high density corrugated plastic core (polyallomer). Faced on both sides with polyester painted aluminum. 10 mm plastic, single profile core, painted faces on both sides	1.45	10	3/8	.86	4 x 10 ft
Macrolux ® Co-Ex Corporation 5 Alexander Drive Wallingford, CT 06492 Phone: 800-888-5364 Fax: 203-679-0600 www.co-excorp.com	**Multiwall Polycarbonate Sheet** Twin, triple, four, five, M-wall, and X-wall. Available thickness 6, 8, 10, 16, 20, 25, 32, 35 mm.	3.12	6 (triple wall)	1/4	.16	4 x 39 ft 1.2 x 11.8 m
		7.81	25 (five wall)	1	.80	6 x 39 ft 1.8 x 11.8 m
Museum Services Corporation 385 Bridgepoint Drive South St. Paul, MN 55075-2466 Phone: 651-450-8954 Fax: 651-554-9217 www.museumservicescorporation.com	**Aluminum Honeycomb Panel** Aluminum skin, aluminum core, basswood edges. (Product #: 0511, 0512, 0513)	28.00	12.7	1/2	1.12	Maximum custom size for single aluminum panel to date: 12 x 16 ft 1.2 x 2.4 m Supplier can seam panels to construct larger size
		28.00	14.2	5/8	1.2	
		33.00	25.4	1	1.4	
	Fiberglass Skin Honeycomb Panel Fiberglass skin, aluminum core, basswood edges. (Product #: 0521, 0522, 0523)	40.00	12.7	1/2	1.0	
		40.00	15.8	5/8	1.1	
		42.00	25.4	1	1.2	

Supplier and/or Manufacturer	Product Name	Price per Sq. Foot/USD	Thickness		Weight/ Lbs./ Sq. Ft.	Largest Panel Available
			mm	inch		
	Dibond ® Composite Panel Faced with .010 gauge aluminum skin, polyethylene core. (Product #: 0531, 0532)	15.00	2	1/8	1.12	6 x 8 ft Supplier can seam panels to construct larger size
		21.00	4	1/4	1.12	6 x 8 ft Supplier can seam panels to construct larger size
	Tycore® Mounting Panel Acid-free, buffered paper, honeycomb, PVA adhesive. (Product #: 0570-1404)	3.57	12.7	1/2	.19	4 x 8 ft 1.2 x 2.4 m
		5.17	19.0	3/4	.33	3.3 x 5 ft 1 x 1.5 m
Teklam Corporation 1121 Olympic Drive Corona, CA 92881 Phone: 909-278-4563 Fax: 909-278-0389 www.teklam.com	**Sandwich Panel** .020" aluminum facings with aluminum honeycomb core. Available thicknesses in inches: 1/4, 3/8, ½, ¾, 1.	17.37	12.7	1/2	.78	4 x 12 ft 1.2 x 3.6 m
Small Corp P.O. Box 948 Greenfield, MA 01302 Phone: 413-772-0889 Fax: 413-773-7386 www.smallcorp.com	**Aluminum Support Panels** Panels have a .016" aluminum skin with a sealed poplar frame and an aluminum honeycomb core. Panels over 48" x 96" have pieced aluminum skins joined to form a continuous flat surface. Supplier can provide panels faced with museum board or fabric.	25.00	12.7	1/2	~1.00	4 x 8 ft 1.2 x 2.4 m Supplier can seam panels to construct larger sizes.
	Photo Mounting Panel 2-ply conservation board surface laminated to a ½" aluminum honeycomb panel. Panel is set into a 7/8" black powder-coated aluminum outer frame. Panels include hanging cleat. Maximum seamless width for paper is 90".	28.00	22.25	7/8	~1.00	4 x 8 ft 1.2 x 2.4 m Supplier can seam panels to construct larger sizes.

* Table originally published by Michelle S. Facini and Stephanie Lussier in "Big Paper, Big Problems: Rigid Support Options for the Mounting and Display of Large Format Works on Paper," The Book and Paper Group Annual 22 (2003), 111-117 (American Institute for Conservation).

Table updated by Sarah Freeman and Marc Harnly, J. Paul Getty Museum, 2009

Table 2. COMMERCIAL ADHESIVES FOR THE MOUNTING OF LARGE-SCALE PHOTOGRAPHS*

Supplier and/or Manufacturer	Product Name/Type	Temperature Range	Largest Width Available	Cost per Square Foot USD
MACtac 4560 Darrow Road Stow, Ohio 44224 P (330) 688-1111 F (330) 688-2540 mactac.americas@bemis.com www.mactac.com	**PermaPrint IP2000 (series of sizes)** Acrylic adhesive (no carrier)	-20° to 200° F -29° to 93°C	51" x 150' 51" x 400'	\$.67 \$.60
	PermaTrans IP2100 (series of sizes) Clear polyester film double-coated with optically clear acrylic adhesive	-20° to 200°F -29° to 93°C	61" x 150'	\$1.38
Drytac 5383 Glen Alden Drive Richmond, VA 23231 P (804) 222-3094 F (804) 226-2330 richmond@drytac.com www.drytac.com	**FaceMount UV™** Optically clear acrylic adhesive (no carrier)	Room temp to 125°F	72" x 150'	\$1.18
	SureTac™ Clear polyester film double-coated with acrylic adhesive	Room temp to 125°F	51" x 300'	\$.46
	SureTac™ White White polypropylene carrier double-coated with acrylic adhesive	Room temp to 125°F	61" x 150'	\$.54
Seal Neschen Americas 7091 Troy Hill Drive Elkridge, MD 21075 P (410) 540-8900 F (410) 579-8960 Customer Service (800) 257-7325 www.sealgraphics.com	**Optimount UV (ultra)** Clear polyester film carrier double-coasted with optically clear acrylic adhesive	45° to 115°F	51" x 400'	\$1.19
	Print Mount Plus Clear polyester film carrier double-coated with acrylic adhesive	Room temp to 104°F	61" x 200'	Special order (negotiable)
	Print Mount Ultra White polypropylene carrier double-coated with acrylic adhesive	Room temp to 95°F	54" x 200'	\$.57
Quality Media & Laminating Solution, Inc. 285 Slate Street, Suite One North Haven, CT 06473 P (800) 552-9427 F (203) 281-6451 info@qmls.com www.qmls.com	**ViewBond** Clear polyester film carrier double-coated with optically clear acrylic adhesive	-40°F to 180°F	72" x 150'	\$.95
	ViewBond R Clear polyester film with optically clear adhesive on the "permanent" side and medium tack acrylic adhesive on the "removable" side	-40°F to 180°F	51" x 150'	\$1.06
	InstaBond White polypropylene carrier double-coated with acrylic adhesive	-40°F to 180°F	79" x 164'	\$1.11
	InstaBond C Clear polyester film double-coated with acrylic adhesive	-40°F to 180°F	62" x 200'	\$.44

Prepared by Sarah Freeman and Marc Harnly, J. Paul Getty Museum, January 2009. All information comes from manufacturers' specifications.

* Format drawn from the rigid support table originally published by Michelle S. Facini and Stephanie Lussier in "Big Paper, Big Problems: Rigid Support Options for the Mounting and Display of Large Format Works on Paper," The Book and Paper Group Annual 22 (2003), 111-117 (American Institute for Conservation).

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Chromogenic Characterization: A Study of Kodak Color Prints, 1942-2008

Gawain Weaver and Zach Long

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

The Eastman Kodak Co. and their coupler-incorporated chromogenic print process, were nearly synonymous with the 20th century color snapshot. Introduced in 1942 and still manufactured today, samples of these prints from intervals across the manufacturing history were studied in detail in order to gain a fuller understanding of the material characteristics of this photographic process. The following aspects of the prints were examined: support, dye cloud structure, layer order, backprinting and stamps, dye and coupler stability, and fluorescence. The prints were documented overall and in cross-section under both visible and UV radiation, using an Olympus AX-70 compound microscope, and a Canon EOS 5D digital SLR. Changes in the print characteristics over time were documented and when possible, correlated to known technological developments. The documentation of these changes over time made it possible to date nearly any print to within a few years. Subsequent findings from this inquiry significantly add to the knowledge about these ubiquitous yet rarely studied photographic prints.

Introduction

The era of the color snapshot began in January 1942 when Kodak introduced Kodacolor--the first consumer-oriented mass production negative/positive color print process. The process, which produced fiber base color prints from color negatives, was dramatically simpler and cheaper than previous alternatives. One of the innovations of this new process was the use of coupler-incorporated negative film and print materials. Issues with color rendition and extremely poor dye stability plagued the process in its early years, though technological innovations led to gradual improvements in print quality and stability. By 1960, color photography overtook black and white in the U.S. amateur photofinishing market.

A general introduction to the history and technology of chromogenic materials will lay the foundation for an understanding of print characteristics. Aspects of support, dye cloud structure, layer order, backprinting and stamps, dye and coupler stability, and fluorescence will be examined in detail.

NOTE: All references to chromogenic prints in this study refer to Kodak's coupler-incorporated print materials that were sold under the Kodacolor and Ektacolor names beginning in 1942.

HISTORY AND TECHNOLOGY

Chromogenic photography is based on silver halide technology, so much so that color prints are often referred to as silver halide prints in industry. The critical step in silver halide photography that we are concerned with here is the developing step:

Developer + Silver halide → Oxidized developer + Metallic Silver

In black and white photography this oxidized developer has no purpose, and is simply washed out of the print as a chemical by-product of the development process. In chromogenic processes, this oxidized developer is used for the image-wise creation of color dyes.

Perhaps the earliest suggestion for using oxidized developer to create color comes from Dr. Benno Homolka, a German chemist. Around 1906, Homolka was investigating the nature of the latent image. Specifically he wanted to determine whether the latent image acted as an oxidizing agent in relation to organic compounds other than typical photographic developers. In order to make this task easier he sought an organic compound whose oxidized form was both colored and insoluble. This way, if the latent image acted as an oxidizing agent, the oxidized organic compound would stay in the emulsion and be visible. He chose two close chemical relatives of indigo dyes, indoxyl and thio-indoxyl. Upon oxidation these convert to insoluble green and red compounds, respectively. While Homolka did note the beautiful photographic effects that could be obtained with these new "developers", he did not suggest that these reactions might be useful in the pursuit of a color photographic process (Homolka 1907).

A few years later, another German chemist, Rudolf Fischer, would be the first to recognize the potential of oxidized developers in producing a photographic color image. In a patent filed in 1912, Fischer coined the terms "color development" and "color formers" (dye couplers), and described the process of chromogenic negative/positive photography in some detail (Fischer 1913). A year later, he listed the color developers and dye couplers that can be used in combination to produce various colors in the "making of colored photographs," many of which are still in use today (Fischer 1914). With Fischer's work we can now complete the chromogenic chemical reaction:

Color developer + Silver halide → Oxidized color developer + Metallic Silver

Oxidized color developer + Dye coupler → Color dye

Despite his visionary description of chromogenic photography, Fischer was not able to create a successful color process. He could not prevent the sensitizing dyes and dye couplers from wandering between the various emulsion layers and causing havoc in the final image. Research at Agfa and Kodak in the 1920s and 1930s would finally solve these problems and pave the way for the introduction of Agfacolor Neu in 1936 (a chromogenic color transparency process) and finally for Kodacolor in 1942.

One of the last steps in solving the practical problems of the chromogenic process was the anchoring of the color couplers to keep them from wandering into other layers or diffusing within their own layer. Agfa was the first to solve this problem. In the early 1930s Wilmanns and

Schneider, working at Agfa Filmfabrik, discovered that the diffusion properties of dyes within a gelatin layer were dependent on the shape of the dye molecule, and that long molecules did not easily diffuse. This soon led to the development and patenting of dye couplers with long carbon chains attached to keep them in place in the gelatin binder. This was the key discovery that made it possible for Agfa to produce Agfacolor Neu.

Kodak was working on the same problem, but found a different solution around 1939. They used shorter carbon tails on the dye couplers, making them water insoluble and oil-soluble. They then dissolved these dye couplers in a resinous binder, which was then dispersed as tiny droplets in the gelatin emulsion. This discovery led directly to the introduction of the Kodacolor process in January 1942 (Coote 1993).

KODACOLOR/EKTACOLOR TIMELINE

1942 Kodacolor introduced (very poor dye stability, severe coupler staining)

1949 Orange coupler mask replaces silver image mask in Kodacolor negatives to improve color rendition

1954 Magenta dye stability improved, coupler staining dramatically reduced, dye layer order reversed

1959 Cyan dye stability improved, coupler staining further reduced, OBAs added during processing, backprinting introduced with Kodak Penny Seal (EKC logo)

1968 Resin-coated (RC) supports and textured surfaces introduced

1974 Optical Brightening Agents (OBAs) added to paper base during manufacture

1988 OBAs added to polyethylene layers

CHARACTERISTICS

SUPPORTS

Kodak has used 4 different supports since 1942 for their chromogenic prints: fiber base, resin-coated (RC), polyester, and laminate.

Fiber base support was used for Kodak chromogenic prints from their introduction in 1942 until it was replaced by RC support in 1968. Fiber base prints were being produced as late as 1971, as evidenced by a sample book from that year. Fiber base support consists of paper, or "raw base" as it was called at Kodak, and a baryta coating. Here is a list of additives to Kodak's raw base from 1945:

Muriatic acid (pH adjustment)
Melamine-formaldehyde (Wet strength agent)
Aluminum chloride

Stearic Acid/NaOH (produces sodium stearate, and mixes with AlCl3 to make Aluminum Stearate which acts as an internal size providing increased water resistance)
Gelatin tub size (external gelatin size, could provide wet strength if hardened, generally acts as a surface sizing agent, holds down the paper fibers, etc.)
Blue dye used in most papers
Magenta dye used in about 5% of papers
Corn starch (dry strength)
Beater gelatin (dry strength)

RC supports were made by sandwiching the raw base between layers of polyethylene (PE). The emulsion-side PE layer was pigmented with titanium dioxide (TiO_2). TiO_2 imparts opacity and whiteness to the pigmented PE layer, replacing the visual function of the baryta layer in fiber base prints. Both rutile and anatase forms of TiO_2 have been used, though surface treatments have been changed over time to reduce the light induced oxidation of the RC support which is catalyzed by TiO_2. TiO_2 surface treatments also prevent clumping and help dispersion of the particles. TiO_2 was added to the raw base of RC supports around 1984. Although the detailed composition of print supports are not known for every time period, after 1988 the layers and additives of Kodak RC color prints were as follows, though some additives may not be listed, and the composition may have changed at some point:

Emulsion layers (CMY)
Pigmented PE layer: TiO_2, Zinc Oxide, OBA, Magenta dye
Raw Base: paper fiber, antioxidants, TiO_2, OBA
Backprinting
Clear PE layer
Anti-static layer (colloidal silica)

Polyester supports were first used for Kodak chromogenic prints in the 1970s with ID print materials, and their use was later expanded into professional papers. Manufactured in transparent, pigmented translucent, and pigmented opaque base, polyester supports have had a niche market since the 1980s. The opaque base was discontinued in 2004, while transparent and translucent materials are available to this day (Eastman 2004).

Laminate supports have been used for two products: Duralife, a short-lived consumer product introduced in 1999, and Metallic Endura, a professional paper with a metallic appearance. These supports have a complex laminate structure, and resist tearing and curling.

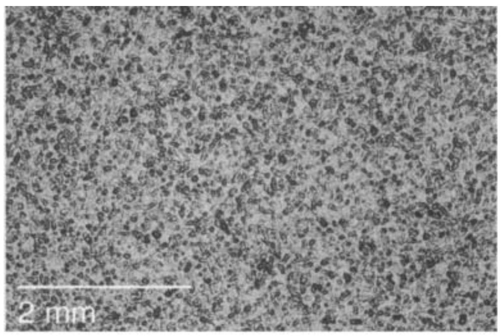
SURFACES

Fiber base print surfaces: F (glossy), air-dried or ferrotyped
Fiber base prints (1942-1968) were only manufactured with an F surface (glossy), which could be ferrotyped or air-dried, giving two possible surfaces for fiber base color prints. Photofinishing prints were nearly always ferrotyped.

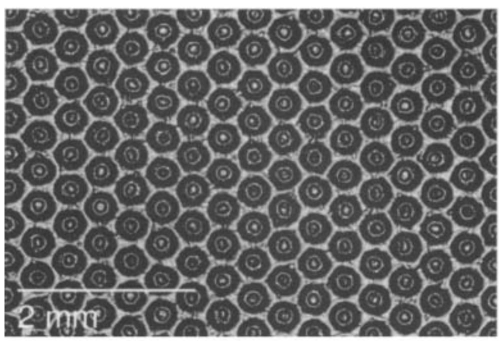
RC print surfaces: F (glossy), N (matte), Y (silk), E (lustre)

Kodak converted from fiber base to RC for Kodak chromogenic color prints in 1968, making available a wider range of manufactured surfaces for color prints. RC print surfaces were made in an entirely new way. After the PE layers were extruded onto the paper base, the support was passed through a nip, and cooled against a textured steel roller, known as the chill roll. The only exception to this was the silk surface, which was originally made by embossing the cooled RC support, and later was made with the chill roll.

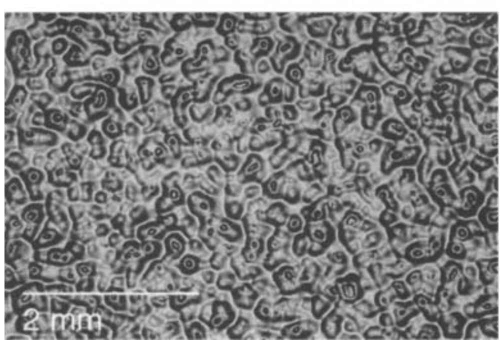
Figure 1. Textured RC print surfaces



Endura N surface 2008



Endura Y surface 2008



Endura E surface 2008

Matte and Silk surfaces were introduced in 1968 (Eastman 1974). Silk was the photofinishing surface of choice in the early 70s, though it was abruptly displaced by E surface in 1976. By 1977, Y surface accounted for only 1% of photofinishing prints (Wolfman 1975-77).

Polyester print surfaces: Ultra-high gloss
Kodak's polyester-base prints have an ultra-high gloss similar to the surface of polyester or acetate-base Cibachrome prints.

Laminate print surfaces: Glossy
Laminate prints (Duralife and Metallic Endura) have a high gloss surface, similar to an F surface RC print.

DYE LAYERS

The conventional emulsion dye layer order of chromogenic photographic materials is (from top to bottom) yellow, magenta, cyan (YMC). Light passes through the blue-sensitive (yellow) layer first, then the green-sensitive (magenta) layer, and finally the red-sensitive (cyan) layer. This allows the use of a yellow filter layer below the blue-sensitive layer, which prevents exposure of the two lower layers to blue light. When the Kodacolor negative-positive system was introduced in 1942, both the film and paper were arranged in this conventional layer order. In 1954, the paper dye layer order for negative working prints was reversed to (top to bottom) cyan, magenta, yellow (CMY). The cyan layer was moved to the top of the emulsion, away from the relatively rough surface of the baryta, in part to reduce perceived mottling because the human eye can distinguish detail more readily in cyan than in yellow. This layer order remains in use today for all negative-working print materials, however positive-working print materials have always retained the traditional YMC layer order.

The use of a yellow filter layer is not possible with the CMY layer order because the blue-sensitive (yellow) dye layer is on the bottom. Instead, blue light must pass through the red- and green-sensitive layers to reach the bottom blue-sensitive layer. The obvious difficulty with this setup is that silver halides have inherent blue sensitivity, regardless of how they have been sensitized to red or green light. Therefore, to make this work the bottom blue-sensitive layer must have greater light sensitivity. This allows relatively small amounts of blue light to pass through the red- and green-sensitive layers and sufficiently expose the blue-sensitive layer.

This new dye layer order with yellow on the bottom has remained unchanged for Kodak chromogenic negative-working print materials. Film has maintained the conventional YMC layer order (photographic still film only, motion picture film varies). Kodak reversal print materials such as Ektachrome paper also use the YMC layer order, as well as other reversal print materials such as Cibachrome. Layer order can be determined non-destructively by using a compound microscope with reflected cross-polarized light at 500x viewing magnification. The limited depth of field at this magnification makes it possible to focus on only one dye layer at a time, thus enabling layer order to be determined by observing the order that these layers come into focus.

DYE CLOUDS

The dye deposits formed in the coupling reaction between oxidized developer and dye coupler are known as dye clouds. These dye clouds form in the immediate vicinity of developed silver. After development of the silver and color dyes, the silver is removed through bleaching and fixing, leaving only the dye clouds to form the image. The size of dye clouds is a function of the diffusion rate of oxidized developer (how quickly the developer molecules travel through the gelatin after reducing the silver halide to metallic silver), the coupling rate (how quickly the oxidized developer reacts with the dye coupler), and the reactions of the oxidized developer with substances other than the coupler (Krause 1989).

In Kodak chromogenic papers dye clouds range in diameter from 1.25 to 4 microns. Yellow dye clouds tend to be larger than their cyan and magenta counterparts. One of the primary means of achieving a high-speed emulsion (which is necessary for the blue-sensitive dye layer) is the use of large silver halide grains, which in turn leads to large dye clouds.

Dye clouds in Kodak negative working prints can be divided into three distinct eras when examined with reflected cross-polarized light at very high magnifications (a 500x viewing magnification on a compound microscope was used in this study). Changes in emulsion manufacture and processing resulted in the edges of dye clouds becoming less diffuse over time, and this can be used in the dating of prints by classification into one of the three groups. The first period is from 1942 through the 1960s, and is identifiable by diffuse dye clouds. Starting in the early 1970s, dye clouds become slightly more defined, having a relatively circular shape with a moderately defined edge. This lasts until the early 1980s when dye clouds become very well defined with hard edges. This period continues to the current day. Since dye clouds in negative and positive working prints evolved at different rates it is imperative to determine layer order, and thus material, before using dye clouds to date prints.

IMAGE DETERIORATION

Image deterioration of chromogenic prints occurs in three primary ways: thermal fading, light fading, and coupler staining. Thermal fading, or dark fading, refers to color image dye loss that occurs by the action of temperature and humidity. Until the 1980s, cyan dye was generally the most susceptible to thermal fading. Therefore, the effect of thermal fading alone on prints of this era has or will be a reddish image tone resulting from a loss of cyan dye. Light fading reveals a different dye weakness. The magenta dye is typically the weakest when exposed to light, and prints left on display will typically become cyan or green in color. Coupler staining is the yellow cast caused by the magenta coupler that remains in the print in inverse proportion to the amount of magenta dye. Wherever magenta dye is not formed, there is magenta coupler that remains in the print after processing. This coupler can yellow in one of two ways: thermal yellowing or coupler print-out. Thermal yellowing, like thermal fading, occurs without light, while coupler print-out is the yellowing that occurs in response to light exposure. Coupler staining has been systematically improved since 1942 (LaBarca and O'Dell 2002, Reilly 1998).

All of these forms of image deterioration can be found on any print in varying degrees. Of course, they are more obvious in older prints that are both less stable and have had more time to deteriorate. While it can be difficult to interpret every nuance of image deterioration in a given print, there are general trends that become quickly apparent when large numbers of prints are examined. These are described here by the five major eras of image deterioration:

1942-54

Early Kodak chromogenic prints, from their introduction in 1942 until 1954, had both very poor dye stability and severe coupler staining. These prints are easily recognizable by their dramatic yellow stain in non-image areas, and the nearly complete absence of color in the images, which have faded to brown with only hints of the original dyes.

1954-59

In 1954 Kodak made significant improvements in magenta dye stability and drastically reduced coupler staining. Prints from the period of 1954 to 1959 are identifiable by their overall magenta image color and only slight coupler staining compared to pre-1954 prints.

1959-1968

In 1959 Kodak introduced prints with even further reduced coupler staining and drastically improved dye stability. These prints do not exhibit overtly characteristic image deterioration. They generally have pleasing overall image colors with only mild dye fade, unless they were left on display over a long period.

1968-1980

With the introduction of RC prints in 1968 a new deterioration problem was created: embrittlement and cracking of the emulsion side PE layer. This problem is unique to RC prints and was corrected by 1980. It was not examined in any detail in this study.

1980-2008

Kodak continued to make improvements in coupler staining and dye stability, particularly balancing relative thermal and light fading rates to improve long-term appearance. New pyrazolotriazole magenta couplers virtually eliminated thermal yellowing and coupler print-out by the late 1980s (LaBarca and O'Dell 2002). A new cyan dye in the early 1980s made yellow the new weak link in thermal fading.

OPTICAL BRIGHTENING AGENTS

Optical brightening agents (OBAs) can be found in chromogenic prints by 1959. OBAs were added to prints from 1959 until 1974 by inclusion in the processing chemistry. Since they were not added during manufacture, some prints from this period do not contain OBAs. Kodak included OBAs in the raw base during manufacture starting in 1974. The final change occurred in 1988 when Kodak added OBAs to the polyethylene layers of RC prints (Keirstead 2008).

An effective method for determining the presence or absence of OBAs is to view the print in question under dim tungsten lighting next to a print without OBAs (such as an early 1950s Kodacolor print). Then turn on a UV-A lamp near the prints and look for any change. Prints with OBAs fluoresce under UV, appearing brighter and with a blue cast. It may be helpful to switch the UV lamp off and on again several times to look for any change. The use of a UV lamp by itself can be misleading, as the blue visible light emitted by the lamp can easily be confused with fluorescence when viewing the white surface of the back of the print.

Photofinishers typically process prints on a roll, a system that creates two different types of prints edges, one exposed to processing solutions and one formed by cutting the individual prints after processing. This difference is often visibly noticeable in RC prints by the staining of the paper fibers on the chemistry exposed (manufacturer cut) edges. An effect that can be used to date prints to before or after 1974 is the presence of OBAs in the paper fibers on the non-chemistry exposed (processor cut) edges. This indicates that OBAs were added during manufacturing, a practice not begun by Kodak until 1974. This can be determined non-destructively by examining the edges of a print under UV radiation and with high magnification (a viewing magnification of 200x on a compound microscope was used in this study).

UV ABSORBERS

UV absorbers are used to improve the light stability of color dyes. They have been used in Kodak color prints since 1950, when they were introduced in Kodacolor Type II paper (Hanley 1974). When examined under UV lamps, prints with UV absorbers appear darker than when viewed under visible light. The effect of UV absorbers on print appearance is different depending on the OBA application method (manufacturing or processing), as well as on the relative amounts of OBAs and UV absorbers.

MANUFACTURER BACKPRINTING

Backprinting was first used on Kodak color papers in October 1958 with the introduction of the Kodak penny seal, a circular emblem containing the letters "EKC." Initially, backprinting was very faint to imitate a watermark, and was referred to as such, despite being printed. From the beginning there was controversy over the presence of the backprint and the density of the printing (Beach 1977). Photofinishers often appreciated the printing as proof of their use of quality photographic materials. Professionals often disliked it, as they preferred the photograph to be their own work, and not labeled by a manufacturer's name. After the introduction of backprinting on Kodak color paper in 1958, unprinted paper was intermittently produced.

In November 1961 a new backprint symbol was introduced, which read "A Kodak ® Paper." In 1968, this backprint made the transition onto RC paper with the introduction of Ektacolor 20 RC. Then on June 14, 1971, selective underlining of the letters in the backprint "A Kodak ® Paper" was introduced in order to identify lateral locations on the paper roll. This was useful in product control and defect tracking. In May 1972 the backprint was changed again, this time to "This Paper Manufactured by Kodak," which lasted until around 1989. Selective overlining was introduced in addition to selective underlining in 1980, in order to accommodate new wider paper rolls (see Figure 2). In 1989 Kodak changed their model of a standard backprint for all materials to one of unique a backprint for each individual product line. This resulted in a multitude of new backprints that were often short-lived (Ward 1973, Keirstead 2008). A detailed chronology of Ektacolor backprints including images when available can be found in the chart "Ektacolor Paper Backprint Chronology" included at the end of this paper.

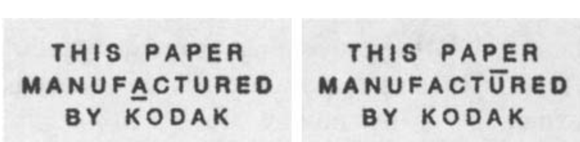


Figure 2. Examples of underlining and overlining on manufacturer backprints

PHOTOFINISHER BACKPRINTING AND STAMPS

Backprinting and stamps are often added by the photofinisher, and can appear as logos, text, or both. Stamps were used by Kodak beginning in 1942 and indicated the date and identified the prints as being from Kodak. Kodak used different stamps over the years, though they are seen less frequently on prints after the 1960s. Processing by non-Kodak labs began after 1954. Stamps from these photofinishers are less common, but still readily found. Back stamps on mounted prints can often be seen using strong transmitted light. Limited experiments with documenting stamps on mounted prints with transmitted IR photography have had some success as well.

The ability to print unique lines of text, including date and print exposure information was first available in the late 1970s with the introduction of the Noritsu minilab. At first only single lines of text were possible, but beginning in the late 1980s, two lines of text became possible, and could be used for the name of the photofinisher or other information. A dot matrix printer has been used from the beginning by Noritsu, and by other manufacturers as well. While Noritsu had a large share of the minilab market, there were other manufacturers, who used their own backprinting systems. Detailed information about photofinisher backprints has not been collected.

Figure 3. Examples of photofinisher stamps on prints from 1944 to 1980

CONCLUSION

Each of the print characteristics discussed here enhances understanding of the chromogenic color print process, particularly Kodacolor/Ektacolor prints. When examining a print, these characteristics can be used to place it within the technological continuum of the chromogenic process and date it within a few years.

Succeeding work in chromogenic print characterization should study other manufacturers such as Agfa, Fuji, and Konica. Additionally, Kodak's non-coupler-incorporated chromogenic print materials, i.e. Kodachrome type emulsion should be studied. Finally, further investigation of the print chemistry of each era needs to be understood. The use of stabilizers are of particular interest, as conservators have often wondered about the effects of water damage and aqueous conservation treatments on prints that were stabilized during processing. An understanding of all of the aspects of chromogenic print materials is of increasing importance. These materials have seen significant use by fine art photographers since the 1970s and have now been fully integrated into digital printing via digital exposure units such as the Durst Lamba. A high percentage of large contemporary prints are being produced in this way. Chromogenic prints now have significant presence in the fine arts, and still maintain a major presence in photofinishing. Our ability to safely treat and preserve these prints will be greatly enhanced by further study of the relationship between their observed characteristics, manufacture, and processing.

ACKNOWLEDGEMENTS

Thanks to James Reilly, Director, Image Permanence Institute for allowing us to pursue our curiosity about the details of chromogenic prints. This research would not have been possible without the help of several retired Kodak employees who gave generously of their time and expertise, in particular Kit Funderburk, J. Michael Keirstead, Ron Mowrey, and Paul Schwartz.

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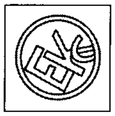
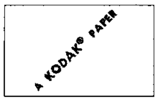
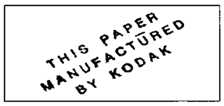
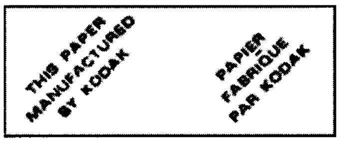
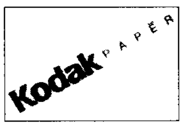
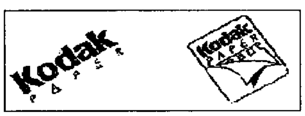
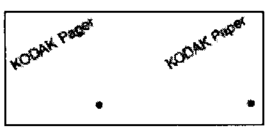
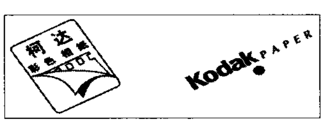
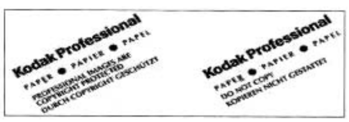
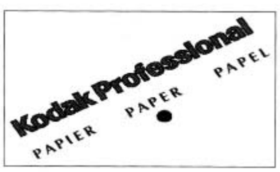
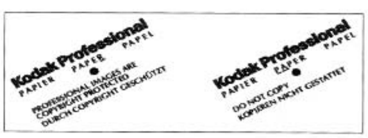
Ektacolor Paper Backprint Chronology

Compiled by J. Michael Keirstead, with contributions from Gawain Weaver and Zach Long

Backprint Image	Backprint Text	Dates Used	Products
	EK$_c$	10/58-11/61	All Ektacolor Papers
	A KODAK ® PAPER	1961 - 1972	All Ektacolor Papers (RC > ~1968) (Selective underlining began June 14, 1971)
	THIS PAPER MANUFACTURED BY KODAK	5/72 - 1/91 5/72 - 1993 5/72 - 7/98 starting 6/80	Ektacolor 74, Plus, etc Ektacolor Professional Papers (Process EP-2) Black & White Professional Papers (Wide machines in US with overlines on 1/2 the paper) *(MANUFACTURED under/overlined for web ID)*
	THIS PAPER MANUFACTURED BY KODAK PAPIER FABRIQUE PAR KODAK	1985 - 1986 1985 - 1991 1985 - 1989	Ektacolor Consumer Products (produced in Canada) Ektacolor Consumer Products (produced in England) Ektacolor Pro Papers (Proc. EP-2)(prod. in England) *(MANUFACTURED and FABRIQUE under/overlined for web ID)*
	Kodak PAPER	1991 - 1995	Ektacolor EDGE,EDGE 2 *(Paper under/overlined for web ID)*
	Kodak Official Sponsor of the Olympic Games	7/95 - 4/97	Ektacolor EDGE 2, EDGE 5 *(Olympic Games under/overlined for web ID)*
	Kodak Official Sponsor of the Olympic Games *(6 languages)*	10/95 - 4/97	Ektacolor EDGE 2, 5 (prod. in England)
	Kodak *PAPER* Kodak *PAPER* (Systems Logo)	4/97 - ~12/98 12/97 - ~6/00 7/97 - 4/00	Ektacolor EDGE 5,7,8 Initial Web Identifiers = 12 Positions/43", P-AR Revised Web Ident = 23 Positions /43", P-APER Ektacolor EDGE 5,7,8 (prod. England w/23 pos'n ID) *(Paper under/overlined for web ID)*
	KODAK Paper	3/97-thru 2006	Ektacolor EDGE 5, EDGE 7, 8 (for China) *(Paper under/overlined for web ID)*
	Kodak PAPER ● Kodak *PAPER* (Systems Logo)	3/00 - thru 2006 3/00 - thru 2006	Ektacolor EDGE 8 Ektacolor EDGE 8 (prod. England) Web Ident = 23 Positions /43", P-APER with 3mm dot
	Kodak PAPER ● *"Kodak" in Mandarin characters* *"Color Paper" in Mandarin* (Systems Logo)	9/03 - thru 2006	EDGE 10 Paper, Type 4009 (for China) *(Paper under/overlined for web ID)*

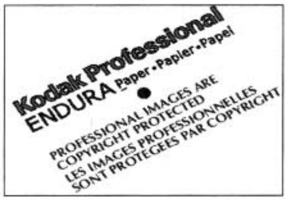
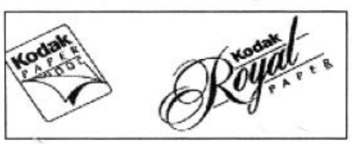
Ektacolor Paper Backprint Chronology

Compiled by J. Michael Keirstead, with contributions from Gawain Weaver and Zach Long

Backprint Image	Backprint Text	Dates Used	Products
	Kodak PROFESSIONAL PAPER ● PAPIER ● PAPEL	9/89 - 7/93	Ektacolor Portra (Process RA-4)
		9/89 - 1/00	Ektacolor Supra, Ultra (Process RA-4)(prod in US)
		4/99 - 5/00	Ektacolor Ultra III (Process RA-4)(prod in England)
		98 - 5/99	Ektacolor Digital II Paper (for non-US market)
		7/98 - ~8/00	Black & White Professional Papers
		??? - 8/00	Ektachrome papers
		6/00 - 7/00	KPro Brilliance (Grey ink for China)
		3/00 - 5/00	ProFoto/ProImage (Gold ink)
			(PROFESSIONAL, PAPER, PAPIER, and PAPEL under/overlined for web ID)
	Kodak PROFESSIONAL PAPER ● PAPIER ● PAPEL DO NOT COPY * or Professional Images are Copyright Protected * *(* in English,French,German,Spanish)*	7/93 - 3/00	Ektacolor Portra, Portra II, III (Process RA-4)
		7/93 - 3/00	Ektacolor Supra, Supra II, III (prod. in Brazil)
		7/93 - 7/00	Ektacolor Supra, Supra II, III (prod. in England)
		7/93 - 4/99	Ektacolor Ultra,Ultra II (prod. in England)
		98 - 5/99	Ektacolor Digital II Paper (for US market)
		12/99 - 3/00	Ektacolor Digital III Paper (E surface only)
			(PROFESSIONAL under/overlined for web ID)
	**Kodak Professional** Digital Paper ● Papier Numerique or Digital Papier ● Papel Digital *(* in English,French,German,Spanish)*	3/99 - thru 2006	Ektacolor Digital III Paper
		3/99 - 12/99	Ektacolor Digital III Paper (E surface only)
		3/99 - 12/00	Ektacolor Digital III Paper (N surface only)
			(Paper under/overlined for web ID)
	**Kodak Professional** PAPER ● PAPIER ● PAPEL	1/00 - 10/02	Ektacolor Supra III F (prod in US)
		1/00 - 12/00	Ektacolor Supra III E surface (prod in US)
		1/00 - ???	Ektacolor Supra III N surface (prod in US) (no logo thru 2006)
		2/00 - ???	Ektacolor Ultra III (prod in US)
		5/00 - ???	Ektacolor Ultra III (prod in England)
		5/00 - ~6/02	ProImage (Gold ink, US)
		5/00 - thru 2006	ProFoto (Gold ink, England)
		5/00 - 9/03	KPro Brilliance (Grey ink for Asia)
		8/00 - 10/05	Black & White Professional Papers
		8/00 - 4Q01	Ektachrome Radiance papers (no logo thru 2006)
		5/01 - 6/02	Portra B&W F&N (E surf 5/01-11/01)
		~2000 - 8/02	KPro Color Metallic paper (laminated)
			(Paper under/overlined for web ID)
	**Kodak Professional** PAPER ● PAPIER ● PAPEL DO NOT COPY * or Professional Images are Copyright Protected * *(* in English,French,German,Spanish)*	11/99 - 6/02	Ektacolor Portra III (prod in US)
		12/99 - 7/02	Ektacolor Supra III (prod. in Brazil)
		7/00 - 6/02	Ektacolor Supra III (prod. in England)
		3/00 - thru 2006	Ektacolor Digital III Paper (US E surface only)
		12/00 - 10/02	Ektacolor Supra III E surface (prod. in US)
		~11/01 - 6/02	Portra B&W E, Sepia E
			(Paper under/overlined for web ID)
	**Kodak Professional** PAPIER PAPER PAPEL ●	3/02 - thru 2006	Kodak Pro Supra ENDURA F (N no logo)
		8/02 - 8/03	KPro Metallic paper (laminated)
		??? - 10/05	ProImage(Gold ink, US)
		3/06? - thru 2006	ProFoto(Gold ink, England)
		??? - 9/03	KPro Brilliance (Grey ink for Asia)
		5/02 - thru 2006	KPro Thermal Laminated Dye Sublimation Papers
		??? - thru 2006	Kodak Inkjet Paper
			(3mm dot w/outline letters)
			(Paper under/overlined for web ID)
	**Kodak Professional** PAPIER PAPER PAPEL ● DO NOT COPY * or Professional Images are Copyright Protected * *(* in English,French,German,Spanish)*	3/02 - 5/03	Kodak Pro Portra ENDURA (prod in US)
		4/02 - 6/03	Kodak Pro Supra ENDURA (prod. in Brazil)
		~3/02 - 5/03	Kodak Pro Supra ENDURA (prod. in England)
		6/02 - 5/03	Kodak Pro Supra ENDURA E surface (prod. in US)
		??? - thru 2006	PX4000 E surface
		~6/02 - ~10/05	Portra B&W E, Sepia E
			(3mm dot w/outline letters)
			(Paper under/overlined for web ID)

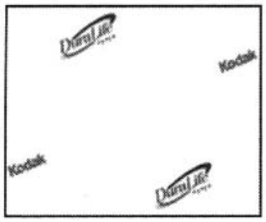
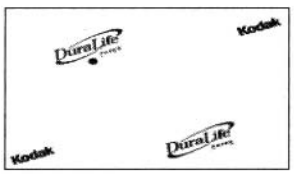
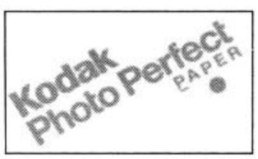
Ektacolor Paper Backprint Chronology

Compiled by J. Michael Keirstead, with contributions from Gawain Weaver and Zach Long

Backprint Image	Backprint Text	Dates Used	Products
	**Kodak Professional** ENDURA Paper · Papier · Papel ●	8/03 - thru 2006 10/03 - thru 2006 9/03 - thru 2006	ENDURA Color Metallic paper (laminated) - US ENDURA Color Metallic paper (laminated) - Europe Ultra ENDURA F,N logo added (prod. in US) **(3mm dot w/outline letters)** *(Paper under/overlined for web ID)*
	**Kodak Professional** ENDURA Paper · Papier · Papel ● DO NOT COPY * or Professional Images are Copyright Protected * *(* in English,French,German,Spanish)*	5/27/03-10/05 ~5/03 - thru 2006 5/03 - 10/05 6/03 - 10/05 ~5/03 - thru 2006 ?? - thru 2006	Portra ENDURA (prod in US) Portra ENDURA (prod in England) Supra ENDURA E,F (N no logo) (prod. in US) Supra ENDURA (prod. in Brazil) Supra ENDURA (prod. in England) Ultra ENDURA E (F,N no logo) (prod. in US) **(3mm dot w/outline letters)** *(Paper under/overlined for web ID)*
	**Kodak Professional** Digital Paper ● Papier Numerique or Digital Papier ● Papel Digital *(* in English,French,German,Spanish)*	9/03 - thru 2006	KPro Brilliance (for Asia) **(3mm dot w/outline letters)** *(Paper under/overlined for web ID)*
	Kodak Royal PAPER	1989 - 2/90	Ektacolor Royal (with Crown & Pearlescent Gold Ink)
	Kodak *Royal* PAPER	2/90 - 7/95 1992 - 7/97	Ektacolor Royal D-2778, Royal II Ektacolor Royal II, V (prod. in England) (Script with Pearlescent Gold Ink) *(Kodak or PAPER under/overlined for web ID)*
	Kodak *Royal* PAPER Kodak Official Sponsor of the Olympic Games	7/95 - 4/97	Ektacolor Royal II, V (with Gold Ink) *(Olympic Games under/overlined for web ID)*
	Kodak *Royal* PAPER Kodak *PAPER* (Systems Logo)	4/97 - 99? 98? - 6/00 6/97 - 6/00	Ektacolor Royal V, VII, VIII Initial Web Identifiers = 12 Positions/43", P-AR Revised Web Ident = 23 Positions /43", P-APER Ektacolor Royal V,VII,VIII (prod. England w/Pearl Gold) Revised Web Ident = 23 Positions /43", P-APER
	Kodak *Royal* PAPER ● Kodak *PAPER* (Systems Logo)	6/00 - 11/05 6/00 - 11/00 11/00 - 11/05	Ektacolor Royal VIII "CN2 Logo" Ektacolor Royal VIII (prod. England w/Pearl Gold) Ektacolor Royal VIII (prod. England w/ Gold) Web Ident = 23 Positions /43", P-APER with 3mm dot
	**Kodak** *Royal* *DIGITAL* ● *PAPER*	11/05 - thru 2006	Ektacolor Royal Digital (have undated sample in gold ink. gw) Web Ident = 30 Positions /73", P-ER under/P-ER over

Ektacolor Paper Backprint Chronology

Compiled by J. Michael Keirstead, with contributions from Gawain Weaver and Zach Long

Backprint Image	Backprint Text	Dates Used	Products
	**Kodak** *Royal* *DIGITAL* *PAPIER • PAPER* Bilder von • Tirages par **cewe**	6/06 - thru 2006	Ektacolor Royal Digital CEWE co-branded product for Europe Bilder von • Prints by **cewe** Web Ident = 22 Positions /57", P-AE under/P-AE over
	Kodak *Duralife* PAPER	3/99 - ~6/99	PX3026 Laminated w/Multicolor logo #1 for initial production
		~6/99 - 8/00	Laminated w/Multicolor logo #2 with reduced size Edge 7,8
		4/00 - 2/01	Europe prod'n Laminated Multicolor w/under/overlines Edge 8 *(PAPER under/overlined for web ID)*
	Kodak *Duralife* PAPER •	6/00 - ~12/00	Duralife (Laminated w/Edge 8 emul) Bronze Ink (sml PAPER)
		2/01 - 10/02	Europe prodn Laminated w/under/overlines Edge8(sml PAPER)
		~12/00 - 4/02	Duralife (Laminated w/Edge 8 emulsion) Bronze Ink (lg PAPER)
		4/02 - 8/02	Duralife 2 US (RC paper design) Bronze Ink (lg PAPER)
		4/02 - 2/03	Duralife II England (RC paper design) Bronze Ink (lg PAPER)
		9/02 - thru 2006	Duralife 2 (US) (RC paper design) Gold Ink (lg PAPER)
		2/03 - thru 2006	Duralife + England (RC paper design) Gold Ink (lg PAPER) *(PAPER under/overlined for web ID)*
	**Kodak** **Perfect Touch** *PAPER* •	~9/03 - thru 2006	Perfect Touch US Gold Ink *(PAPER under/overlined for web ID)*
	**Kodak** **PhotoPerfect** PAPER •	2/03 - thru 2006	PhotoPerfect (England) Gold Ink *(PAPER under/overlined for web ID)*

NEW APPLICATIONS FOR PAPER FIBER ANALYSIS IN CHARACTERIZING GELATIN SILVER PRINTS

LEE ANN DAFFNER AND PAUL MESSIER

Presented at the 2009 winter meeting in Tucson, Arizona

The core of many fine art photography collections is the gelatin silver print, the dominant process from mid 1880's to the present day. A print's origin can be elementary to understanding the work, its historical context and the creator's artistic intent. It carries implications for treatment, display and storage and can influence its market value. Tangible information, such as the presence of optical brightening agents, manufacturer back printing, paper fiber analysis, and surface texture characterization can corroborate print dates. Paper fiber analysis and detection of optical brighteners were pivotal in exposing landmark counterfeits (Man Ray in1998 and Lewis Hine in1999), proving that a characterization methodology based on the chemical and physical properties of photographic paper could become a valuable tool for scholarship and authentication.

In 2001 The Museum of Modern Art (MoMA) Conservation Department and Paul Messier embarked on a collaborative study to analyze a selection of papers from the Messier reference collection, identifying fiber content through forensic fiber analysis. Outlining responsible sampling techniques and protocols for works of art and evaluating statistical confidence were central to this study.

Pulp process and fiber species identification for a set of 139 reference gelatin silver papers from the 20th century were obtained. Based on this data, a trial test was carried out to determine the printing date of 20 selected prints with established provenance from the MoMA collection, with good results. The prediction accuracy was further improved by the presence or absence of optical brightening agents (OBAs). The application of statistical protocols, currently under review by MoMA conservation scientist Ana Martins, shows promise of establishing confidence intervals for results and developing an algorithm to automate the dating process based on fiber data.

Placed into a larger context, sampling – the removal of original material – should not be the starting point for dating photographs. The risks and benefits of collecting data must be weighed against information gained. An evaluation of factors is taken into consideration for each work to be sampled. The PAPER FIBER SAMPLING PROTOCOL that follows describes this process. A separate worksheet documents the quality of the sample and the sample site, to be used alongside digital documentation. The number of fibers collected varies from 22 - 300. A generous sample measures 0.3 mm x 4mm while a small sample measures 0.3 x 2 mm.

Paper fiber analysis alone is a powerful tool, but adding qualified data points to the methodology (OBAs, manufacture markings, sizing agents and surface texture) catalyzes credible dating for 20th century photographic prints. This collaborative research will have ramifications in photography scholarship that reach far beyond this one field of inquiry. For fine art collections in particular, these results will yield data that significantly enhances and refines the interpretation of individual works and, more broadly, the stylistic development of artists.

Papers presented in *Topics in Photographic preservation, Volume Thirteen* have not undergone a formal process of peer review.

PAPER FIBER SAMPLING PROTOCOL

1. Why is this action needed?
   Are the priorities and goals clearly laid out?
   Is sampling absolutely essential to investigation?
   Are there alternative photographs to sample?

2. Are there records available to consult?
   Is the provenance strong or circumstantial?
   Have other similar works been examined?

3. Are stakeholders, peers, and other specialist available to consult?

4. What effect will my action(s) have on the evidence of the factors contributing to the identity and significance of the object(s)?
   Is this a single object inquiry or part of a larger investigation?
   What is the statistical strength of the group and historic time frame?

5. Is sampling the best use of resources?
   Assess need vs. the cost of sampling
   Can the object be sampled again: is there enough material to retest?

6. Do I have sufficient information and skill to assess and sample?

7. What are my options for sampling that will produce appropriate results with minimum intervention?
   What is the condition of recto?
   What is the condition of the edges?
   Can the edges be readily sampled?
   Do I have access to the verso?
   Is the mount a barrier or could it contaminate the sample?
   If sampling from a damaged edge, can the damage be effectively repaired after sampling, or are fibers critical for structure?

8. What are the benefits/risks of sampling?
   What is the ratio of the object to the sample size?
   Is there a coating?
   Is the work mounted?

9. Can I effectively document the quality of the sample?

Adapted from the Victoria & Albert Museum Conservation Department Ethics Checklist.
2nd Edition December 2004

The Museum of Modern Art
Conservation of Photographs
PAPER FIBER SAMPLING WORKSHEET

Artist
Accession #
Batch/sample #
Sampling Date
Conservator

DOCUMENTATION
□ Digital image
□ OBA recto + / -
□ OBA verso + / -

LOCATION OF SAMPLING SITE/S
□ Recto
□ Verso

QUALITY OF SAMPLE
□ Good □ Fair □ Poor
□ Surface fibers
□ Interior fibers
□ Near baryta
□ Other

QUANTITY OF FIBER
Number of sites sampled:
□ Minute
□ Moderate
□ Generous

QUALITY SAMPLE SITE/S
□ Good □ Fair □ Poor
□ Compact
□ Friable
□ Shaving (scalpel)
□ Fiber cluster (tweezers)

FOLLOW-UP SAMPLING AND NOTES

□ This photograph could be sampled again
□ This photograph should not be sampled again
□ Justification/s

POLAROID VECTOGRAPHS

BRENDA BERNIER

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

Vectographs are photomechanical stereo images developed by the Polaroid Corporation in the 1940s. Each monochrome print or transparency is a set of polarizing images, created by the reaction of iodine on oriented polyvinyl alcohol film and viewed with special polarized lenses. The process was embraced by the ophthalmology field for vision testing and by the US military during World War II for use with aerial photography and technical illustrations. A few stereo photographers produced Vectographs as an artistic endeavor, primarily through the 1980s.

The Polaroid Corporation Records at Harvard Business School's Baker Library contains thousands of Vectographs, intermediate negatives, film samples, prototypes, and accompanying documentation. Some Vectographs in the collection remained in pristine condition while others had suffered from catastrophic deterioration, prompting the need for a condition survey and material testing. Ultimately the data was used to formulate a preservation strategy for the collection. This paper will discuss the manufacture, history, deterioration, and preservation of stereo Vectographs.

General description

As reflective prints or transparencies, Vectographs look like shiny double images on a plastic base. (See figure 1.) Monochrome or "black and white" images have a tonality that ranges from cool blue to warm brown, sometimes even on the same print. Color Vectographs have a full range of cyan, magenta, and yellow dyes. Reflective prints invariably have a metallic paint or laminate on the verso. Sizes can vary between standard lantern slide sizes to 12 x 14 inches, with 6 x 9 inches being the most common size.

Figure 1. Recto and verso of *Stereo Fly* printed by Stereo Optical, 2008.

Vectographs are images that rely on the properties of polarized light to create a three-dimensional effect. Instead of light being scattered in all directions, light is channeled in one plane, or polarized, as it passes through a Vectograph. One image of the Vectograph is polarized in one direction. The second image is polarized 90° to the first. Special glasses have polarized filters, with each lens polarized at 90° to each other. The effect is that each eye sees a slightly different image which is combined by the brain into a three dimensional scene. (See figure 2.)

A more exact explanation was given by John Dennis in a 1981 volume of *Stereo World* and is quoted here, maintaining the emphasis he placed on particular words.

> Instead of *being* polarized in a projector, Vectograph images *are* the polarizers – rather than looking at polarized images, you are looking at "imaged polarizers". Using the right eye as an example, with regular polarized projection the right eye viewer filter extinguishes the entire left image and lets only the right image through, as it is polarized at the same axis as the filter. With a Vectograph, the right eye image is on the side of the Vectograph film that is at a *crossed* axis to the right eye filter. The image's dark tones are thus *created*, varying with the degree of polarization. Light tones or white areas are seen because they *aren't* polarized and light comes straight through (or reflects off the aluminized backing of the print). Any dark tones comprising the *left* image aren't seen through the right eye filter because they are polarized at the same axis and no contrast is created. The crossed axes of the *two* images create the imperfect image seen when the Vectograph is viewed without filters.

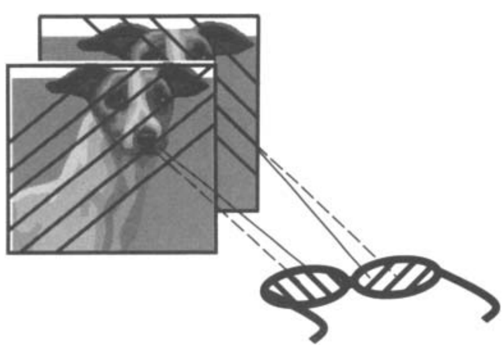


Figure 2. Each image is polarized at 90° to each other. Tones are created through the degree of polarization as seen through the polarized glasses. The two images are combined in the brain, resulting in the perception of a three dimensional image.

Composition and Structure

The film used as the Vectograph substrate is a composite material. First a film of polyvinyl alcohol is stretched to between four and six times its length, resulting in an alignment of the molecules, which allows the film to polarize light. The polarizing film is then laminated to each side of a core made of cellulose triacetate or cellulose acetate butyrate. (See figure 3.)

Once printed, the top is coated with a protective lacquer while the bottom is coated with aluminum paint. The aluminum paint is necessary in order to reflect the light in a way that keeps the polarization intact. A white background would scatter the light and ruin the effect.

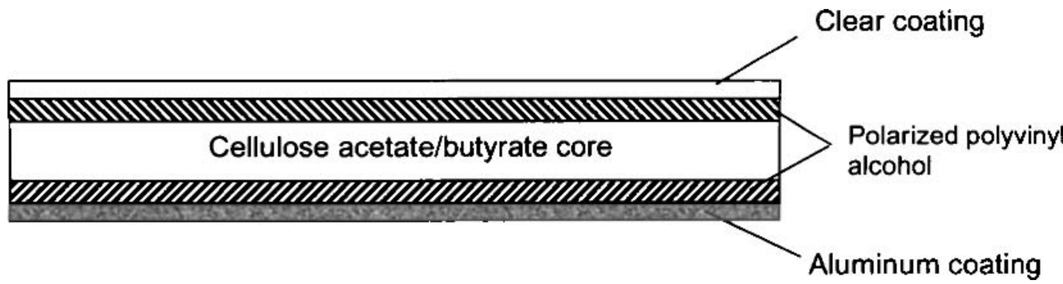


Figure 3. Cross section of Vectograph reflective print.

If a Vectograph is intended to be a transparency instead of a print, the aluminum paint is omitted and the back also gets a clear protective coating. Newer Vectographs use laminates instead of coatings. When a transparency is projected, the screen must have a silver surface in the same way that the prints have aluminum backings.

Manufacture

In order to make a simple monochrome Vectograph of a subject or scene, the photographer must begin by taking a right and left negative, usually with a stereo camera. Then a gelatin relief matrix is made for each negative using a wash-off relief film. The thicker areas of the gelatin will hold more of the so-called ink and will correspond to the darker areas of the finished Vectograph. The matrices are taped in registration and soaked in an iodine solution. The Vectograph film is placed between the matrices and run between rollers. (See figure 4.)

The Vectograph is proportionally more polarized in the darker areas, where the iodine has reacted with the polyvinyl alcohol. As mentioned above, the double image seen without the glasses is where the two images are crossed axes. With glasses, the darks of each image are actually *created* as they are viewed through the cross axes of the corresponding eye filter. The resulting viewed image is not a dyed image *per se*, but instead is rendered in terms of percentage of polarization.

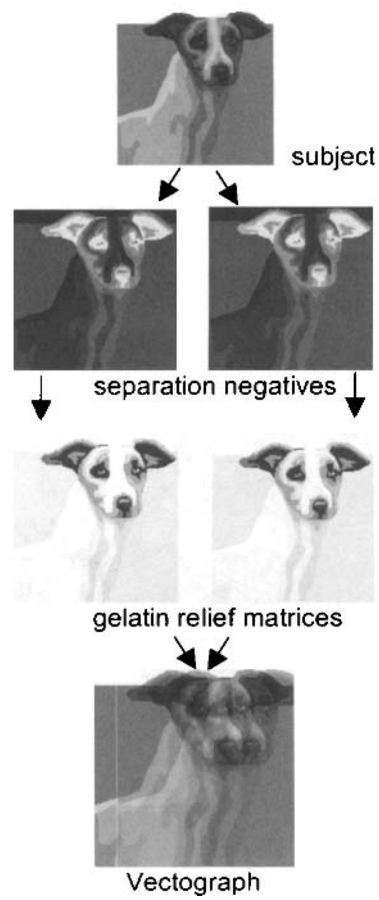


Figure 4. Vectograph production

As described above, a simple monochrome Vectograph required four additional pieces of film in the process. Color Vectographs are significantly more complicated, requiring up to fourteen separate pieces of film to make a single Vectograph. The photographer would need two color positives or negatives, six separation negatives – cyan, magenta and yellow for each eye – and six gelatin matrices – one for each separation negative. The photographer would then need to print the three sets of color matrices in perfect registration, a technically exacting procedure.

History

During the 1930s, the idea of using polarized filters for stereoscopic projection was well known. Edwin Land's companies – first Land-Wheelwright Laboratories, then Polaroid Corporation in 1937 – specialized in perfecting the manufacture and promoting the use of polarizing filters. In 1938, a Czechoslovakian inventor named Josef Mahler suggested to Land that instead of using polarizing filters, the image itself could be the polarizer. Land immediately hired Mahler to head the Vectograph research team at Polaroid.

Material from the Polaroid Corporation Records at Harvard Business School's Baker Library Historical Collections illustrates how quickly the Vectograph process evolved. The first Vectograph demonstration made by Mahler appears as two small squares of opaque plastic film with pinpricks outlining a cube shape on one and a three-dimensional diamond shape on the other. The objects do not resemble Vectographs as we know them but the inscription on the original sleeve is in Mahler's handwriting: "Very first Vectograph made for Mr. Land. The first test. January 1938."

A year later Mahler used polyvinyl alcohol as the polarizing layers, enabling the refinement of the process to occur at a rapid pace. The example dated March 23, 1939, has no discernable image but the object does have some beginning characteristics of a true Vectograph. The polyvinyl alcohol layer is secured onto an aluminum-painted paper with black tape, indicating the discovery of the need for a reflective back surface. A Vectograph made just two weeks later also has aluminum-painted paper crudely taped together with black tape but the cockled sheet of polyvinyl alcohol clearly shows an image of a sculpture. The process had progressed enough during 1939 that Edwin Land was able to give a very successful Vectograph lantern slide presentation to the Optical Society of America in December of that year.

During WWII, Polaroid – as its name implies – had a number of products utilizing polarized film. Vectographs were used by the US military for machinery training and aerial photographs. Vectographs worked particularly well for aerial photographs because they enabled the viewers to experience the topography of the land. The National Archives and Records Administration has aerial photographs of the Normandy beaches that were used in the planning of the D-day invasion.

Polaroid set up a Vectograph training facility in Cambridge, Massachusetts where over 1500 military personnel were instructed. Polaroid supplied complete Vectograph kits that were about the size of a foot locker. There were even instructions for how to adjust the solutions if sea water was used.

Vectographs made with two very different images were called comparison Vectographs. Such Vectographs would not have been viewed with polarized glasses but with a viewer that alternated from one filter to the other, letting the observer see first one image then the other. Inventive servicemen were purported to have made "disroboscopes" – Vectographs which featured a woman with and without clothes. Polaroid used a less risqué Vectograph of a bikini-clad "Glare Girl" for marketing purposes. Samples dating from the 1960s in the Polaroid Corporation Records also include comparison Vectographs of John F. Kennedy on one side and Barry Goldwater on the other.

Polaroid promoted the use of Vectographs for scientific purposes, including graphs, x-rays and photomicrographs. They also saw the potential for Vectographs in studying sculpture. Land worked with Smith College professor Clarence Kennedy who used Vectographs to teach art history. Kennedy, a respected photographer in his own right, made numerous Vectographs of sculpture at the Boston Museum of Fine Arts.

The first color Vectograph was made in 1939, the same year that monochrome Vectography was perfected. This first color Vectograph is an image of a couple walking down a lane, holding hands. The object is comprised of three sheets taped together but more closely resembles a red-green anaglyph image than a true color Vectograph. One of Mahler's samples from May 1940 presents two young boys with a much sharper and more naturalistic color image, demonstrating the tremendous progress made in the dye diffusion process.

During the late 1940s and 50s, Polaroid perfected color Vectography and tried to develop a viable process of making Vectograph motion pictures. However at that time, Polaroid began investing its resources in the development of instant photography.

By far the greatest use of Vectographs has been in the field of ophthalmology where they are used to test for binocular vision. A monochrome Vectograph of a fly on a sugarcube, supposedly taken at Polaroid's military training facility, can easily be considered the single most-viewed image in the history of stereo photography. (See figure1.) Over the last 50 years, uncounted millions of people, particularly children, have seen *Stereo Fly* during eye exams. The viewer is asked to grab the fly's wings. How far the viewer holds his fingers over the Vectograph reveals how well his binocular vision is working. For some patients with imperfect binocular vision, Vectographs then are used therapeutically as part of a vision therapy regimen. Stereo Optical and Vision Assessment Corporation continue to be major producers of Vectographs for vision testing and training, making a range of hand-printed Vectograph prints and transparencies, including *Stereo Fly.*

While never a mainstream process, artistic Vectographs are considered collectable by enthusiasts of stereo photography who deem them optically more enjoyable than the common red-green anaglyphs. During the 1980s Stereo Optical was one of the foremost printers for collectable Vectographs. Collectable Vectographs printed at Stereo Optical should each bear a set of stamped numbers on the verso to indicate the date of printing. For example, the number 103087 stands for October 30, 1987.

Limited edition Vectographs were occasionally printed by Stereo Optical but packaged and marketed through Reel 3-D Enterprises. Instructions printed on the Reel 3-D Vectograph holder for the Steve Aubrey print *City Escape* wisely suggests that the customer should "keep it in a cool, dry place, away from direct sunlight" so that "…it will bring many decades of 3-D enjoyment."

Polaroid Corporation Records

In 2006, Harvard Business School's Baker Library acquired the Polaroid Archives. The mandate of Baker Library Collections is to collect and preserve material that can be used in the research and teaching of business history and theory. Since Polaroid was an exceptionally innovative and successful international corporation, headquartered just down the road from Harvard University, its archives are rich in business history. In addition to business records and legal documents, the large archive contains marketing material, patents, research and development documents, prototypes, and product samples. Timothy Mahoney, the manuscript librarian processing the Polaroid Corporation Records, as it is now called, estimates that there are nearly 4,000 linear feet of material, taking up nearly ¾ of a mile of shelving.

There were 139 boxes of material in the collection that had been identified as pertaining to Vectographs. The material was brought to the attention of the Weissman Preservation Center because some items were clearly deteriorating and the staff at Baker Library needed a preservation plan.

Initial inspection revealed an array of objects: complete Vectographs in presentation albums or mats, uncut samples of varying quality, prototypes, separation negatives and relief matrices. Some were in pristine condition while others had catastrophically deteriorated, making them unusable. Many Vectographs exhibited imperfections that were not immediately identifiable as deterioration or as processing flaws, making research into Vectograph production and deterioration a necessary component to a condition survey.

At one time, Polaroid kept important prototypes and samples of their products in what they called the Polaroid Museum, which was part of the larger Polaroid Archives. A significant number of Vectograph materials from the Polaroid Museum have original enclosures with specific inscriptions indicating production details, including date, creator, and processing variations. Some enclosures were even signed and witnessed. Any preservation plan would have to include the retention of these original enclosures with the accompanying photographic materials.

The collection also contained many complete sets of color Vectograph materials, including the completed Vectographs and all separation positives, separation negatives, and matrices for left eye and right eye, all well labeled in folders as received from Polaroid. Meanwhile, other boxes contained what looks like a random assortment of unlabeled and currently unidentifiable materials.

Survey

The initial assessment helped the library staff and conservator understand the scope of a preservation survey and agree on the goals. The goals of the survey were identified as follows:

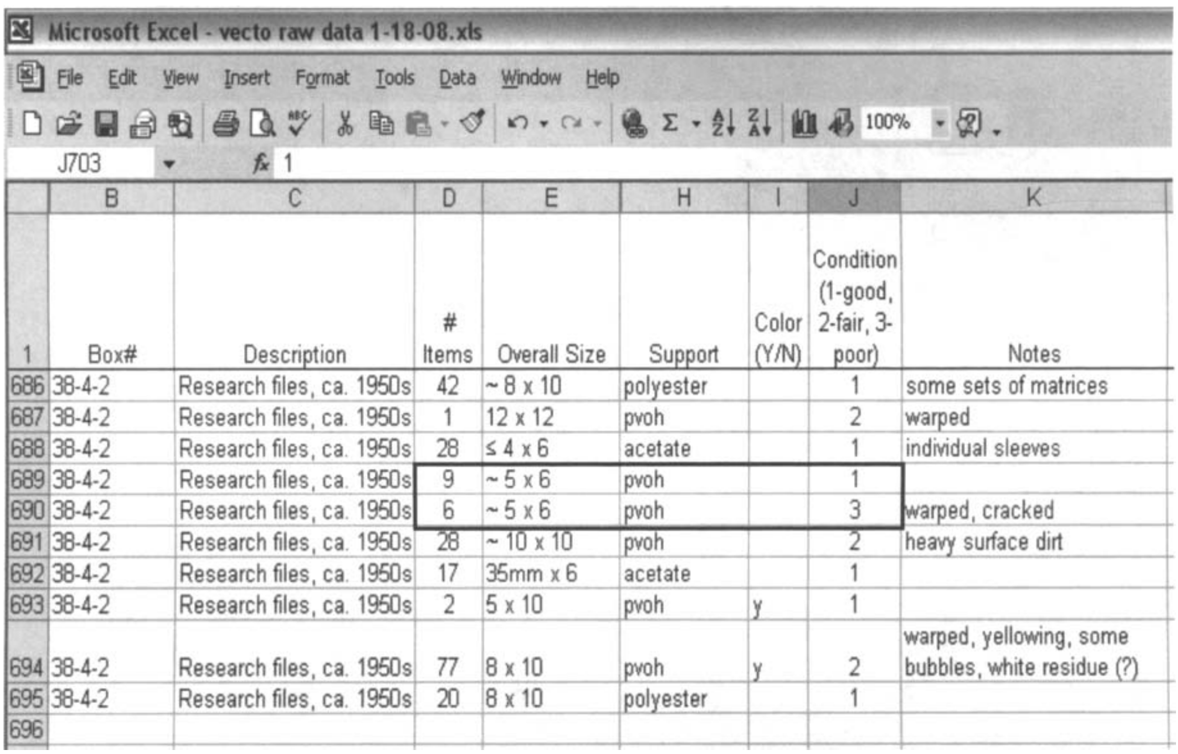
- *Assess overall condition.* How pervasive was the deterioration? Since the materials were recently received by Baker Library and would be stored in very good environmental conditions from that point on, it was considered to be the right time to get a baseline of the health of the collection.
- *Determine specific deterioration characteristics.* Because there are no known comparable collections of Vectographs in the world, Vectograph deterioration was an unstudied phenomenon. Do the relative conditions of segments of the collection provide clues to the deterioration process?
- *Note items too deteriorated to use.* If library staff decide in the future to deaccession select unusable Vectographs that are not part of a set or do not have historical significance, the survey should identify possible candidates.
- *Identify types of plastics.* When possible, this was done through standard means, such as context, edge printing, notch codes and polarizing filters. It was discovered through the course of the survey that polyvinyl alcohol has a cloudy blue appearance when seen through polarizing filters.
- *Develop housing and storage plan.* It was decided early on that frozen storage would be necessary for the long-term storage of the Vectographs and related acetate material. The survey was designed to help calculate how much space would be needed.
- *Determine preservation priorities.* The survey would help identify areas of the collection where rehousing efforts should begin and where additional analysis was needed.

It was clear that the survey design needed to be detailed enough to provide item counts that could be sorted by size to aid in the housing plan, as well as be sorted by condition in order to determine the stability of the Vectographs, identify preservation priorities, and recommend items for possible deaccession. An item-level survey was ruled out because there were several thousand items, most with no specific identifier such as a number or title.

Therefore, a simple Excel spreadsheet was used to perform a box-level survey. For each box, items were broken down into *categories* based on size, material composition and condition, which enabled the data to be sorted in a number of ways. See figure 5 below for data collected for a typical box. Due to the excessive offgassing of the cellulose acetate and cellulose acetate butyrate, the survey was conducted in a fume hood located on-site at Baker Library. The time spent assessing each box ranged from ten to forty-five minutes, depending on the uniformity of the material. The survey and data analysis took a total of 105 hours over a span of twelve months and was performed by a single conservator.

Each item was briefly assessed for overall condition. Again, since the individual items were not numbered, it was not possible to record the condition of particular items. Instead, within each box, items of the same size and material were grouped according to a condition scale of 1-3. Level 1 indicated good condition, even if there was some minor damage. Level 2 indicated fair condition, meaning there was damage/deterioration but the item was still usable. For example, a warped Vectograph with good image would be considered level 2. Level 3 indicated poor condition that made the photograph unusable. A number of level 3 items that are unusable have been marked for recommended deaccessioning.

During the course of the survey, measurements in inches were recorded on the spreadsheet. Later during data analysis, the measurements were rounded up to standard housing sizes when possible with the exception of the Vectographs whose most common size was 6x9 inches. On the spreadsheet, the collection items were grouped into a set number of standard sizes so that the approximate number of enclosures and boxes could be estimated.



	B	C	D	E	H	I	J	K
1	Box#	Description	# Items	Overall Size	Support	Color (Y/N)	Condition (1-good, 2-fair, 3-poor)	Notes
686	38-4-2	Research files, ca. 1950s	42	~8 x 10	polyester		1	some sets of matrices
687	38-4-2	Research files, ca. 1950s	1	12 x 12	pvoh		2	warped
688	38-4-2	Research files, ca. 1950s	28	≤ 4 x 6	acetate		1	individual sleeves
689	38-4-2	Research files, ca. 1950s	9	~5 x 6	pvoh		1	
690	38-4-2	Research files, ca. 1950s	6	~5 x 6	pvoh		3	warped, cracked
691	38-4-2	Research files, ca. 1950s	28	~10 x 10	pvoh		2	heavy surface dirt
692	38-4-2	Research files, ca. 1950s	17	35mm x 6	acetate		1	
693	38-4-2	Research files, ca. 1950s	2	5 x 10	pvoh	y	1	
694	38-4-2	Research files, ca. 1950s	77	8 x 10	pvoh	y	2	warped, yellowing, some bubbles, white residue (?)
695	38-4-2	Research files, ca. 1950s	20	8 x 10	polyester		1	
696								

Figure 5. Data recorded for a single box. Note fifteen 5x6 Vectographs were separated into two categories because some were in good condition, others in poor condition. After the survey was complete, sizes were rounded up to standard housing supply sizes, eg. 5x6 became 5x7. The designation "pvoh" was a shorthand label for Vectographs. The support would have also contained a cellulose acetate or cellulose acetate/butyrate core. Examples of unsupported pvoh were found in the collection and subsequently identified in the notes field.

Survey Results and Deterioration Observations

The survey results indicated that there are approximately 4,600 Vectographs and almost 7,000 negatives, matrices, and other film items in the Polaroid Corporation Records. It also revealed that the deterioration was not as pervasive as had been feared. 82% of the Vectographs were identified as being in good or fair condition. The 18% considered to be severely deteriorated were characterized by any or all of the following: fine cracking or crizzling of the polyvinyl alcohol layers, image dissolution, and acetate warping and channeling. The major deterioration types are described below.

Deterioration of the cellulose acetate or acetate butyrate core. Many Vectographs had the appearance of severely channeled acetate film, with the Vectograph becoming very brittle and puffing up to around a half-inch thick. It is well known that deteriorated cellulose acetate has a characteristic odor of acetic acid or vinegar. Deteriorated cellulose acetate butyrate releases butyric acid which has a strong rancid odor. Acetic acid and butyric acid released as off-gassing can speed the deterioration of adjacent material but it is unclear to what extent this mechanism played in the deterioration of this collection. Many of the deteriorated Vectographs were found in groups, many of which were likely to have been made from the same stock material at the same time. Occasionally a catastrophically deteriorated Vectograph was in close contact with another Vectograph in fair or good condition, with seemingly little adverse interaction.

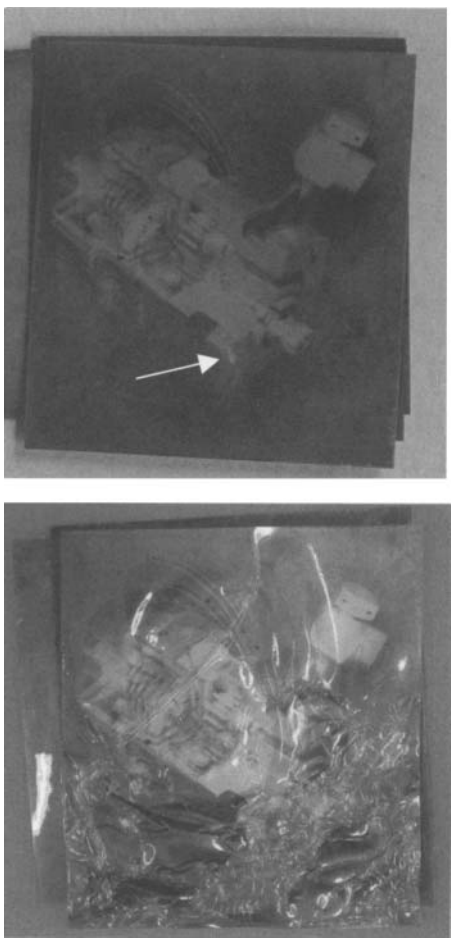


Figure 6. Top: white crystalline deposit barely visible at arrow, October 2007. Bottom: same Vectograph in December 2008.
Polaroid Corporation Records, Baker Library.

In other instances, Vectographs clearly suffered from some autocatalytic reaction when housed in enclosed spaces such as between glass as lantern slides or in plastic (including polyester or Mylar®) sleeves. Vectographs that had been housed in polyester sleeves by Polaroid Corporation during the 1990s were in various stages of deterioration and often had white crystalline deposits on the surface of the prints. Prior to the survey, one Vectograph that remained in a polyester sleeve was observed to have such a small bloom (~ 2mm x 2mm) of white crystalline material. Within fourteen months, the Vectograph was completely channeled and unusable. (See figure 6.) With this in mind, Vectographs in polyester sleeves were targeted as a priority for rehousing into paper sleeves during the rehousing phase due to the potential rapidity of the decay.

A sample of white crystalline deposit was analyzed by pyrolysis gas chromatography mass spectroscopy (GCMS) at Harvard Art Museum's Straus Center for Conservation and Technical Studies. Senior Conservation Scientist Narayan Khandekar indicated that the accretions were phthalate plasticizers that had migrated to the surface but could not freely evaporate because of the polyester sleeve. As with cellulose acetate negatives, removal of plasticizers results in embrittlement and shrinking of the plastic support.

Adhesion problems. In some Vectographs, the aluminum paint used on the back of reflectance prints is poorly adhered, causing blisters and flaking. In other cases, particularly with color Vectographs, the polyvinyl alcohol layers have delaminated from the acetate core. (See figure 7.) In discussions with contemporary Vectograph makers, layer delamination is occasionally seen immediately during processing, indicating an original flaw with the material. Less frequently, delamination occurs as the acetate or acetate/butyrate core shrinks.

Figure 7. Delamination of polyvinyl alcohol layers in color Vectograph.
Polaroid Corporation Records, Baker Library.

Image and polyvinyl alcohol deterioration. Image deterioration is difficult to classify because flaws in the original processing can mimic image fading or staining. Since many of the Vectographs in the Polaroid Corporation Records represent the early development of the process, it is unclear if the samples were retained because they were flawed and hence were instructive to the manufacturer. While iodine formulations and other modifications were designed for warmer or cooler toned images, it is unlikely that two tones in the same Vectograph would have been created intentionally because both sides would have been inked at once with the same batch of solution. When one image of a Vectograph is warmer than the other, it is possibly due to some failure (or absence) of coating on one side to protect the polyvinyl alcohol from oxidation. Local spots or stains may be the result of deterioration or may be processing flaws. For example, Vectograph makers report that a trapped air bubble during printing will result in an area with no image while a piece of dust or debris will result in a dark spot.

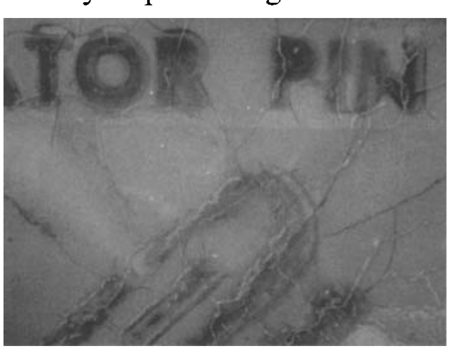


Figure 8. Magnified detail of image deterioration. U.S. NavyTraining Kit.
Polaroid Corporation Records, Baker Library.

Some Vectographs in the collection exhibited a feathering or ghosting around the image, accompanied by fine cracks. (See figure 8.) This may be a precursor to a total dissolution of the image layer into a brown and white mass, as Vectographs with both types of deterioration were often found in close proximity, particularly in the U.S. Navy Training Kit booklets. (See figure 9.) There were several copies of specific Training Kits and severe deterioration was noted on exactly the same Vectographs in each of the booklets, indicating that particular prints were made in a batch and all suffered from the same improper processing or inherent material flaw. Often, completely deteriorated Vectographs were in the same display pocket, back-to-back with one in very good condition.

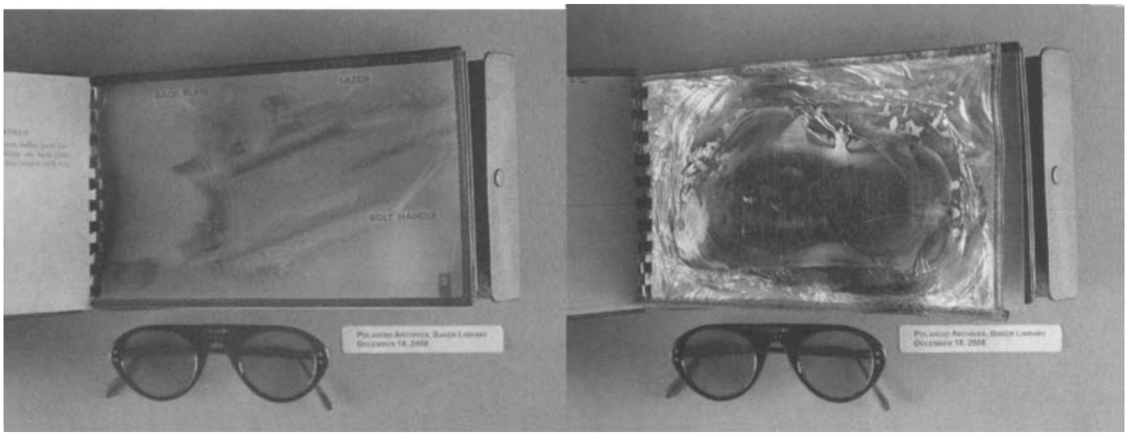


Figure 9. Left: Vectograph in very good condition. Right: Catastrophically deteriorated Vectograph in same booklet as one on the left. U.S. Navy Training Kit. Polaroid Corporation Records, Baker Library.

Very infrequently, a series of diagonal, parallel hash marks can be seen in the polyvinyl alcohol layer. The hash marks are clear in color and sometimes intersect at a 90º angle. They appear to be following the direction of polarization. Observations from workers at Stereo Optical indicate that the lines appear immediately when a Vectograph has been left too long in the so-called fixer solution of hot boric acid. No research on the mechanism of Vectograph image deterioration has been found.

Preservation Plan: Rehousing and Cold Storage

The deterioration of the Vectographs cannot be reversed. However, as with other photographic materials, the rate of deterioration can be slowed down through storage at low temperatures. Cold or frozen (less than 32ºF) storage requires some caution. Plastics are often brittle at low temperatures and pressure-sensitive tapes can fail. Additionally, strict acclimation protocols must be followed when removing items from cold storage before they can be handled by staff or researchers. The collection was packed into a 74 cubic foot, So-Low lab and pharmacy freezer, set for 0°F. It was necessary to purchase additional shelves to accommodate the most efficient packing of the freezer.

Commercial freezers can have high and fluctuating relative humidity, therefore proper packaging is crucial. Packaging of the Vectograph material in the Polaroid Corporation Records first involved acclimatization of the rehoused collection in the Baker Library Collections climate controlled stacks (60°F, 35%RH). Boxes were then double-wrapped in 0.004" thick polyethylene (LDPE film) because many boxes were odd sizes and did not fit into heavy-duty zip bags. The polyethylene used has an operating range specified to be -60 to 150°F. The polypropylene carton-sealing tape (3M #375) was selected for its ability to withstand freezing temperatures up to -30°F if applied at temperatures between 55 and 120°F.

Cobalt salt-based RH indicator cards are not calibrated to work in freezing temperatures. Therefore, acting on advice from conservator Constance McCabe, cover sheets were fabricated and affixed on the cards showing the proper scales for reading at both room temperature and at 0°F. (See figure 10.) For each box, two RH indicator cards were placed in visible locations under the plastic for easy monitoring by library staff. One card was placed just below the outer layer of plastic. If the outer plastic becomes compromised, the first card will reflect the change in humidity. Library staff are then instructed to look at the second RH indicator card to see if the inner layer of plastic wrap continued to protect the contents of the box in spite of the breach to the outer layer. Library staff will continue to monitor the cards on a regular basis and acclimate and re-wrap boxes when necessary.

%RH
Read top of blue
between blue & pink
at correct temperature

75°F		0°F
10		X
20		X
30		X
40		10
50		20
60		30
70		40
80		50
90		60
100		70

Read here
for freezer

Figure 10. Temperature conversion template for RH indicator card.

Due to the complications cold storage can bring to item retrieval, the finding aid for the Vectographs was made to be sufficiently detailed without item-level processing. Two boxes were assembled to contain a representative sample of Vectograph processes, types and products. Although still stored in frozen storage, the boxes are intended to serve the research needs of all but the most specialized researchers and limit the number of boxes that must be retrieved from the freezer. For the most part, the other boxes were packed predominately by size in order to maximize the most efficient use of space within the freezer.

As with all photographic materials, high quality, lignin-free storage materials were specified. Buffered paper enclosures and boxes were used for rehousing. Where possible, enclosures that have passed the Photographic Activity Test (PAT) were used. The PAT is designed to ensure that the enclosures will not cause fading or staining of photographic materials over time. However, some sizes or types of enclosures were not available with the PAT designation. In those cases, high quality buffered material that would be suitable for use with paper-based collections were used.

Some Vectographs and associated material were kept in their original enclosures because the enclosures had significant inscriptions identifying the item, date, creator, and signature of the creator as well as signature of a witness, making the enclosure a document in its own right. Other original enclosures, such as office file folders, were also retained if the enclosure was in good condition and could physically support the photographs. The acidic nature of the original enclosures was less of a concern because it was clear that the collection would be stored in frozen storage. The primary concerns were that the items were physically protected and that each Vectograph had its own enclosure. These concerns were balanced against the need to keep the collection from expanding too much so that it could fit in the freezer. Some techniques for achieving these goals were as follows:

- When possible, items were housed with items of like size in order to minimize the size box needed. Groups of items that were clearly meant to be part of a set were kept together, with the largest applicable size enclosure predominating. For the most part, the order of original material did not need to be maintained. The archivist maintained documentation that could intellectually reconstruct the original box contents.
- Vertical storage was used for most items less than 8-1/2 x 11 inches.
- Only Vectographs were given individual enclosures. Other material was organized into folders, with interleaving or paper-weight subfolders as necessary.
- Since most Vectographs measured 6 x 9 inches, standard archival enclosures were not available. In order to save room in the freezer, 8x10 archival sleeves were trimmed to make paper "L-sleeves" measuring 6x10 inches. Custom clamshell boxes – called Microclimates™ boxes from Custom Manufacturing Incorporated (CMI) – were then made to accommodate these groups of Vectographs.
- Original enclosures were photocopied and discarded when the inscriptions were deemed to have informational value but not inherent value, like those signed and witnessed.
- A small number of Vectographs were warped so they nested together. To save space these were kept together without individual enclosures.
- Custom spacers or frames made of archival corrugated board were made to protect curled or warped items.

In order to rehouse over 12,000 items, two technicians worked a combined total of 152 hours, spread out over six months. Planning for cold storage and the manuscript librarian's work on refining the intellectual control spanned an additional six months, with packaging for the freezer taking three additional days.

Conclusion

Vectographs are images that rely on the properties of polarized light to create a three-dimensional effect. The Vectograph material in the Polaroid Corporation Records at Harvard Business School's Baker Library has the potential to be a valuable resource for researchers. Not only are Vectographs unique in the history of photography, the development and marketing of this innovative product sheds light on the Polaroid Corporation's internal workings, wartime contributions, relationship with the motion picture industry and more.

Unfortunately, the Vectographs are made with inherently unstable materials, requiring close attention to their long term storage. The polyvinyl alcohol layers and cellulose acetate or cellulose acetate/butyrate core can be vulnerable to deterioration, such as loss of plasticizer, particularly when kept in an enclosed environment like plastic sleeves. The deterioration of Vectographs cannot be reversed but can be slowed through storage in a cool, dry environment with proper housing materials.

Brenda Bernier
Paul M. and Harriet L. Weissman Senior Photograph Conservator
Weissman Preservation Center, Harvard University Library

Acknowledgements

I would like to express my gratitude for the exceptional efforts of my colleagues on this project: manuscripts librarian Timothy Mahoney and conservator Priscilla Anderson from Baker Library, and technicians Maggie Wessling and Andrea Youngfert from the Weissman Preservation Center. Former Polaroid employees Vivian Walworth and George Ehrenfried were extremely helpful as they shared with us many insights about Vectographs and Polaroid Corporation. Tracy Winslow provided electronic copies of papers by his father-in-law, Joseph Mahler. The staff at Stereo Optical, particularly Bozena Chatys and William Baker were generous in demonstrating the Vectograph process and providing samples. Analytical testing was kindly performed by Dr. Narayan Khandekar of the Straus Center for Conservation and Technical Studies, Harvard Art Museum. I am also very appreciative of the generous support of the Weissman Preservation Center, Harvard University Library, Harvard College Library, The Andrew W. Mellon Foundation, and Paul and Harriet Weissman.

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Relevant primary source material at Harvard University:

Harvard Business School's Baker Library: Polaroid Corporation Records
Fine Arts Library: Edwin Land Collection of Clarence Kennedy Photographs
The Collection of Historical Scientific Instruments at Harvard University

Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

XRF IDENTIFICATION OF 20TH CENTURY DEVELOPER-INCORPORATED STABILIZED PRINTS

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Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

Twentieth-century stabilized prints are silver-gelatin photographs that have been subjected to a two-bath process: activation of an incorporated developer and stabilization of the development process. Unlike traditionally processed silver gelatin prints, stabilized prints have not been fixed or washed and were originally intended to provide quick, high-quality images for proofing. These prints are vulnerable to darkening, staining, fading or complete image loss and have been observed to transfer stains to adjacent objects. Accurate identification of stabilized photographs will increase understanding of this unique process and lead to better informed conservation and preservation decisions.

This paper provides a basic description of the stabilization process and presents results from X-ray fluorescence spectrometric analysis of a group of Diane Arbus photographs suspected to have been printed using a stabilization process and a corresponding group processed traditionally. Results of the XRF analysis indicate that the elemental composition of the stabilized processed photographs differs from traditionally processed silver gelatin photographs in that silver is present in the highlights and non-image areas and higher than normal amounts of halides remain in the print. The presence of unreacted halides and elevated levels of silver overall are consistent with a photograph that has not been fixed or washed and may provide a set of characteristics useful for identification of stabilized silver gelatin photographs.

1. INTRODUCTION

In January 2002, a group of 22 black and white fiber base photographs by Diane Arbus, on 11 x 14 inch paper, arrived for examination and possible treatment at The Conservation Center for Art and Historic Artifacts in Philadelphia. They were acquired by The New Jersey State Museum in 1979 and have been housed in 4-ply alkaline window mats in climate controlled storage since acquisition. On the back of the photographs there are notations including occasional handwritten felt marker inscriptions of "Eliminated" or "OK" in addition to numbers apparently written in pencil. Neil Selkirk, the exclusive printer of Arbus' photographs since her death in 1971, examined the 22 prints at CCAHA on August 25th 2009, and positively identified the numbers on the back as having been written by him to identify the images at the time he made the prints in 1972. These images are part of Arbus' *Untitled* series. The photographs were taken by Arbus from 1969 to 1971 at various residences for developmentally handicapped adults throughout New Jersey.

Preliminary research on these photographs began in 2002 at The Conservation Center for Art and Historic Artifacts in Philadelphia. X-ray fluorescence spectrometry was conducted in 2008 at The Museum of Modern Art in NY with the assistance of Chris McGlinchey, Ana Martins and Lee Ann Daffner.

2. DESCRIPTION

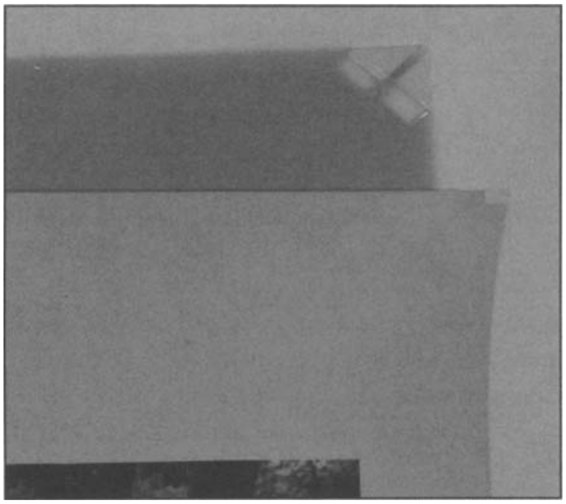


Figure 1 Reprinted with permission from CCAHA

As mentioned above, the photographs from the New Jersey State Museum have never been exhibited and have been stored under climate controlled conditions since their acquisition in 1979. Nonetheless, the museum has noticed significant deterioration over time. At first look, the photographs appear to be in excellent condition. The single-weight, fiber base paper supports have minor handling creases but no tears or losses and although many of the images have a flat tonality, the silver image material is in good condition with no silver mirroring or fading visible. However, when the photographs are removed from the mats, significant brown staining can be seen on the margins and versos of all the photographs (Figure 1) and the interiors of the mats. (Figure 2) In fact, significant discoloration is found wherever the mat and photograph are in direct contact with one another. Discoloration can also be seen on the versos of the back mats in a shape and size corresponding with that of the window opening of the mat stored beneath it in the stack. (Figure 3) This appears to be the only case where the brown staining is not the result of direct contact with the photographs.

The deterioration pattern is not one commonly observed with conventionally processed silver gelatin photographs and the typical causes of discoloration can be easily eliminated; the photographs have not received significant light exposure and pH and fiber analysis indicated good quality mat board and photographic paper. Rather, the dark brown staining of the photographs and adjacent materials is similar to that observed with stabilized silver gelatin photographs. Although not necessarily representative of the known body of Diane Arbus' work, exhibitions such as *"Family Album"* and *"Revelations"* have included stabilized prints and have made reference to her use of a Fotorite stabilizing processor and chemistry as a means of proofing prints before creating final enlargements. Subsequent conversations with Neil Selkirk have confirmed that Arbus owned a Fotorite processor (which is still in the possession of the estate) and used stabilized prints when making contact sheets and 8 x 10 proofs. The image quality and tone of the New Jersey State Museum photographs, however, are exceptionally well preserved when compared to other stabilized photographs of this era and are printed on 11 x14 instead of the standard 8x10 paper.

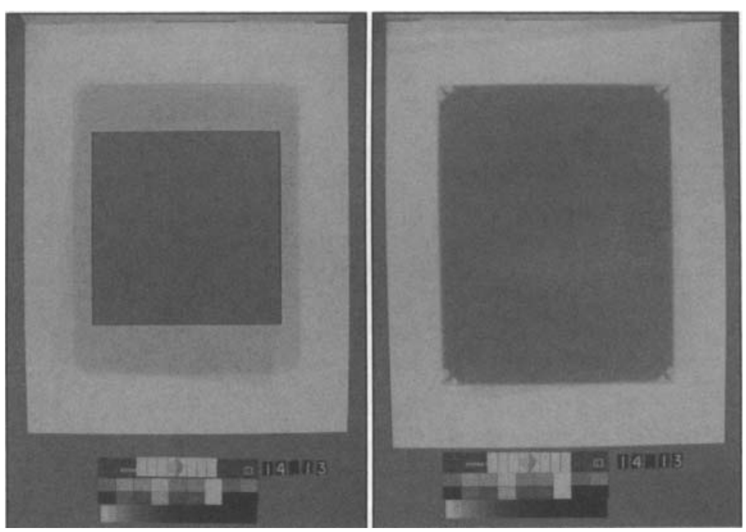


Figure 2 Reprinted with permission from CCAHA

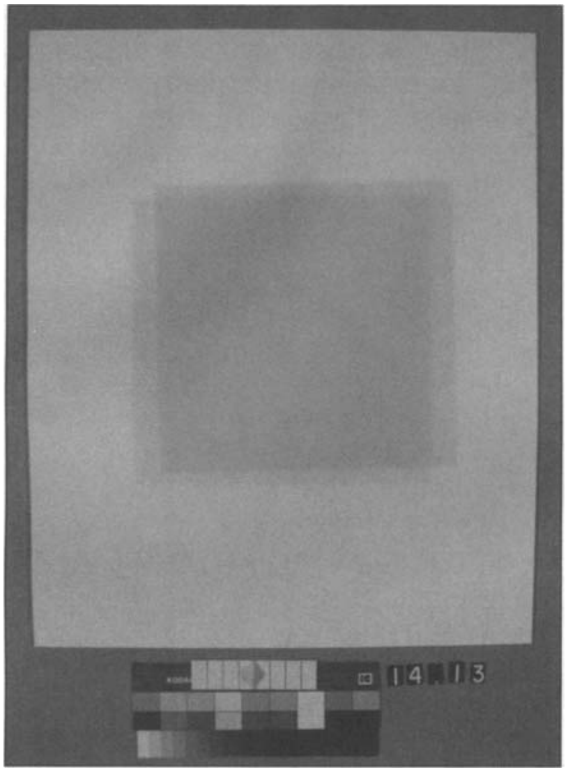


Figure 3 Reprinted with permission from CCAHA

3. PHOTOGRAPHIC STABILIZATION PROCESS

3.1 DEFINITION

Stabilization can be defined as a rapid two-step photographic process in which an alkaline solution (the developer activator) is applied to a developer impregnated paper followed by a slightly acidic stabilizer solution. By definition, these images are *not fixed and washed,* merely stabilized to reduce sensitivity to light. In 1950, H.D. Russell, E.C. Yackel and J.S. Bruce defined stabilization as "fixation without washing to make the unexposed and undeveloped silver halides relatively inert to heat, light, humidity and atmospheric gases". (Russell, Yackel, Bruce 1950; Haist 1979, 2000) Since the process does not include a fixing or washing step, all the residual chemistry is retained in the print. "Stabilization processing" is an umbrella term encompassing six major systems; thiourea, thiosulfate, thiocyanate, thiol, iodine and heat or dry stabilization. Although thousands of patents for stabilizing processes were issued, thiourea, thiosulfate, and thiocyanate-based processes seem to have enjoyed the widest use. There is some indication that Diane Arbus used both the Kodak Ektamatic stabilization paper and chemistry (a thiocyanate-based system) and the Agfa Fotorite stabilization system.

3.2 HISTORY

Stabilized processed photographs were a 20th century commercial invention prepared for the mass market and intended to be quick, simple and temporary. Although many stabilization processes were patented during and after WWII, the process reached its zenith during the 60s, 70s and early 80s when the market then turned toward computers, copiers and printers to create high quality pictures quickly and easily. Besides speed of production, the stabilization process had the advantage of being simple enough for anyone to use without prior knowledge of photochemistry. Premixed bottles of chemistry and a table top processor requiring no water made the process extremely portable and adaptable to a variety of circumstances. The stabilization process found wide use in the newspaper, military, medical and scientific fields – anywhere that speed of image production was more important than long-term image stability. (Sturge 1977)

3.3 BASIC CHEMISTRY

In general, the chemical agents used for conventional processing were also used for stabilization processing. However, while conventional silver-based processing includes developing, stop bath, fixing and washing steps, stabilization processing contains only two steps: *activation* of the developer incorporated in the paper and *stabilization* of the silver image. In conventional processing, developers contain a hydroxide ion activator and a reducing agent, such as hydroquinone, to reduce silver halide to silver metal. In stabilization processing, a hydroquinone reducing agent is already incorporated into the paper. This allows the development process to begin immediately when the paper is immersed in an alkaline activating solution such as potassium bromide or sodium hydroxide. The stop and fixing baths are omitted in stabilization processing and the print proceeds directly from a slightly alkaline developing solution to a slightly acidic stabilizing solution. The stabilizing bath complexes the silver halide instead of removing it through fixing and washing, converting the undeveloped silver halides to colorless compounds, such as silver salts of thiosulfate, thiocyanate, or thiourea which are more or less stable to light. (Sturge 1977) As a result, the process leaves both silver compounds and residual chemistry in the print creating a photograph that is much less permanent than conventionally fixed and washed images. For better permanence, stabilized prints could be traditionally fixed, washed and toned shortly following processing.

3.4 PAPER AND PROCESSING

In order to decrease processing times, silver gelatin stabilized papers were manufactured with a developer already in the emulsion ("developer- incorporated"). Immersion and application times of less than 10 seconds were recommended to prevent excessive absorption and a tabletop roller transport processor could turn out a dry-to-dry 8 x 10 photograph in approximately 10 seconds (Sturge 1977). Although manufacturers usually included directions for both tray and machine processing, machine processing was recommended because of the precise timing and temperatures needed for proper pickup of solutions. Papers intended for stabilization processing were commercially available, but traditional photographic paper could also be processed with stabilization chemistry.

3.5 INCORPORATED DEVELOPER

Incorporated developers have been known to diffuse through stacks of resin-coated papers causing brown staining in processed prints, especially under conditions of high humidity or temperature. (Wilhelm 1993) In one of his patents, Edward Yackel stated, "I have found…developing agents such as … hydroquinone…do not remain in the emulsion layer during long periods of keeping. Instead, it wanders throughout the gelatin and waterproofing layer of a material….and from one piece of material to another when the two are in close contact. This wandering of the developing agent results in undesirable stain." (Yackel 1947) Since residual hydroquinone is washed out during traditional photographic processing, brown staining is less of a concern in fiber base photographs. In stabilization processing however, the developing agents and other processing chemistry remain in the print. It is quite possible that the brown discoloration on the mats and photographs is partially the result of "wandering developer".

4. XRF ANALYSIS

Although some stabilized photographic processes can be characterized by an overall warm color, flat tonality, fading or discoloration, a well preserved print may not exhibit any of these characteristics. In addition, the wide variety of stabilization processes often makes it extremely difficult to discern stabilized prints from other photographic or graphic reproduction processes. Improper identification could lead to unwise decisions regarding preservation or treatment, ultimately endangering the prints and the collection items surrounding them.

Elemental analysis using X-ray fluorescence spectrometry (XRF) can be used to detect the presence of inorganic materials in photographs such as silver, halides and sulfur, theoretically providing an identifying fingerprint for each process. In a traditionally processed photograph, one would expect to find silver only in the dark and mid-tones where the image is formed by the presence of metallic silver. In non-image areas or highlights, where unreacted silver has been removed by fixing and washing, one would not expect silver to be present. Similarly, although trace amounts of halides can be detected in conventionally processed photographs, the majority of light sensitive bromides or chlorides are removed during the fixing and washing process. Higher than normal amounts of halides in the print as well as the presence of silver in non-image areas could indicate that a photograph was stabilized processed.

Four photographs from the New Jersey State Museum's *Untitled* series and four identical, but traditionally processed images from the collection at The Museum of Modern Art were analyzed side by side in the MoMA Conservation Department. Chris McGlinchey and Ana Martins from the Conservation Science department at MoMA performed the analysis and data interpretation.

The photographs were analyzed using the Tracer III-V portable XRF manufactured by Bruker (nee Keymaster) with a Rhenium target and silicon PIN detector. Data was collected under two separate conditions: 40 keV and 4 micro amps with a copper, titanium aluminum filter set (for high z excitation) and 15 keV and 15 micro amps with no filtration for low Z excitation. The former relied on bremstrahlung for excitation and the latter the rhenium L lines. In this study (optimized for both tube and filtering conditions), iron and below was considered low z.

The photographs were photocornered into precut window mats with a Coroplast backing which would not interfere with the spectrometric readings. For each of the photographs, three readings were taken from an area of minimum density (D-min), two areas of maximum density (D-max) and one non-image area in the margin. An additional reading was taken at the top right corner of the stabilized prints where discoloration was present (Figures 4, 5, 6, 7). *Untitled #6* corresponds with MoMA 224.2004; *Untitled #8* corresponds with MoMA 331.1972; *Untitled #5* corresponds with MoMA 224.2004; *Untitled #14* corresponds with MoMA 335.1972.

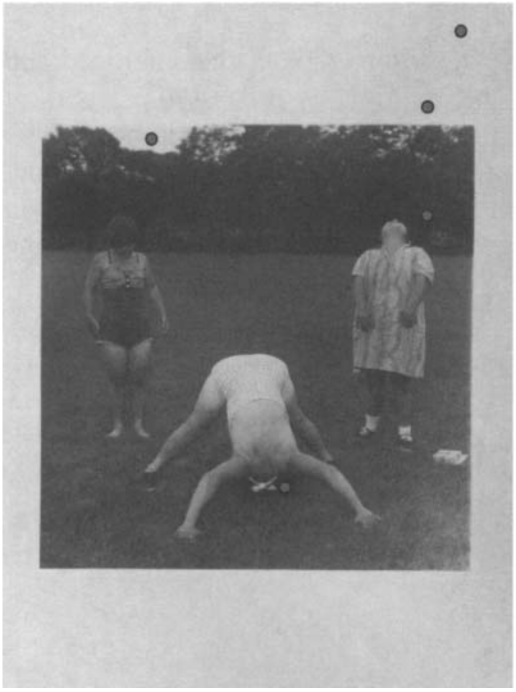


Figure 4: *Untitled (6)* 1970-71 Copyright © 1972 The Estate of Diane Arbus, LLC. Courtesy of the New Jersey State Museum, Trenton

Figure 5: *Untitled (8)* 1970-71 Copyright © 1972 The Estate of Diane Arbus, LLC. Courtesy of the New Jersey State Museum, Trenton

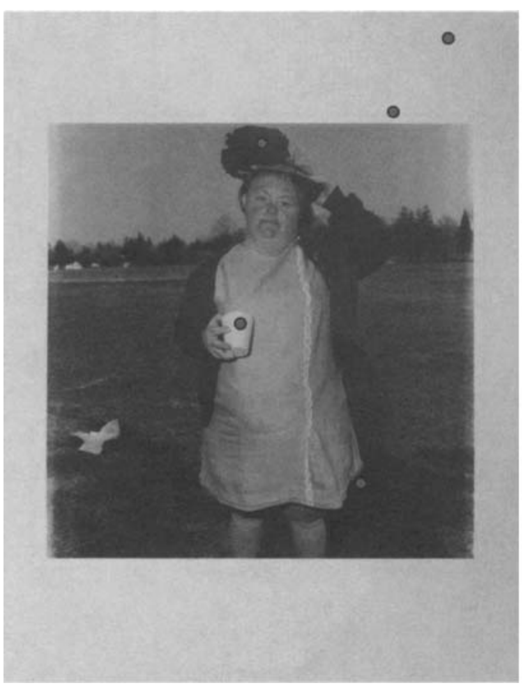
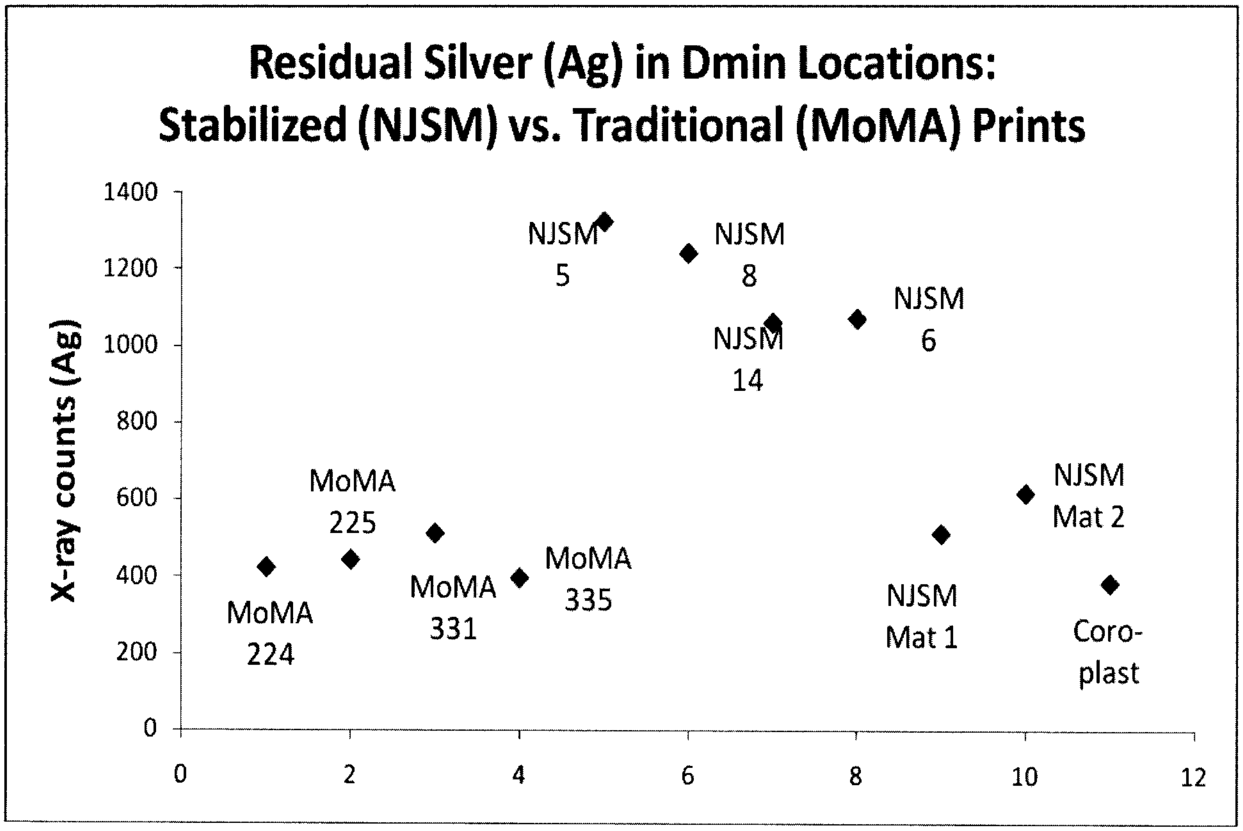


Figure 6: *Untitled (5)* 1970-71 Copyright © 1972 The Estate of Diane Arbus, LLC. Courtesy of the New Jersey State Museum, Trenton

Figure 7: *Untitled (14)* 1970-1971 Copyright © 1978 The Estate of Diane Arbus, LLC .Courtesy of the New Jersey State Museum, Trenton

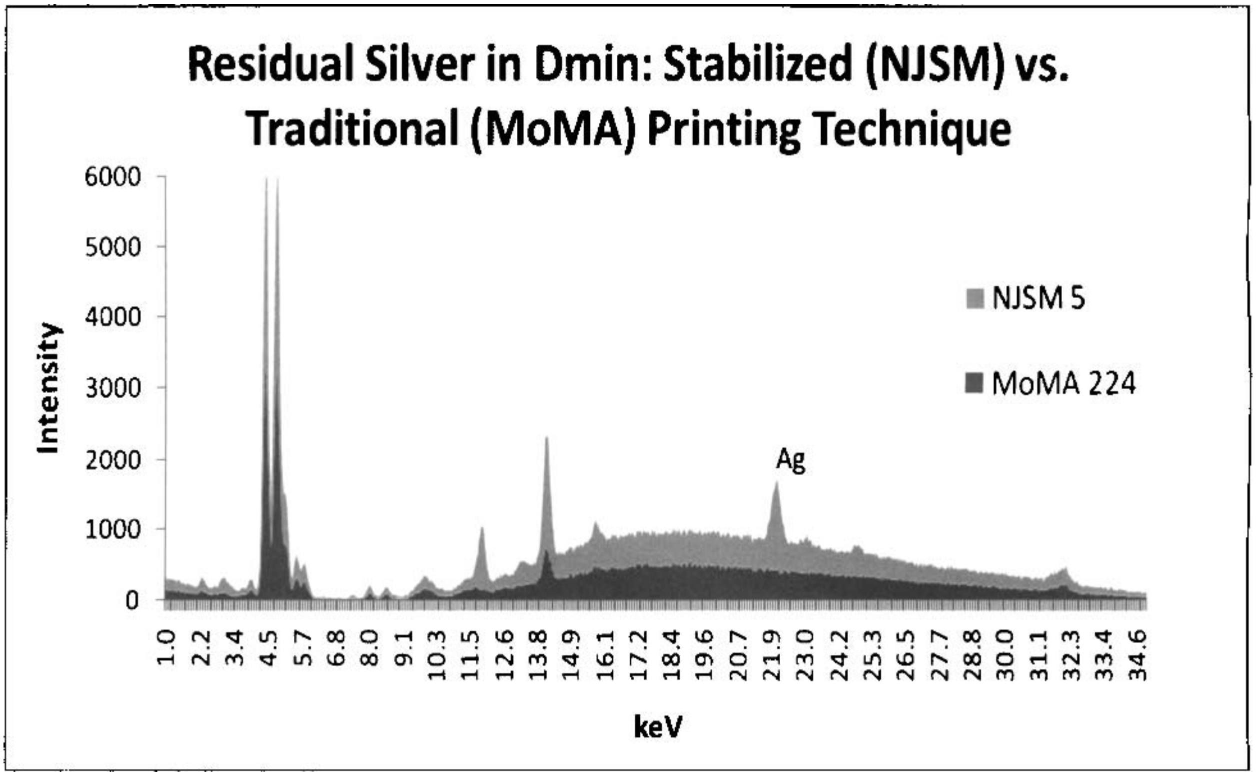
4.1 RESULTS

Graph 1 shows the amount of residual silver in the D-min locations of both the stabilized and traditionally processed prints. As expected, readings from the traditionally processed prints from the MoMA collection followed the convention of little or no silver in the D-min and non-image areas. In fact, silver readings from the D-min and margin areas are comparable to readings from the matboard and the Coroplast. The New Jersey State Museum photographs, however, contain a greater concentration of silver throughout the entire photograph including the white non-image border areas.



Graph 1: X-ray counts showing elevated levels for silver in Dmin locations of NJSM photographs compared to low (background) levels for Dmin in MoMA prints, NJSM mat and Coroplast samples.

Graph 2 compares the XRF spectra in D-min locations of *Untitled #5* and its counterpart MoMA 224. Note the silver peak present in the New Jersey State Museum print but non-existent in the MoMA print.



Graph 2: X-ray Fluorescence (XRF) spectra of Dmin from the same image printed two different ways: stabilized print at top (NJSM 5) showing residual silver (Ag) and no detectable Ag (only background radiation) in MoMA traditional print. XRF location of 'MoMA 224' and 'NJSM 5' are approximately identical.

Readings for the presence of halides also confirmed expectations for both the stabilized prints and traditional prints. Extremely small amounts of residual halide are found in the traditionally processed prints while the stabilized prints contain significantly higher amounts of bromine. The presence of unreacted halides and elevated levels of silver overall are consistent with a photograph that has not been fixed or washed.

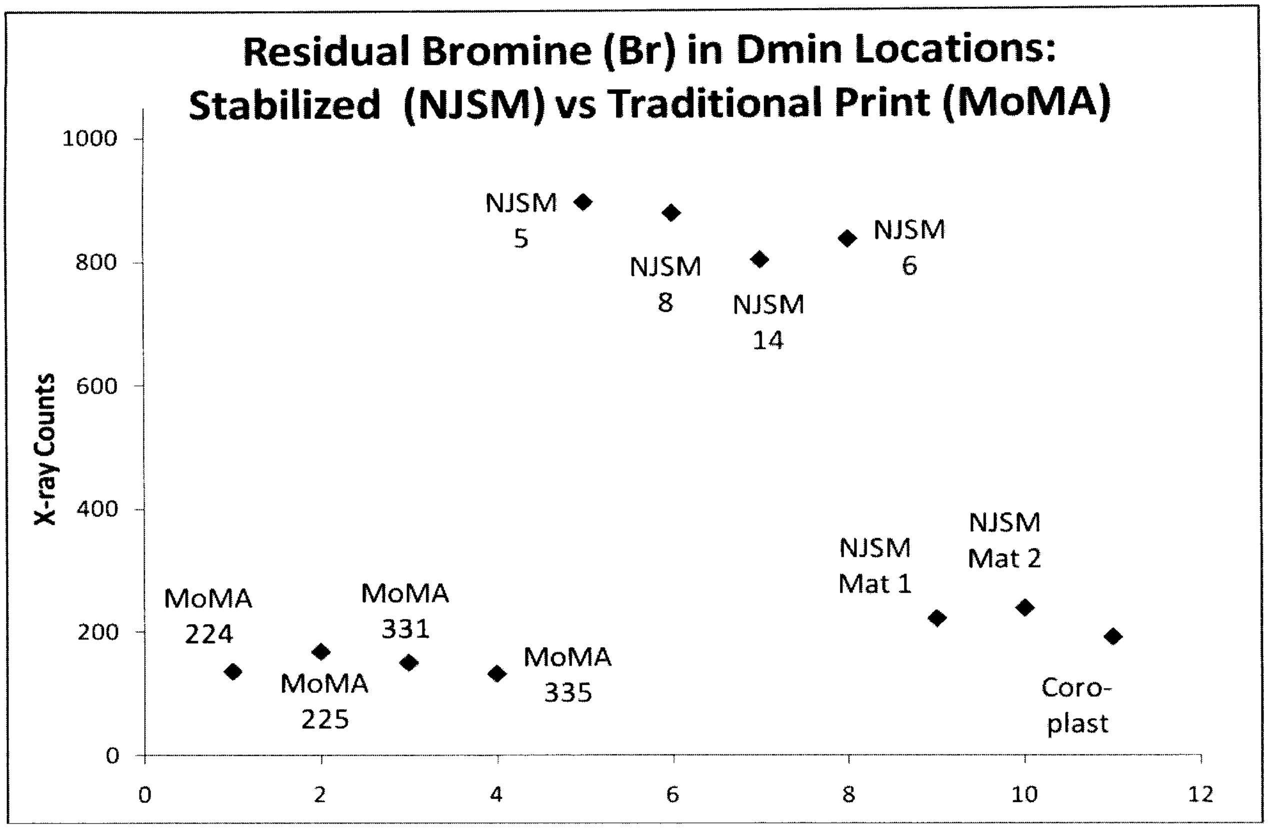


Figure 3: X-ray counts showing elevated levels for Bromine in Dmin locations of NJSM photographs compared to low (background) levels for Dmin in MoMA prints, NJSM mat and Coroplast samples. Experimental conditions: unfiltered Rhenium excitation, 15 keV voltage and 15 microamps current.

Elevated levels of sulfur and cadmium were also found in the New Jersey State Museum photographs. Significantly higher amounts of sulfur may be the result of retained chemistry in the print, especially if a thiosulfate-based stabilizing system was used. Although the difference is not significant, the stained areas of the New Jersey State Museum prints contain slightly higher levels of sulfur than in the unstained non-image areas. The source of cadmium in both the traditional and stabilized papers may be attributed to the addition of cadmium during the paper manufacturing process in order to provide a warm image tone. Excess sulfur and cadmium may also be an indication that a print was never washed after processing to remove residual chemistry and manufacturing additives.

5. CONCLUSION

XRF analysis indicates that the elemental composition of the New Jersey State Museum stabilized processed photographs differs from traditionally processed silver gelatin photographs. The presence of silver in the highlights and non-image areas is consistent with a print that has not been fixed and washed since the silver remains throughout the print. The presence of higher than normal amounts of bromine (or halides in general) is also consistent with stabilization processing since both reacted and unreacted halides remain in the print. It should be assumed that high amounts of unreacted halides in the prints indicate a tendency toward continued light

sensitivity and exhibition of the originals is not recommended. Elevated levels of sulfur and cadmium seem to further indicate that the prints were not washed following processing.
A clear mechanism for discoloration could not be discerned from the XRF analysis. It could be a result of alkaline interactions, developer diffusion, oxidation of residual chemistry or a combination of many causes. Understanding the mechanism could be helpful in preventing or slowing down the progress of deterioration of stabilized prints and adjacent collection materials. Using neutral pH, all-rag matboard, interleaving paper or folders is a simple, non-invasive way to eliminate one of these variables. Since increased temperature, humidity and pH can cause deterioration of the excess stabilizing chemistry, storage environments should be carefully monitored.

ACKNOWLEDGEMENTS
Many thanks to Mary Schobert of CCAHA and Margaret O'Reilly of the New Jersey State Museum .Thanks to Lee Ann Daffner, Chris McGlinchey, Ana Martins, Rosina Herrera and Eva Respini at The Museum of Modern Art and Lisa Barro, Nora Kennedy and Jeff Rosenheim at the Metropolitan Museum of Art. Special appreciation to Doon Arbus, Neil Selkirk, the National Endowment for the Arts, the Photographic Materials Group membership, the Photographic Materials Group Professional Development Stipend and The New York Public Library.

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SURPRISE, SURPRISE... TECHNICAL ANALYSIS OF PHOTOGRAPHS IN THE ALFRED STIEGLITZ COLLECTION AT THE ART INSTITUTE OF CHICAGO

BY EVA GRIETEN

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona;

Abstract:
Platinum, palladium, gum dichromate, gelatin silver, and photogravure are among the processes found in the collection of Alfred Stieglitz. His work is a testament to both the aesthetic and technical evolution of American photography, from the end of the 19th to the middle of the 20th century. His early work was without restriction - he used many techniques and experimented with a vast array of materials. Over time, he moved away from hand-made photographs toward more commercially-produced photographic papers. This evolution is not only visible in his work, but also in the works he collected during his life. After his death in 1946, his widow, Georgia O'Keeffe, divided and donated the collection to several institutions, including a major gift to the Art Institute of Chicago, but process identifications were sometimes absent or misleading. There have been limited attempts by the Art Institute of Chicago in the past to accurately identify certain photographs in the collection, but due to limitations of time and equipment, no comprehensive effort toward this goal has been undertaken. In the current project a protocol is developed for the analytical equipment at the Art Institute to map out the Alfred Stieglitz collection.

Keywords: *photography, photographic techniques: FITR-(ATR); Raman; FT-Raman; XRF; Alfred Stieglitz*

Introduction:
Museum professionals, experts and collectors typically rely on visual examination to identify photographic processes. However, visual identification alone can be misleading. The present study describes applications of several instrumental analyses used to identify organic and inorganic materials non-destructively.
A protocol was developed for two types of X-ray fluorescence spectrometers, a portable micro-focus system and a handheld macro-set-up, and validated with standard replicas of known photographic techniques. Qualitative XRF identification of the metallic salts allows unambiguous identification of the process used for each photograph.
The presence of a coating complicates the identification of the used medium. Therefore a protocol on non-destructive analyses (Infrared and Raman Spectrometry) for coatings was developed. The study investigated several combinations of coatings on photographs. For the comparisons with unknown coatings three types of photographic paper (one, two and three layered papers) and five primary components of coatings were used to develop different model systems. The next step was to use these models in case studies and is now being used to identify photographs in the Alfred Stieglitz collection.

Alfred Stieglitz and his collection

With photography increasingly recognized as a distinct artistic medium, the Alfred Stieglitz (1864-1946) Collection has gained great historical significance, and is now one of the most important collections of photographs at the Art Institute of Chicago. In addition to creating his own work, Stieglitz also discovered, promoted and collected the work of many other photographers, wrote articles, and published magazines – all with a singular goal: the recognition of photography as an independent art form. The breadth and quality of the work he had amassed by the end of his life set a precedent for subsequent collections of photography. His collection represents an artist who explored the photographic medium to find the techniques and materials that would reflect his ideas and, rather than providing an historical overview of a given artist, speaks to the interest and collaboration of Alfred Stieglitz with that particular person. This collection was divided and donated to several museums, archives and universities. According to Georgia O'Keefe, Stieglitz's widow, this was the ideal way to show the work to the largest possible audience.[1]

The identification of photographic and characteristic metal elements of various processes

The Alfred Stieglitz collection captures a defining moment for the creation of visual vocabulary of modern photograph. There is a great variety in techniques present in the collection: autochrome, carbon, gelatin silver, gum dichromate, photogravure, platinum, palladium, Satista, salt print and combinations thereof.

It is useful to categorize photographs as having one, two, or three layers. Within these categories, aspects such as size, color and finishing are important parameters for the estimation of the technique used. It is often possible to distinguish photographic techniques by visual identification, relying on individual characteristics such as grain pattern, layer structure and other special features.[2] However, artists have access to a great number of different products and options to translate their ideas into photographic imagery resulting in a melting pot of both commercially produced photopapers and manipulated handmade photographs. Stieglitz was widely known to experiment with different sensitizers, developers, and toners to achieve a specific aesthetic result, which can further complicate the identification procedure.[3]

The artist also strongly believed in the presentation of a photograph, which often-included mounting the photograph on a specific paper and applying a coating on the image surface. He used coatings for both aesthetic reasons as well as preservation enhancements.[4] The application and type of coating used varies from minimal to one drastically altering the surface and perception of a photograph.[5] The presence of a coating layer can also interfere with accurate visual identification. There is an abundance of materials and application methods that can be used.

The composition of metallic elements is directly related to the used technique and the structure of the photopaper. Salt prints, platinum, Satista, palladium and platinum-palladium are the most common single-layered photographs in the Alfred Stieglitz Collection. One-layered photographs have a matte surface, no binder or baryta layer, and the paper fibers are clearly visible. These techniques can sometimes be distinguished by the color of the print. In a salt print Ag and Cl make up the image material, while Au can be present as a toner. In contrast to the salt print, the platinum or palladium process is based on the light sensitivity of iron salts, which react with the platinum or palladium compounds to produce a non-silver image.[6] Platinum prints often have a neutral grey-black hue while palladium prints tend to have a warmer brown tone. The two processes have very similar chemical reactions – they are often interchangeable. In a platinum print Fe, Pt, is used for the image with possible toning, development or sensitization achieved with U, Hg, and Au. In a palladium print, almost the same elements are found but pt is replaced with pd. When a combination of the two salts is used both pt and pd are present in the final image. In the Satista process the characteristic elements are Pt, Ag and Fe.

In photographs with two layers, there is a binder present but not a baryta layer, so the paper fibers remain visible in the highlights. The Stieglitz Collection contains carbon and gum dichromate prints. Both techniques are based on the light sensitive properties of dichromate slats and fine pigments suspended in a binder such as gum arabic for the gum dichromate prints and gelatin for carbon prints. During the Pictorialist movement this technique was often used in combination with other techniques. It is difficult to distinguish between carbon and gum dichromate with XRF, as both have the same characteristic elements: Cr, Fe and pigments.

In photographs with three layers, there is a binder and a separate baryta layer, which obscures the paper fibers.[3] The binder may be gelatin or collodion, in which a silver emulsion has been suspended. The baryta layer is a combination of $BaSO_4$ and gelatin.

Introduction of analytical techniques

X-ray fluorescence spectrometry (XRF) is a non-destructive analytical tool often used in photograph conservation to identify the elemental composition of a photograph. XRF is based on the ionization of atoms of the material being investigated by an energetic beam of primary X-rays. The characteristic radiation or fluorescence X-ray that is emitted by the ionized atoms contains information on the nature of the present elements. In the past decade, several publications have described applications of XRF to art analysis.[7-13] The elements of portability, non-contact, characterization through multi-elemental fingerprinting, and both qualitative and quantitative analysis capabilities are very attractive features for cultural heritage applications.

Previous applications of XRF to the study of photographs include identification of photographic techniques to support art historical research, the quantification of $BaSO_4$ for authentication and dating of photographs and the examination of differences between traditional developed gelatin silver prints and developer incorporated stabilized photographs.[3,15] The work described here builds on the foundations established by previous studies conducted at The National Gallery of Art in Washington, DC on the use of XRF spectrometry to characterize the Gallery's collection of Stieglitz prints.[3,16] Since the time of those publications many improvements in portable and handheld X-ray fluorescence instrumentation made it possible to better detection of the elements that characterize the final tone and technique of the photographs, without the need for tailored secondary target excitation.

Identification of the photographs is a two-part process. It is possible to detect the metallic elements with XRF but questions on the organic compounds are not answered. In several cases the binding materials are as important to identify the technique. A good example is the presence of Cr; it can be a gum dichromate or a carbon print. More important is the presence of a coating. As coatings are the top layer of the photograph, their condition and identification is important. The coatings may degrade or get damaged, critically affecting the photograph and the perception of the image. Thus, sensitive detection and accurate identification of a photographic coating, together with the determination of its condition, is crucial to inform appropriate conservation treatments. Among non-invasive techniques of analysis, FTIR-ATR has been the method of choice for the identification of coatings on photographs, whereas little attention has been devoted to the study of these films with Raman spectroscopy.[17] Fourier transform Raman spectrometry

measures the wavelength and intensity of inelastic scattered light from molecules while using an interferometer and a 1064 nm laser source. The use of the 1064nm source eliminates the fluorescence of the samples. The Raman technique has the advantage of being not only non-invasive, but also non–contact, overcoming one shortcoming of FTIR-ATR, namely a residual small indentation left on the surface of the artwork as a result of the analysis.
Laboratory simulations allowed the determination of the thermal sensitivity threshold of each combination, correlation of coating thickness, as well as detection capabilities and limitations. FT-Raman was compared to other complimentary vibrational spectroscopy techniques such as micro-FTIR-ATR and micro-FTIR performed in transmission with diamond anvil cell.

Instrumentation
XRF analyses
Bruker ArtTAX air-path portable μ-XRF *system* with spot size of 0.2 to 2 mm, micrometric control of the position of the measuring head with respect to sample, laser pointer and integrated camera system that allow optimal positioning at a fixed distance of approximately 5 mm from the sample surface. The system is equipped with interchangeable excitation tubes with Mo and W targets. (max. 50 kV, max. 800 μA) and 0.2 mm air cooled Be window with Cu-radiator. The X-ray detector is an X-Flash® detector (5 mm^2) with energy resolution of 165 eV for the full width at half maximum of the MnKáline at 10kcps
Bruker/KeymasterTRACeR III-VTM energy dispersive handheld X ray Fluorescence analyzer, with Peltier cooled advanced high-resolution Silver-free SiPIN detector with a 13μm Be window and resolution of approximately 175 eV for the full width at half maximum of the MnKáline. The system has titanium and aluminum changeable filters, and is equipped with a rhodium (Rh) transmission target with max voltage of 45kV and tunable beam current of 2-25μA.
FT-Raman analyses
A Bruker Vertex 70 FTIR Spectrometer coupled with Ram II FT-Raman module and Ramscope III FT-Raman microscope was used. The system is equipped with Nd^{3+}/YAG laser, with excitation at 1064 nm and high sensitivity, nitrogen cooled Ge detector. Between 5000- 50 000 scans were accumulated at 4 cm^{-1} resolution using a 10x objective, with a nominal laser power of 5-500 mW.
FTIR analyses
FTIR spectrophotometer a Bruker tensor 27 FTIR spectrophotometer with mid-IR glowbar source and DTGS detector was used, coupled to Hyperion 2000 Automated FTIR microscope with nitrogen cooled mid-band and broad-band MCT detectors (covering the range 7000-). Sampling accessories with ATR objective (germanium crystal) and diamond micro compression cell in connection with microscope at a resolution of 4 cm^{-1} for 256 seconds.

Experimental
Detection of metallic elements with XRF*
Different conditions with both instruments on facsimiles developed at the National Gallery, Washington DC. were used to validate a protocol.[3, 18] In table 1 an overview of the different settings is given. If radiation dose is a concern, low KV settings in conjunction with He flushing and evaluation of the M lines for Pt and Pd and L lines for Pd Ag Hg and Au is a possibility. However, peak overlap is more pronounced and the sensitivity lower than when operating at

* Grieten, E. and F. Casadio. *X-ray fluorescence portable systems for the rapid assessment of photographic techniques in notable art collections: the Alfred Stieglitz Collection*. X-ray Spectroscopy, in press exp. Feb. 2010.

higher voltages and with primary beam filtration, which provided optimal conditions for detection of the metallic elements.

	Anode	Detector	Measurement type	Filter	Aperture size	Atmosphere	Accelerating potential	Anode current	Measurement live time
ArtTAX	Mo	Silicon Drift (SDD)	In air	12.5μm Mo	1.5 mm	Air	50 kV	800 μA	250 S
	Mo	Silicon Drift (SDD)	Low voltage He	none	1.5 mm	He	50 kV	800 μA	250 S
TRACeR III-V	RH	Silicon PIN	In air	none	6 mm	Air	40 kV	7 μA	250 S

Table 1: Experimental conditions used for the XRF analysis of the Stieglitz collection with portable (ArtTAX) and handheld (TRACeR III-V) spectrometers

To reduce the background of the spectrum and improving the signal-to-noise ratio a acrylic stage was specially designed The photographs were placed flat on a specially designed acrylic stage, the stage has a adaptable support bars allowing the opening to change to support the photograph were necessary and enables sampling in air (Figs.1, 2). The horizontal acrylic stage is advantageous for the analysis, poses less stress and strain on the artifact. All analyses were performed in no-contact mode, for the Keymaster TRACeR III-V the instrument is placed perpendicular to the surface and is supported by a tripod over the acrylic stage, hovering at a 2-3 mm distance from the surface (Fig. 1). The ArtTAX measuring head is angled at 45 degrees towards the photograph to minimize scattering and is separated from its surface by about 5 mm.

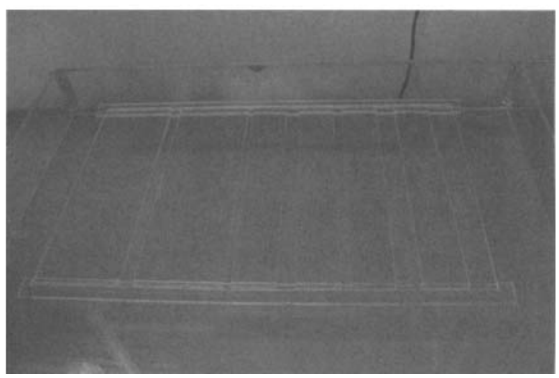


Figure 1: Experimental set-up with handheld TRACeR III-V positioned over portrait of Georgia O'Keefe (AIC 1949.745A) by Alfred Stieglitz
Figure 2:Acrylic stage for analysis of photographs and other works of art on paper

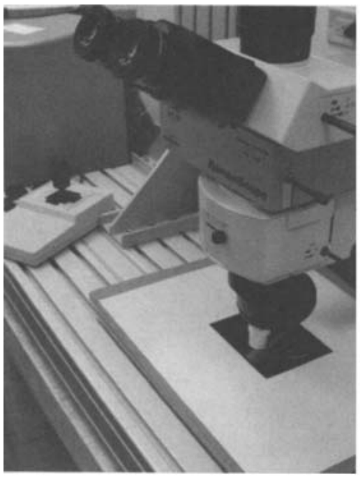
The use of XRF in characterizing photographs brings a unique set of challenges to data interpretation. Due to the low amounts of metallic elements in a thin layer, even with long acquisition times, there are detection limitations from the technique as well as extraneous peaks deriving from instrumental contaminations in our case Ni, Cu and Zn are present inside the instrument. Additionally one has to be aware that the collected information is not only related to the image material but also to its paper and its support.

To overcome matrix and instrumental interference and to guarantee macroscopic homogeneity of samples, several analytical spots were selected on each artwork. This resulted in multiple spectra taken from different density areas, as well as spectra of the different paper layers and museum mounting board. By collecting the spectra of each component of the mounted photographs, and overlaying the data it is possible to clearly identify the elemental peaks that are solely related to the image material.

Development of protocol for non-destructive FT-Raman spectroscopy on photographs

The study used four types of photographic papers (salted paper, cyanotype, albumen and gelatin silver paper) and five primary components of coatings (dammar, gelatin, gum arabic, linseed oil and white beeswax used independently or diluted with turpentine). On the photographic paper, step wedges were printed to test the entire range of densities of the photographs. To compare the coated photographs, bulk samples as well as photo papers without coatings were prepared and analyzed with the same analytical techniques.

The Ramanscope III FT-Raman microscope can be mounted to a metallic stage that allows to analysis of photographs without removing them from the mounts or restriction in the location of the analysis.



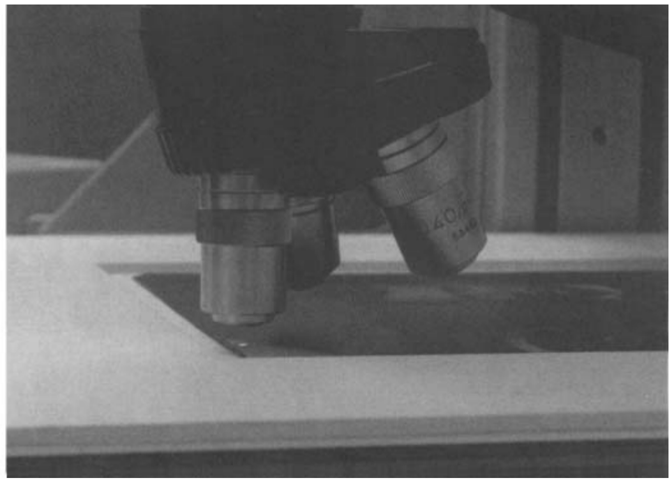


Figure 3: FT-Raman set-up with photograph by Alfred Stiegltiz
Figure 4: Detail FT-Raman set-up with Self-portrait of Edward Steichen

Identification of coatings on different photographic papers

To avoid thermal damage and possible degradation of the sample the maximum power for each type of coating and paper was determined. At the minimum density (step 21) maximum nominal power (at 500 mW) showed no thermal damage. The density of the paper affects thermal sensitivity and the darker the area the lower the power that can be used, due to enhanced absorption of the laser light. There is an inverse relationship between the density of the sample and the maximum power that can be used for analysis. It was also clear that each combination of photo paper and coating has different thermal damage thresholds. There is a tendency for the one layered papers to be more sensitive to thermal damage than the two or three-layered papers.

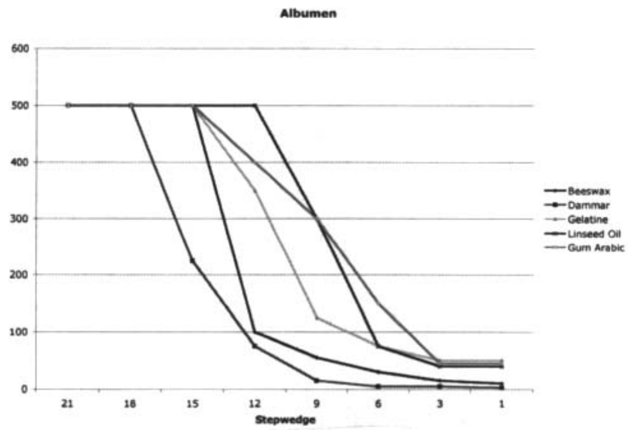


Figure 5: Power that can be used before thermal damage

Detection limits with FT-Raman[19]
The thickness of the coating affects the detection limit of the FT- Raman. To have an idea of the detection limits in terms of coating thickness a semi-quantitative study was carried out. White beeswax and turpentine were applied in three thicknesses (0.5 mm, 0.25mm and 0.05mm) on salted paper. This resulted in actual coatings measured on SEM images of 1.5µm, 2.5 µm and 150 µm. The FT-Raman spectra were collected at 50 mW with a 10x objective for 20 000 scans. The ratios of the relative intensities of the Raman bands corresponding to the beeswax and the paper were used for data evaluation for this semi-quantitative study. The ratio intensities at 2848 cm^{-1} and 1379 cm^{-1} for white beeswax and paper were used respectively. It can be concluded that thicknesses > 3µm coatings can be detected with the FT-Raman.

Detection capabilities of the FT-Raman[20-23]
The Raman spectra were recorded for 5000-50000 scans at 4cm^{-1} resolution with a nominal laser power of 50- 200 mW (resulting in actual powers measured at the sample of 25 – 100 mW). The laser was focused on the coatings of the different photographs, using a 10x objective. With the 10x objective more light is back collected into microscope allowing for a increased signal.

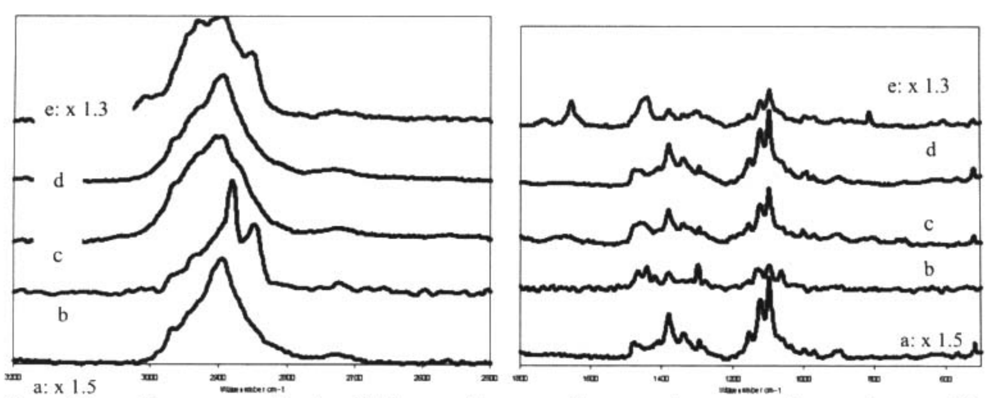


Figure 6-7: a: salt paper no coating, b: white beeswax+ turp. on salt paper, c: dammar on salt paper, d: gum arabic on salt paper and e: linseed oil on salt paper

In figure 6 and 7 the different coatings, detected by the FT-Raman, on salt paper are presented. Although peaks related to the paper substrate are still visible in the spectra, the peaks of the applied organic materials are still distinguished and characteristic so that the coating can be identified.

Dammar (fig 6-7) as a coating was detected with the FT-Raman on salted paper, cyanotype and albumen but not on gelatin silver paper (POP) possibly due to the thinness of the coating on this non-absorptive paper. In the region between 3000 and 2800 cm$_{-1}$ in addition to the peak around 2894 cm$_{-1}$ characteristic of the paper, a band at 2922 cm$_{-1}$ frequency is visible characteristic of CH stretchings of the Dammar. Also the peaks at 1450 and 712 cm$_{-1}$ are more pronounced when compared to reference spectra of uncoated papers. It is sometimes challenging to compare unprocessed spectra of coated and uncoated papers, but spectral subtraction of reference spectrum of the paper substrate from the spectrum of the coated papers allows to enhance the peaks due to the coating only.
Linseed oil (fig 6-7) as a coating is detected with the FT-Raman on one-layered papers (salted paper, cyanotype), two-layered paper (albumen) and three-layered papers (POP paper).
Peaks at 1744, 1439, 1070, 800 and 600 cm^{-1} were detected with the FT-Raman for linseed oil can be distinguished from the peaks of the paper.
Several of the peaks of gum arabic (fig 6-7) overlap with the peaks of the paper. To evaluate the coating of gum arabic a spectral subtraction provides a clearer identification. Peaks at 1461, 1340, 1261, 979, 879, 842 cm^{-1} were detected after subtraction of the paper. FT-Raman detected the gum arabic on one-layered photographs but not on the two-layered and three-layered photographs.
FT-Raman does not detect gelatin on one, two, or three-layered photographs.
Pure white beeswax and white beeswax diluted with turpentine are detected with the FT-Raman on the one-layered, two-layered and three-layered papers.

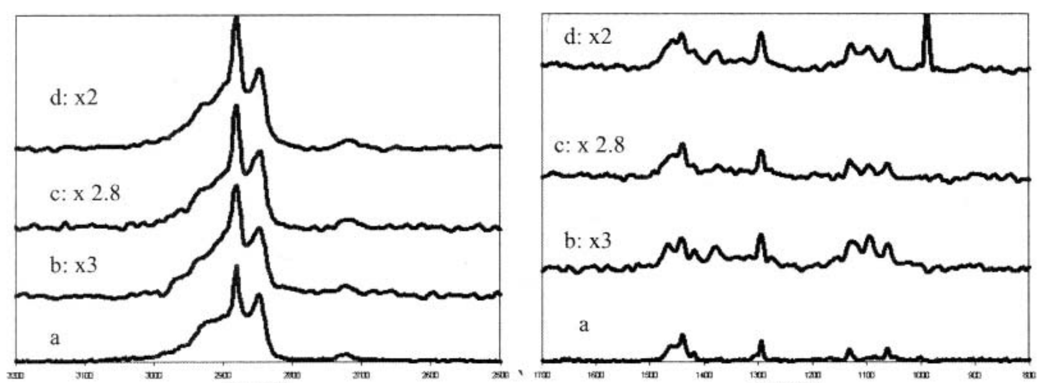


Figure 8-9: a: white beeswax (bulk), b: white beeswax on salt paper, c: white beeswax on albumen, d: white beeswax on gelatin silver paper (pop)

In the region between 3000 and 2800 cm^{-1} clearly visible and the sharp absorption at 2922 cm^{-1} typical of white beeswax. Also the peaks at 1439, 1294 and 890 cm^{-1} are evident, superimposed to the spectral signature of the paper substrate.

Comparison of the non-contact FT-Raman technique with ATR-FTIR and FTIR

FTIR- ATR is a widely used analytical technique to identify films and coatings compounds without sampling. The goal of these test was to see where the two techniques in parallel to each other to gain the best information of the coatings.[24] As FT-Raman cannot detect all the different materials the use of FTIR- ATR can complete the gathered information. Samples were also analyzed in transmission through the microscope after compression in a diamond micro-compression cell.

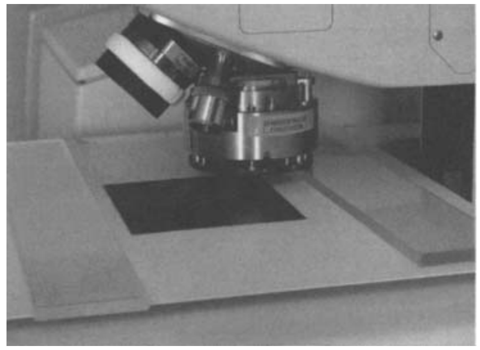
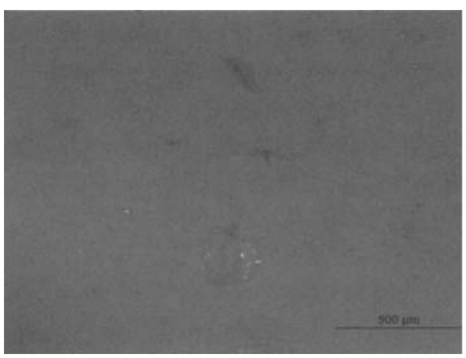


Figure 10: Set up ATR-FTIR

The analyses with the FTIR- ATR were on the same samples as the FT-Raman. The FTIR- ATR detected all the different coatings on the one, two, and three- layered photographs with the exception of the gelatin coating on albumen and pop paper. Infrared spectrometry cannot make a distinction between proteinacous materials of different origin but only the general class of compounds is identified. The ATR-objective is pressed onto the coatings of the photo papers.
The advantage of the ATR-objective is that it only penetrates a few micrometers so there is less interference of the paper as compared with the FT-Raman. One drawback of the FTIR-ATR is that it leaves a residual small indentation on the surface of the artwork as a result of the analysis.
The ATR-objective leaves a larger indentation on the three-layered photographs. Depending of the type of coating the diamond leaves a circular indentation with possible cracking (fig 13). On the other hand, with one layered papers the fibers can relax back after contact with the ATR crystal and so the analysis leaves virtually no trace (fig 14).



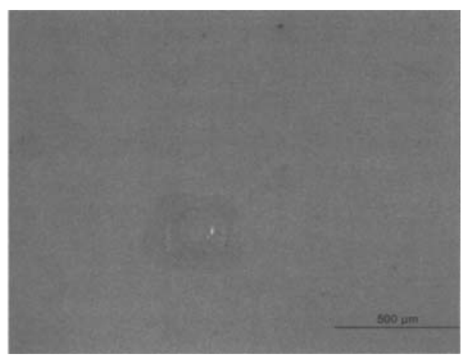
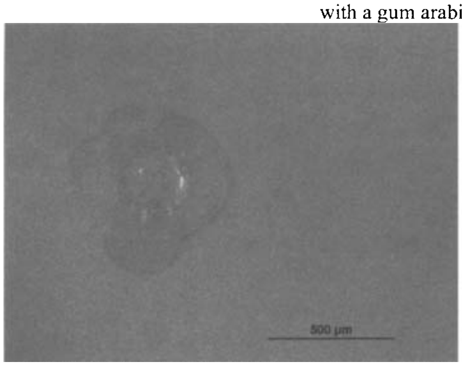


Figure 11 and 12: Indentation of ATR- objective on a pop paper with a linseed oil coating (left), Indentation of ATR-objective on a pop paper with a gum arabic coating (right)



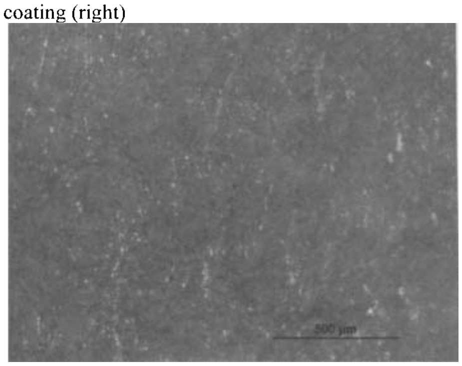


Figure 13 and 14 : Indentation of ATR- objective on a pop paper with a dammar coating (left), Indentation of ATR-objective on a salt paper with a dammar coating (right)

In case sampling is an option transmission infrared spectrometry can be applied. With the diamond cell the different compounds can be identified without interference of the paper.
Only a small amount, a few micrometers, is required to perform the analysis. The sampling is not visible with the naked eye, unless there is an extremely thin coating[25]

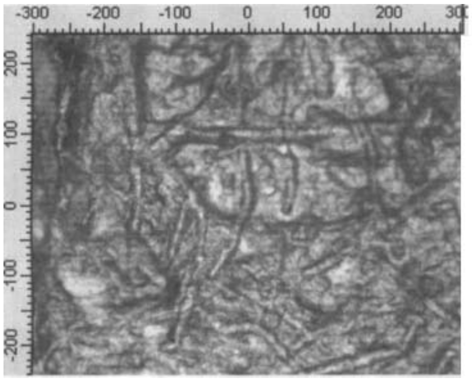
Overview of non-destructive techniques that can be used to identify coatings

	One Layered	Two layered	Three layered
Dammar	FT-Raman ATR-FTIR	FT-Raman ATR-FTIR	ATR-FTIR
Gelatin	ATR-FTIR	N/A	N/A
Gum Arabic	FT-Raman ATR-FTIR	ATR-FTIR	ATR-FTIR
Linseed Oil	FT-Raman ATR-FTIR	FT-Raman ATR-FTIR	FT-Raman ATR-FTIR
White Beeswax + turpentine	FT-Raman ATR-FTIR	FT-Raman ATR-FTIR	FT-Raman ATR-FTIR

Results and discussion

In total 62 out of 250 photographs of the Alfred Stieglitz Collection were tested with XRF. The selection within the collection was made based on the uncommon appearance of the photographs, questionable information on earlier records, and specific requests by other researchers.
The XRF analyses clearly identified all the characteristic elements for the photographs.
Attributions of the various elements to specific steps in the process of creating the final image were hypothesized, based on the total area of the element's peaks detected in the high density, low density or paper substrates of the photographs. In total, 36 platinum prints were identified, 17 palladium, 3 gum dichromate, 2 gum dichromate over platinum, 1 gelatin silver and 1 platinum-palladium. Table 2 gives an overview of the photographs that have been tested.
The FT-Raman detects drying oils, waxes, resinous media and gums on photograph papers (albumen, cyanotype, salted paper, and pop paper) only when thickness is > 3 μm. Due to the interference of the paper the coating has to be thicker than 3 μm to be detected. The best results were gathered on one-layered papers and especially on salted paper. To obtain the spectra long collection times are necessary. There is interference from the paper substrate that makes data collection and interpretation laborious. In the following, specific examples are discussed regarding photographs whose technique presented challenges to visual identification that were unraveled by instrumental analysis.

A portrait of Georgia Engelhard (1949.716) by Alfred Stieglitz was identified as a palladium print however micrographs showed a glossy surface. XRF analysis with the ArtTAX confirmed that pd was the image material and that the glossy surface there is most likely a coating. Due to the thinness of the layer initial measurements with the FT-Raman did not identify the coating.
Therefore a small sample (a few microns) was taken from a damaged are in the corner outside the image. The coating was identified with diamond cell FTIR as an extremely thin wax coating.



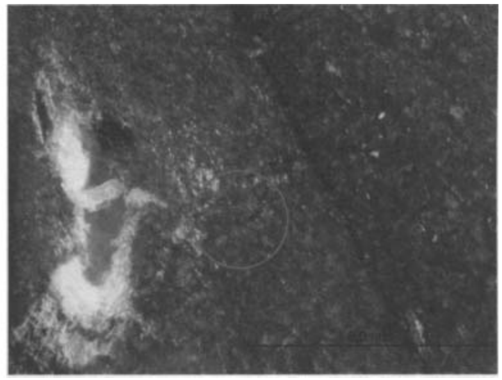
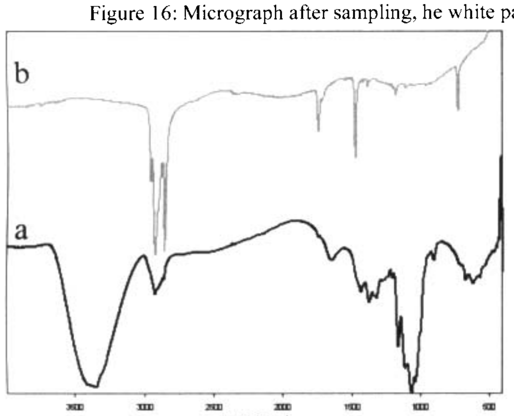


Figure 15: Micrograph of surface of Portrait (1949.716) by Alfred Stieglitz
Figure 16: Micrograph after sampling, he white paper fibers are evident fro a pre-existing area of loss



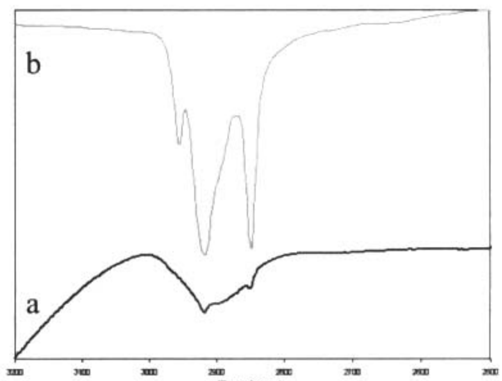


Figure 17-18: Spectrum a is taken from the is the photograph with coating compared to spectrum b, a bulk samples of beeswax. In spectrum a from the photograph, contributions from the beeswax coating are evident, superimposed to the paper absorption and are especially visible in the range 3000- 2800 and 730- 720 cm^{-1}. On the right a detail of the CH stretching with b reference beeswax and a the coated paper fiber.

A photograph of Georgia O'Keeffe's hands (1949.743) by Alfred Stieglitz was visually identified as a palladium print. Under magnification there was a atypical hue and cracks evident indication that a coating was present. XRF analysis with the handheld spectrometer confirmed that the image is produced with Pd and also contains Hg. Hg can be present in the sensitizer, developer or toner and is responsible for the warmer hue of the print. Data was collected with the FT-Raman for 8000 scans at 100 mW. When comparing it to reference samples of coated salt papers the coating can be identified as a gum Arabic. There are still some questions that the coating maybe a mixture of gum and wax. Longer acquisitions will provide more accurate data.

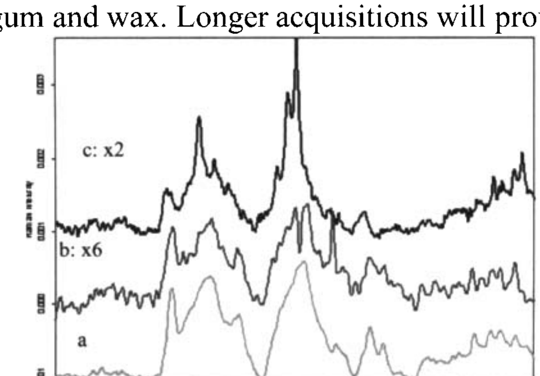
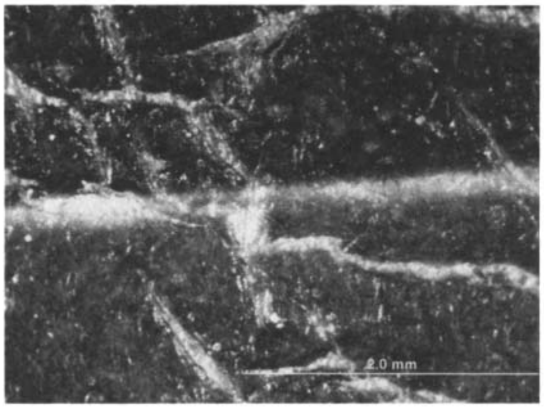


Figure 20: Spectra a is the bulk of Gum Arabic, spectra b is the subtraction of gum Arabic (reference) on salt paper (reference) and c is the spectra from the photograph by Alfred Stieglitz

A portrait of Georgia O'Keeffe (1949.745A AIC) by Alfred Stieglitz was described in the past as a gelatin silver print with yellowing at the edges. In 1989 the portrait of Georgia O'Keeffe was identified with XRF as a palladium print with traces of platinum and gold. The micrograph see fig. 22n clearly shows cracks and a substance on the surface of the palladium print.



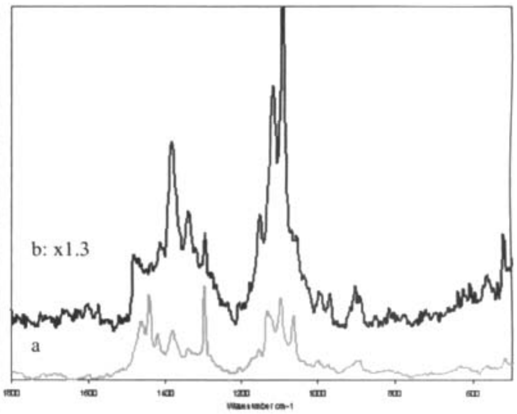


Figure 21: Micrograph of Georgia O'Keeffe hands (1949.743 AIC)
Figure 22: Spectra a is the reference of wax on salted paper, spectra b is the spectra of the photograph of Georgia O'Keeffe hands

Girl with a muff (1949.856) by Clarence H. White, visually identified as a Pt print, was examined because other prints of this same negative exist and the technique was questioned. XRF proved the presence of pt in the image. However, analysis also detected the presence of Hg, which could explain the warm tone of the image, a characteristic typically not associated with Pt prints.

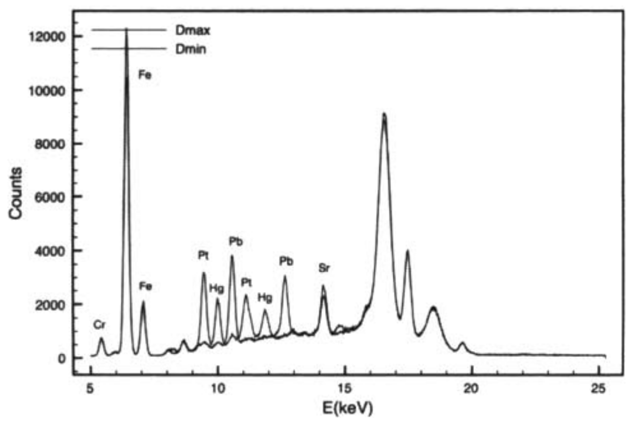
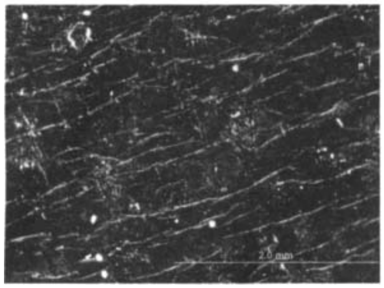


Figure 23: XRF results for the photograph of *Girl with a muff* (1949.856 AIC). The difference between the max and min density is clearly visible, pt and hg are present in larger quantities in the darker area's indicating that they are used as medium for the image.

A portrait of Clarence White by Edward Steichen is (1979.828) was in the past identified as a platinum print with mercury toning. The visual identification showed a very glossy surface with cracks (Fig. 23). XRF identified the elements, Pt, Hg, Fe and Cr. The presence of Pt and Hg suggest a platinum print, and the chromium points to a gum dichromate layer. The top layer of the photograph was later indentified with ATR-FTIR as a gum Arabic. The photograph of Clarence White can with certainty be identified as a gum dichromate print on top of platinum with mercury print.



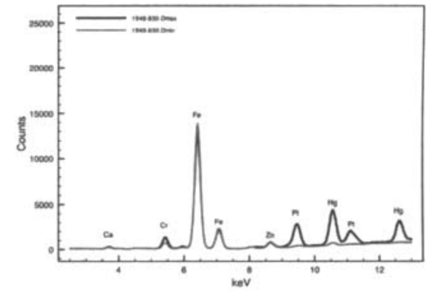
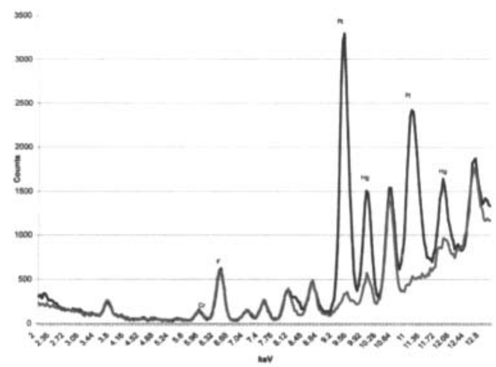


Figure 24: micrograph of the portrait of Clarence White by Edward Steichen is (1979.828 AIC), the cracks are clearly visible. Figure 25 is XRF spectra of the max and min density with the ArtTAX[18]

The photograph *Moonrise* (1949.830) made by Steichen at Lake George is an excellent example of how the combination of analytical data with archival research can lead to an enhanced understanding of the photographic processes. In the past this photograph was associated with several different techniques. Two proposed identifications suggested the combined technique of gum over cyanotype or gum over platinum print. The XRF spectrum illustrated in Fig. 25 shows the presence of Pt, Cr, Fe and Zn, so it can be said with certainty that this is a platinum print. On the other hand the element chromium indicates a gum dichromate print, with an iron-based pigment. The ATR-FTIR results show clearly that the top layer is gum Arabic and that the iron based pigment is Prussian blue.[26]

This knowledge, supplemented by correspondence between Alfred Stieglitz and Edward Steichen can allow identification of the photograph as 3 prints: *From a letter by Edward Steichen to Alfred Stieglitz on the technique of the photograph: "Moonrise: 16x 24[1904] in three printings: first printing, grey black platinum, 2nd, plain blue print (secret) and 3rd greenish gum".*



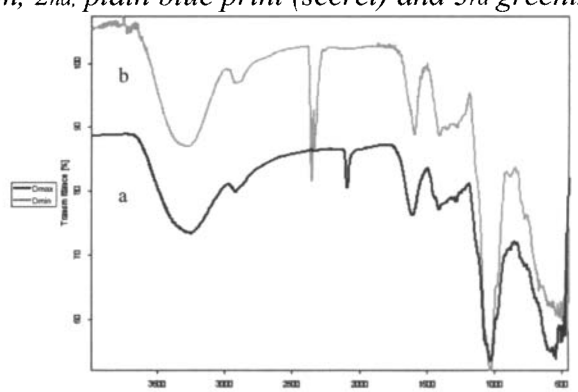


Figure 26: XRF results of Edward Steichen's Moonrise

Figure 27: Spectra b is the reference sample of gum arabic with ATR-FTIR and spectra a is the Moonrise (1949.830 AIC) of Edward Steichen

Conclusion

The goal of the project was to develop a protocol to characterize photographs by identifying the elements used in the process and organic components presents in the binder or as coatings by fingerprinting the materials with vibrational spectroscopic techniques. Two different XRF instruments were used to develop a protocol enabling a clear identification of the characteristic elements. As a result, we proved that satisfactory process identification can be achieved both with a laboratory set-up, but also with a hand-held system that can be carried in storage spaces, conservation labs or galleries with ease. To identify organic compounds a second protocol was developed with special attention to the non-destructive, non-contact FT-Raman spectroscopy technique. FT-Raman proved promising results for positive identification of coatings on various systems, but has limitations in its ability to identify all organic compounds especially when the films are very thin. Also the collection of the data is a long process. FTIR-ATR is faster in collecting the data, is able to detect all the most common traditional coatings materials but leaves an indentation on the surface, which is especially visible in three layered photographs. Also there is a limitation on the location of the analysis because of the FTIR-ATR set-up. There is a limitation on the width of the mount that allows the crystal to still make contact with the actual image. Alternatively, by taking a small sample of a damaged area or corner the coating can be analyzed with the diamond cell in transmission FTIR. FTIR is a quick effective technique to analyze a coating without the interference of the substrate.

At the moment this protocol is being used at the Art Institute of Chicago to identify organic and inorganic compounds on photographs. Depending on the tools and the object, different analytical approaches can be used to identify the organic compounds. At the conclusion of the project, among the 62 tested photographs, 8 that had been incorrectly identified were rectified, 13 more although correctly identified by visual observation gained additional fabrication information as a result of the XRF study, and 26 analyses confirmed the existing medium display, allowing the museum to remove long-standing question marks on exhibition labels and media description information.

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Table 2: Overview of analyzed photographs of the Alfred Stieglitz Collection, previous visual identification and new media description based on XRF analysis.

Object number	Artist	Title	Date	Technique based visual identification	Metallic elements (XRF)	Process identification from XRF results
1949.671	Frank Eugene	La Cigale, c. 1900	c. 1900	Platinum	**Pt**, Zn	Platinum
1949.673	Frank Eugene	Portrait of Goetz	n.d.	Platinum	**Pt**, Hg	Platinum

1949.674	Frank Eugene	Portrait of Alfred Stieglitz	n.d.	Platinum	**Pt**, Hg	Platinum
1949.675	Frank Eugene	Portrait of Two Young Men	n.d.	Platinum	**Pt**, Hg	Platinum
1949.676	Frank Eugene	Small Boy Dressed as a Faun	n.d.	Platinum	**Pt**, Hg	Platinum
1949.677	Frank Eugene	Portrait of a Woman	n.d.	Platinum	**Pt**, Hg	Platinum
1949.699	Alfred Stieglitz	A Street in Sterzing, The Tyrol	1890	Platinum	**Pt**, Hg	Platinum
1949.709	Alfred Stieglitz	From the Window of 291	1915	Platinum	**Pt**, Zn	Platinum
1949.710	Alfred Stieglitz	From the Window of 291	1915	Platinum	**Pt**, Zn	Platinum
1949.711	Alfred Stieglitz	Marsden Hartley	1915	Platinum	**Pt**, Zn	Platinum
1949.712	Alfred Stieglitz	John Marin	1911	Platinum	**Pt**, Zn	Platinum
1949.713	Alfred Stieglitz	Arthur G. Dove	1911	Platinum	**Pt**, Zn	Platinum
1949.714	Alfred Stieglitz	Ma	1949	Platinum	**Pt**, Zn	Platinum
1949.716	Alfred Stieglitz	Portrait	1922	Palladium	**Pd**, Zn	Palladium
1949.718	Alfred Stieglitz	Rebecca Salsbury Strand	1922	Palladium	**Pd**, Zn, Hg	Palladium
1949.719	Alfred Stieglitz	Rebecca Salsbury Strand	1922	Palladium	**Pd**, Zn	Palladium
1949.722	Alfred Stieglitz	Waldo Frank	1920	Palladium	**Pd**, Zn	Palladium
1949.723	Alfred Stieglitz	Katharine Dudley	1922	Palladium	**Pd**, Zn, Fe	Palladium
1949.726	Alfred Stieglitz	Sherwood Anderson	1923	Palladium	**Pd**, Cu	Palladium
1949.743	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Hg, Zn	Palladium
1949.745A	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Zn, Fe	Palladium
1949.745	Alfred Stieglitz	Georgia O'Keeffe	1920	Palladium	**Pd**, Zn	Palladium
1949.746	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Hg	Palladium
1949.750	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Zn	Palladium
1949.751	Alfred Stieglitz	Georgia O'Keeffe	1919	Palladium	**Pd**, Hg, Zn	Palladium
1949.752	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Zn	Palladium
1949.754	Alfred Stieglitz	Georgia O'Keeffe	1922	Palladium	**Pt, Pd**	Platinum-palladium
1949.758	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Zn, Fe	Palladium
1949.759	Alfred Stieglitz	Georgia O'Keeffe	1918	Palladium	**Pd**, Hg, Zn	Palladium
1949.762	Alfred Stieglitz	Georgia O'Keeffe	1922	Platinum	**Pt**, Au, Fe	Platinum

1949.821	Frederick Evans	Piscina in Chapel of Little Snoring Church, Norfolk, England	c. 1906	Platinum	**Pt**, Hg	Platinum
1949.822	Frederick Evans	York Minster: Looking from the Chapter House Interior	c. 1902	Platinum	**Pt**, Hg, Fe	Platinum
1949.826	Edward Steichen	Rodin, Paris	1907	Palladium	**Pt**, Hg, **Cr**, Fe	Gum dichromate over platinum
1949.827	Edward Steichen	Portrait of Alfred Stieglitz	1915	Gum bichromate over Pt	**Cr**, Fe	Gum dichromate
1949.828	Edward Steichen	Portrait of Clarence White	1908	Gum bichromate over Pt	**Pt**, Hg, Fe	Platinum
1949.829	Edward Steichen	Midnight Lake George	1904	Gum bichromate over Pt	**Pt, Cr**, Pb, Fe	Gum dichromate over Pt and blue print
1949.830	Edward Steichen	Midnight Lake George	1904	Gum bichromate over Pt	**Pt, Cr**, Pb, Fe	Gum dichromate over Pt and blue print
1949.831	Frank Eugene	The Horse	n.d.	Platinum	**Pt**	Platinum
1949.833	Frank Eugene	Hortensia	1898	Platinum	**Pt**, Hg, Zn	Platinum
1949.851	Clarence H. White	Alfred Stieglitz	n.d.	Toned gelatin silver	**Pt**, Hg, Pb	Platinum
1949.852	Clarence H. White	The Fountain	1907	Platinum	**Pt**, Hg, Pb	Platinum
1949.853	Clarence H. White	Untitled	1905	Platinum	**Pt**, Hg	Platinum
1949.854	Clarence H. White	Untitled	n.d.	Platinum	**Pt**, Hg, Pb	Platinum
1949.855	Clarence H. White	Sunlight	1901	Platinum	**Pt**, Hg, Pb	Platinum
1949.856	Clarence H. White	Girl with Muff	1906	Platinum	**Pt**, Hg	Platinum
1949.862	Gertrude Kasebier	Alfred Stieglitz	1906	Gum bichromate	**Pt**, Hg, Pb	Platinum
1949.868	Heinrich Kuhn	Portrait of Young Boy with Arm Across Back of Chair (Hans Kühn)	c. 1906	Gum bichromate	**Pt**, Hg	Platinum
1949.869	Heinrich Kuhn	Seated Woman Untying Slipper	c. 1910	Gum bichromate	**Pt**, Hg, Cr	Platinum
1949.870	Heinrich Kuhn	Portrait of Stieglitz	1909	Platinum	**Pt**, Hg	Platinum
1949.871	Edward Steichen	Winter Landscape	1899	Platinum	**Pt**, Zn	Gum dichromate
1949.872	Edward Steichen	Young Tycoon (self-portrait)	n.d.	Gum bichromate	**Cr**, Fe	Platinum

Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

The Use of the Salted Paper Print as a Copying Technique for Architectural Drawings and Maps

Adrienne Lundgren

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

Photography has been used as a reproduction technique since its invention. Nicéphore Niépce's early experiments to reproduce engravings resulted in the invention of his heliogravure process, and William Henry Fox Talbot's *Pencil of Nature* sang the praises of using photography in reproducing rare works of art. By the turn of the century, there were many processes developed for the express purpose of reproducing line drawings and large format materials resulting in a booming industry catering to the architecture, engineering, and cartographic fields. However, from 1840 to the 1870's, the salted paper process was one of the main photographic methods used to reproduce architectural drawings and maps.

While used by early practitioners such as William Henry Fox Talbot, the copying of large format and rare line drawings using the salted paper process is most prevalent just prior and during the Civil War. Used as a means to supply updated information of important landmarks and troop locations, the production of maps via photography was a rapid and strategically essential undertaking on which tactical advantages depended. This talk charted the history of the use of the salted paper as a technique for reproducing line drawings. While all of the techniques described result in a salted paper print, the methods for achieving the print were varied, including several patented techniques.

Due to the nature of the materials being copied, these salted paper prints often pose challenging treatment issues. Often prints are colored and inscribed using a variety of materials from watercolors and graphite to iron gall ink. Many times, the reproductions are large and are composed of many small prints collaged together posing problems for treatment and storage. This paper discussed several treatments undertaken by the author in hopes of illustrating the complex issues one is confronted with when treating these types of materials.

Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

AUTOCHROME RESEARCH AT THE METROPOLITAN MUSEUM OF ART: TESTING METHODOLOGY AND PRELIMINARY RESULTS FOR ANOXIA LIGHT-FADING

LUISA CASELLA

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

ABSTRACT – The Metropolitan Museum of Art has in its collections an important group of Autochrome plates that have been surveyed and documented in digital image-based condition reports using *Adobe Acrobat©*. It is this collection that provided the context for an investigation of the effectiveness of anoxic environments in delaying the fading of dyes used in the Autochrome process – Tartrazine, Erythrosine B, Rose Bengal, Patent Blue, Crystal Violet, and Malachite Green Orthochlorinated. The dyes were subjected to accelerated light fading in both an atmospheric and an anoxic environment (argon gas with oxygen scavengers). Significant increases in color stability were observed under anoxic conditions, though fading was not completely arrested. A preliminary microfading test was also explored. The sensitivity of Autochrome dyes to light was confirmed: exposure for approximately 8 Mlux-hrs in a standard oxygen environment resulted in visual changes perceptible to an average viewer.

1. INTRODUCTION

The Autochrome was the first commercially viable color photographic process. Introduced by the Lumière brothers in 1907, it remained in production until 1935. The Autochrome was a reversal process that produced one unique image – a positive transparency on a glass support, meant to be viewed by projection or against a light source.

Because of the risk of fading of the color screen layer, the majority of museums and collections now have a policy of not displaying original Autochromes. However, the literature on dye stability has suggested that oxygen is often a critical element in the fading reaction (Arney et al. 1979). This investigation therefore set out to explore the application of anoxic environments to the display of Autochromes.

1.1. THE AUTOCHROME PROCESS

In the Autochrome process, a glass support was covered with a layer of varnish composed of dammar resin and natural rubber dissolved in toluene. This varnish layer remained sticky, adhering the color screen layer, composed of evenly mixed potato starch grains individually dyed orange-red, green and violet-blue. Fine black carbon powder was used to fill remaining gaps between the grains and the layers were then pressed flat in a rolling press. A second varnish composed of nitrocellulose, castor oil, and dammar resin was applied to protect the starch grains from moisture, followed by a panchromatic silver gelatin emulsion, which constituted the light sensitive layer.

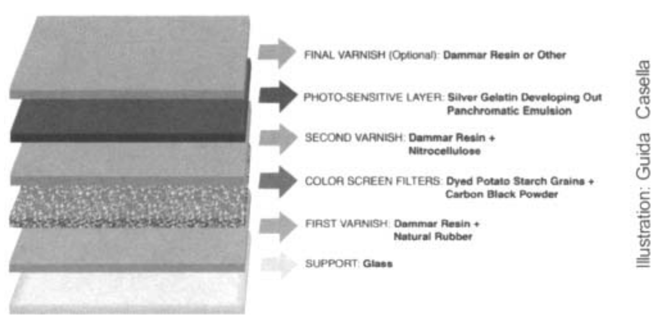


Fig. 1. *Autochrome layered structure*

After exposure in a camera and processing, photographers often coated the image with a further layer of varnish - commonly dammar resin, although other varnishes were also applied (cf. Passafiume 2005).

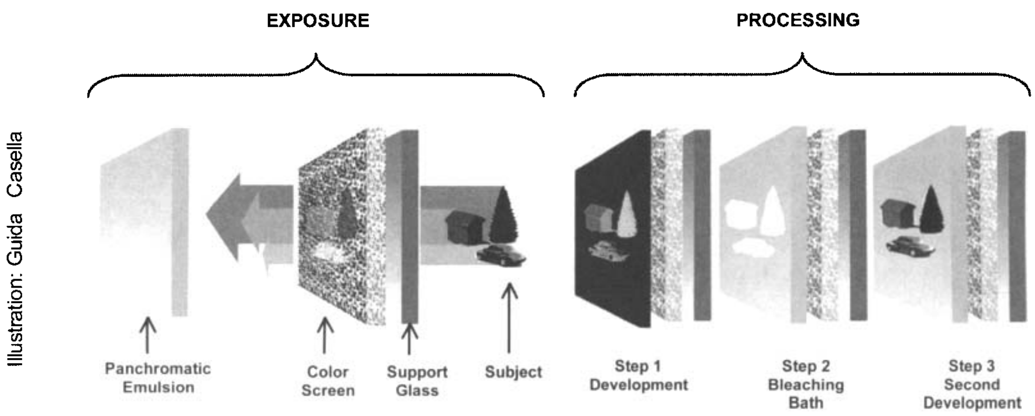


Fig.2. *Exposure and processing steps*

The Autochrome plate was exposed in the camera with the color screen layer facing the subject (fig.2). Light reflected from this subject therefore reached the photo-sensitive silver gelatin emulsion only after passing through the red, green and blue potato-starch filters. Thus, for example, red colored light reflected from the subject would preferentially pass through the red grains affecting the sensitive emulsion in that area, but would be blocked by the green or blue grains.

During the first development, the areas affected by light were reduced to dark metallic silver, resulting in a black and white negative image. At this point, the remaining photo-sensitive silver halides – which had not been affected by light – were still present in the silver gelatin layer. A bleaching solution then removed the black, developed metallic silver, leaving only the still photosensitive silver halides that had not been exposed initially. Next, the plate was exposed to light, affecting the remaining silver salts, and developed a second time. When the resulting black and white positive transparency was viewed in transmitted light, the minute color filters embedded in the color screen produced the effect of a positive image with natural color.[1] Finally, the plates were commonly bound against a cover glass, using a paper tape with a heat activated adhesive.

2. AUTOCHROME COLLECTION AT THE METROPOLITAN MUSEUM OF ART

The Department of Photographs of The Metropolitan Museum of Art in New York has in its collections forty Autochrome plates, primarily by early twentieth-century Pictorialist photographers. Alfred Stieglitz and Edward Steichen, two key figures in the Pictorialist movement, had been present when the Autochrome process was made public by the Lumière brothers in Paris. They then played a pivotal role in the introduction of the process in the United States. The Autochrome process was, however, used by Stieglitz and Steichen's circle for only a short time in the years following 1907 (Hammond 1994) and this has enhanced the rarity and importance of the images in the Metropolitan Museum's collection. The Museum has, in addition, two plates in the Department of Arts of Africa, Oceania and the Americas by Fred Payne Clatworthy and Franklin Price Knott - two photographers known for their contributions to *The National Geographic Magazine* - and a

[1] Because the color screen faces the subject during exposure, to observe an Autochrome in the correct orientation, the silver image layer should face the observer.

group of fifty plates belonging to the Egyptian Department, taken by Harry Burton to document a Metropolitan Museum of Art archaeological expedition to Egypt in the 1920s.

2.1. SURVEY OF THE MET AUTOCHROME COLLECTION

The plates belonging to the Department of Photographs have been surveyed and photographed and individual digital condition reports have been created using *Adobe Acrobat©*. Documenting the condition of objects represents a vital aspect of any conservator's responsibilities. The importance such documentation cannot be overstated, in recording the condition of objects and enabling any changes to be monitored over time. Condition reports are most commonly entered on the Museum's database, *The Museum System©* (TMS).[2] The conservation form has several fields, though condition reports are, for the most part, entered as free text in the 'Remarks' field. Since the location of any damage is difficult to describe accurately in a text format, condition reports are frequently accompanied by a hand-annotated hardcopy of the image.

More recently, *Adobe Acrobat Standard 8©* has been used to generate digital condition reports including images annotated with commenting tools. High quality digital images were taken for these reports by the Museum's Photography Studio, saved in PDF format, and combined, using *Adobe Acrobat©*, in a single document containing multiple views and details of the object. This method offers several advantages: files can be opened using free software (*Adobe Reader©*); documents can include multiple views of the object; digital condition reports can be attached to TMS, e-mailed or printed; and the same document can be used for condition reporting over time. The report is saved on a shared drive that is regularly backed up. In addition, a copy that has no interactive features is saved and linked to TMS. This second copy is electronically more stable in the long-term and has a lower file size than the original report.

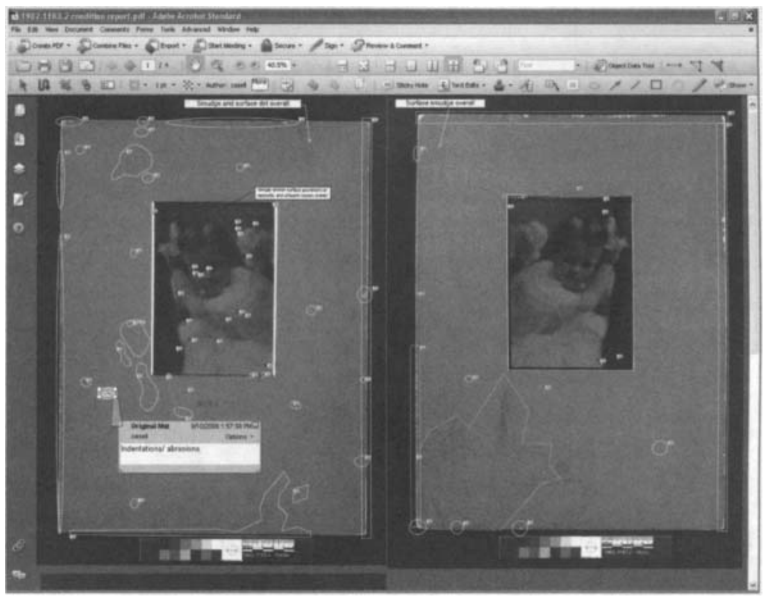


Fig.3. *Example of annotated condition report made with Adobe Acrobat© (seen here plate MMA#1982.1183.2)*

3. ANOXIA EXPERIMENT

3.1. PAST ANOXIA RESEARCH AND RATIONALE

Autochrome plates are generally considered *"extraordinarily light-sensitive"* (Wagner et al. 2001), so facsimiles are usually put on display in place of originals. Past research (Krause 1985; Lavédrine and Gandolfo 1993) has demonstrated that Autochrome plates are very sensitive to moisture and heat as well as light. Light will cause the dyes in the color screen layer to fade; moisture may cause the dyes to dissolve or migrate; heat will cause cracking in the image layer.

[2] *The Museum System©* is a commercial database developed by Gallery Systems, used by many museums in the USA and abroad.

It has been known since the end of the 19th Century that some colorants will be more stable in light if kept in oxygen-free conditions. In 1888, the Russell and Abney Report cited light fastness test results for a variety of watercolor materials, demonstrating that, in the absence of oxygen, the majority of colorants tested were seen to fade at a much slower rate or not at all. Since the Russell and Abney Report, several studies of the effects of anoxia have established that different dyes react differently, so that they have to be tested individually. For example, Prussian Blue, which is found in cyanotypes, will be adversely affected by the absence of oxygen, suffering a photo-reduction reaction and therefore fading.

Anoxic enclosures have been successfully used for the preservation of other museum objects (Maekawa 1998). Research into the application of anoxia to artists' color materials is currently being carried out by the Getty Conservation Institute and Tate Britain (Beltran et al. 2008; Townsend et al. 2008). Yet, the application of anoxic environments to the display of photographic materials has been limited to a few objects of great value, such as Niépce's *Vue de Gras* at the Harry Ransom Center in Austin, Texas, and *The Cincinnati Panorama* daguerreotypes from the Public Library of Cincinnati and Hamilton County, Ohio, for which an anoxic frame was designed by Ralph Wiegandt of George Eastman House in Rochester, New York.

Prior to the present project, research on the application of anoxic environments to color photographic materials, such as Autochromes, had not been undertaken. There is thus no literature on the anoxic light fading behavior of such materials, and specifically of the six dyes present in the Autochrome color screen (table 1).

Table 1: *Dyes in the Autochrome color screen*

Filter	***Dye***	***C.I. Number***	***Other Names***
Orange-red	*Erythrosine B*	*45430*	*Acid Red 51*
	Rose Bengal	*45440*	*Acid Red 94*
	Tartrazine	*19140*	*Acid Yellow 23*
Green	*Patent Blue*	*42051*	*Acid Blue 3*
	Tartrazine	*19140*	*Acid Yellow 23*
Violet-blue	*Crystal Violet*	*42555*	*Basic Violet 3*
	Malachite Green Orthochlorinated	*42025*	*Basic Blue 1*

3.2. EXPERIMENTAL

The experiment was designed with input from and the collaboration of colleagues and experts in the field. Samples were prepared following the historic dilution percentages of the dyes and varnish recipes. Because the purpose of the test was solely to study the color screen, the samples did not have a photosensitive layer. The experimental anoxia setup drew from past research methodologies but called for the development of an original protocol, using custom-made glass tubes sealed with caps. In order to achieve an anoxic environment, the tubes were first purged with argon gas. RP-K System™ scavengers were used to absorb any residual oxygen and monitoring of oxygen concentration was done with Ageless Eye™ oxygen indicators.[3]

Four groups of samples were prepared (see table 2). The first group consisted of dyed potato starch grains[4] on a glass support[5] encased between two varnish layers. The purpose of this group was to

[3] RP-K System™ oxygen scavengers do not affect the relative humidity levels within the sealed environment. These and the oxygen indicators were generously provided by Mitsubishi Gas Chemical America.
[4] Each dye was tested individually rather than in the mixtures found in the Autochrome color screen to form the red, green and blue grains (see table 1).
[5] 1mm thick microscope glass slides were used as support.

observe the behavior of individual dyes as they are found in the structure of the Autochrome plate. The layering order for this batch of samples was as follows: glass/ first varnish/ dyed starch/ second varnish. The second group was created by infusing the colorants into separate pieces of Whatman filter paper.[6] This group allowed the behavior of the dyes to be observed in isolation. The third group was created by applying two varnish layers to a glass support, to show changes such as discoloration or cracking. The layering structure here was: glass/ first varnish/ second varnish. The fourth sample group consisted of historical Autochrome plates. The use of historical samples in accelerated tests can be problematic since their processing and storage history is not known. In this experiment, the behavior of the historical samples served as a comparison with the results in the other groups, giving a measure of what might be expected with actual Autochrome examples.

For each of the four groups, ten duplicates were created, five of which were tested under anoxic conditions and five in a normal atmospheric environment, yielding a total of 140 samples.

Table 2: *Groups of samples produced for the test*

Group 1 *(60 samples)*	*Starch grains dyed with each of the 6 dyes, between varnish layers, on a glass support*
Group 2 *(60 samples)*	*Whatman filter paper saturated with each of the 6 dyes*
Group 3 *(10 samples)*	*The two types of varnish layers on a glass support*
Group 4 *(10 samples)*	*Historical samples*

All the varnish layers on the samples were applied using a spreader to ensure a consistent thickness (fig.4).

The dyed potato starch grains in the first group were applied to the sticky varnish with a soft brush.

The paper samples were prepared by blotting them with cotton saturated with the dye.

Historical samples were purchased at flea markets and cut into small samples for testing.

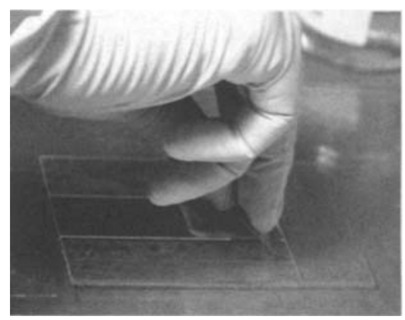


Fig.4. *Applying varnish layer using a spreader*

3.2.1. COLOR AND DENSITY MONITORING

Prior to the fading test, benchmark readings were taken from the paper samples using an X-Rite 968 spectrophotometer. In the glass-supported samples, spectral data was collected using a Cary 50 UV-Vis Spectrophotometer. Polyester sheet overlays were used to ensure consistency of the measurement areas before and after exposure in the light-fading unit.

3.2.2. TESTING SETUP

The samples (nine per tube) were assembled on aluminum strips, overlaid by five-step density grayscales to create a gradational fading rate for the dyes (fig.5). In each sample, one area was left fully exposed, while another was fully protected from light using aluminum tape.

Sample placement was made in a random manner in each tube, so that, in the event that one or more of the tubes

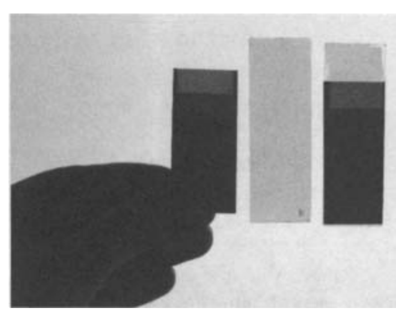


Fig.5. *Grayscales were placed over the samples*

[6] Whatman Qualitative Filter Paper No.1.

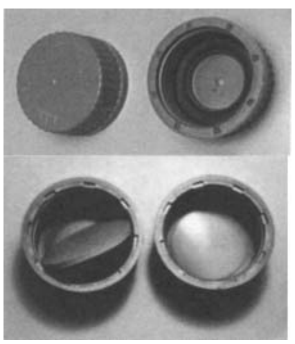
should experience oxygen ingress, part of the data could still be retrieved.

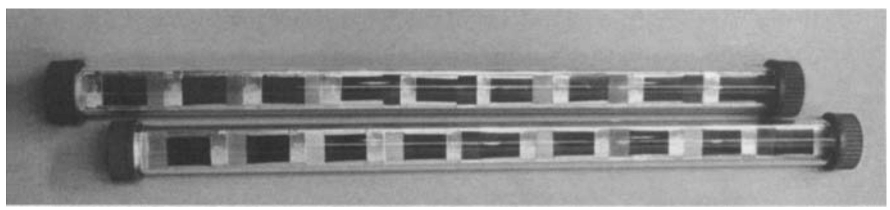
The aluminum strips were placed inside custom-made, low expansion borosilicate glass tubes[7] sealed on each end with plastic caps. The decision not to use heat-sealed glass ampoules, which would have been very efficient (Arney and Jacobs 1979), arose from the desire to create a practical and reusable experimental set-up that could be easily sealed, without requiring the services of a glass technician.

Achieving a successfully sealed oxygen-free environment inside the tubes involved several failed attempts - failure being caused by the permeability of the caps used initially. For the final setup, the caps used had a thick PTFE[8] lining (fig.6.).

The eight anoxia tubes were filled with Argon gas humidified to 45% RH. The moisture content of the argon was adjusted before introducing it into the tubes by mixing the dry gas directly from a cylinder with moist gas which passed through a water trap filled with distilled water. The purging process of each tube was constantly monitored using an oxygen analyzer (Illinois Instrument, Inc. Model 911) and oxygen concentration was lowered to less than 500ppm. Three RP-3K System™ oxygen scavenger pouches were placed inside each tube to absorb any residual oxygen[9], together with one Mitsubishi Ageless Eye™ oxygen indicator to monitor oxygen concentration during light exposure.

Top: plastic caps with O-rings (O_2 setup). Bottom: PTFE lined plastic caps (Argon setup)





Anoxia tubes include RP™ System O_2 Scavengers and Ageless Eye™ O_2 Indicators (top: recto; bottom: verso)

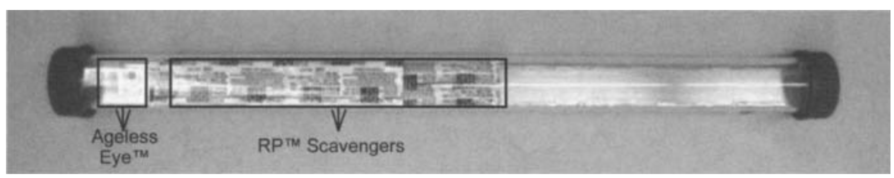


Fig.6. *Testing Setup*

And additional eight tubes, identical in every way except that they contained normal atmospheric oxygen levels and did not include oxygen scavengers, were sealed in a 45% RH environment.

A third set of samples was kept in the dark, inside an aluminum foil pouch, under ambient conditions, as a control.

3.3. ACCELERATED FADING

The tubes were wrapped in aluminum polyethylene foil to protect them from light and transported to the Image Permanence Institute at Rochester Institute of Technology, where they were placed for 54 days in a light fading unit with fluorescent lamps with very low UV content, emitting 6400lux[10], for a total of 8.29Mlux-hours. This would be the equivalent to displaying an Autochrome on a

[7] The tubes were manufactured by Kimble-Kontes using Corning Pyrex 7740, which has a refraction index of 1.474.
[8] Polytetrafluoroethylene.
[9] RP-K System™ oxygen scavengers are available in two levels of oxygen absorption: 300cc (RP-3K) and 500cc (RP-5K). Tak Izawa from Mitsubishi Gas Chemical America calculated that 3 pouches of RP-3K in each tube would provide an excess of scavenger to absorb residual oxygen for the volume of the tubes.
[10] Twelve cool fluorescent lamps (Sylvania F40/CWX).

common light box emitting 2000lux for 9 hours a day over a period of 20.95 months. An exhibition period of about 3 months would represent an exposure of 2Mlux-hours - one quarter of the total light fading test exposure.[11]

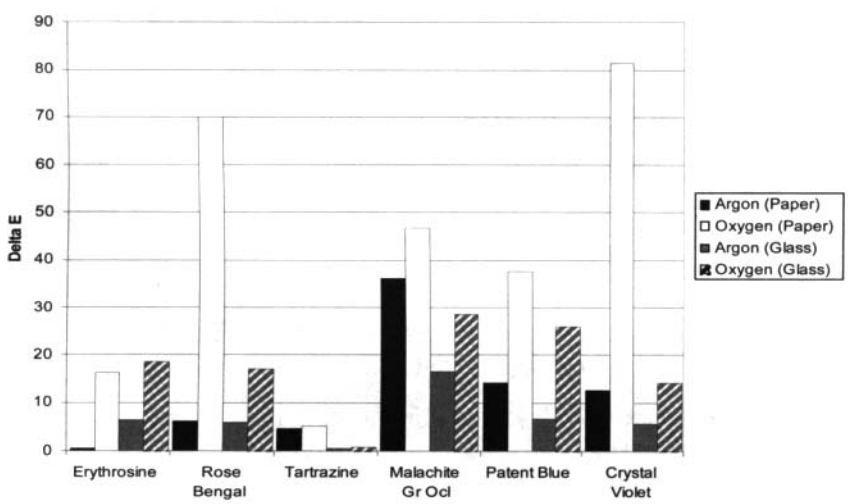
In the light fading unit, the lamps moved while the samples stayed in place to ensure the homogeneity of the light exposure of all the samples. Constant ventilation prevented heat build-up and maintained a temperature of 25°C, measured using a Raytek Raynger ST™ non-contact thermometer on the surface of the glass tubes.

3.4. RESULTS

After exposure in the light fading unit, the experiment tubes were wrapped in aluminum polyethylene foil and transported back to The Metropolitan Museum of Art. The samples were removed from the tubes as promptly as possible. Densitometry and spectrophotometry readings were made of each sample, measuring the five areas of graded exposure and the one control, giving a total of six measurements from each sample.

Graph 1 illustrates the ΔE[12] values recorded by the samples from groups 1 and 2 (see table 2), in the area of the sample that was fully exposed to light. The results show the clear benefit to all the dyes, to a greater or lesser degree, from the anoxic environment. Clear instances of this are the Crystal Violet and Rose Bengal, which show a considerable decrease in fading under anoxic conditions. Malachite Green Orthochlorinated is the dye showing the least benefit from anoxia. Tartrazine is the most stable dye and shows very little fading in any environment.

A full account of the data resulting from the test will be included in a future article.



Graph 1: *Relative stability of glass and paper samples based on $\Delta E76$*

4. MICROFADING EXPERIMENT

The microfader is an analytical tool that collects light fading data on a minute testing area (100µ in diameter). The assessment of lightfastness is done at a very early stage of fading that is not discernable by the human eye but is measurable by the spectrophotometer. The microfader combines in its probe a single optical fiber cable that focuses an intense light on the area to test, and a spectrophotometer that measures the resulting change.

[11] Although in actual exhibition conditions, original Autochromes would not be constantly illuminated but would more likely be displayed using a motion or visitor activated light box.
[12] The equation used was ΔE 76 following what was used in most of the references.

In collaboration with Chris McGlinchey at the Museum of Modern Art in New York, accelerated aging studies were conducted on test samples of dyed Whatman filter paper using a microfader unit fitted with a close contact bifurcated fiber optic head designed to purge oxygen from the sample area during the test. Were this method to prove a viable means of carrying out tests in anoxia, it would then be possible to assess the benefits of anoxic exhibition without having to create a chamber for the entire object, making it much more convenient and economical to evaluate individual objects. Preliminary results are promising and will be the subject of a future publication.

5. CONCLUSIONS

Developing the methodology for anoxic testing was challenging. The choice of a reusable system of glass tubes with caps provided a successful setup for creating an anoxic environment. The Autochrome dye samples exposed to light in normal environment conditions show a marked color shift due to light exposure. The results of the experiment demonstrate the clear benefit of anoxia in decreasing the fading rate, though the complete arrest of fading was not achieved. The protective role played by the varnish layers is confirmed, as is evident from a comparison between the results from the samples of dyes in paper with those from the dyes on a glass support, which show a significant difference (table 2, groups 1 and 2). The specific results of the test, together with their interpretation, will be published in the near future. By analyzing the gradational fading data, it will be possible to establish precise light level recommendations for Autochrome display under anoxic conditions.

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Daguerreotype Research at the Materials Research Laboratory, The Pennsylvania State University: 1979-1984

M. Susan Barger, PhD

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract:

From 1979 – 1984 there was extensive research into the materials characterization of the daguerreotype process at the Materials Research Laboratory at The Pennsylvania State University. This paper is a brief overview of the work done there.

William B. White and M. Susan Barger, 1991. Daguerreotype by Robert Shlaer.

In the fall of 1977, I left Rochester, New York, where I had completed two years of non-degree graduate work in photographic science, to begin studies for my doctorate at the Materials Research Laboratory (MRL) of The Pennsylvania State University. In 1979, after the completion of my comprehensive examinations, I began working exclusively on the materials analysis of the daguerreotype and that work continued until the fall of 1984 when I left to become the Mellon Fellow in Preservation Science at the Library of Congress Research and Testing Laboratory. There was some additional work that was done later, but most was of the daguerreotype research was completed before I left. My daguerreotype study at the Materials Research Laboratory resulted in part in my doctoral dissertation, a large group of scientific and technical papers, and finally, the book, **The Daguerreotype: Nineteenth Century Technology and Modern Science** (1st ed. Smithsonian Press, 1991). A complete listing is given at the end of this paper.

The research that I did at the MRL was the first application of the principals of materials science to the study of any photographic process, and outside of the field of metallurgy, one of the first applications of materials science to study art materials in general. It remains the largest and most extensive materials analysis of any photographic material. The aim of my work was to understand what a daguerreotype is, what gives rise to its characteristic optical properties, and based on my findings to define what properties of a daguerreotype must be maintained when a daguerreotype is cleaned, preserved, or treated in some way. Work done after the completion of my dissertation in 1982 was concerned with understanding corrosion mechanisms that affect daguerreotypes, devising an effective method to remove tarnish and corrosion from daguerreotype surfaces, and finally, understanding image formation in daguerreotypes.

The MRL at Penn State is the second oldest materials lab in the United States. It was very well known for pioneering research in materials characterization and in devising the instruments for such characterizations, as well as for fundamental work in semiconductors, crystal growth, nanotechnology, cement, and for mapping the SiO_x phase diagrams. It was also a place that was particularly interested in the relationship of art and science and so, the daguerreotype project was welcomed and stimulated a good deal of interest. Being in MRL, meant that I had easy access to the most advanced materials characterization tools and expertise. For instance, I had three scanning electron microscopes ten feet down the hall from my office and for several years made almost daily use of those instruments. MRL allowed me to take a significantly different view of daguerreotypes – to view them as materials, rather than viewing them through the established photographic model.

Samples

The research done at MRL was done with a very large and varied sample set that included about 130 garden-variety daguerreotypes gather from a variety of sources, geographic locations, and ages; 20 gilded and 20 ungilded daguerreotype step tablets made by Irving Pobboravsky and additional step tablets later made by me, on daguerreotypes plates manufactured in the lab; daguerreotypes loaned by collectors for analysis; and finally, some of the earliest American daguerreotypes including the oldest, extant American daguerreotype, "View of Central High School" by Joseph Saxton and about two thirds of the, then known, Robert Cornelius daguerreotypes. This widely varied sample set of daguerreotypes made it possible to move beyond the realm of speculation to develop a quantitative understanding of the properties of daguerreotypes and the daguerreotype process

Analysis Techniques Employed

The analytical techniques used to characterize daguerreotypes and daguerreotype corrosion products were: scanning electron microscopy, energy dispersive x-ray spectroscopy, Computer Evaluation of Scanning Electron Microscopic Images (CESEMI), diffuse reflectance spectroscopy, infrared spectroscopy, Fourier transform infrared spectroscopy, goniophotometry, profilometry, x-ray diffraction, Gandolfi x-ray diffraction, atomic emission spectroscopy, Auger electron spectroscopy, Raman spectroscopy, transmission electron microscopy, optical microscopy, optical spectroscopy, and optical densitometry.

Image Structure and Chemistry

The long held myth about daguerreotypes is that the image is a static silver amalgam that causes the image to be forever mushy and fragile. My work at MRL showed in a quantitative way that neither of these beliefs is true.

In order to determine the structure and chemistry of daguerreotype images, I used one of the first scanning electron microscopes designed to analyze and count particles on surfaces using a process then called, Computer Evaluation of Scanning Electron Microscopic Images (CESEMI). I used this instrument to analyze hundreds of thousands of daguerreotype image particles on many different daguerreotypes to determine the chemistry of each particle as well as its size and particle to particle spacing. These results led to the conclusion that daguerreotypes are made up of almost pure silver crystals on a silver surface (the daguerreotype plate) whose size and particle to particle spacing are the same size as the wave-to-wave measurement of the visible light. In other words, daguerreotype image particles are generally between 400 and 700 nanometers in diameter and height, as well as in their spacing from each other. The whitest highlights of a daguerreotype have approximately 200,000 particles/mm^2 and images areas that are midtones have proportionately fewer image particles of approximately the same size and chemistry with slightly larger average particle to particle spacing. Shadow areas have approximately 10 particles/mm^2 and those particles tend to be very large and poorly formed – I called them shadow particle agglomerates.

The agglomerates are visible to the naked eye and appear as bright spots in shadow areas. It is interesting to note that several cross sections of daguerreotype image particles have been published in the past and based on my image particle measurements, these all appear to be cross sections of shadow particle agglomerates rather than more typical image particles found in highlight or midtone image areas.

Shadow particles agglomerates usually have some measurable amount of mercury, however, the vast majority of daguerreotype image particles are silver (compare 200,000 silver particles per square millimeter to ten particles per square millimeter). Daguerreotype images are formed in mercury vapor (see section on image formation below) and image particles start out as a silver-mercury solid solution or an amalgam thus, the freshly-made image is somewhat mushy. Think of when the dentist makes a silver amalgam filling to fill a dental cavity. The amalgam is initially plastic so that it can be molded to the cavity, but in a matter of hours the amalgam begins a process call "hardening" which continues over time until the dental filling is firm and with sufficient aging a filling can even become embrittled. The freshly made daguerreian image is analogous to the dental filling and the small amount of mercury present in most image particles is lost over time due age hardening (for ungilded plates) or during the gilding process. The image particles are dynamic and continue forming either until the plate has been gilded or the age hardening has been completed – a process that takes about a year. The agglomerates retain some mercury that is neither lost during gilding nor during the process of age hardening. However, in general daguerreotype image particles do not retain mercury and ultimately, it is misleading to refer to the image as an amalgam.

In addition to looking at the microstructure of the daguerreotype image, I did make some measurements of the nanostructure of the image; however, these analyses added nothing of significance to the overall materials characterization of the daguerreotype except to confirm what had already been determined through the study of the microstructure.

Along with the particle counting and chemical analysis, I measured the optical properties of daguerreotypes using diffuse reflectance spectroscopy. While this technique is more often used for chemical analysis, it is also used to characterize surfaces to understand microstructure. Diffuse reflectance curves for daguerreotypes are bell shaped curves centered over the visible spectrum. These curves indicate that the dominant optical feature of daguerreotypes is light scatter in the highlights and high reflectance in the shadow areas. It also happens that the diffuse reflectance spectra match the distribution curves of image particle sizes and particle to particle spacing. The reflectance spectra of the daguerreotype surface predict the daguerreian microstructure and visa versa.

The Physical Model for the daguerreotype that I devised from particle counts and analysis and diffuse reflectance spectra ties image appearance to image structure and provides a framework for understanding what daguerreotype characteristics need to be controlled in order to preserve daguerreian images. The surprising result is that maintaining the image microstructure, i.e. particle size and spacing is far more important than maintaining the specific chemistry of the image. The Physical Model also indicates that small changes in particle size and spacing can equal large changes in the appearance of a daguerreotype. Therefore, a cleaner that etches or alters the daguerreotype plate surface, causes changes in image particle size or spacing, or leaves films on the daguerreotype surface will produce undesirable changes in the appearance of a daguerreotype. The specific chemistry of a daguerreotype is of minor importance in the preservation of a daguerreotype.

Gilding

The first of the only two changes made to the daguerreotype process after it was introduced in 1839, was the adoption of gilding. Gilding is a process where a weak solution of gold chloride and hypo is placed on a daguerreotype plate after washing the developed image in hypo, and the plate is heated. There is a persistent idea that gilding causes a gold layer to be put down on the daguerreotype plate. Again, this idea is not borne out by analysis. Gilding does two things: gold replaces mercury in image particles making them 1) larger (gold atoms are somewhat larger than mercury atoms) and 2) more mechanically robust. Gilded daguerreotypes have whiter highlights than ungilded daguerreotypes because the slight enlargement of the image particles shifts the image scattering curve to make it more directly centered over the visible spectrum with a maximum at 550 nm if the daguerreotypist has developed skill in making daguerreotypes. The bell shaped scattering curve for the diffuse reflectance spectra of a gilded daguerreotype matches what is called the luminosity curve of human vision – that is where human vision is most sensitive.

Unless gilding is overdone or the gilding solution too saturated, there is no layer of gold laid down on the daguerreotype surface. First, there is not sufficient gold in the gilding solution to make a gold layer. Secondly, gold is *aurophobic* i.e. gold atoms tend to form small, isolated clumps rather than form continuous films; it takes many, many atomic layers of gold to form a continuous film. There are also some people who refer to the process of gilding as gold toning implying that this process is the same as gold toning in conventional photographic processes. While gold toning in conventional photographic processes is derived from the gilding process in daguerreotypes, the two processes are not the same.

Daguerreotype Corrosion

Once image structure and appearance were understood, I turned to understanding how daguerreotypes age. Using a wide variety of materials characterization techniques, I discovered that the corrosion process for daguerreotypes is far more complicated than had been previously thought. Daguerreotypes did not act like silverware – corrosion films were composed of a variety of silver oxides, combined with thin films left from using cleaning solutions containing cyanide or thiourea cleaning. The most surprising results were my discovery of the role of glass corrosion in the deterioration of daguerreotypes which results in very odd silicate corrosion products on the daguerreian surface, including products once identified visually identified as mold and fungus. Using a multitude of characterization tools, I was able to show that these odd silicates seen in the daguerreotype package as well as those materials previously identified as "fungus" or "mold" on glass lenses were not living organisms: they could not be cultured and had no DNA or RNA. I was the first person to identify and report on the relation between glass corrosion and deterioration of both daguerreotypes and photographs on glass supports.

Daguerreotype Preservation

The ultimate aim of my research was to determine better ways to preserve daguerreotypes, which covered two general subjects: daguerreotype cleaning and the daguerreotype package. The prevailing thought when I began to work on daguerreotypes was that the efficacy of a daguerreotype cleaner could be determined by assessing the amount of mercury found in spent cleaning solutions. Thus, a "good" cleaner would have little or no mercury present. The work on image structure and chemistry showed that this clearly would not be a profitable pursuit because there is almost no mercury in the daguerreotype image.

At MRL we investigated both the traditional ways of cleaning daguerreotypes (cyanide and thiourea solutions) to measure their effects on plates and we looked at new ways to cleaning, including using high vacuum sputtering and electrocleaning. We rejected sputtering because it required high vacuum equipment and it was very difficult to control – part of controlling the process meant doing counter-intuitive things like adding hydrogen sulfide gas to the sputtering chamber to poison cleaned surfaces to prevent etching of bare silver. Vincent Daniels at the British Museum reported on this process and ultimately came to the same conclusion as we did. We also briefly looked at laser cleaning, but it was clear that, at that time, it would be very difficult to control lasers sufficiently to have practical cleaning method for daguerreotypes.

Above all, I wanted to find a cleaning method that was easily adoptable by conservators and that would produce reliable results, while assuring that the daguerreotype image structure was not affected by process and that no cleaning residues would be left on the plate surface to initiate corrosion in the future. Ajay Giri and I tried electrocleaning, a well known and much used process for many metals, after abandoning sputter cleaning. It looked very promising, but I felt I needed a conservator to test this process in the field. I wanted to work with someone who would follow our instructions, who would give a fair analysis of the work, and who would be a good partner in the development of the cleaning process.

Tom Edmondson became my tester after he made a brief stop at MRL while returning from a trip to the West. We showed Tom what equipment and chemicals he would need, gave him instructions and sample daguerreotypes that had been cut in half to use for testing and sent him home. Tom went back to Connecticut where he was living at the time, put together an electrocleaning rig and began working. He eventually came back to MRL so that we could examine what he had done and compare cleaned daguerreotypes with the untreated portions that had been left at the lab. Before we announced the electro cleaning method at the PMG Winter meeting in Philadelphia, we had had cleaned and analyzed over 100 daguerreotypes. We had done sufficient testing so we no longer consider the method as experimental.

The Daguerreotype Package

Even 30 years ago, there were many people working designing the ultimate daguerreotype package. The traditional method used to seal daguerreotypes was made up of the daguerreotype plate, a mat, glazing and a tape to hold the whole thing together. This package has both positive and negative effects on the daguerreotype. The package protects the daguerreotype from scratches and physical damage. The tape helps to slow down corrosion and helps to keep water vapor from entering the package, however it is difficult completely seal a daguerreotype.
In more recent times, various sealing methods were introduced for daguerreotypes ranging from complicated packages constructed out of archival mat board and various tapes to elaborate treasure box enclosures that allowed the viewer to remove layer by layer of the package and finally, view the bare daguerreotype plate. Brass mats were removed because some people thought that the metal mats initiated corrosion.

In my examination of the daguerreotype package, I analyzed corrosion films and the locations of corrosion films. There are two corrosion fronts on daguerreotypes: 1) at the plate edge and 2) the interior edge of the mat. It turns out that these are both active corrosion areas because of the geometry of the daguerreotype package. Using tape as a seal slows down corrosion and it turns out the style of taping is also a factor. A continuous tape seal is better than a seal made up of several short pieces of tape. The geometry of this protective package also drives glass corrosion on the interior of the daguerreian package because it is impossible to have an impermeable package that has no openings. Water vapor enters the daguerreotype package through the tape and becomes trapped on the interior of the daguerreian package. Under the right conditions, even the smallest amount of water vapor will initiate corrosion of the inside of an unstable cover glass. Since it is impossible to completely seal a daguerreotype, I feel that the parts of daguerreotype seals should be viewed as ephemeral and that they should be unhesitatingly changed as needed.

In addition to looking at the daguerreotype package, the Getty Conservation Institute was investigating protective coatings for objects. The thought was that protective coatings could be used to prevent corrosion and allow objects to be treated once and coated. About 1982, I was asked me to submit daguerreotypes to be coated with Parylene. We also looked at several sputtered coatings for daguerreotypes. All of these coatings were interesting; however, none of them were appropriate for daguerreotype preservation because they all of these filmes altered the daguerreotype's characteristic optical properties.

Image Formation in Daguerreotypes

One of the final things I looked at was how the daguerreian image is formed. Previous to my work, the general assumption about image formation in daguerreotypes was that mercury acted like a photographic developer in that it caused the reduction of silver halide at latent images sites to form the image. When I began looking at image formation, this conventional photographic model was my guide.

I quickly had to dismiss the conventional photographic model because it was clear that mercury was not a reducing agent for silver salts. Further, from practical experience, it was clear that there is very little mercury is consumed when a daguerreotype is made. A daguerreotypist might use the same mercury in his mercury bath for many years with no significant loss. Also, the specific silver halides used in the daguerreotype process are not the same as in conventional photographic processes. In a daguerreotype silver is corroded in halogen vapor to form a silver halide layer rather than having discreet crystals of silver halide formed from solution dispersed in some sort of carrier as would be the case for conventional photographic processes.

My work showed that daguerreotype image formation is an example of chemical vapor deposition in which silver crystals are grown in a vapor phase mercury solvent. This crystal growth process takes some skill to learn and I was able to show that it is possible to identify a novice daguerreotypist because there are image structures that are characteristic of incomplete or transitional phases during crystal growth in mercury vapor; once a practitioner has matured these structures are rarely observed in his work. My experimental observations were verified when I was able to examine the Robert Cornelius set of daguerreotypes. I was able to use microstructure to sequence Cornelius' daguerreotypes according to when they had been made and also to identify when he began to use bromine as an addition to his sensitizing process. The addition of bromine to the sensitizing procedure is the second of the two changes made to the daguerreotype process and its adoption made possible portrait photography by reducing exposures to well under a minute.

There was quite a bit published from the work done at MRL. The following is a complete listing.

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A CASE FOR PRESERVATION:
REVISITING THE AGASSIZ COLLECTION OF DAGUERREOTYPES FROM THE PEABODY MUSEUM ARCHIVES AT HARVARD UNIVERSITY

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Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

This paper is an overview of a case study of the documentation and preservation of 36 significant daguerreotypes from the Peabody Museum of Archaeology and Ethnology at Harvard University. The collection includes fifteen rare pre-Civil War portraits of African-American slaves commissioned by Harvard University professor Louis Agassiz in 1850. The daguerreotypes were stabilized at Harvard University Library's Weissman Preservation Center. This project is an example of exceptional professional collaboration among the spectrum of conservators, archivists and photographers.

Introduction

The daguerreotype collection at the Peabody Museum of Archaeology and Ethnology consists of 36 highly valuable and significant images.

Figure 1- "Jack Driver Guinea" before treatment (35-5-10/53043). Courtesy Peabody Museum of Archaeology & Ethnology (PMAE), Harvard University.

Of the daguerreotypes, fifteen were taken by photographer J.T. Zealy who was commissioned to take the images by Louis Agassiz of Harvard University. The Zealy daguerreotypes were probably intended as research tools for Agassiz' burgeoning theory on polygenesis, and feature African American slaves who Agassiz examined in 1850 while visiting plantations near Columbia, South Carolina. Thus these images represent the oldest known daguerreotypes of African American slaves and serve as an important documentary of the unique social issues of pre-Civil War America.

Along with the Zealy images, the remaining Agassiz daguerreotypes feature so called 'ethnic type' portraits taken by well-known 19th century photographers: L.G. Chase, T.M. Easterly, W.F. Langenheim and Southworth & Hawes. This paper will discuss the preservation and treatment of the Peabody Museum's daguerreotype collection undertaken by Harvard University Library's Weissman Preservation Center.

Figure 2- Unidentified Chinese women by L. Chase, before treatment (35-5-10/53057). Courtesy of PMAE, Harvard University.

The provenance of the Agassiz daguerreotypes indicates that the Peabody Museum accessioned the objects in 1935 (accession 35-5-10) upon their transfer from Harvard's Museum of Comparative Zoology. Notably, in 1977, the daguerreotypes were rediscovered by former Peabody Museum staff member, Eleanor Reichlin who found them in an unused storage cabinet in the museum's attic. At that time, Dan Jones, the Peabody Museum's photo archivist collaborated with Ms. Reichlin to document their story and have them published for Reichlin's article, "Faces of Slavery" (*American Heritage,* June 1977); Dan Jones later confirmed to us that before publishing the Zealy daguerreotypes they were treated with thiourea, a commonly used cleaning method at that time.

Unfortunately, during the 1970s there were no established protocols for object documentation before, during, or after treatment. The oral history of the conservation interventions performed at that time was thus documented through a series of oral interviews with Dan Jones.

Accordingly, documented treatments, conservation interventions, and surveys for the collection as a whole began in 1991. Subsequent interventions took place in 1994, 1997, and 1999. Occasional condition examinations were done for the purpose of loaning specific objects. All records from these interventions were systematically collected by conservators and archivists. Beyond that, however, there is indication of previous treatment on many daguerreotypes that was never documented, including the use of different types of binding tape. Many of the daguerreotypes had transparent self-adhered binding tape with no known conservation record.

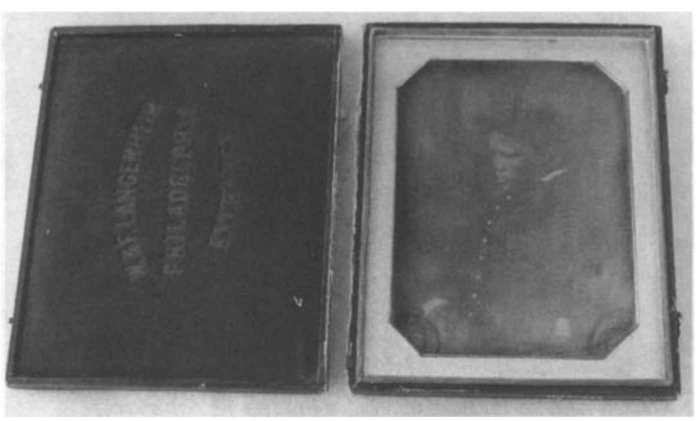


Figure 3- Portrait of unidentified boy also identified as "a Hottentot Boy" before treatment (35-5-10/53069). Courtesy of PMAE, Harvard University.

After their rediscovery and removal from the Peabody Museum attic, the daguerreotypes were housed in a more controlled location within the photographic archives department and then for a short period in the three-dimensional organic materials storage vault. In 2002, the daguerreotypes were moved to cool storage (58°F and 35%RH) where the museum's black and white photographic materials are kept.

The conservation documentation and oral history based on the interviews of the former archivists and contractor-conservators dating from 1977 also reflect the history of both daguerreotype conservation efforts and the photograph conservation profession in general.

Project Goals

Begun in June 2007, the Peabody daguerreotype stabilization project at the Weissman Preservation Center (WPC) was originally intended to be part of a summer work study project for graduate student and conservation intern Jessica Keister (Winterthur/University of Delaware Program in Art Conservation). While Jessica performed conservation treatments on a few daguerreotypes that summer, the stabilization and imaging of the entire collection eventually grew into an eighteen month project.

As the earliest photographs, daguerreotypes are becoming increasingly important due to their rarity, fine art value, and uniqueness. The long-term preservation of these complicated objects poses a significant challenge for photograph conservators. Previous conservation experience within the field has demonstrated the extreme complexity of decision making for a daguerreotype treatment proposal. With this in mind, the stabilization of the Peabody Museum daguerreotypes was designed to serve as a pilot project and serve as a potential model for WPC conservators when considering preservation protocols for the many thousands of daguerreotypes located throughout Harvard.

The objectives that were established for this project include:

1. Collect the history of conservation intervention for each daguerreotype.
2. Produce detailed written and photographic documentation of the daguerreotype's condition before, during and after stabilization to provide a basis for future monitoring and to provide information to researchers that may limit the need to access the original daguerreotype.
3. Determine treatment priorities based on the daguerreotype's condition and conservation history.
4. Stabilize each daguerreotype using the best current practices and proper, archival materials.
5. Keep original elements of the daguerreotype package intact when possible. When existing elements (original and historical) are replaced, they must be stored with the object.
6. Analyze specific forms of daguerreotype deterioration at the Harvard Art Museum's Straus Center for Conservation & Technical Studies.
7. Properly house the collection in preparation for climate controlled storage at the Peabody Museum at a constant temperature and humidity (58°F, RH 36%).
8. Re-examine the daguerreotype collection on a regular basis.

General Condition

The daguerreotypes had many conservation issues such as glass deterioration, broken and tight cases, and binding tape problems. Additionally, there was severe brass preserver corrosion, as well as tarnishing and different types of accretions and stains on the plates. According to the existing documentation, more than half of the plates were previously cleaned, but most of the daguerreotypes still show very good image condition. It is interesting that those daguerreotypes that were used for exhibitions and publications were in noticeably worse condition overall.

Most of the daguerreotypes had modern binding tape and glass; only on eight daguerreotypes did the glass appear to be historic, if not original. Most of the wood cases had evidence of prior case repair.

In order to assess the condition of each daguerreotype it was critical to understand its treatment history. Therefore, all existing written and photographic documentation was requested by WPC conservators at the beginning of the project. Prior to the establishment of WPC's photograph preservation program in 2005, Harvard libraries and archives contracted directly with regional centers or conservators in private practice. The retention rate of conservation documentation varies, depending upon the Harvard repository; however, the Peabody Museum Archives and Conservation Departments have a strong record of photograph preservation efforts and maintained most of the relevant paperwork.

As part of the detailed condition report, all known or documented treatments were duly noted. In addition to the comprehensive paper files amassed during this project, we created a simple Microsoft Access database to compile dates and types of conservation interventions undertaken for each daguerreotype. The database was designed to be an easy tool, not only for looking at the treatment history of an object, but also for sorting by preservation projects such as the 1994 conservation intervention.

Cover glass

In 2007, we observed a thick white film or haze on the cover glass of almost every daguerreotype, making it very difficult to see the actual images. In fact, the film appeared on both historic glass and on the ten to fifteen year-old replacement glass. It was unclear if the haze was simply glass deterioration or if it was another type of accretion resulting from the storage environment.

Upon closer examination, it was evident that the white film had developed not only on the exterior of the glass, but on the interior as well. Therefore we decided to analyze the film's composition. Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM) analyses were undertaken at the Straus Center for Conservation & Technical Studies. The SEM showed that there were numerous tiny crystals of NaCl (sodium chloride) and an unidentified organic material. Since glass tends to deteriorate by loss of sodium and potassium ions (initially) as hydroxides, the presence of NaCl indicated that the daguerreotypes had severe glass deterioration issues, a surprising find considering that most of the glass was only ten to fifteen years old.

The deterioration of the original historic glass (as observed in the 1990s) was severe and appropriately warranted intervention at that time. Based on conservation documentation and oral history, we believe that most of the daguerreotypes had glass replacement during the 1990s. Two daguerreotypes had glass replacement in 1994 during a Harvard-wide daguerreotype survey and preservation project coordinated by the WPC and funded by a grant from the National Endowment for the Humanities. At that time, framers glass was used, which was, and continues to be, a common practice in conservation. Unused glass from 1994 was found in the WPC lab in

2007. This glass also showed signs of severe deterioration, revealing that the contemporary framers glass was less stable than we had hoped.
(See figure 4.)

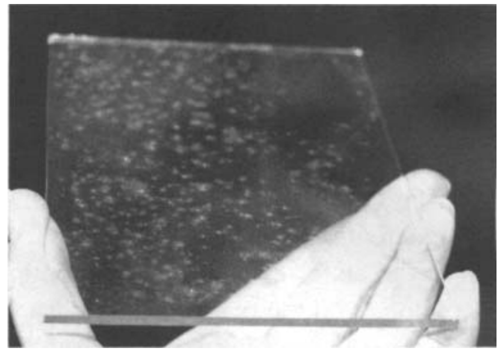


Figure 4- Glass from 1994.

With this information in mind, we decided to replace the glass on all 36 daguerreotypes with borosilicate glass, the same type of glass used in Pyrex® products because it is physically stable, chemically inert, and highly transparent. Additionally, it has been tested in the conservation field over the years, albeit inadvertently, as a component of accelerated aging packages, and has proven to be at least twice as stable as regular window glass. Borosilicate glass can be ordered in different thicknesses from 1.75mm to 15.00cm, but unlike window or framers glass, it is very difficult to cut precisely on your own. Two different vendors, Swift Company and Howard Glass provided our replacement glass and also custom cut each piece to specified sizes. It should be noted that this is the first project at Harvard where an entire daguerreotype collection experienced glass replacement with borosilicate glass so the condition of the glass will be closely monitored over time.

Plates

The Peabody daguerreotypes are generally in good condition. However, as previously mentioned, it was evident that the daguerreotypes used heavily for exhibition or publication were in worse condition as they were exposed to light and changes in the environment more frequently. These images were also cleaned several times using different methods: for example, thiourea (CSN_2H_4 or $(NH_2)_2CS$) was commonly used for daguerreotype cleaning prior to the 1980s when electrocleaning was developed as a safer alternative. Plates cleaned with thiourea and then electrocleaning appear much duller, with a flatter appearance and more surface scratching.

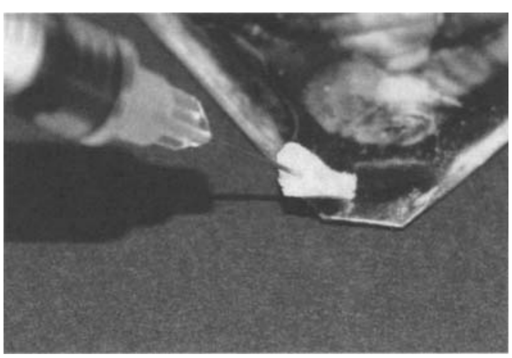


Figure 5- Removal of adhesive from pressure-sensitive tape on the plate using solvent-filled syringe with small sponge tip.

Four of the daguerreotypes had double-sided pressure-sensitive tape found on the front corners of the plates. In this project, the tape was removed mechanically and the residue was removed locally with toluene, using a method developed by Ralph Wiegandt at the George Eastman House. The applicator was an insulin syringe with a small wedge of cosmetic sponge affixed to the tip of the syringe. (See figure 5.) The sponge was filled with a drop of toluene from the syringe, and then introduced to the residue; the toluene dissolved the residue, which was then pulled back into the syringe through the sponge tip. This method worked well, with no detected changes to the surface after treatment.

All of the African-American slave daguerreotypes were photographically documented with long wave (UVA) and short wave (UVC) ultraviolet radiation visible fluorescence. This decision was made because the collection had undergone numerous treatments over the past 30 years and we wanted to document as much of the daguerreotypes' treatments as possible.

A yellowish green fluorescence under the UVC possibly indicated copper cyanide compound. (See figure 6.) This may be a product of a cyanide compound chemically reacting with the copper element of the plate. The cyanide compound could be the residue from the original plate manufacturing, electroplating process and/or a cleaning process to remove the tarnish, such as cleaning with cyanide solution.

A quick rinse in distilled water/ammonium hydroxide solution (10/1) helped to reduce accretions, oily substances and possible cyanide compounds; eight plates from the collection were washed in distilled water and four were rinsed in water/ammonium solution.

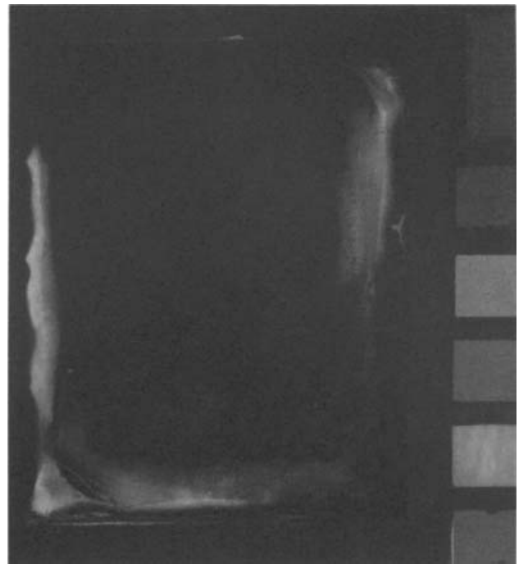


Figure 6- Plate image (front) under UVC

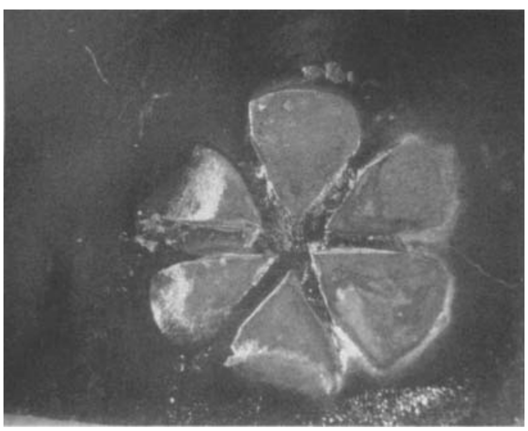


Figure 7- Hallmark, 50x (35-5-10/53053)

While the daguerreotypes' packages were open, many images were taken under magnification to document plate details. (See figure 7.) Eleven daguerreotypes have unique hallmarks, which are a rich source of information for researchers. Hallmarks can determine a plate manufacturer or percentage of silver within in a plate.

Brass Mats and Preservers

All of the ethnic type daguerreotypes taken by Chase had very strong corrosion on the brass preservers and on the copper backing of the plates. (See figs 8-11.)

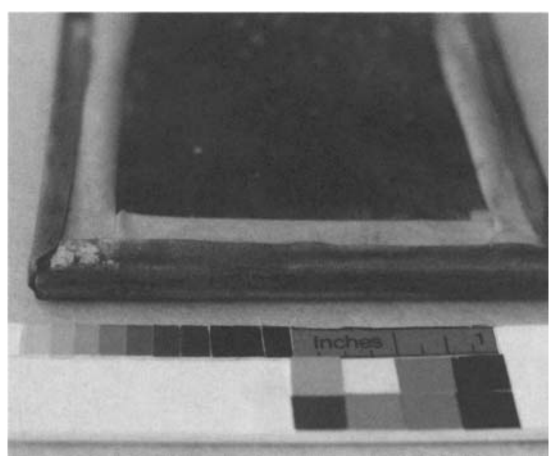


Figure 8- Copper corrosion

The corrosion was prominent on the interior of the trays as well, exhibiting at least three different colors of corrosion: green, pink and transparent white. The texture of the corrosion was sticky and soft and while it was possible to mechanically remove it using a cotton swab, the metal remained green in color.

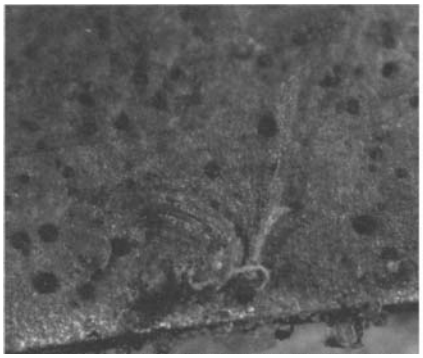


Figure 9- Copper corrosion, 80x on the back of the plate

Figure 10- Copper corrosion

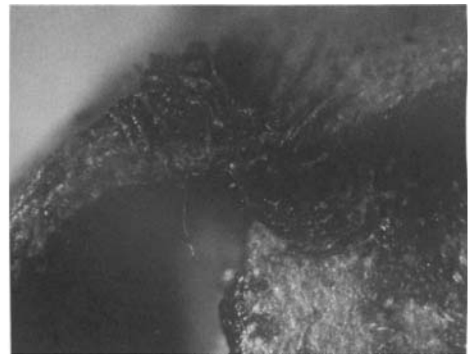


Figure 11- Copper corrosion, 50x

Instrumental analysis was carried out by Harvard's Straus Center for Conservation & Technical Studies. Fourier Transform Infrared Spectroscopy (FTIR) of a green corrosion sample showed that it contained copper palmitate and wax. We think this could be a reaction of the copper in the brass and beeswax which also contains fatty acids. Stoddard solvent was used to remove the corrosion from the preservers on four of the daguerreotypes.

Another phenomenon we noticed was the presence of amber colored drops and stains on the brass preservers and mats. We assumed this might be related in some way to the severe corrosion. The Straus also performed an FTIR analysis of a sample of brown material from the inner edge of a brass preserver that ultimately matched a library spectrum for amber. The amber spots appeared on several daguerreotypes from the Chase photography studio and was located on the interior side of the brass mats, between the daguerreotype and the brass mat. So far, our research has not determined an explanation for why amber oil would have been used inside this daguerreotype package. However, Canada balsam has similar visual characteristics to amber oil and was commonly used by nineteenth-century photographers so we plan to do further testing of Canada balsam with FTIR to compare its similarities in spectra to amber oil.

Binding tapes

The materials and techniques used for binding the daguerreotypes varied over the years and serve to illustrate ever changing methods. Regardless of the type of binding tape used, all of the daguerreotypes developed the same glass deterioration. Thirteen daguerreotypes had pressure-sensitive transparent tape adhered directly to the back of the plate. Gummed paper that was probably used in the nineteenth century was found on nine daguerreotypes. This paper was very loose and did not safely hold the plate packages. Most striking was a daguerreotype that was bound using a nineteenth-century Boston newspaper. (See figure 12.) Although

Figure 12- Late 19th century Boston newspaper used as binding tape

the unidentified adhesive had failed, the newspaper itself was very well preserved, not even yellowing over the years. Nine daguerreotypes had Filmoplast P-90 binding tape, some with paper backings and others with Mylar backings. Four daguerreotypes did not have cases at all and were inadequately mounted with poor quality board using black paper as a binding tape. Many of the daguerreotypes also had remnants of several layers of different binding tapes adhered to the back.

We used Filmoplast P-90 archival tape to re-bind the daguerreotypes. The group of daguerreotypes which originally did not have preservers were re-bound with Filmoplast P-90 and pre-coated (water/aquazol-15%) Tanbo Japanese paper, toned with acrylic/mica media. (See figure 13.) We included a backing of Mylar-D polyester. Pre-coated paper strips were slightly remoistened before use.

Figure 13- "Renty" with new binding tape (35-5-10/53037) Courtesy of the PMAE, Harvard University.

Mica pigments were chosen for two specific reasons: 1) since it is a metallic oxide on mica, it was used to imitate the brass mat finishing on the paper binding; and 2) it was hoped that the mica particles would diminish the air flow through the binding tape, thus further reducing possible deterioration.

We then wrapped the binding tape over the front of the cover glass, even though it would be visible without a preserver. Unpublished research by Hanako Murata (*Investigation into Traditional and Modern Daguerreotype Housing Systems from Conservation Point of View)* demonstrated that binding tape creates a tighter environment inside the plate package when the binding tape wraps over the front edges of the cover glass. Murata's research also confirmed that two layers of binding tape protect more than one layer, and that using a strip of continuous tape is better than four separate pieces.

Cases

Nineteen daguerreotypes had broken cases ranging from major to minor, particularly along the spines. The cases were repaired using thin Hollytex and Japanese paper in order to re-create any missing spines. A mixture of poly vinyl acetate (PVA) and wheat starch paste was used as adhesive. For a collection as heavily used as this one, the durability of the hinge is an important consideration when using the PVA/wheat starch paste mixture. Although PVA is not as easily reversible as pure wheat starch paste, it can be mechanically reduced.

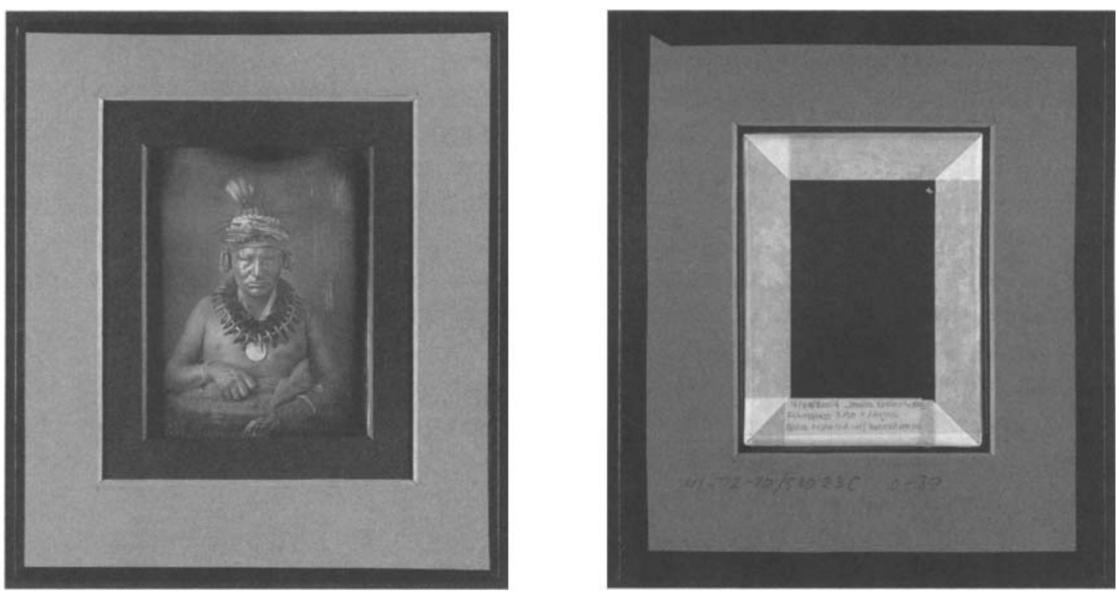
According to previous and recent conservation documentation, the cases for eleven out of fifteen African American slave daguerreotypes were too small to hold the plate packages, and therefore all had broken corners in the tray. Since many daguerreotypes had several leftover layers of binding tapes on the back from previous conservation treatments, we deduced that this could be why the cases were so tight. However, even after removing the tapes, we still encountered a problem of not having enough room in the case to properly fit the plates. Through the years, different conservators attempted to resolve this problem by using smaller glass for the plate package and then fixing the corners. However the brass mat was still slightly larger than the repaired interior of the tray, so each time a plate package was removed, the tray was sure to break from stress.

It was hard to determine the exact cause of the tight cases, since they were very high quality cases and original to the daguerreotypes. One explanation is that, being made of wood, the cases might have shrunk over the years. Another explanation might be that the plate packages may never have had binding tape, although this is reduced to speculation since prior to 1977 there was no photographic documentation or evidence to support these theories.

Even so, the cases needed to be repaired in such a way that they could accommodate the binding tape and not break each time a plate package was removed. After several discussions, case maker and daguerreotypist Alan Bekhuis suggested that we remove the cardstock from the velvet preserver. This technique solved the problem by providing a much needed additional 1.5 to 2 mm on each side of the tray allowing enough room inside of the case to hold the plate using the binding tape previously described.

Custom mounting system

Four daguerreotypes that did not have cases required a mounting system that allowed the image to be presented inside mat board holders with window cutouts, making it possible to view them from front and back. (See figures 14-15.)



Figures 14-15-"Man with bear claw necklace" re-mounted daguerreotype, front and back (41-72-10/53023C) Courtesy of the PMAE, Harvard University

In keeping with best practices, our goal was to eliminate the use of paper based materials inside the plate packages. Therefore, a sink mat made of 2mm thick borosilicate glass was used with Z-shaped Mylar trays to safely store the daguerreotype in the mount structure. The thickness of the sink mat was just enough to place the package inside of the cutout window without creating additional thickness in the package; Mylar D was used as a barrier from the mat board backing with the cutout window to see the back of the daguerreotype. (See figure 16.)

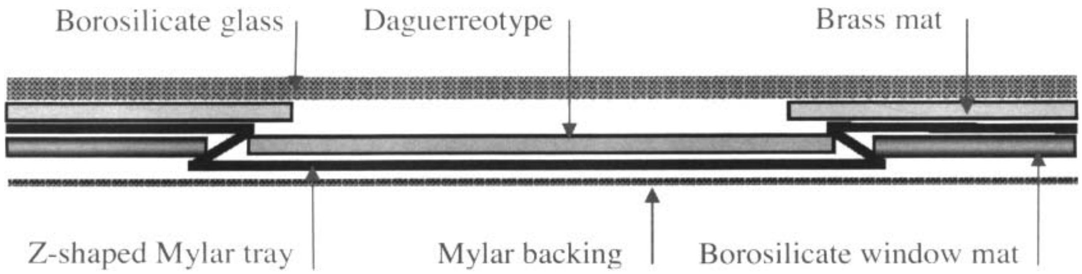


Figure 16- Schematic structure of the new mounting system

Imaging

After treatment was completed, all of the daguerreotypes were imaged at Harvard College Library Imaging Services. We decided to take several images of each plate. First, we shot the images 'bare plated' without the glass or cases, this included both front and back views. Once the final binding was applied, the bound plate package was imaged both in and out of the case. Each digital image was taken at 600dpi with a Sinar 54 H camera equipped with a 90mm HM APO lens and illuminated with electronic flash. The copy setup included a black piece of construction paper serving as the background for the daguerreotypes. To avoid reflection from the copy lights, the camera was also fully covered with black shields and anything white or metallic on the camera was covered with black tape. This setup was in a room with black painted walls and ceiling. The standard contrast curve in the Sinar Captureshop software was adjusted to obtain more gradation in the shadows of each daguerreotype. Each file was exported as a 16-bit per channel RGB TIFF file, then converted to 16-bit per channel grayscale using Adobe Photoshop. It was decided that color and tonal corrections would not be performed, so each image was saved and delivered both as a 16-bit per channel file without an imbedded color space, and as an 8-bit per channel file with Adobe RGB (1998) imbedded within each one. These digital images will be used both for publishing and preservation purposes as well as documentation in monitoring the daguerreotypes' condition over time.

Housing


Figure 17- Housing for daguerreotypes

After all 36 daguerreotypes were stabilized and photographed, they were placed in specially designed archival storage boxes and each daguerreotype was housed in an individual folderstock wrapper. This type of housing had been incorporated into the collection as part of the 1994 university-wide daguerreotype preservation project and the majority of the wrappers were in fine condition for re-use. Coroplast® strips were used to create an individual nest for each daguerreotype within the box. A Mylar lining was also used to reduce direct interaction with paper-based materials inside of each box. The collection is now stored in a climate controlled environment at the Peabody Museum at a constant 58°F and 35%RH.

Figure 18- Two seated men in Chinese in Western dress, after stabilization (35-5-10/53068). Courtesy of the PMAE, Harvard University.

Conclusion

The Agassiz collection of daguerreotypes at the Peabody Museum of Archaeology and Ethnology has a long history of preservation interventions, mirroring the trends in daguerreotype conservation over the past thirty years. In the field of photograph conservation in general, conservators have become very conservative in their approach to treating these unique and fragile images after seeing the unfavorable consequences of thiourea cleaning, and in some cases of electrocleaning. So it is, too, with the collection of daguerreotypes from the Peabody Museum. After stabilizing all the case elements, we determined that no further cleaning method for the plates themselves seemed safe enough to justify the risk to such significant images at this time.

The archivist and conservators in this project determined that the priority for the daguerreotypes is for long-term monitoring to effectively document changes in their condition in the future. Since the introduction of the photograph preservation program at the Weissman Preservation Center, a mechanism now exists for sustained collaboration between photograph conservators and the Peabody Museum. This collaboration serves to enable photograph conservators to regularly monitor these complex three-dimensional objects and to re-evaluate the suitability of borosilicate glass and other materials over time while continuing to advocate for safe methods and materials in the future.

Elena Bulat, Photograph Conservator, Weissman Preservation Center (WPC)

India Spartz, Senior Archivist, Peabody Museum of Archaeology and Ethnology (PMAE)

Brenda Bernier, Paul M. and Harriet L Weissman Senior Photograph Conservator, WPC

T. Rose Holdcraft, Conservator and Administrative Head of Conservation Department, PMAE

Preservation Action During Project	# of Objects	Preservation Action During Project	# of Objects
New conservation form designed and utilized		Plates surface cleaned with manual air blower	36
All previous documentation collected		Plates washed in distilled water	8
Conservation history database designed and utilized		Plates washed in ammonium/water solution	4
Oral history of 1977 conservation intervention		Copper corrosion removed from brass preservers	4
In-house photographic documentation taken before, during and after treatment	36	Borosilicate glass sink mats for small daguerreotypes	4
In-house photomicrographs of hallmarks	11	Analysis of glass decomposition	
In-house photomicrographs of deterioration details	33	Analysis of copper corrosion	
In-house UV documentation of J. Zealy daguerreotypes	15	Analysis of brown accretions	
Cases repaired	19	Professional imaging of bare plates after treatment	36
Tray liners adjusted to fit plate package	11	Professional imaging of plate packages after treatment	36
Cover glasses replaced with borosilicate glass	36	Professional imaging of cased daguerreotypes after treatment	36
Binding tapes replaced	36	Daguerreotypes re-housed	36

Figure 19- Summary of project elements.

Acknowledgements

The authors would like to express their gratitude to the many talented colleagues who contributed to this project from the Peabody Museum of Archaeology and Ethnology, the Weissman Preservation Center, Harvard College Library Imaging Services, and Harvard Art Museum's Straus Center for Conservation & Technical Studies. Dan Jones, former archivist at the Peabody Museum Archives, provided valuable insights to the collection that were critical to the success of the project. The authors would also like to acknowledge the generous support of the Peabody Museum, Harvard University Library, Harvard College Library, The Andrew W. Mellon Foundation, and Paul and Harriet Weissman.

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Treatment of an American Political Tintype Badge, Case-Study

Karina Beeman

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

ABSTRACT
This paper presents a case-study, the treatment of an American political tintype badge bearing the image of Abraham Lincoln and his Vice-Presidential running-mate. The tintype was in very poor condition and required immediate conservation treatment. Combination of different materials in one object (die, iron, collodion, asphaltum varnish), small scale and limited published experience provided challenges. The treatment required conservators to innovate treatment methods, test new materials, and develop specialized tools for working under the microscope.

This case study was presented as a joint paper at the 2009 PMG Winter meeting in Tucson Arizona. The first section of that paper, not included here, was presented by Wiegandt who broadly addressed philosophically the benefit of applying cross-disciplinary conservation specialty techniques commonly used in treatment of non-photographic objects to treating photographic objects. Wiegandt provided examples of such applications in general, and Karina Beeman presented this complete case-study as an example of the interdisciplinary benefit of problem solving drawing on techniques from other conservation specialties.

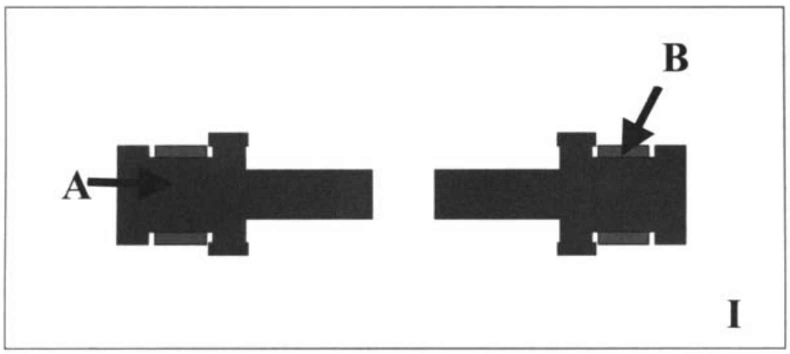
1. DESCRIPTION OF THE OBJECT

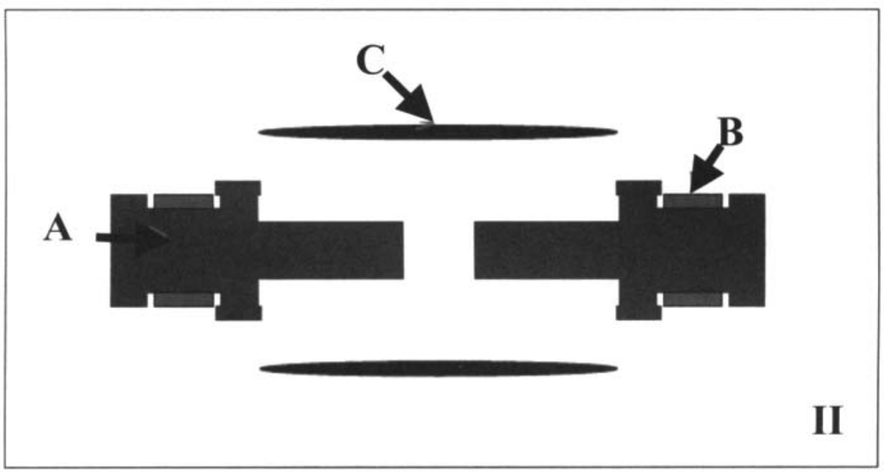
The object for treatment was a political badge – very often called a button - for the first president campaign of Abraham Lincoln in 1860 (Fig. 1). It is a round two-sided medalet with tintype photographs of president and vise-president candidates on each side. Two tintype images are encased in a solid brass frame, which is 25 mm in diameter. The verso of the frame is inscribed: "Abraham Lincoln 1860"; on the recto: "Hannibal Hamlin 1860". On each side there are olive sprays with two leaf clusters on the bottom of frame. A hole for hinging is on the top of the frame. The portrait of Abraham Lincoln used as a master copy for production of this particular badge is a reproduction of the famous "The Brady Cooper Union Portrait", taken in the morning of February 27, 1860. This was the first picture, taken of Lincoln in New York City and one of the few full-length photographs of him before he became president. It is also famous being one of few images picturing Lincoln without the beard. Ferrotype badges are plentiful for the 1860 campaign and exist in numerous sets for all candidates – Lincoln, Douglas, Breckinridge and Bell. This particular badge is relatively common and listed as Sullivan/DeWitt AL-1860- 97 (Sullivan 1981).

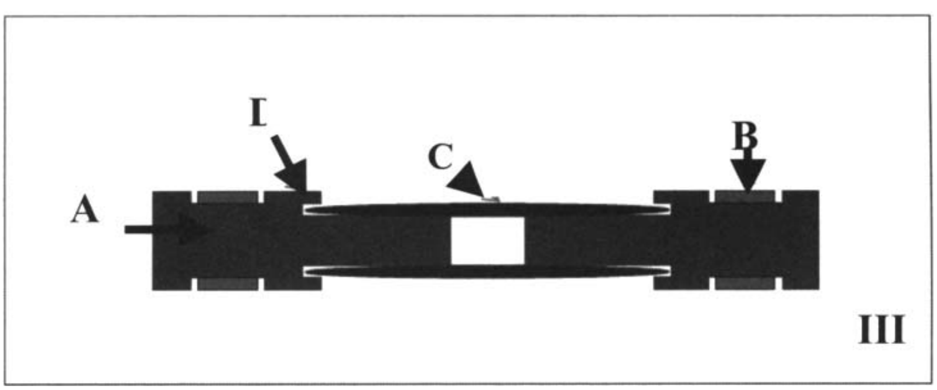
Fig.1. Political double-sided badge, 1860, tintypes in brass frame, diameter 2 ½ cm. Before treatment.

2. TECHNOLOGY OF THE TINTYPE BADGE, TECHNIQUE AND MATERIALS

There are three inventions that led to production of this badge and many other political badges. First, the invention of the tintype process was patented in 1856 (Smith 1856). The patent illustrates "the obtaining of positive impressions upon a japanned surface previously prepared upon an iron or other metallic or mineral sheet or plate by means of collodion and a solution of a salt of silver". The six basic steps involved in the tintype process were: coating, sensitizing, exposing, developing, fixing, washing the metallic plate and varnishing. Second, mass production of ferrotypes was made possible by Simon Wing's invention of the multiple tube camera (Wing, 1860).







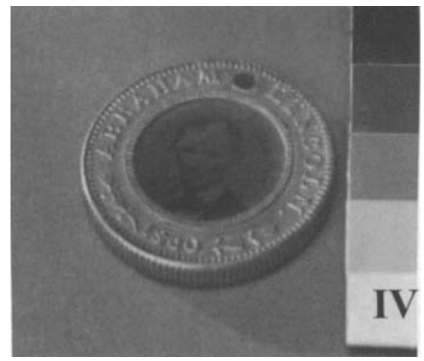


Fig.2. Schemes of making of a tintype badge as described in a patent paper:
I. The sheet of metal die-cut with a matrix by stamping press; A – solid metal; B – decorative rim with text.
II. A photographic picture placed on each side of a frame; A – solid metal; B – decorative rim with text; C – tintype images.
III. The rim was pressed down to secure the photographs A – solid metal; B – decorative rim with text; C – tintype images; D – securing rim.
IV. The badge is small, the diameter of a frame is 2 ½ cm.

Ferrotype pictures were produced by copying a master portrait with a multi-lens camera. The lenses with the furthest angle from the master produced a slightly distorted image. And third invention of D.F. Maltby of Waterbury, Connecticut, who conceived the idea of preparing special medals with tintype portraits of the candidates in the 1860 campaign. As many as thirty-six ferrotypes could be taken on a single plate, and then cut apart. The double-sided medalet was made by setting tintypes on each side of a brass frame (Fig. 2). From this period onward, with the development of mass production of tintype badges, they became essential ephemera of political campaigns.

When tintypes were pressed inside the frame, they obtained a slightly domed shape and an unsupported hollow space was introduced inside the frame of medalet. Normally the campaign medals were made in the shape of the coins of that time. The traditional way of displaying them was to make a hole in the top of the frame, through which a ribbon was run and attached to the wearer's coat or waistcoat. The medals were made struck from dies, precisely as in coin manufacture. Also badges might have variations allowing for different manner of portrayal: such as a pin-back, shank-back and hinge ring.

3. CONSERVATION ISSUES AND NEEDS: COMMON AND UNIQUE;

The badge had many of the common problems that tintypes can have. The badge had soiling, dust, and accretions overall, especially on the perimeter of each tintype (side). The collodion emulsion on both tintypes – the portrait of Abraham Lincoln and the portrait of Hannibal Hamlin - was cracking. The Lincoln tintype was the most severely damaged and unstable. It had two losses of collodion on the image. The collodion on the Lincoln side had significant cracks all over the tintype, with loose particles lying on the surface. Because of the iron support being electrostatic these particles of collodion were very fragile and could further loosen and move at any moment. This complicated the handling and treatment significantly, since with any slight touches the fragments of cracked collodion moved. The iron support was visible in the loss areas and iron corrosion was visible under magnification. The side with the portrait of Hamlin did not have much cracking but had a fingerprint right in the center and degraded varnish. Note that the size of the badge is only 2 ½ cm in diameter.

The badge had an immediate need for stabilization. Vulnerability of the damaged Lincoln portrait with its loose pieces was the primary reason for the urgent treatment.

It also needed restoration. The areas of loss were located on the sitter's face and severely disfigured the image. It was very desirable to compensate losses and restore the image.

Long-term storage was an also an issue. An preservation enclosure was needed to safeguard and protect the object from further damage.

These are not unique needs for political badges and tintypes in general. Quite often they have cracking in the collodion that leads to image losses. Such damage diminishes and devalues the object. It can get worse over time – most often from mishandling, which is easy with such a small object.

4. CHALLENGES

There were a number of obvious conservation treatment challenges.

- The combination of several different materials complicated the choice of materials to use for treatment. It is preferable to work on tintypes (and other metallic objects) with non-aqueous materials to prevent corrosion or rusting in the case of ferrous metals.

- The small size of the badge and tintype image required specialized fine tools and precise applications, including housing and fixturing set-ups to facilitate maneuvering and handling during treatment.
- The fact that it was a two sided object and the relatively poorer condition of the severely damaged collodion on the Lincoln side.
- Lack of guiding information in the conservation literature and relevant publications. Published conservation experience on loss compensation and consolidation of tintypes is quite limited (Chen 2000).

Ralph Wiegandt, Andrew W. Mellon Advanced Research Fellow at George Eastman House, who had previous experience as an objects conservator was available to propose innovative treatment options and potential materials, generally uncustomary to photograph conservators. This collaboration resulted in some new approaches and customized tools for the treatment of this Lincoln badge.

5. TREATMENT STEPS

Because the object was very fragile due to damage and diminutive scale, in order for it to be handled safely, a custom box was created first – for storage and for protection of the treatment (Fig. 3). The box was made from 4-ply acid-free board, which held the retaining cushion with a cavity cutout that secured the .the badge. It was fabricated from Volara® Foam that was covered with inert, soft Teflon™ film, sold as Relic Wrap™. After the treatment a smaller box for storage was created, with the same cushion inside.
Accretions were carefully removed with a fine sable brush № 000 as much as possible at this point in the treatment.

The badge had an urgent need for consolidation. The side with the portrait of Lincoln was more damaged; it had numerous loose particles of collodion and most of the damage was on the image area. The cracks and loose flakes of collodion were consolidated with 5% solution of Paraloid B-72 in toluene. The percentage of this adhesive solution was figured through experiment –a lower percentage was too thin and did not achieve consolidation, and higher percentage was too thick and did not flow efficiently. Precautions were made due to the toxic nature of the solvent, and work was carried out under a solvent exhaust unit. Adhesive was carefully applied on the area of losses and cracking with fine sable brush №000. Brushes from Windsor & Newton series 7 were found to be the finest and the best to work on a small scale, due to the finest hair of these brushes. The difficulties at this moment resulted from the electrostatic charge. The flakes that were loose on the surface easily "jumped" from their place with any slight touch of the brush hairs. To move them into proper place a sharpened wooden stick was used; thus eliminating the electrostatic charges. The tintype needed to be consolidated three times. Residue of adhesive was removed mechanically with sharpened wood stick. After complete consolidation of the Lincoln

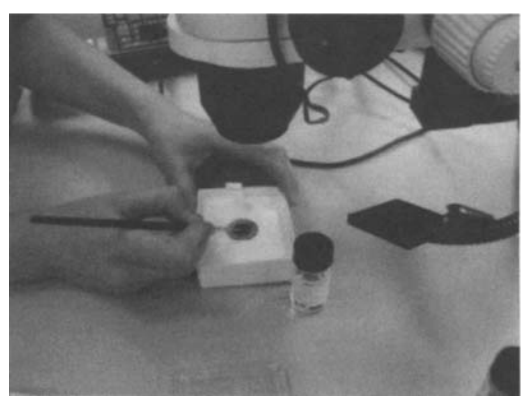


Fig. 3. During treatment: the badge is in custom made box; work is performed under the microscope.

side, the tintype on the other side of badge (Hannibal Hamlin) was consolidated in the same way. All procedures were performed under the microscope.

The surface of the tintype after the consolidation was not totally flat – pieces of collodion that were had originally lain flat now formed a somewhat faceted shape. To minimize this complication, the consolidated area was placed under minimal weight after each cycle of consolidation. Only light pressure was used: silicon-release Mylar (dimensioned to the diameter of the tintype), overlain by a piece of latex sponge to fill the space, and compressed by only a piece of glass 0.5 mm thickness placed on top (Fig. 4).

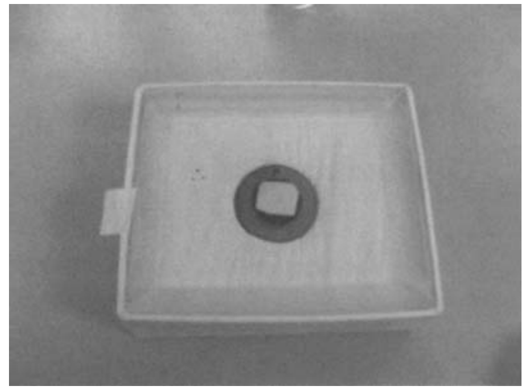


Fig. 4. System of light press after each consolidation cycle: the badge is in custom box, silicone release Mylar, latex sponge and glass on top.

The area of loss was covered with thin layer of B-72 solution. This was done to create an isolating layer for the subsequent fill material and to prevent further development of corrosion.

Now that the loose collodion particles were secured by consolidation, another cleaning attempt was made. Both sides of the tintype especially cemented accretions near the rim of the frame were cleaned with saliva applied by cotton swabs. It was rinsed with distilled water applied with cotton swabs.

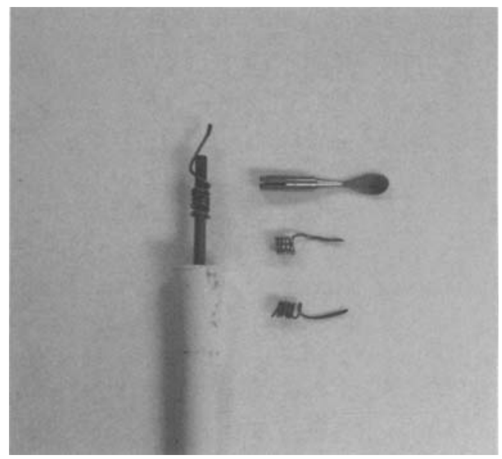


Fig. 5. Heat spatula with original tip and custom-made micro tips (shaped copper wire).

At this point the object was ready to have its losses compensated. The method of compensation was proposed by Wiegandt. A mixture of Cosmolloid 80H microcrystalline wax and Arkon P-90 resin, colored with fine dry pigments was used as loss compensation material.

To prepare mixture, wax and resin should be warmed up on the hot plate until uniform and transparent. The proportion of the wax-resin mixture can be varied: more wax in mixture will create softer filler, more resin – harder fill. The author tried 1: 1 (proportioned by weight), and 1:2, but eventually used the 1:1 mix. For convenience, the mixture can be poured into a silicone mold to cool and harden into sticks or any shape.

The wax-resin mixture can be mixed with dry pigments on a ceramic palette with a heated spatula, temperature at an approximate temperature of 60°C.

The colored mixture was applied to the loss area with a customized hot spatula. The temperature of 50°C degree for the spatula setting for the fill mixture application was worked the best. For application the author used a Micro Matic™ Electronic Waxer and custom micro tips, made of copper wire, shaped and wrapped around the point of a spatula (Fig. 5). For application of the mixture a pointed tip was used, and for flattening and for polishing a flat tip was used (Fig. 6 and 7). All work had to be performed under the microscope due to the small size of the losses. The fill should be built up gradually, dot by dot, not up to the edges. After that the fill was flattened and evened with the edges of the loss. The fill was covered with silicon release Mylar™, and flattened with small bone spatula. Sometimes a hot spatula was used to flatten the fill, in this case with maximum temperature 40°C in order not to melt the entire fill (Fig. 7). After flattening Mylar™ was not removed from the working area immediately, and the fill was allowed to cool down. Heptane solvent, applied with a fine brush, also helped to make the fill smoother. Application of heptane was done under a solvent exhaust unit, due to the hazard of the solvent.

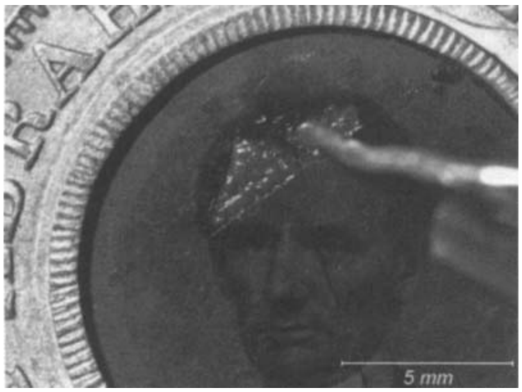


Fig. 6. Application of wax-resin mixture. 6.5X

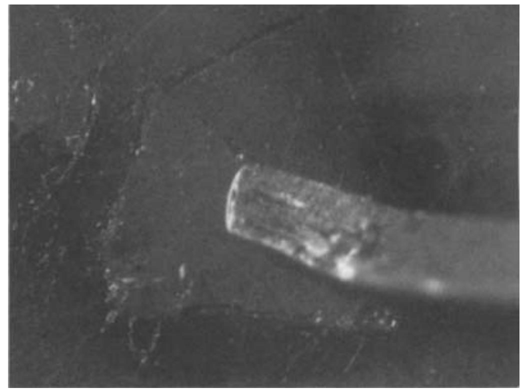


Fig. 7. Flattening of the wax-resin fill with a custom heat spatula, made of copper wire. 6.5 X

Fig.8. Retouching of the forehead area with dry pigments in Heptane an a Windsor&Newton series 7 sable brush № 000

It was possible to remove the excess of mixture application with aliphatic solvents (petroleum benzine or VMP Naptha). Naptha had no effect on the collodion or B-72 consolidant, which was convenient especially since it was necessary to redo the fill many times to achieve the best outcome with little danger to the object.
The forehead and hair were retouched using only heptane as the carrier for dry pigments (Fig.8). High density could be achieved without building up additional layers in the very small loss area. However, on the very black areas the black pigment alone did not give enough density and looked gray rather than black. It was mixed with wax again. This way it was possible to get the deep black color.
The final step was to overcoat the image. A spray application of PVA resins (AYAA and AYAC) modifies the gloss and adds protection to the wax-resin fill. The 10% mixture of AYAA and AYAC resins in ethanol and toluene (1:1 by weight) was prepared. Then 10 drops of cellulose acetate was added to 15 ml of this mixture in order to modify the gloss. After several experiments it was found that airbrush application in 5-6 layers would provide an even finish with the desired semi-gloss.

6. EVALUATION OF TREATMENT

This case study addressed a very specific object – a tintype badge in metal medalet. Although the particular object has primarily historical value, the method of treatment developed in this case can be applied to any tintype artifact. Taking into account limited publications on this topic, the author hopes this article will promote further studies. The treatment was quite successful. The loss area is not visible with naked eye (Fig. 9). The loss compensation method using wax-resin mixtures appears to be a promising method for many photographic objects. It is an easily reversed and versatile material to work with on sensitive surfaces. The Cosmolloid 80H microcrystalline wax and Arkon P-90 resin mixture creates a fill material that is easy to modify and reshape. Depending on wax to resin ratio the fill could be modified to be softer, more flexible or harder. In this particular case author did not observe much difference between use of softer and harder versions of wax mixture probably due to the very small size of the fills but it is definitely a property that could be useful for other objects. Despite the custom made tips for heated spatula, it was quite difficult to work on such small scale. The whole experience proved that there is a clear need to develop new tools for photograph conservators to work comfortably under the microscope.

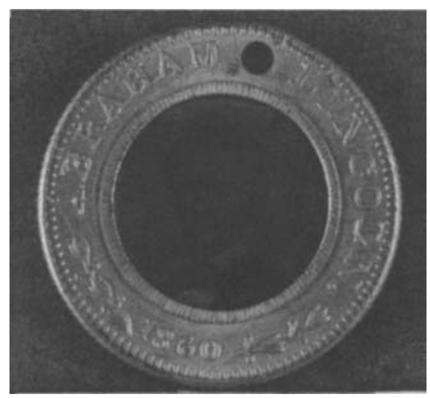


Fig. 9. Badge after treatment

7. FURTHER DEVELOPMENT

This case study was successful, and showed a few topics to develop further. During the experiments the author used the method on various tintypes from the study collection. The method was not successful on all objects; some losses did not have enough depth to accept the wax-resin fill. Obviously there is a need for an impainting media that would be thin enough, safe for collodion, match the visual appearance and be reversible. There were also a few experiments on damaged ambrotypes with the application of wax-resin mixture and consolidation with Paraloid B-72 of damaged ambrotypes. Results were quite promising, but further research is needed.

MATERIALS AND TOOLS

Acryloid (Paraloid®) B72
Copolymer of ethyl methacrylate and methyl acrylate
Rohm and Haas Company Philadelphia , Pennsylvania
(Avalable at Talas)

Cosmolloid 80H microcrystalline wax
Astor Petrochemicals Ltd
(Avalable at Talas)

Talas
330 Morgan Ave. Brooklyn, NY 11211
Phone: 212-219-0770
Fax: 212-219-0735
http://talasonline.com

Arkon P-90 resin
Arakawa Chemicals Industries, Chicago, Illinois
http://www.arakawa-usa.com

Various dry pigments
Kremer Pigments Inc.
247 West 29th Street New York, NY 10001
Phone (212) 219-2394
Fax (212) 219-2395
http://www.kremerpigments.com/

Winsor & Newton brushes
11 Constitution Avenue
Piscataway New Jersey 08854
Telephone: 800-445-4278
Fax: 732-562-0941
http://www.winsornewton.com/

Micro Matic™ Electronic Waxer
Kerr Corporation
Customer Service: 800-537-7123
www.kerrlab.com

Relic Wrap™
Plastomer Technologies
10633 W. Little York, Bldg3 Suite 300,
Houston, TX 77041
http://www.plastomertech.com/relicwrap.htm

Volara® Foam
Sekisui Voltek
http://www.sekisuivoltek.com/
Available at MASTERPAK™
145 East 57th Street
New York, NY 10022
Telephone: 1 (800) 922-5522
Fax: 1 (212) 586-6961

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Wing, S. 1860. *Improvement in photographic pictures,* U.S. Patent 30850.

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Conservator
Paul Messier Conservation of Photographs and Works on Paper

Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

Treatment of Alfred Stieglitz's Lantern Slides

Rosina Herrera

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

Alfred Stieglitz's lantern slides have remained largely understudied and until recently, were a lost chapter in Stieglitz's ouvre. They were produced from negatives taken in his early years as a photographer, often on his travels to Europe. Many of the images Stieglitz captured as lantern slides are unique: only a few images exist and in most cases were not printed in any other format.

Stieglitz considered the lantern slide process a great medium to express his art. More than simple positives on glass, his slides are objects of delicate appearance and color. Stieglitz refined developing and toning techniques that allowed him to achieve maximum results, publishing his improvements in photographic journals. Though the published formulas and directions are clear, the difficulties of the process meant that only an extremely skilled photographer could master them.

Conservation techniques, technical examination and material analysis applied to the group of twenty – nine lantern slides held at the George Eastman House International Museum of Photography and Film have shed new light on the making and presentation of this rare group. .

Stieglitz's lantern slide collection at George Eastman House

Following Stieglitz's death in 1946, Georgia O'Keeffe, assisted by Doris Bry, worked to organize and distribute the photographer's legacy to selected public collections.[i] The largest collection of Stieglitz's work was deposited at the National Gallery of Art in Washington, DC. Known as The Key Set[ii], it includes an example of every print that had ever been mounted before Stieglitz's death. It is worth noting that there are no lantern slides in The Key Set.

One hundred Stieglitz's prints, autochromes and lantern slides were delivered to George Eastman House between 1951 and 1952. The acquisition also included his photographic equipment, two complete sets of Camera Work and two calotype negatives by the Scottish photographers D.O. Hill & Adamson.

Geogia O'Keeffe's *Conditions for the Care of the Alfred Stieglitz Collection*[iii] includes carefully considered recommendations for the storage and exhibition of this invaluable collection. Interestingly, this text does not include any special directions for the group of lantern slides. Since Stieglitz himself loved the technique of slide making, the distinction between the prints and his lantern slides probably reflects O' Keeffe's personal predilection.

Alfred Stieglitz and the Lantern Slide

In 1891, Stieglitz joined The Society of Amateur Photographers of New York, which was an early organization established in 1884 and devoted to amateur photography. The members of such clubs regularly organized exhibitions for viewing and sharing their work. For this purpose, they relied on lantern slide projection, an effective medium for sharing images to a large audience. Additionally, a branch of the organization, The American Lantern Slide Exchange, employed slides to discuss and criticize the activities of similar societies around the country.[iv]

In 1897 the Society merged with a parallel association, the New York Camera Club to form The Camera Club of New York. Stieglitz was offered the presidency of the new organization but declined the office. Instead, he became vice–president and took a seat on the "Exhibitions and Lantern Slides Committee." Some of his extant slides bear a printed label with the legend "The Camera Club, N.Y." Stieglitz also assumed the chairmanship of the Publications Committee[v] after which the lantern slide process became a common subject in the journal The Amateur Photographer.

Stieglitz exhibited lantern slides during the time he lived in Germany and New York and was traveling through Europe. The George Eastman House collection contains examples dated from 1886 to 1894. At that time, Stieglitz was interested in photographing the local landscape and people. Accompanying his photographs he published notes and impressions of the scenery, appearance and life style of the inhabitants. In his personal accounts he also included technical information.[vi]

To date, no lantern slides made after 1900 have come to light. At that time, Stieglitz started experimenting with the new process of autochrome as well as the gelatin silver paper. More importantly, his aesthetic approach had changed dramatically. He had moved away from Pictorialism and no longer participated in the photo club activities for which he made his masterful lantern slides.

Characteristics of this collection

All but two of Stieglitz's lantern slides at the George Eastman House have a square European format (3 ¼ x 3 ¼ in) instead of the rectangular American format (3 ¼ x 4 in) It is common to find examples of irregularly hand cut - cover glass.

It is not easy to determine whether a given lantern slide was made in camera (with reversal development) or copied from a negative, but the second method was more common at that time. Stieglitz printed some of those images also on paper, and therefore an original negative probably exists. Apart from that, he actually mentioned the use of a reduction camera.[vii] Stieglitz used gelatin dry plates in all the examined lantern slides.

When it came to making the positive from those negatives, he specifically mentions his preference for Carbutt plates over those from Eastman.[viii] He considered Eastman plates too slow and found they required exposure times between 35 and 45 times longer than the Carbutt plates. In addition to longer exposures, a stronger developer was needed for Eastman plates. He also describes Carbutt plates that stained after processing; a problem he thought was caused by the developer (hydroquinone) After testing the developer and comparing the results to Eastman plates, he concluded that that the stain was caused by an old batch of Carbutt plates:

> "The Carbutt slide emulsion deteriorates in a much shorter time than the Eastman, probably due to the excess of iodide of silver in it, used to make the

> emulsion works clear. In a slow plate, like Eastman, the amount of iodine of silver, if used at all, cannot be very great."[ix]

Once the image was exposed and processed, it was often toned to different colors. Stieglitz cared a lot about the tone of his lantern slides and most of his examples exhibit tonal adjustment.

Many of the untoned lantern slides exhibit slight warm tone. For his "artistic work", Stieglitz preferred warm image tonality while black is acceptable for other subjects.[x] The final color of the photographic plate depends on silver particle size, which varies depending on the silver halides in the emulsion and the exposure and developer times. At the time Alfred Stieglitz was using dry plates, there were many products based on bromide–chloride or bromide–iodine combinations that yield a warmer tone than the later bromide based emulsions, as discussed above. Smaller particle sizes can be achieved by using a long exposure and weaker developer, key for obtaining warmer tones.

In addition, there are some very striking examples that exhibit colors from brown to red or blue. Stieglitz even had a method to tone partially or completely, with one or two colors.

In 1892, *The Photographic Times* published a talk Stieglitz had given to The Society of Amateur Photographers of New York on the use of uranium nitrate salts for toning. In this article, Stieglitz gave formulas and instructions for obtaining six different image colors from blue to red. Five years later, in *The Amateur Photographer*, he published other formulas for achieving blue, green and red tones (here, only red is uranium nitrate-based too) He also described what he called local and partial toning based in gold chloride.[xi]

Stieglitz also perfected the finishing and mounting of his lantern slides, as he was very particular about the final presentation of this work. After they were processed, fixed and toned, the plate, paper window mat and cover glass were sealed with paper tape to protect and hold the pieces of glass together. He displayed all his lantern sides in the same personal and peculiar way, with the same type of binding tape, window mat and labeling with handwritten inscriptions. This original appearance has been preserved in all but four cases, where past intervention campaigns resulted in the replacement of the binding tapes and the loss of valuable inscriptions.

The presentation elements add valuable information to the way lantern slides were conceived as objects.

• Binding tape

The package formed by the photographic glass plate and the cover glass is bound with four strips of paper tape around the edges that overlap along the corners at a 90-degree angle (fig.1). The traditional tape used for closing lantern slides was sold at that time in a roll with a gum based adhesive.

This binding tape is never composed by one singular paper strip.

Figure 1

• Window mat.
The image is cropped and masked with a paper window mat that serves as a spacer between the emulsion and the cover glass.
Stieglitz used a pre-made commercial mask, which is a rather rare example of a specific mat sold for lantern slides (fig.2). It came with several markings as a guide for cutting different sizes of windows. On the front, "This Mat Copyrighted 1890, by Wm. Garrison Reed, Boston, Mass." appears in print, together with a series of lines to be filled with technical details. The "Plate" and "Developer," information was never filled in by the photographer.

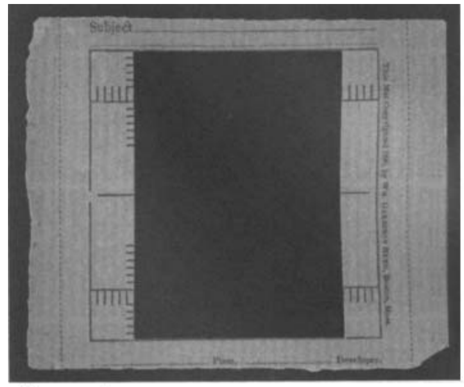

Figure 2

• Labels and inscriptions
Stieglitz was careful in organizing, labeling and presenting his lantern slides. A paper label attached to the cover glass includes the title, date and sometimes his signature or the process information.

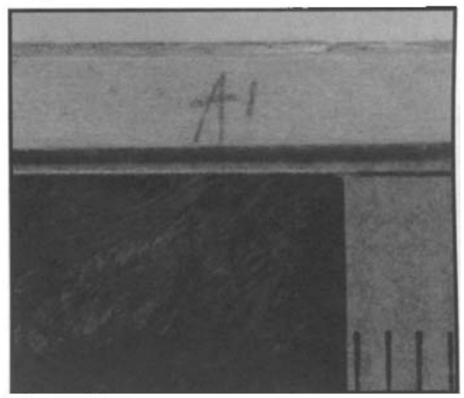

Figure 3

The pre-printed label that reads "Alfred Stieglitz, New York" is present in half of the collection (figs. 1, 4). In black ink, Stieglitz filled in the image's title or location, and very often the year. We can also find a later numeration added in pencil by Georgia O'Keeffe or Doris Bry after Stieglitz's death (figs.1, 4). Stieglitz's name appears more frequently pre-printed in this way than handwritten. Twelve of the twenty-nine objects in the collection have this label while only one carries his signature.

Figure 4

The most interesting inscription that appears (common in his prints but also in his lantern slides) is "A.1" (fig.3). It was written by the photographer himself and refers to his grading of the print quality. An "A.1" print is what he was looking for after several proofs:

> "But I try and try until I get what I want… I reject all others – but what I am after is the A.1 – One from each negative."[xii]

• Orientation Marks
Another characteristic of most of Stieglitz's lantern slides are two round stickers near the top corners, for marking the correct orientation of the image when charging the slide in the magic lantern (fig. 4).

• Paper tabs
Along the edges and under the binding tape there are paper tabs, a great example of Stieglitz's binding technique. In figure 4 we can see three paper tabs on the left, right and top edges holding the glasses from front to back. They appear to have been used by Stieglitz to keep the plate and the cover glass together during the binding process.

Condition of this collection
Before this project, the overall condition of the collection was fair. Existing records do not allow us to trace the condition of these lantern slides since their arrival at George Eastman House in 1952. O'Keeffe's document *Conditions for the Care of the Alfred Stieglitz Collection* again doesn't include any handling guidelines or any restriction for the lantern slides group.

In the 1980's a group of six lantern slides accidentally broke and shattered and needed more serious intervention. At that time, this group was rebound and stabilized with two sheets of glass or a piece of glass and a polyester sheet and then rebound in a Filmoplast P90 tape border. This method increased the width of the package that prevented the objects from being placed back in their original container slots (fig. 8).

As part of this project, ten of the 29 slides were conserved, prioritizing those with severe glass deterioration and breakage of support and/or cover glass.

Advanced glass deterioration in the cover glass occurred in five cases, interfering with viewing the image. Figure 5 shows under axial specular illumination the advanced glass deterioration in the cover glass of *Moonlight off the Battery, New York,* 1895. Under magnification, no relationship between the condition of the cover glasses and the condition of the final image in the plates was noticed. For that reason, once the slide packages were opened and the cover glass cleaned with a 50% solution of ethanol and water, the glasses were reused and the slide rebound back.

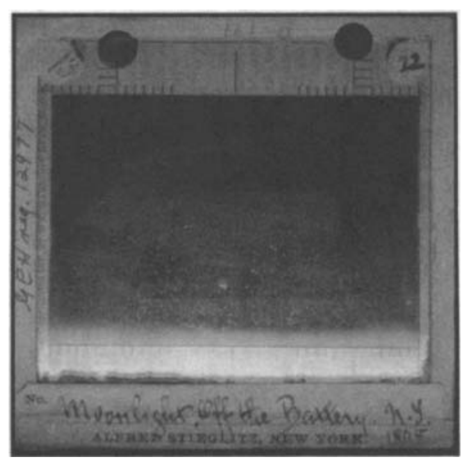

Figure 5

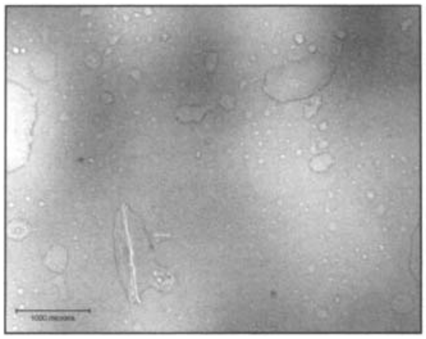

Figure 6

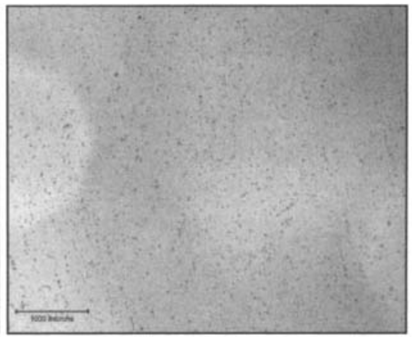

Figure 7

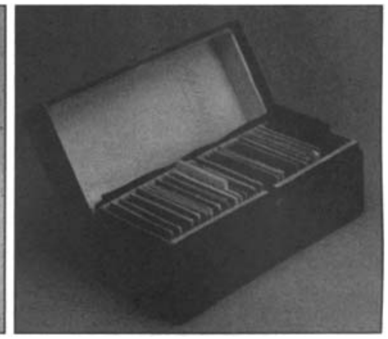

Figure 8

In some cases, glass deterioration occurred on both sides of the cover glass. Figure 6 shows inner side of the cover glass on *Moonlight off the Battery* while figure 7 shows glass deterioration also on the outside. The presence of glass deterioration on the outside of the cover glass is likely due to the method employed in storing the lantern slides. Inside the original storage box (fig.8) the lantern slides are kept in slots, in a vertical position and closely packed to one another. The gap between each lantern slide is so small that moisture can be trapped.

Besides glass deterioration, other chemical deteriorations were observed, such as silver mirroring. However the physical damages present in six broken examples were the main concern. The damages were assessed and divided into three case scenarios:

a. Broken cover glass: *[Peasant working in the field]*, ca.1890; *Maria Bellagio,* 1887 and *Experiment in local toning,* 1894 (fig.9).
b. Broken photographic plate: *A Dutch Woman*, 1894 (fig.16).
c. Broken both; cover *A hook in Pallanza*, 1887 and *A bit of Katwijt*, 1894 (fig.18).

In the following, the methodology and treatment of this group will be discussed:

A. Broken cover glass

The treatment performed on the broken cover glass examples consisted in opening the slide package, replacing the damaged cover glass with a new one of the same thickness and rebinding with Filmoplast P-90 tape toned to match the original tapes.

[Peasant working in the field] had a binding tape from the 1960s or 1970s. Since this plastic tape had no historic value, it was replaced during treatment and kept with the original in a separate Mylar sleeve.

The other two examples, *Maria, Bellagio* and *Experiment in Local Toning* (fig. 9, before treatment), still had their original binding tapes. Several ink inscriptions on labels were attached to the broken cover glasses. These paper attachments were locally humidified for removal from the glass. The inscriptions (Stieglitz handwriting in blue ink and the George Eastman House former accession numbering in black ink) were highly water-sensitive and were fixed with Paraloid B-72 in Acetone (5%) prior to humidification.

The label adhesive and binding tape were softened and the ancillary elements released mechanically with the help of a scalpel or a spatula (fig.10). The discolored, brittle and fragile paper elements were separated and then washed, flattened and reinforced with Japanese tissue and Methylcellulose.

Figure 9

Figure 10

When the package was opened (fig.11, during treatment: cover glass with paper elements and spacer on photographic plate), the emulsion side of the photographic plate was dusted with an air bulb and the glass side was cleaned with a 50% water – ethanol solution. Finally, the whole package was put back together and rebound with a single strip of Filmoplast P-90 toned with Golden acrylics to match the original. Finally, the treated paper elements were reattached to the object over the new tape with Aquazol 500 in ethanol, thus preserving the original appearance and presentation (fig.12, after treatment).

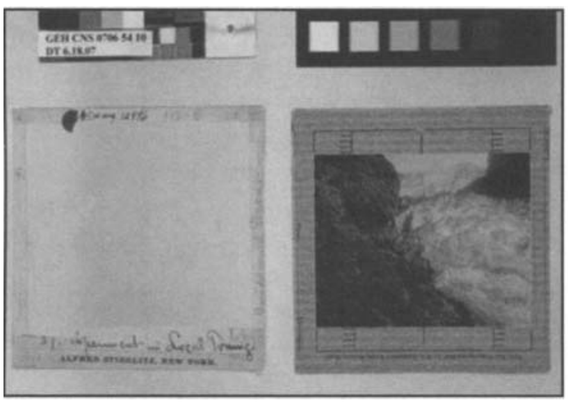

Figure 11

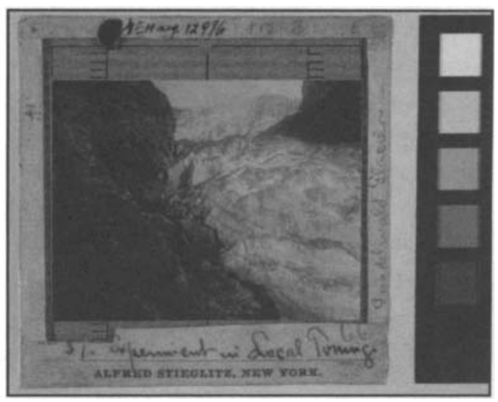

Figure 12

B. Broken Photographic Plate

If the photographic plate was broken but the cover glass remained intact, the treatment criteria varied. The original cover glass could be reused, the broken glass plate was removed and repaired and a third sheet of glass was added as extra support in the final assemblage. A Permalife paper spacer was incorporated between the plate and the new glass support to avoid the formation of Newton rings.[xiii] After treatment, this spacer remained hidden underneath the binding tape.

In the case of *A Dutch Woman* (fig. 16, before treatment), taking the plate out of the package did not require the removal of all tapes and labels. Since the cover glass was not being replaced, the pieces of broken glass plate could be removed by lifting the binding tape from the verso, where there were no inscriptions and direct humidification could be applied.

The separate treatment of the broken glass plate deserves special attention. An innovative method developed by Katherine Whitman during the 4th Cycle of the Advanced Residency Program in Photograph Conservation (ARP) was applied to this group.[xiv] Vertical assembly (fig. 13) allowed us to take advantage of gravity and guaranteed a perfect joint of the pieces[xv]. Before the actual repair, the separate broken glass fragments were rejoined and held together with "sticky wax" applied to the glass side of the plate (fig. 14). A *lightline* illuminated the object from the front, and facilitated an exact alignment of the pieces (fig.14).

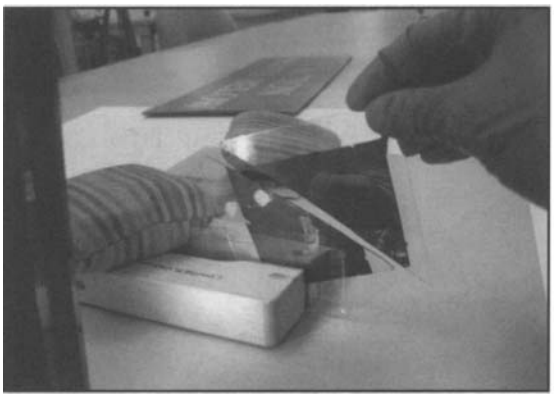
Figure 13


Figure 14


Figure 15

Once the pieces were aligned, the adhesive was wicked into the cracks with a small brush or tool such as a steel wool swab. With transmitted light it was possible to see the adhesive filling the space of the crack by capillary action, rendering the crack nearly invisible. Based on Whitman's research, Paraloid B-72 in toluene was the adhesive selected for its reversibility and long drying time, a useful quality for alignment of the pieces needs. After 48 hours of curing, the sticky wax was mechanically removed and cleaned with Naphtha (fig. 17, after treatment)


Figure 16

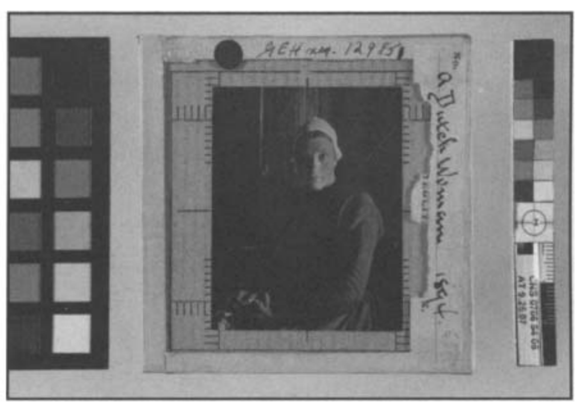
Figure 17

C. Broken Cover Glass and Broken Photographic Plate

In two cases, *A hook in Pallanza* and *A bit of Katwijt* (fig.18, before treatment), both the cover glass and plate were broken. The conservation protocol in these examples was to replace the cover glass, glue the broken photographic plate and add a new glass as a support. The new sheets of glass (cover and new support) were selected a little thinner than the original (1 mm instead of 2.5mm) to minimize the increase in thickness of the whole package.[xvi] Between each piece of glass a Permalife paper spacer was incorporated to prevent again the formation of Newton rings.

The package was opened and its elements treated following the methods described above: treatment of original tapes and labels was performed and the plate was cleaned and repaired. Finally the package was re-assembled adding a Filmoplast P-90 binding tape toned to match the originals. To preserve the original presentation, the new tape was covered with the original biding tape and labels, as described before.

A bit of Katwijt was the only example in the collection that had a black binding tape (fig.18, before treatment: the multiple pieces of glass were hold temporary with sticky wax). This unusual tape, made of very thick paper coated with a shiny media, was too deteriorated, skinned and friable to be reused.

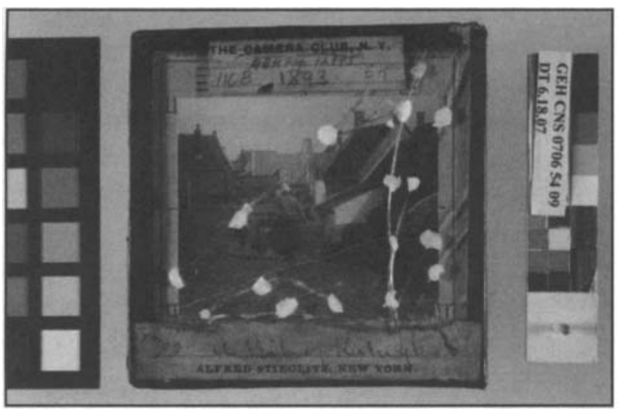

Figure 18

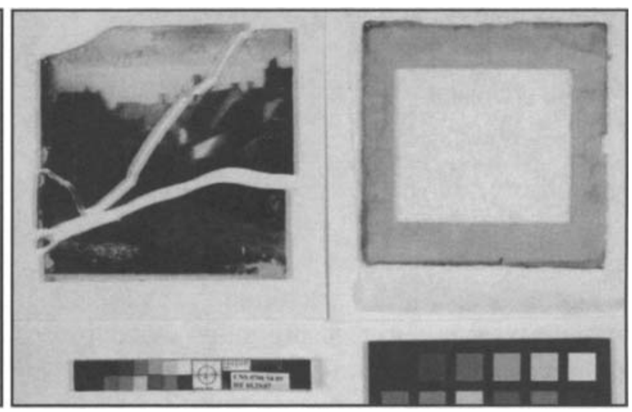

Figure 19

Once the original black binding tape was removed and the package opened (fig.19, during treatment), each component could be treated separately. The photographic plate was glued with Paraloid B-72 in toluene, as described above. Filmoplast P-90 toned in black color with Golden Acrylics was used to rebind the package (fig.20). A final coating of Paraloid B-72 in Acetone was added to imitate the shiny surface of the original tape. Once the original labels reattached, the new tape was trimmed as usual, in order to match the original look of the object (fig.21, after treatment).

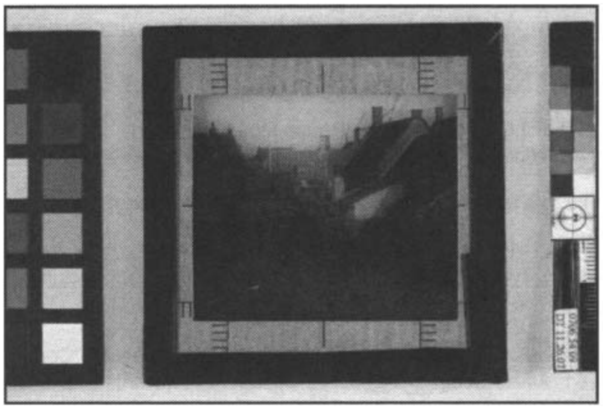

Figure 20

Figure 21

Conclusions

Prior to this conservation investigation, half of the Stieglitz's lantern slides at George Eastman House were in fair condition. Due to the general lack of knowledge of these objects, they are rarely requested and never exhibited but Stieglitz's lantern slides are key examples of his early steps as a photographer. Parallel to his work on paper, these positives on glass are evidence of his aesthetics and interest in anthropological themes during his early years. Nevertheless what is even more revealing is Stieglitz's personal interest in this media:

> "The lantern slide is the most peculiarly fascinating branch of photography (...) The technique of slide making may be quite as interesting as any known printing processes, even including the gum methods that are now coming into vogue." [xvii]

One hundred and fifty years ago, when extra-large format prints did not exist, the lantern slide projection was the only way of making a large photographic image, the size only limited by that of the wall. When a photograph is enlarged and projected, defects, scratches, dust and any other tiny disruption in a lantern slide would result in a greatly amplified disturbing spot on the screen. For this reason, careful processing, retouching and manipulation skills were essential.

Alfred Stieglitz pushed the process to it's fullest potential, creating some of the most exquisitely beautiful examples of lantern slides recorded in the history of photography. In addition to the ones held at George Eastman House in Rochester, there are other collections in The Philadelphia Museum of Art, The Art Institute of Chicago and The Museum of Fine Arts in Boston. On one hand, a thorough characterization project, examination and analysis of those other groups is highly recommended to understand this important chapter in Stieglitz's career. On the other hand, more research regarding the treatment and display of glass-supported photographs would contribute to the preservation of rare material from the masters of photography.

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Papers presented in Topics in Photographic Preservation, Volume Thirteen have not undergone a formal process of peer review.

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[i] For this subject, see documents and correspondence in the registrar office at George Eastman House Museum.

[ii] Greenough Sarah, *Alfred Stieglitz. The Key Set. The Alfred Stieglitz Collection of Photographs*, Vol. 1, 1886-1922, National Gallery of Art, Washington, 2002.

[iii] This document accompained the Stieglitz estate and was sent attached to a letter to Beaumont Newhall, then director of the George Eastman House Museum, on June 18, 1951.

[iv] Valeria Wingfield, Camera Club of New York. Records, 1889 – 1983, The New York Public Library Humanities and Social Sciences Library Manuscripts and Archives Division, 1993, p.4; http://www.nypl.org/research/chss/spe/rbk/faids/cameraclub.pdf (accessed March 2007)

[v] Wingfield, 1993 (reference III), p.3.

[vi] Stieglitz, Alfred, "A day in Chioggia," *The Amateur Photographer*, prize tour number (June 1889), pp.7-9; Alfred Stieglitz, "Cortina and Sterzing," *Sun Pictures from Many Lands* (London, 1892), pp.60–61; Alfred Stieglitz & Louis H. Schubart, "Two artists haunts," *The Photographic Times*, 26 (January–June 1895): pp. 9-12.

[vii] Stieglitz, Alfred, "Experience with slide plates", *The American Amateur Photographer*, vol. IV, Feb. 1892, p. 63.

[viii] For a detailed comparison between Carbutt and Eastman plates see Stieglitz, 1892 (reference VII). The information in this article should be taken carefully because, at that time, the batches of plates differed from one to another and the technology wasn't developed yet to get homogenous results in each batch

[ix] Stieglitz, 1892 (reference VII), p.62.

[x] Stieglitz, 1892 (reference VII), p.63.

[xi] This lecture "Toning slides with uranium salts, and a few additional remarks on the color of slides in general" was published first in *The Photographic Times*, January 22, 1892, pp. 42-43 and later in the *Bulletin de la Société Française de Photographie,Tome Huitième*, 1892, pp. 187–190. As part of this project, 10 lantern slides from the collection were analyzed with X- Rays Fluorescent in order to find out the nature of the toning element. The results of this analysis are in progress to be published. Some of the results can be consulted at the Advanced Residency Program webpage (http://www.arp-geh.org//indexsep.aspx?nodeidp=417, accessed on 8.26.09) A synthesis of the conclusions of the analysis can be found also at webpage Notes on Photographs, as part as the George Eastman House site (http://notesonphotographs.eastmanhouse.org/index.php?title=Herrera%2C_Rosina._XRF_Analysis_of_Alfred_Stieglitz%E2%80%99s_Lantern_Slides, accessed on 8.26.09)

[xii] Stieglitz to Paul Strand, 11 August 1919 (Center for Creative Photography, The University of Arizona, Tucson)

[xiii] This phenomenon is an interference pattern (concentric colored rings) caused by the reflection of light between two pieces of glass that are pressed together. The rings appear when there's a tiny air gap between two pieces of clear material.

[xiv] See ARP capstone projects http://www.arp-geh.org//indexsep.aspx?nodeidp=401. See also Katherine Whitman and Ralph Wiegandt, "Case study: repair of a broken glass plate negative", *Topics in Photographic Preservation,* Vol. 12, The American Institute for Conservation of Historic and Artistic Works, Washington D.C, 2007, pp.175-181.

[xv] This method has been developed and proposed by Stephen Koob, head of conservation at the Corning Museum of Glass in Corning, New York, who had used it for repairing glass objects but never for photographs.

[xvi] Each new sheet of glass that was incorporated was hand cut. The edges were sanded to avoid cutting through the binding tapes.

[xvii] "Some remarks on lantern slides", *The Amateur Photographer,* vol. XXVI, Sep. 10, 1897, p. 203. At that time, Stieglitz was using photographic processes such as carbon, gum dichromate and photogravure.

THAWING AND TREATING WATER-DAMAGED PHOTOGRAPHIC MATERIALS

BARBARA LEMMEN

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Every Photograph Conservator has likely had to deal with water-damaged photographs at some time. The Field is lucky to have some published research on the recovery of these objects; discussion of the practical aspects of treatment procedures is more limited.

This talk will review the speaker's experiences treating a wide variety of water-damaged photographic materials; black-and-white and color prints, glass and film negatives, slides, and albums. The majority of these materials arrived, frozen, at the Conservation Center for Art and Historic Artifacts in the period from 2001 to the present. The procedures for thawing, washing, and drying the objects will be summarized, as well as successful methods for tracking items and odor reduction. The treatment procedures used were based on previous work by other conservators, published processing methods for new prints and negatives, and standard photograph treatment methods.

The issue of decontamination and the research under way by other institutions on this topic will also be addressed.

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Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

PURPLE HAZE:
THE DEVELOPMENT AND ANALYSIS OF A VAPOR IODINE TREATMENT FOR THE REDUCTION OF SILVER MIRRORING

SARA BISI, DR. GREGORY D. SMITH, GARY E. ALBRIGHT

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

1. Abstract

The development of a novel vapor phase iodine treatment for the reduction of silver mirroring from developed-out silver gelatin photographs is discussed. This new method was evaluated in comparison to the established treatment developed by Edith Weyde (1977) that utilizes an iodine/ethanol solution followed by fixing and bathing the photographic print. Among other benefits, the vapor treatment method removes the need for buying and maintaining anhydrous alcohol, can be performed quickly and easily, and potentially reduces risks of iodine penetration into the photograph to attack image silver.

For this study, tests were completed using identical sets of developed-out silver gelatin photographs treated using both the alcohol and vapor treatments. The samples were evaluated for reduction of mirroring, bleaching of highlights, and loss of image silver. Although further testing and analysis are underway, vapor treatment thus far has proved to be a viable option if reduction of silver mirroring is desired. A simple iodine vapor chamber is described which produces even reduction of mirroring in seconds and can be easily replicated by conservators.

2. Background

The formation of silver mirroring has been investigated by a number of scientists and photograph conservators. Many agree with Hendriks (1988) who has described the deterioration to be the result of oxidation of the image silver to silver ions that can migrate through the gelatin emulsion, deposit at the surface of the photograph, and cause the characteristic reflective surface. It is likely that this effect is accelerated under high relative humidity conditions due to softening of the gelatin emulsion layer and increased mobility of the ions. Transmission electron microscopy (TEM) images have supported Hendriks' theory by revealing small silver-containing particles surrounding a larger granule of image silver. Ulla Bøgvad Nielsen (1993) examined this theory further with TEM comparisons of freshly processed and naturally aged photograph samples, confirming that the mirroring is a result of a layer of particles on the surface of the emulsion. In addition, Hendriks (1991) discusses the evidence found by Weyde (1955) that silver ions also migrate down to the baryta ($BaSO_4$) layer of the photograph. The migration of silver to the baryta layer is irreversible. Treatment is restricted to the accessible silver that is deposited on the surface of the print.

It is not possible to return the silver in the surface 'mirror' to its original location within the emulsion layer. Therefore, methods for its reduction or removal have been investigated and practiced with varying results. Luzeckyj (1999) found that removal of silver mirroring using vinyl erasers caused abrasion and burnishing of the surface. Treatment using an ethanol/water solution applied with cotton swabs was also determined to remove material from the emulsion layer of matte samples, causing voids that were visible in SEM micrographs. A third technique investigated the use of microcrystalline wax and methylcellulose to coat the surface of matte and glossy prints with silver mirroring. Luzeckyj reports that the coating was more effective for reducing the metallic sheen visible on the matte sample than that on the glossy sample. However, the surface of the matte print was altered as the coating materials filled recesses in the surface producing a smooth appearance. The only test that effectively removed the silver mirroring without altering the surface characteristics of the photograph was a wet chemical treatment using an iodine/ethanol solution (Weyde 1977) followed by fixing and bathing the print.

Literature indicates Weyde's solution of iodine and ethanol has been effectively used for the reduction of silver mirroring on both prints and negatives. Anhydrous ethanol is necessary in order to prevent any included water from swelling the gelatin layer, thereby allowing the iodine to penetrate and attack the image silver (Hendriks 1991) in addition to the surface silver present in the mirroring. Nishimura (2001) outlines other concerns with the treatment. He states that it is difficult to monitor the photograph in the opaque deep-purple iodine solution, and treatment in a shallow bath is advocated. However, such a treatment situation could lead to increased water absorption from the air unless the bath is kept covered. In considering the ancillary benefits of this treatment, it is also important to note that based on Brandt's (1984) study on silver image stability, iodine treatment has a potentially stabilizing effect when silver particles with adsorbed iodide ions resist oxidation by peroxides.

Once exposed to iodine in the ethanol solution the photograph is submersed in a series of fixing and washing steps to remove the silver iodide. The reaction has been described by Nishimura (2001) and outlined as follows:

$$1/2\ I_2 + Ag \rightarrow AgI$$

$$AgI + n(S_2O_3)^{2-} \rightarrow Ag(S_2O_3)_n^{(2n-1)}$$

Nishimura explains that the silver thiosulfate compound is soluble in the final wash when n equals 2 or 3.

In the present study, a variation on the iodine treatment was explored. Because of its ability to sublime at room temperature, iodine could potentially be used in the gas phase to treat silver mirroring on photographic negatives and prints. In these experiments, one sample set was exposed to vapor phase iodine and compared to a second set of samples treated using Weyde's ethanol solution of iodine. The vapor treatment successfully reduced the visual effects of silver mirroring from the surface of a naturally aged matte gelatin silver photograph during the initial tests. The paper support was also brightened. This result was expected since it is known that iodine is a mild oxidative bleach. This bleaching has been observed in the past as well during experimentation with Weyde's formula during a PMG workshop (Nishimura 2001). Further analytical work was undertaken to assess the chemical and visual effects of both treatment approaches.

Importantly, the iodine vapor treatment removes the need for expensive anhydrous ethanol as well as reducing the risk of swelling the gelatin emulsion during the treatment step. The original hypothesis that the iodine vapor treatment only reacts with the silver particles on the mirrored surface of the emulsion was investigated using XRF, SEM, and TEM.

3. Experimental Section

3.1 Treatment Samples

A total of 48 samples were removed from both freshly processed as well as naturally aged gelatin silver prints. The new gelatin silver prints were developed from a Kodak 10-step Q13 grayscale negative onto semi glossy Kodak Polymax Fine Art Paper, Figure 1.

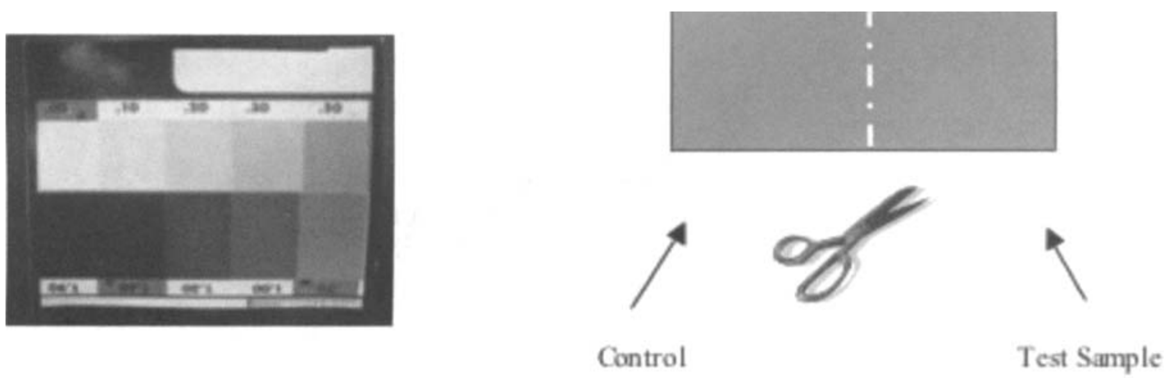

Figure 1. Freshly processed black and white silver gelatin prints used to assess the attack of the iodine treatments on image silver. Each D_{max}, D_{med}, and D_{min} sample was cut to provide test and control samples for each treatment.

Kodak Professional Fixer was used to process the freshly prepared photographs and in the treatment steps described below. Three sets of samples were chosen to represent a minimum (D_{min}), medium (D_{med}), and maximum (D_{max}) image density from the sections marked 0.00, 0.70, and 1.90, respectively. An evenly exposed area was chosen for each image density sample and cut to provide both control and test sample with a shared cut edge for cross-section analysis. No silver mirroring was developed on these samples; they were used to evaluate only the effect of each treatment on image silver within the gelatin emulsion.

Naturally aged gelatin silver developed-out photographs with signs of silver mirroring and yellow colloidal silver were selected from vintage photographs of unknown age (likely 25-50 years old). The photographs were donated to the department with the understanding that sampling techniques and analysis were destructive. Control and test samples were cut in the same manner as the *freshly processed* photographs.

3.2 Iodine/Ethanol Treatment

This treatment, detailed in Scheme 1, followed an adapted version of the Edith Weyde Formula. The alcohol used was anhydrous, containing 94-96% ethanol and 4-6% methanol and isopropanol. The samples tested were equilibrated prior to treatment to the laboratory conditions: approximately 70°F and 45% RH. The tray containing 0.1% (w/v) iodine in ethanol was covered with a sheet of clear acrylic during treatment to prevent moisture in the air from entering the ethanol bath.

Scheme 1.

Iodine/Ethanol Treatment

1. Submerse sample in 0.1% (w/v) iodine/ethanol solution (3 min or 9 min).
2. Rinse in anhydrous ethanol bath for 1 min.
3. Submerse in Photoflo bath for 1 min.
4. Fix for 10 min with constant agitation.
5. Rinse with running deionized water for 1 min.
6. Submerse in Hypoclear for 3 min.
7. Wash with running deionized water for 30 min.
8. Submerse in Photoflo for 30 sec.
9. Air dry.

Two sample sets were tested for (A) 3 min and (B) 9 min in the iodine/ethanol solution. The length of the iodine treatment was based on a frequently reported minimum 2-3 minute treatment time as well as a maximum treatment time (9 min) that was purposefully much longer than necessary to achieve desirable results. These two treatment times were chosen to evaluate whether the aggressiveness of the iodine on image silver correlated with the exposure period.

3.3 Iodine Vapor Treatment

To create a sealed vapor chamber, a glass dessicator with perforated ceramic shelf was set up with a thin layer of silicon vacuum grease spread on the lid for the seal, Figure 2. A Petri dish containing roughly ½ tsp. iodine crystals[1] was placed at the bottom, below the ceramic shelf. The sealed chamber system was set into a fume hood. The crystals began to sublime and developed an even purple gas within the chamber. The chamber could be set on a warm surface to accelerate sublimation, although it was not necessary. Iodine crystals were replenished as needed.

In order to expose samples to the iodine vapor, the container was opened by sliding the lid to the side providing enough of an opening to place the samples or photographs onto the ceramic shelf. To contain some of the vapor within the chamber during this process, the fume hood exhaust was shut off briefly, samples were placed inside, the lid was replaced on the chamber, and the exhaust turned on immediately to remove any iodine gas that escaped the chamber. The concentration of gas was not monitored and may have varied somewhat between treatments. The chamber was sealed to allow the iodine to sublime for approximately 10 minutes between sample exposures.

[1] Iodine is stored as a black/purple solid and sublimes at room temperature to a purple gas with an irritating odor. Iodine is CORROSIVE. It can cause eye and skin burns, severe respiratory and digestive tract irritation, and possible allergic reactions with skin. Target organs include the kidneys and thyroid. Wear protective clothing, gloves, and goggles while working with iodine in ethanol or as a gas under a fume hood. Do not inhale fumes.

Figure 2. Sealed dessicator chamber with perforated ceramic shelf for iodine vapor treatment.

Treatment of samples using the iodine vapor technique, Scheme 2, followed the steps outlined in Scheme 1 for the alcoholic iodine treatment with the exception that steps 1 through 3 were substituted with exposure of the samples in the iodine vapor chamber. Treatment times were chosen based on testing of a preliminary sample set, which indicated that (A) 30 seconds was sufficient for removal of moderate silver mirroring, and (B) 5 minutes was well over the time necessary for successful treatment of all the samples tested. Once exposed to iodine vapor, the surface of the samples obtained a purple hue. Some residues and stains on the reverse of samples also changed color in the vapor chamber. The purple hue dissipated immediately upon submersion in the fixing bath. Staining was not visible after treatment.

Scheme 2.

Iodine Vapor Treatment

1. Expose sample in iodine vapor chamber (30 sec or 5 min).
2. Fix for 10 min with constant agitation.
3. Rinse with running deionized water for 1 min.
4. Submerse in Hypoclear for 3 min.
5. Wash with running deionized water for 30 min.
6. Submerse in Photoflo for 30 sec.
7. Air dry.

4. ANALYSIS

4.1 Spectrophotometer Color & Gloss Measurements

A GretagMacbeth® Color Eye® XTH spectrophotometer was used in conjunction with Color iControl software to analyze the sample sets from both schemes before and after treatment. The D65 Illuminant was used with the 10° observer, spectral component included, and small area of view (SAV) attachment. This non-destructive test was used to record color measurements using the CIE L*a*b* color space. Color difference (ΔE^*) was calculated by the Color iControl software. The value is calculated from changes in each L*, a*, and b* component: $\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$ where ΔL^* represents the change in lightness/darkness, Δa^*

represents the change in the redness/greenness, and Δb^* represents the change in yellowness/blueness of the sample. In addition, a 60° gloss measurement was recorded, with changes in gloss after treatment being expressed as ΔG. A $-\Delta G$ value reveals a greater gloss after treatment, and a $+\Delta G$ value indicates a more matte surface. The meter was programmed to obtain three consecutive readings and record the mean value. A calibration of the spectrophotometer was conducted at the start of each session using a standard white tile provided by the manufacturer.

Comparisons of the quantitative data with the impressions from visual inspection are essential to evaluate the reported values for ΔE^*, ΔL^*, Δa^*, and Δb^*. R. Johnston-Feller (2001) stresses that the data related to changes in color from different regions of the color spectrum are not equal to one another. It is indicated that, "one unit of color difference in the blue region does not represent the same perceived difference as one unit in the red region" (pg. 33). However, a total change in color, represented by ΔE^*, is calculated based on each of the regions as equal parts in the ΔE^* equation. Although a $\Delta E \geq 1$ is often reported as the limit for a visibly perceptible change in color, Johnston-Feller points out that this is based on an industry standard that is dependent on the equation used. It is not necessarily indicative of a just perceivable difference, and Johnston-Feller suggests the value of total color change calculated from the above equation represents approximately three times a just perceivable difference, but only under ideal viewing conditions that are rarely achieved in practice.

Results of Spectrophotometer Analysis:

***Freshly Processed Samples*:**

Color measurements of *freshly processed*, non-mirrored photographs treated with the two iodine protocols were difficult to confirm visually. According to the color data, expressed in positive ΔL^* values, all freshly processed samples were lighter after treatment with iodine regardless of its form. This measured change was not visibly detected despite ΔL^* values as high as 2.97. Changes in Δa^* (redness/greenness) were negligible with a maximum value of -0.18 reported. The changes in the yellowness/blueness were expressed in low Δb^* values ranging from -0.09 (bluer) to 0.59 (yellower). There was no significant difference between the data from iodine vapor or ethanol solution treatments for the freshly processed photograph samples.

The gloss changes for all three image density sets of *freshly processed,* non-mirrored samples were small and seemingly random in the direction of their change. The ΔG values could not be visually confirmed; the naked eye could not detect changes between untreated controls and the iodine treated test samples.

Naturally Aged Samples:

Before treatment, D_{min} samples showed no visible mirroring on the surface of the historical photograph, but the areas appeared yellowed due to either small amounts of colloidal silver or due to yellowing of the support and gelatin emulsion. Color measurements confirmed this observation as all D_{min} naturally aged samples fell within the yellow area of the 1976 CIELAB color space. After both the ethanol and vapor treatments, this yellow component was reduced as evidenced by substantially negative Δb^* values. Similarly, the ΔL^* value indicated the samples were significantly lighter after treatment. The ΔL^* values were 4.32 and 4.61 for the vapor treatment performed on two D_{min} replicates, and 3.2 and 3.7 for those treated with the ethanol solution. There was negligible change in Δa* values. The large magnitude of the ΔL* and Δb* values contributed to the most significant ΔE* values calculated for any sample set tested.

Gloss values for D_{min} *naturally aged* samples were somewhat problematic. These samples were most likely too matte to obtain reliable measurements using the 60° gloss setting available on the ColorEye XTH instrument. Typically a more oblique 85° measurement best highlights subtle changes in matte surfaces. Regardless, no change in gloss was visibly identified for the D_{min} *naturally aged* samples.

Color data indicated that the *naturally aged*, heavily mirrored D_{max} samples were darker after treatment, as one would expect when removing the highly reflective surface silver. Data relating to samples submersed in the ethanol treatment showed the greatest -ΔL* values. Removal of the silver mirror revealed the less reflective, rich dark image tone beneath. The Δb* values indicate a greater change in samples treated with the Weyde formula than with the iodine vapor treatment. The +Δb* values represent a greater reflectance in the yellow region of the spectrum and is attributed to the reduction of the mirroring, which often has a silvery-blue tone. The silver mirroring was observed to be more highly reflective of the shorter wavelengths of the visible spectrum. Because the silver mirror is removed by the iodine treatment, the +Δb* values are not interpreted as a change in the color of the photographic image within the emulsion, but a reduction of the density of mirror particles from the surface.

D_{med} and D_{max} *naturally aged* samples contained visible silver mirror before treatment. Both vapor and ethanol treatments were successful in reducing the mirroring, producing +ΔG (more matte) values for all samples. Changes in surface texture of the emulsion underlying the silver mirror due to treatment with either iodine method could not be confirmed through visual inspection of samples when comparing D_{med} and D_{max} areas.

4.2 X-Ray Fluorescence Spectroscopy (XRF) of *Freshly Processed* Samples

An attempt was made to determine whether image silver within non-mirrored, *freshly processed* Q13 grayscale samples was affected by either iodine treatment. In addition, the XRF spectra were utilized in an attempt to identify the presence of residual iodine in the treated samples. Control and treatment samples were analyzed using an ArtTax μXRF spectrometer (Bruker). The molybdenum x-ray tube was operated at 50keV and 70μA with a helium purge gas to reduce absorption of characteristic x-rays from low atomic number elements. The area sampled was 1 mm in diameter, and data were collected during 90 second scans. Three scans were completed in the same spot on each sample, and the mean and standard deviation was found for the three analyses. Peak counts for barium (Ba), strontium (Sr), and silver (Ag) were recorded as were the counts per second (cps) for each element.

Results of XRF: Iodine & Image Silver

Peak counts for Ba vs. Ag k-alpha peaks were plotted, as were identical graphs using the counts per second. The two plots showed identical trends, therefore only peak count data were used for further assessment of the samples. A strong correlation is observed in Figure 3 between the three sample sets of varying image density; when Ag peak counts increase (e.g. in the D_{max} samples), the Ba peak counts decrease. This may be the result of an attenuation effect of the barium in the sample due to screening by the overlying layer of silver. The D_{min} and D_{med} samples displayed very low peak counts for silver, and so the D_{max} sample sets provided the best opportunity to study the potential loss of image silver due to the iodine treatments.

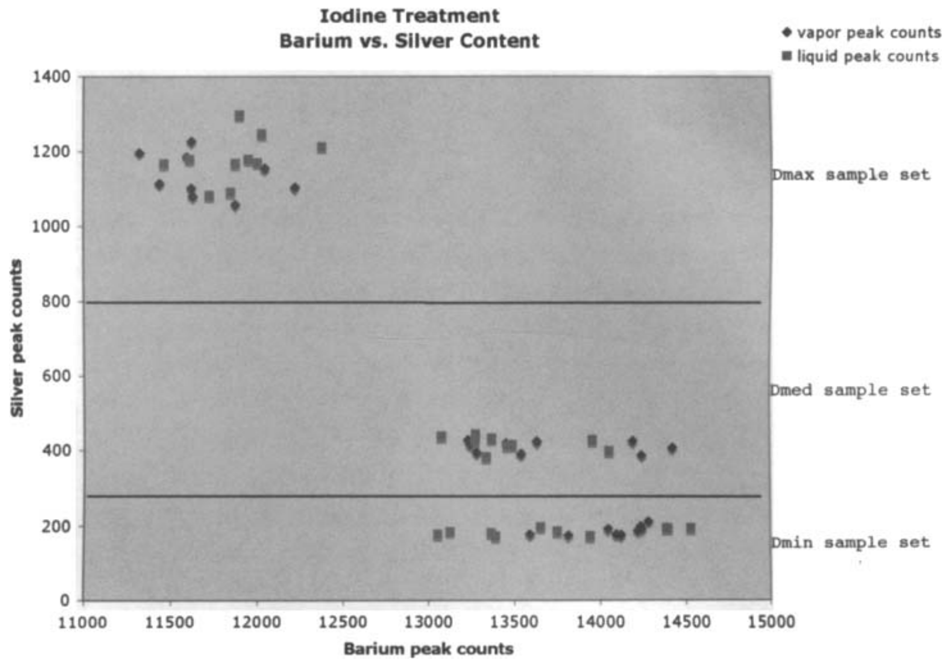

Figure 3. Distribution of peak count data for Ag vs. Ba collected for non-mirrored, freshly processed samples.

Figure 4 shows the mean values with error bars for Ag and Ba peak counts in the D_{max} control samples and the same samples after the two iodine treatments for both (A) short exposures and (B) long exposures. Each data point represents the average of three replicate analyses with a 3.3% error in Ag and a 1.4% error in Ba peak count data.

A small change in Ag counts is apparent when comparing the control to the two shorter treatments (liq A and vap A). The longer treatments (liq B and vap B) showed a slightly increased loss of silver content in these freshly processed, non-mirrored samples. At this scale, the proximity of the data points to one another in conjunction with the size of the error bars indicates that there is little difference between the vapor and liquid treatments with regard to their effect on image silver. Additionally, only a modest increase in image silver loss appears to occur with excessively long treatments by either method. It is recognized that these data are at best semi-quantitative and further testing and analysis using quantitative analytical techniques would be necessary to confirm any trends observed here. Importantly, visible assessment of the controls and treated samples showed no evidence of change in color or lightness for these *freshly processed* Q13 gray-scale samples.

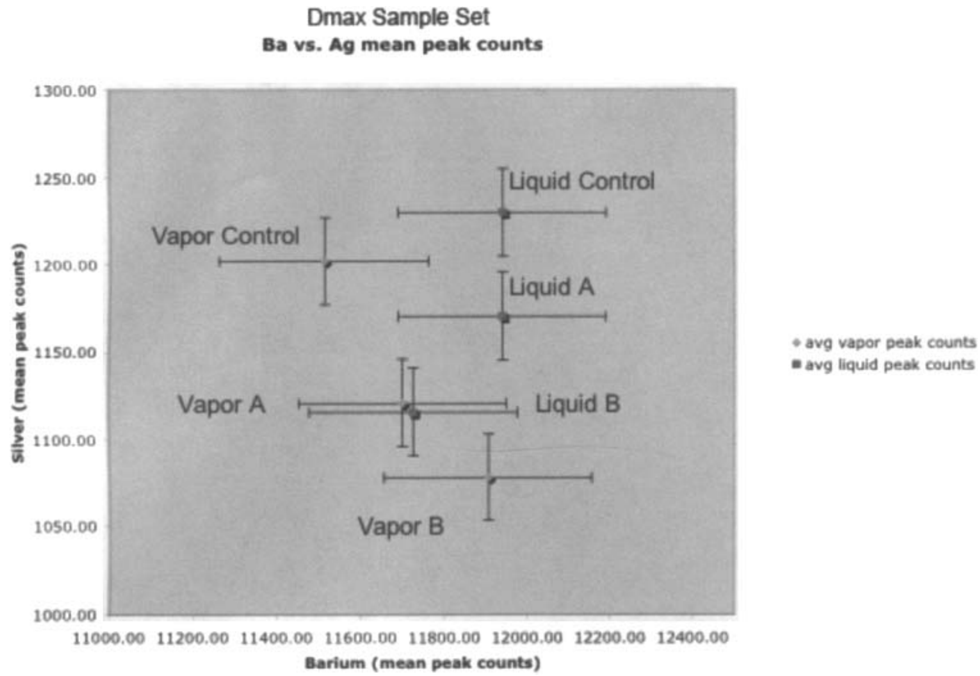

Figure 4. Distribution of peak count data collected for Dmax, non-mirrored, freshly processed samples.

4.3 Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM/EDS)

Cross-sectional analysis was performed for both *freshly processed* and *naturally aged* samples using scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM/EDS). SEM/EDS helped to identify whether any silver iodide remained in the emulsion after treatment. SEM provided a backscattered electron (BSE) image of the samples that was then used to target specific areas for analysis using EDS, which produces an elemental analysis of the area. The technique required the removal of microsamples, which were then embedded in epoxy, ground to expose the cross section, and finely polished. Carbon coating was used to reduce charge buildup on the samples during SEM/EDS analysis.

Results of SEM/EDS: Iodine & Silver Particles

Figure 5 shows the EDS spectrum of an area of high silver content in the D_{med} samples treated in the iodine vapor chamber. No iodine was present above the limit of detection for this technique, e.g. ~1%.

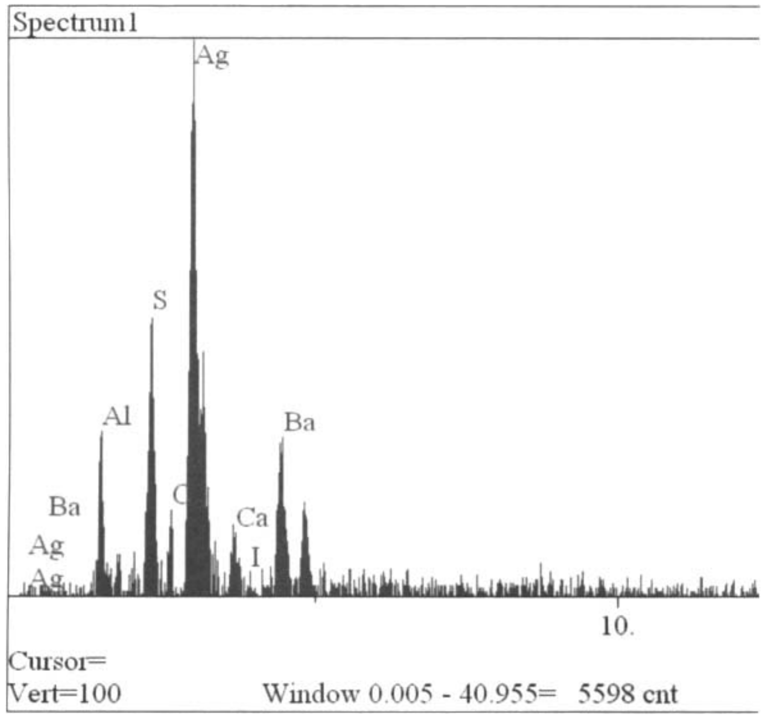

Figure 5. EDS spectrum of a freshly processed Dmed sample treated in the iodine vapor chamber. No residual iodine was detected.

4.4 Transmission Electron Microscopy

Transmission electron microscopy (TEM) produces a beam of electrons that are accelerated and transmitted through a thin section of the original sample. The cross-section absorbs electrons depending on the composition of the material and the thickness over the section, i.e. folds appear darker as do more atomically dense features. The resulting image is magnified and displayed on a screen.

TEM analysis of control and iodine-treated sample cross sections was completed by Ann Lehman, Director of Electron Microscopy at Trinity College in Hartford, CT. Samples were embedded with Spurr's low viscosity embedding mixture using the 'firm standard formula' provided by the manufacturer. Prior to embedding, samples were dehydrated using a 100% ethanol soak for 20 minutes. This was followed by a two step infiltration of 50/50 resin/ethanol for 20 minutes then 100% resin for 40 minutes. Each resin block was labeled, and then the samples were cured in a 70°C oven. The cured blocks were cut into thin sections of approximately 70 nm thicknesses using an ultramicrotome. Extensive sample preparation was necessary to produce thin cross sections in good condition for analysis. The preparation and cutting of samples was difficult as many suffered tearing and wrinkling of the photographic emulsion. Cross-sections were placed on a copper mesh support and examined using a Philips/FEI TEM at 120kV.

The TEM research is still in progress at the time of writing. Analysis of images collected by TEM will continue with more quantitative measurement of the size, distribution, and quantity of silver particles for evaluation of the effects of the different iodine treatments on silver mirroring as well as image silver.

Current Results of TEM:

TEM proved to be the most useful technique for visual analysis of cross-sections from naturally aged, heavily mirrored D_{max} samples. Silver mirroring is clearly detectable at the surface of the emulsion, as shown in the before treatment image of Figure 6 (left). The silver particles at the surface often appear tightly packed and rounded in shape. Some samples exhibited gaps in the mirror layer; however, this is likely an artifact of sampling and thin section preparation. Directly below the surface of the mirroring layer lie much smaller, round silver particles that generally appear to increase in size the closer they are to the surface. Similar observations were made by di Pietro (2002) in a study of mirroring on glass plate negatives. The mirroring is clearly removed from the surface of the emulsion following iodine vapor treatment (right). Qualitative inspection of cross-sections and recorded TEM images has not yet revealed any significant changes to silver particles within the emulsion, or 'image' layer, following treatment. Additional, quantitative analysis is currently underway.

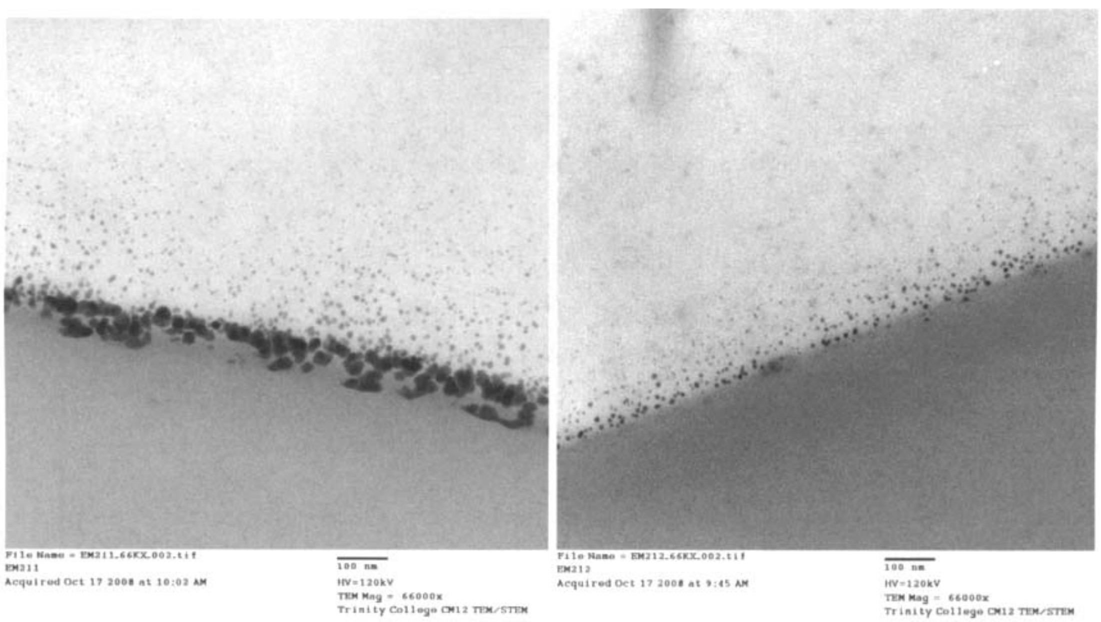

Figure 6. Naturally aged D_{max} samples before (left) and after (right) iodine vapor treatment. The emulsion layer lies at the top of each image. The silver mirroring (left, dark layer) is largely removed following treatment (right).

5. Iodine Vapor Treatment Applied to Actual Photographs

In addition to evaluating the new vapor technique using freshly prepared photograph samples, two gelatin silver photographs were treated in order to gauge the effect of the treatment in actual practice. The historical photographs exhibited two varieties of silver mirroring deterioration: the print shown in Figure 7 (left), displayed a hazy silver mirror while the print shown in Figure 8 (left) was visibly mirror-like and difficult to read.

Figure 7. A matte gelatin silver print with a hazy form of silver mirror deterioration on the surface before treatment (left) and the same print after iodine vapor treatment (right). The details of the background and density of image in the hair and shadows has become more readable.

Each photograph was lightly surface cleaned to remove any dust or grime and treated for three minutes in the vapor chamber. The iodine exposures were followed by the same series of fixing and washing steps as outlined earlier in Scheme 2. Figures 7 and 8 (right) show the dramatic improvement in the appearance and readability of these historical images in specular lighting.

Figure 8. A gelatin silver print with a highly reflective form of silver mirror deterioration on the surface (left) and the same print under identical specular lighting following iodine vapor treatment (right). The details in the dense image areas have become more readable.

6. Conclusion

The iodine vapor treatment developed and tested during this research was effective in reducing silver mirror deterioration from the surface of the photograph samples tested. Color measurement, microscopy, and visual inspection confirmed this. After treatment, greater changes were clearly evident among *naturally aged* photographs. *Naturally aged* D_{min} samples clearly showed the effects of what may be the mild oxidative bleaching action of iodine combined with aqueous washing, a technique known to remove soluble discoloration from fiber based materials. These slight color changes detected in the yellow/blue areas of the color spectrum should be expected as a side effect of treatment with iodine vapor as well as with the Weyde formula, especially in the highlights of silver gelatin photographs. Although further investigation is clearly necessary, there has been no significant evidence thus far to indicate that iodine vapor penetrates the emulsion and effects image silver.

These comparative XRF analyses can neither confirm nor disprove theories that iodine treatment effects image silver within the gelatin emulsion layer. However, they do suggest a potential change that is too small to identify accurately using the equipment available for this study. Further analysis of cross sections imaged using TEM will provide more information regarding the effects of iodine treatment applied to silver gelatin photographs.

The treatments applied to actual mirrored photographs helped to restore the contrast of silver densities obscured by silver mirror deterioration. Technically, image silver is lost in the treatment of these objects as the silver mirror deterioration now at the surface of the emulsion was once held within the gelatin emulsion as image silver. Once deposited on the surface, it is no longer a part of the image, but a shield, obscuring the image beneath its surface.

There are benefits and drawbacks to each treatment option. These must be thoroughly understood before considering such treatment of actual art or historical images. The chemical and appearance characterizations for samples treated by both methods, i.e. ethanol solution and vapor phase iodine treatments, was nearly indistinguishable. In addition, it was difficult to see by eye the changes measured by the analytical techniques used in this study; the exception being the clear removal of silver mirroring and a reduction of yellowness in image highlights of naturally aged photographs. This treatment has been shown to provide better stability to the photographic image after treatment, thus reducing the recurrence of mirroring (Brandt 1984). This preventative aspect should be considered in the evaluation of these techniques for conservation treatment of photographic prints and negatives.

A practical comparison of these treatment protocols revealed some benefits of using iodine vapor over an anhydrous ethanol solution. During the treatment procedure it became obvious that the samples were easier to see and monitor in the vapor chamber than in the colored iodine solution bath. In addition, since the vapor is so effective for short treatment times, it may be possible to develop a system or device for more controlled, local application of vapor. Such a treatment could avoid the ancillary bleaching effect of the iodine on image highlights if warranted. The elimination of ethanol during treatment essentially removes the risk of swelling the gelatin emulsion, eliminating one potential mode of attack on image silver. In addition, the iodine vapor treatment is considerably faster, significantly cheaper, and easier to maintain than using anhydrous ethanol baths.

As is the case with virtually all conservation treatments, it is up to the careful considerations of the conservator to decide if the benefits and potential drawbacks of the treatment are worth carrying out on the object. The data presented in this project adds to the information available to the conservator about the chemical reduction of silver mirroring.

7. Acknowledgements

The authors wish to thank Ann Lehman (Trinity College Electron Microscopy Facility) and Peter Bush (University of Buffalo South Campus Instrument Center) for assistance with analytical measurements. Profs. Dan Kushel, Aaron Shugar, and Judith Walsh of Buffalo State College's Art Conservation Department are recognized for their guidance and assistance throughout this research. Henry A. DePhillips Jr. (Dept. of Chemistry, Trinity College), Doug Nishimura and Jim Reilly (Image Permanence Institute), and Mogen S. Koch (The Royal Danish Academy School of Conservation) are acknowledged for their helpful comments regarding the iodine vapor treatment. SB was supported through a Margaret & Charles Balbach Art Conservation Fellowship, a Buffalo State College Tuition Scholarship, and funding through the Leo & Karen Gutmann Foundation and the Stockman Family Foundation. GDS received research support funding through the Andrew W. Mellon Foundation.

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Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

TIP: LOCALIZED LIGHT BLEACHING WITH A FIBER OPTIC LAMP

VALERIE BAAS AND SARAH FREEMAN

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Occasionally challenging problems require innovative treatments. Sometimes objects are deemed "unexhibitable" due to condition problems that are perceived to be too difficult. The Getty Museum has a small group of photographic materials that fall into this category.

A portrait of "Eleanor", a triptych, in the Museum's collection by Harry Callahan is one of these unfortunate examples. The Museum was planning to display a selection of the collection's great portraits in February 2009 and Callahan's work was under consideration. The curator noted that a green stain located in the center print of the triptych was very disfiguring and she asked what could be done, if anything, to improve the print. After consulting the conservation records for the museum and reviewing the current condition of the print, we resolved to attempt a treatment. Recent research on the efficacy of light bleaching on gelatin silver prints overall has revealed that light bleaching can produce excellent results for some gelatin silver prints. Methods for local light bleaching for fine art on paper have proven successful under certain conditions.

The problem: The green stain. It appeared to be permanent, possibly a spot toner. The stain penetrated the gelatin emulsion layer and created a disfiguring mark in the center of the image. Solubility tests on the stain were all negative, that is, nothing seemed able to move or lighten it. The surface of the print and the mount did not react to the application of moisture or solvents during testing. We considered what the risks would be for chemical bleaching and light bleaching. The print is mounted to a signed illustration board, which is Callahan's original presentation. We felt that this aspect of the artist's intention should be preserved. We then considered how we could treat the stain without removing the print from the mount. Successful tests with light bleaching led to the treatment and local reduction of the stain.

The treatment process: The object was placed flat on the worktable and the lamp was adjusted so that the illumination was directed over the stain area. Small beads of de-ionized water were applied to the area of the stain locally with a Winsor Newton Series 7 sable brush. The lamp provided a small area of light with a soft edge. This helped to prevent the appearance of bleach borders and eliminated the need for masking templates. The lamp was approximately 1cm away from the surface of the print. The lamp intensity was raised to the highest level and care was taken to be sure that the fan was running continuously during the exposure time. The lamp partner to the fiber optic extension was directed away from the print during exposure.

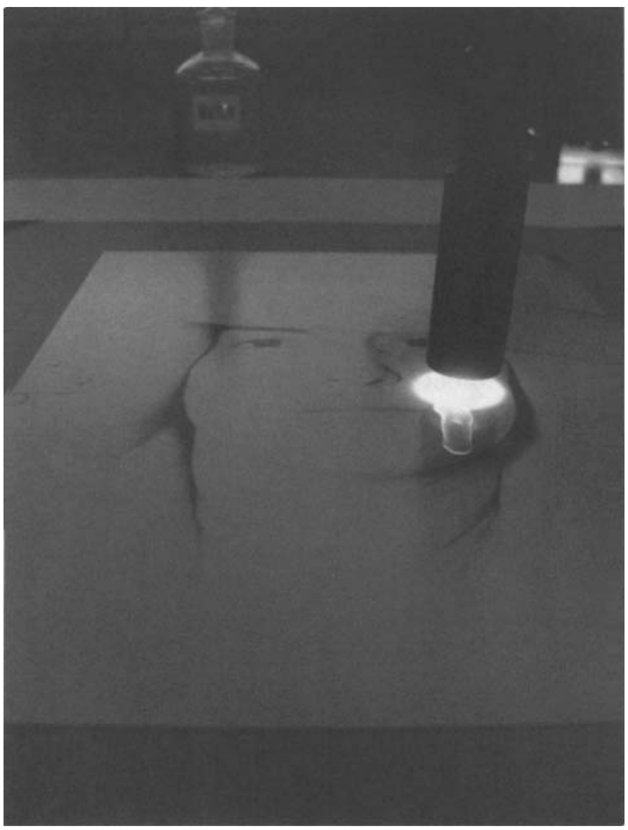
The stain was exposed for approximately four hours, with close monitoring, and rewetting whenever the area appeared dry. Care was taken to avoid possible darkening of the exposed area during treatment. The stain was not completely eliminated, but reduced sufficiently to allow the viewer to enjoy the portrait.

Materials: We used a McBain Instruments Fiber Optic unit with a 250-watt Eiko quartz halogen projector lamp. The ultraviolet radiation and lamp intensity at the end of the fiber optic tube was measured with an Elsec 764 light meter and readings ranged from 45-53 microwatts per lumen at full lamp intensity.

Results and conclusion:

Light bleaching as a treatment option must be carefully considered by the conservator. As a result of the treatment the portrait of "Eleanor" was displayed as a centerpiece of the exhibition. The print will be monitored in the future for changes in the stained area.

Other materials have been treated with this set-up, also with good results. The suitability of the treatment for any particular object is dependent upon the ability to control wetting and avoiding possible water staining.



Topics in Photographic Preservation, Volume Thirteen have not undergone a formal process of peer review.

RESEARCH ON METHODS FOR CLEANING FACE-MOUNTED PHOTOGRAPHS

LUISA CASELLA AND CAMILLE MOORE

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

ABSTRACT

As part of the Global Face-Mounting Initiative, Photograph Conservation at The Metropolitan Museum of Art investigated the effects of various cleaning methods on the poly(methyl methacrylate) surface of face-mounted photographs. Samples of face-mounted photographs were cleaned regularly and the effects on the photograph's surfaces were evaluated qualitatively and documented with photomicrographs. Results demonstrate that all contact cleaning methods cause some abrasion of the poly(methyl methacryle) surface. A preliminary test of an anti-static ionizing gun is also presented.

1. INTRODUCTION

Photographs face-mounted to poly(methyl methacrylate) (PMMA) have posed several new challenges to photograph conservators. PMMA, commonly known as acrylic or *Plexiglas®*, collects dust and dirt, but cleaning this sensitive plastic has proven to be a complex issue. PMMA surfaces scratch easily and the use of inappropriate solvents and cleaners may cause micro-crazing. In order to better understand the issues involved in the conservation of these photographs, conservators and scientists began an international collaborative research effort, known as the Global Face-Mounting Initiative. As part of the Initiative, Photograph Conservation at The Metropolitan Museum of Art began a long-term study on the cleaning of face-mounted photographs in January 2006. The study tested the use of various wet and dry cleaning methods to remove dust from samples of face-mounted photographs on a regular basis. The study was intended to mimic cleaning methods carried out in a museum environment in real time. Data from the study has aided in developing guidelines for cleaning face-mounted photographs on display at The Metropolitan Museum of Art.

2. BACKGROUND

The face-mounting technique was first used by artists in the mid-1970s and rose to widespread popular use in subsequent years. A face-mounted photograph consists of a PMMA sheet adhered directly to the emulsion (face) of a photograph, often a chromogenic print. The adhesive used is usually proprietary, but is often a type of silicone sealant or pressure sensitive acrylic adhesive. Prints may also be mounted on the reverse to a solid support such as aluminum or *Dibond®*.

Face-mounting has become popular among contemporary photographers for several reasons. Photographic binder, silicone rubber adhesive, and PMMA all have very similar refractive indexes, so there is little reflection and refraction of light at the interfaces between these materials. This results in colors appearing deeper and more saturated in face-mounted photographs (Pénichon and Jürgens, 2001). The PMMA layer also allows for a minimum of framing and no additional glazing, lending a sense of immediacy to the photograph that is not possible with a print matted and framed in the traditional manner. Face-mounting a photographic print also creates a flat and rigid object that is in many ways easier to handle than a traditional photograph, especially if the photograph is in a very large format.

As with other contemporary art works made using new materials or techniques, conservators have questions about appropriate treatment methods for face-mounted photographs. Unlike the glazing in a frame, the PMMA in a face-mounted photograph is an integral part of the artwork and cannot be easily replaced. Therefore, the methods that have been used to clean the acrylic glazing in a traditionally framed artwork may not be appropriate for use on the acrylic surface of an art object.

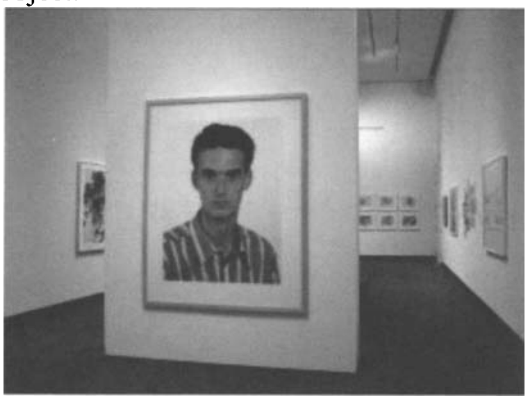


Fig. 1. *Face-mounted photograph by Thomas Ruff on display in the Joyce and Robert Menschel Hall for Modern Photography at The Metropolitan Museum of Art*

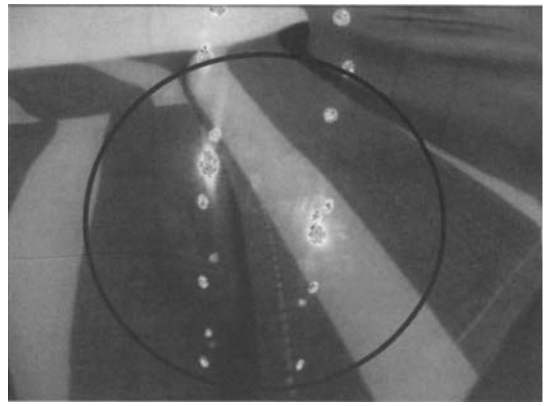


Fig 2. *Detail of fingerprints on the surface of Thomas Ruff's "Portrait (A. Siekmann)" face-mounted photograph (Acc.# 1999.210)*

3. GLOBAL FACE-MOUNTING INITIATIVE AT THE METROPOLITAN MUSEUM OF ART

The Global Face-Mounting Initiative was established in 2004 to conduct loosely collaborative research with the goal of developing sound guidelines for the preservation and conservation of face-mounted photographs. Bill Wei of the Netherlands Institute for Cultural Heritage is currently coordinating the project that involves photograph conservators in private practice and within institutions primarily based in Europe and North America.

The Metropolitan Museum of Art is participating in the Initiative by determining appropriate cleaning methods for face-mounted photographs. This is of particular importance since face-mounted photographs are usually displayed without additional protective glazing, making them susceptible to collecting dust, fingerprints and other accretions while on exhibition. The surface of PMMA is very sensitive to abrasion, so cleaning runs the risk of scratching the delicate surface, and the use of many liquid cleaners and solvents is considered risky, as they may cause internal stresses and crazing of the plastic.

Much of the research available on PMMA is from our colleagues in objects conservation. In his 1993 article, "An evaluation of eleven adhesives for repairing poly(methyl methacrylate) objects and sculpture," Don Sale noted that only two solvents typically used by conservators are safe for use on PMMA, water and petroleum (mineral) spirits (Sale, 1993). Sale noted that ketones, such as acetone, would likely swell or dissolve PMMA, while aliphatic alcohols like ethanol and isopropanol would likely cause crazing. Aliphatic hydrocarbons would also likely cause crazing of PMMA on long-term exposure. It is important to note that damage caused by solvent exposure is not always immediately visible. While cracking and crazing may not be initially present, the PMMA may be stressed by solvent contact, making it more vulnerable to subsequent solvent exposure.

Even though water has been presented as an appropriate solvent for use on PMMA, moisture absorption has also been noted to cause crazing of PMMA sheets under extreme conditions of cycling (Van Oosten, 2002).

4. EXPERIMENTAL DESIGN

In order to learn about the long-term effects of wet and dry cleaning methods on PMMA, Camille Moore, then a graduate student at the New York University graduate conservation program, established a long-term cleaning experiment in Photograph Conservation at the Metropolitan Museum in January 2006. The study has continued for several years with the help of Metropolitan Museum volunteers, interns and fellows. At the date of publication the samples had been cleaned 65 times over a two and a half year period.

The following cleaning materials (*Table 1*) were chosen from a master list developed by members of the Global Face-Mounted Initiative. The choice of materials was also guided by the results of other studies, most notably by Erin Murphy (Murphy, 2007). Museum technicians were also interviewed about commercial cleaning products they commonly use on acrylic glazing.

Table 1. *Cleaning methods included in the test*

DRY CLEANING MATERIALS
Chamois cloth
Cyber Fabric™ cloth
Cotton cloth
Hake brush
Kinetronics StaticWisk™ antistatic brush
Kinetronics StaticWisk™ with grounding cord
Kinetronics Panther™ microfiber cleaning cloth
Modem Magic Blue Suede™ microfiber cleaning cloth
Sunglasses Giant Deluxe Miracle™ lens cleaning cloth
TAP™ microfiber cleaning cloth
WypAll X-70™ cloth

WET CLEANING MATERIALS	
CLOTH	SOLVENT
Chamois	Deionized water
Kinetronics Panther™	*Kinetronics Precision* ™ glass cleaner
TAP™ microfiber	Acetone
TAP™ microfiber	*Brillianize Plastic Cleaner and Polish*™
TAP™ microfiber	Deionized water
TAP™ microfiber	*Gamsol*™ mineral spirits
TAP™ microfiber	*Kodak Photo-Flo*™ 1:200 in water
TAP™ microfiber	*Kinetronics Precision*™ glass cleaner
TAP™ microfiber	*Novus #1 Plastic Cleaner and Polish*™
TAP™ microfiber	Reagent alcohol
TAP™ microfiber	*Sparkle*™ glass cleaner

A variety of dry cleaning methods were tested, including traditional materials, like Hake brushes and cotton cloths, and newer materials, like antistatic brushes and several microfiber cloths. Microfiber is known for its softness and many manufacturers claim that the fibers actually trap dirt, so it was hoped that these cloths might produce fewer scratches during cleaning, since the cloth would trap the dirt instead of dragging it across the PMMA surface.

The wet cleaning tests also included a variety of materials, including those that are known to be harmful to PMMA, in order to represent extremes. The majority of these cleaners were applied with the same type of cloth. The *TAP*™ cloth was chosen as it performed well in Erin Murphy's initial dry cleaning tests (Murphy, 2007). The *Panther*™ cloth combined with the *Kinetronics Precision*™ glass cleaner was included since this combination is sold commercially as a cleaning system.

Fig. 3. Samples placed on ledge in the photograph conservation laboratory, The Metropolitan Museum of Art

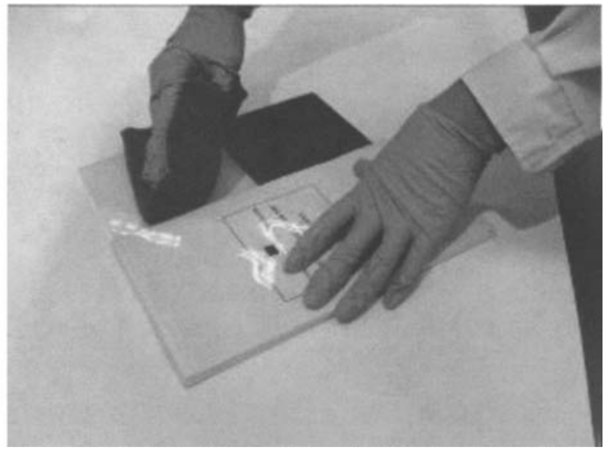


Fig. 4. Left side of sample is covered while right side is cleaned with the various systems

Samples of face-mounted photographs were obtained from Bill Wei at the Netherlands Institute for Cultural Heritage in Amsterdam. The specimens were chromogenic prints printed on *Laserchrome®* paper and were face-mounted using the *Diasec®* process by Grieger GmbH in Düsseldorf, Germany. A black and white image was selected for better visual evaluation of surface characteristics, including the accumulation of surface debris, as well surface abrasion.

The samples were placed on a ledge in the photograph conservation lab and left to collect dust, though in practice little dust settled on them (*Fig. 3*). They were cleaned according to a standardized procedure approximately two to three times per month. Half of the photograph was protected with a mat board mask, to retain as a control, while the other half was cleaned (*Fig. 4*). For dry cleaning, the surface was wiped with the cloth or brushed six times top to bottom. For wet cleaning, the cloth was sprayed with the solvent or cleaner six times. The damp cloth was then used to wipe the surface from top to bottom four times and then wiped with a dry portion of the cloth twice to remove any residual solvent or cleaner.

5. OBSERVATIONS

The samples were evaluated by visual observation under magnification and were documented with photomicrographs using a 25X objective. Although this method did not provide quantitative results, it is clear which cleaning systems produced the greatest damage.

All dry cleaning methods caused some abrasion (*Table 2*). The *Modern Magic Blue Suede*™ microfiber cloth and the dry chamois caused the least amount of scratching. The *Modern Magic* cloth caused fewer scratches than the *TAP*™ microfiber cloth, which had performed well in Erin Murphy's initial research. The most scratches occurred with the *Cyber Fabric*™, the *WypAll*™ cloth, and both *Kinetronics*™ anti-static brushes. The Hake brush, commonly trusted to be safe for delicate surfaces, also caused considerable abrasion. After Erin Murphy's publication of her research results in 2007, a sample cleaned regularly with a lambswool duster (found to be the most acceptable contact dry cleaning method in Murphy's study) was included in this test. The sample also shows scratching after 10 cleanings (*Fig. 5*).

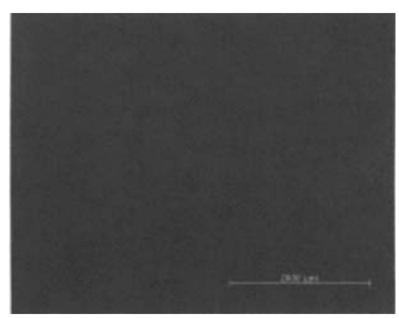
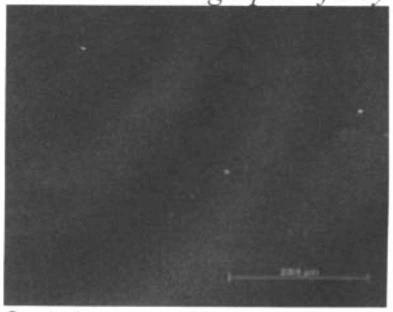
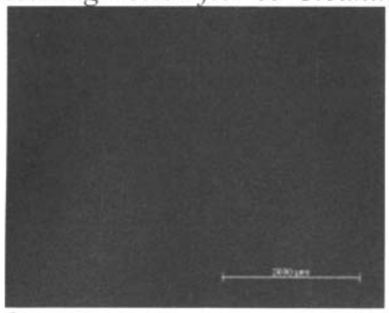
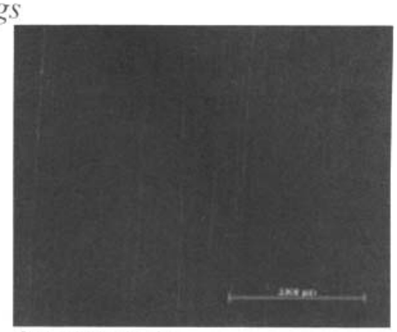


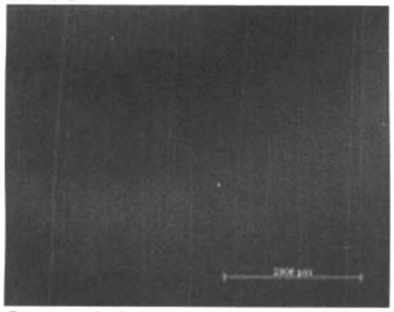
Fig. 5. Lambswool duster sample micrograph after 10 cleanings

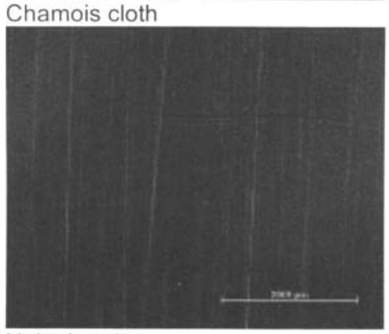
Table 2. *Micrographs of Dry Cleaning Tests After 65 Cleanings*

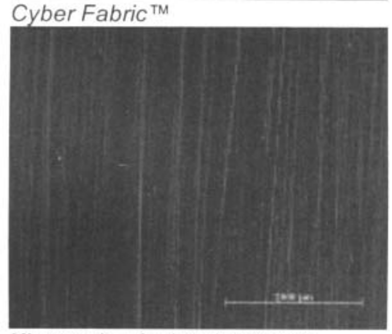

Control

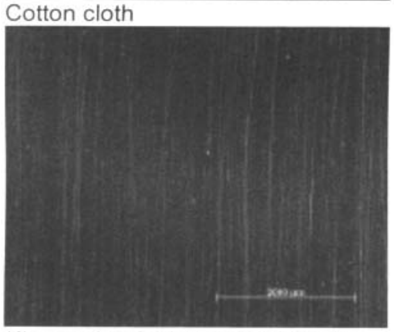

Chamois cloth

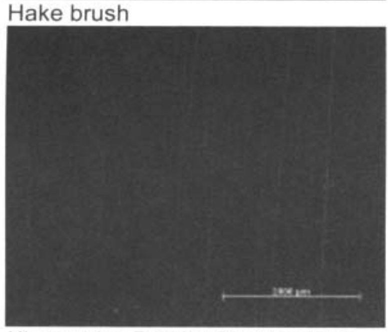

Cyber Fabric™

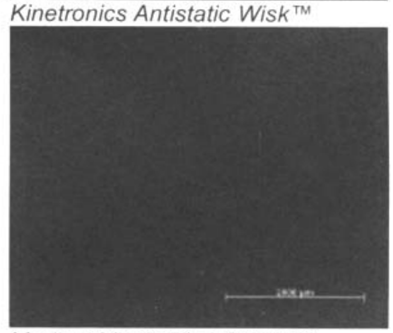

Cotton cloth

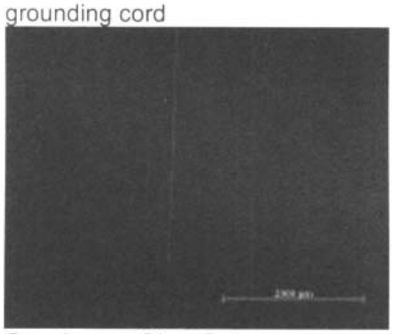

Hake brush

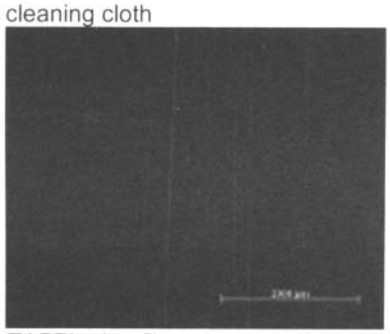

Kinetronics Antistatic Wisk™

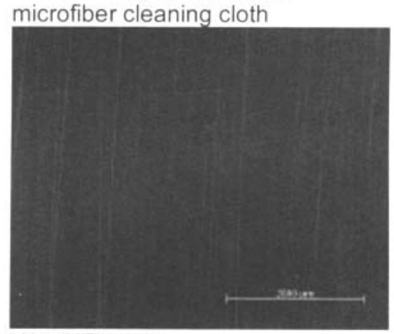

Kinetronics Antistatic Wisk™ with grounding cord


Kinetronics Panther™ microfiber cleaning cloth


Modern Magic Blue Suede™ microfiber cleaning cloth


Sunglasses Giant Deluxe Miracle™ lens cleaning cloth

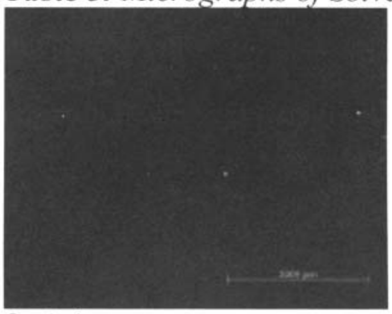

TAP™ microfiber cleaning cloth


WypAll™ cloth

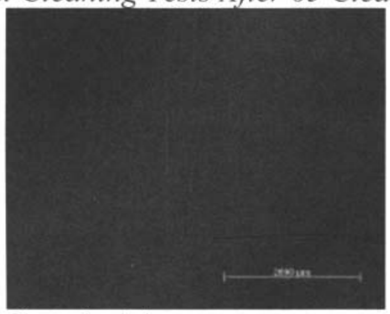
Wet cleaning methods were overall less damaging to the photographs than the dry cleaning methods. Nonetheless it is possible to observe scratches in all the samples (*Table 3*). Fewer scratches were caused by the use of *TAP*™ microfiber cloth with *Brillianize Plastic Cleaner and Polish*™ and the *TAP*™ cloth with *Novus #1 Plastic Cleaner and Polish*™. Despite their positive results in this test, these products cannot be endorsed for cleaning face-mounted photographs as they contain proprietary materials, as well as abrasive polishing particles. The long-term effects of these materials are unknown. The use of chamois with water resulted in the appearance of streaks, but this could possibly be minimized by changing the application method.

Although we do not endorse their use, it was found that the aggressive methods (acetone, reagent alcohol, proprietary glass cleaners, etc.) have not yet shown the expected damage, such as dissolution or crazing of the poly(methyl methacrylate).

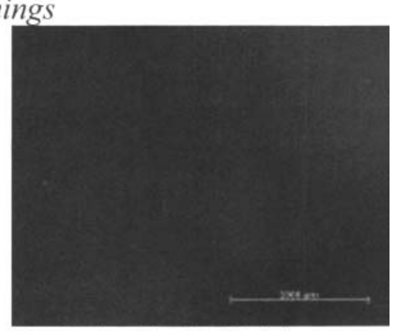
Table 3. *Micrographs of Solvent Cleaning Tests After 65 Cleanings*



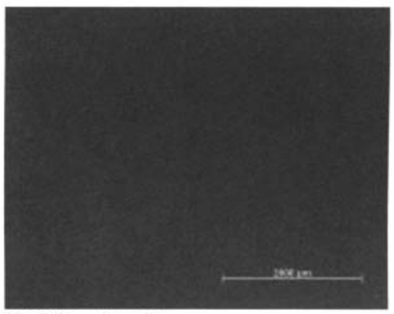
Control



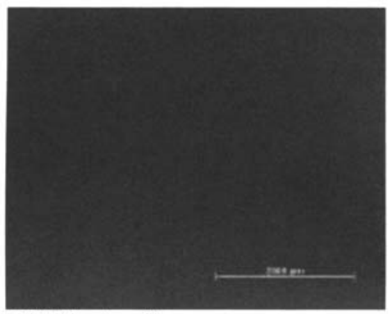
Chamois cloth + w



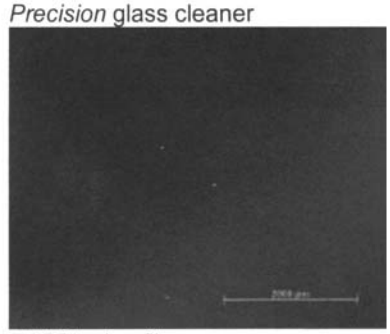
Kinetronics Panther™ cloth + *Precision* glass cleaner



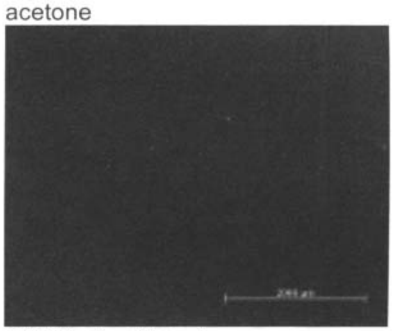
TAP™ microfiber + acetone



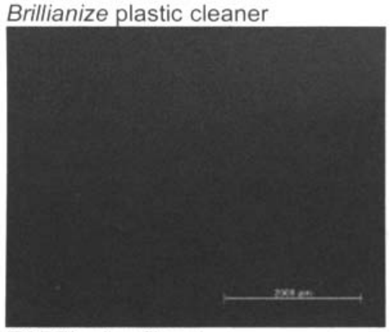
TAP™ microfiber + *Brillianize* plastic cleaner



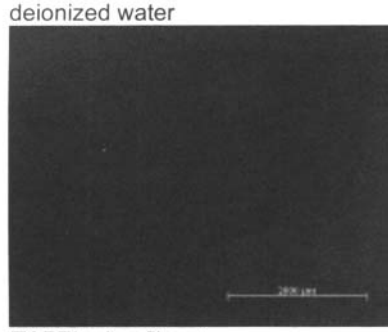
TAP™ microfiber + deionized water



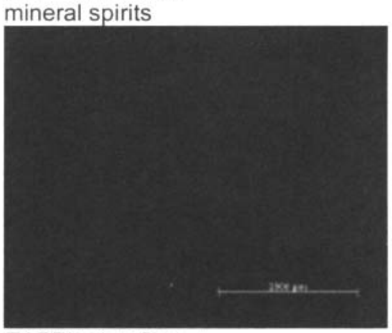
TAP™ microfiber + mineral spirits



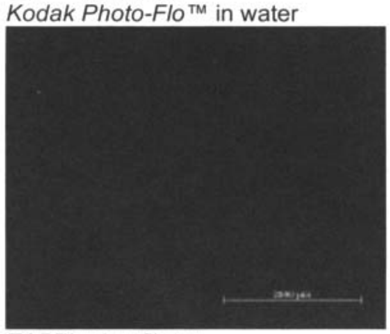
TAP™ microfiber + *Kodak Photo-Flo*™ in water



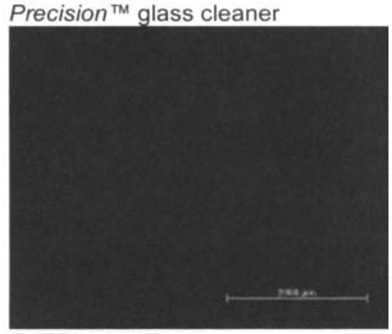
TAP™ microfiber + *Precision*™ glass cleaner



TAP™ microfiber + *Novus #1*™ plastic cleaner



TAP™ microfiber + reagent alcohol



TAP™ microfiber + *Sparkle*™ glass cleaner

6. ADDITIONAL TESTING: ROUGHNESS MEASUREMENTS
Selected samples were sent to Bill Wei at the Netherlands Institute of Cultural Heritage (ICN) for roughness measurements using a confocal profilometer (µSurf from NanoFocus). These measurements will provide quantitative results in the future. No results were available at the time of submission of this article.

7. ADDITIONAL TESTING: ANTI-STATIC IONIZING GUN

The use of an anti-static ionizing gun has also been suggested as a possible efficient and safe cleaning method (Murphy, 2007). This device uses an ionization process that converts surface particles into neutral ions by adding or removing charged electrons or excess ions. This breaks the static bond between an object's surface and accumulated debris. The anti-static gun is attached to a compressed air source. The airflow passes through the gun's ionizing point and then neutralizes the surface of the statically charged object. In the course of this research, a 190HP gun from *Electrostatics* was informally tested (*Fig. 6-8*).

Fig. 6. *Measuring static on face-mounted photograph*

Fig. 7. *Anti-static ionizing gun (190 HP from Electrostatics) attached to air compressor*

Fig. 8. *Using the anti-static ionizing gun to clean a face-mounted sample*

Tests were performed on dusty samples, and an air brush compressor was used as an air source. When a low airflow was applied, debris was not removed completely from the samples. Turning the ionizing function of the gun on and off produced identical results, indicating that the anti-static component offered no advantage.

Another attempt was made to slowly neutralize the surface by blowing the ionizing airflow on the sample for a period of 5 minutes. Again, this had identical results to use of continuous airflow with the gun's anti-static function turned off. The use of a higher level of air pressure was more efficient in removing the surface dust due to the physical strength of the airflow. Debris that was not removed with the gun could be easily removed with an air bulb.

It is likely that there is not a great amount of static tension on a surface of a face-mounted photograph and, therefore, the use of anti-static guns is not an efficient method for cleaning these objects. An informal measurement of the surface static electricity of Thomas Ruff's "Portrait (A. Siekmann)" with a static meter produced a reading of 0.1 Kv, a very low value in comparison to 0.2 Kv on a common acrylic glazing, and 2.8 Kv on the surface of an acrylic display case.

8. CURRENT CLEANING PROCEDURE FOR FACE-MOUNTED PHOTOGRAPHS ON DISPLAY AT THE METROPOLITAN MUSEUM OF ART

The cleaning procedure for face-mounted photographs at The Metropolitan Museum of Art has benefited from Erin Murphy's previous research as well as the research presented in this article. The opening of the Joyce and Robert Menschel Hall for Modern Photography in 2007 has resulted in an increase in the exhibition of face-mounted works at The Metropolitan Museum of Art and an increased need for satisfactory cleaning methods.

Based on the current evidence, the cleaning protocol followed at MMA limits surface contact as much as possible. The first step is to remove the surface dust overall with an air bulb, taking great care not to touch the surface with the plastic nozzle. Fingerprints and accretions are cleaned locally with a microfiber cloth slightly humidified by spraying with de-ionized water. On certain occasions, such as at the end of an exhibition, the surface dust accumulation has been too great to remove with merely an air bulb. In these cases, a *Modern Magic Blue Suede*™ cloth is used to clean the surface overall. The cloth's outer seams are trimmed, and the cloth is rolled and swiped in a downward motion, applying very slight pressure. The cloth is periodically turned and refolded to ensure that a clean portion is used at all times. However, the general policy is to reduce cleaning to a minimum and restrict cleaning to local areas whenever possible.

9. CONCLUSIONS

All of the tested cleaning methods caused some effect that may cause concern for conservators. We will continue with this real-time test and will also continue conducting profilometry (roughness) measurements to obtain quantitative results. The air bulb is still the safest method to remove dust from the surface of face-mounted photographs. There is no ideal method to reduce accretions and fingerprints, since all systems involve contact with the surface, which always causes abrasion.

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Van Oosten, Thea B. 2002. Crystals and Crazes: Degradation in Plastics Due to Microclimates. *Plastics in Art: History, Technology, Preservation*. Munich: Siegl. 80-88.

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Jürgens; Hadassa Koning; Peter Mariani (Electrostatics Inc); Frank Picciano, Pentek Industrial/ Haug; Bill Wei.

SOURCES OF MATERIALS

Acetone 99+% Extra-Pure: Acros, www.acros.com

Brillianize Plastic Cleaner and Polish: Brillianize, Inc., www.brillianize.com

Cyber Fabric™: Avaiable from Modern Solutions Inc., www.modernsolutionsinc.com

Histological Grade Reagent Alcohol, Fischer A962F: Fisher Scientific, www.fishersci.com

Kinetronics StaticWisk©, Kinetronics StaticWisk© with grounding cord, Kinetronics Panther microfiber cleaning cloth, and Kinetronics Precision Glass Cleaner: Kinetronics, Co., www.kinetronics.com

Modern Magic Blue Suede microfiber cleaning cloth: Modern Plastics, www.modernplastics.com/

Gamsol Odorless Mineral Spirits: Gamblin Artists Colors, www.gamblincolors.com

Novus #1 Plastic Cleaner and Polish: Novus Inc., www.novuspolish.com/

Kodak Photo-Flo 200 Solution: Kodak, www.kodak.com/

Sparkle Glass Cleaner: A.J. Funk & Co., www.glasscleaner.com/

Sunglasses Giant Deluxe Miracle lens cleaning cloth: Sunglasses Giant, www.sunglassesgiant.com/

TAP microfiber cleaning cloth: TAP Plastics, www.tapplastics.com

WYPALL X70 Wipers:* Kimberly-Clark Corp., www.kcprofessional.com

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Papers presented in *Topics in Photographic Preservation, Volume Thirteen* have not undergone a formal process of peer review.

APPROPRIATE TECHNIQUES FOR SURFACE CLEANING INKJET PRINTS

TESSA GADOMSKI

Presented at the 2009 PMG Winter Meeting in Tucson, Arizona

Abstract

Establishing protocol for surface cleaning inkjet prints is a need within the field of art conservation, and was determined to be the goal of this project. The materials tested are widely used to create fine-art inkjet prints. The Epson Stylus Pro 4800 printer was chosen for this reason, and because it employs the K3 Ultrachrome ink set, which is pigment based. Two different microporous inkjet papers, Epson Ultra Premium Photo Paper Luster and Ilford Galerie Gold Fibre Silk , were tested. A digital file, or "target," was designed using well-known color space values, and used to create twelve sample prints. Preliminary quantitative measurements of changes in color were made, as well as qualitative analysis of surface sheen and dye migration. This analysis was repeated after testing.

The cleaning solutions tested were deionized water, a water and ethanol solution, and a PhotoFlo and water solution. These materials were chosen because they are common cleaning agents which are likely to be found in the labs of most photograph conservators. Two cleaning techniques were tested; application with a cotton swab and full immersion.

Results suggest that two of the cleaning materials used may be acceptable for future treatment of inkjet prints. Ethanol and water was determined to be inappropriate for cleaning the inkjet materials tested in this study, and immersion was determined to be inappropriate for prints created on Ilford Galerie Gold Fibre Silk. Cleaning with cotton swabs produced noticeable changes in surface sheen in paper white areas, but this technique may be acceptable for image areas. Further research of alternative cleaning methods and materials is suggested to yield conclusive results.

1. Introduction

The research presented in this paper was conducted as an honors senior thesis project at the University of Delaware over the course of the 2008-2009 academic year. The thesis work began with a summer internship at Aardenburg Imaging and Archives that provided a foundation in creating and identifying inkjet prints, as well as an understanding of color science and color management. Over the course of the fall semester materials to test were determined, the target image was designed, the samples were created, and preliminary analysis was conducted.

After investigating the many different dry and wet cleaning methods currently employed by conservators when caring for photographs and works of art on paper, it was determined that this project would focus on wet cleaning. This type of cleaning was appropriate for the project because it provided the opportunity to test potentially damaging techniques on samples, rather than real art objects.

2. Selection of Materials and Creation of Samples

When selecting the materials to be tested it was determined to choose materials which were, and are, widely used to create fine-art inkjet prints. An Epson Stylus Pro 4800 printer was chosen for this reason, and because it employs the K3 Ultrachrome ink set.

The K3 Ultrachrome ink set is pigment based and consists of eight different color cartridges, including cyan, magenta, yellow, light versions of cyan and magenta, two greys and black. Two options for the black cartridge are available; either matte black or photo black. The black ink cartridge can be interchanged depending on whether matte or glossy paper is being used. For this project, the photo black ink was used.

While the exact chemical composition of the K3 Ultrachrome ink is proprietary, its general composition is available (Table 1) (Material Safety Data Sheets 2000-2009). A pigment based ink set was chosen, rather than a dye based ink set, for several reasons. First, pigment based ink does not exhibit short-term drift like dye based ink. Therefore, using the K3 Ultrachrome ink eliminated the issue of deciding when the ink had finished "settling." This was particularly important to this research in ensuring that any color change or dye migration would be due to the tests performed not independent movement of the ink after printing or fluctuations in humidity. Secondly, pigment based inks have proved to be more waterfast than dye based inks because pigment particles are not soluble in water. This ink set in particular has high waterfastness and permanence ratings according to the findings of Wilhelm Imaging and Research (Epson Stylus Pro 4800-Print Permanence Ratings (preliminary) 2005).

Table 1 Composition of K3 Ultrachrome Ink (Material Safety Data Sheets 2000-2009)

		% By Weight Composition				
Cartridge Number	Color	Carbon Black	Dyes and Pigments	Organic Materials	Glycerols	Ethylene Glycol
T565100	Photo Black	<3%	<5%	5-10%	10-15%	
T565200	Cyan		<10%	5-10%	5-10%	
T565300	Magenta		<15%	5-10%	15-20%	
T565400	Yellow		<7%	5-10%	10-15%	<4%
T565500	Light Cyan		<3%	5-10%	20-25%	
T565600	Magenta		<3%	5-10%	25-30%	
T565700	Light Black	<2 %	<2%	10-15%	20-25%	
T565900	Light Light Black	<1%	<1%	10-15%	15-20%	

The final material chosen was paper. It was decided that two different microporous inkjet papers would be tested to compare whether or not the ink behaved differently on different paper supports. Microporous papers are a major type of paper being used by printmakers today, and were expected to respond better to wet cleaning in comparison to other inkjet papers. Two papers from the same general category were chosen so that they could be compared more easily, and provide more conclusive results. The two papers chosen were Epson Ultra Premium Photo Paper Luster and Ilford Galerie Gold Fibre Silk. While both are microporous papers, the Epson is a resin-coated paper, and the Ilford is fiber based. Because of this, the two papers were expected to respond to treatment differently. Both have "luster" type surfaces.

Epson Premium Photo Paper Luster was recently renamed by Epson, and is now called Epson Ultra Premium Photo Paper Luster. This paper has received high permanence ratings when used in combination with the Epson Stylus Pro 4800 and K3 Ultrachrome ink set according to tests conducted by Wilhelm Imaging and Research (Epson Stylus Pro 4800-Print Permanence Ratings (preliminary) 2005). This paper was also recommended by Mark McCormick-Goodhart as one likely to be encountered by conservators in the future due to its popularity among fine-art printmakers.

Ilford Galerie Gold Fibre Silk, in comparison to the Epson paper, is a fairly new fine-art inkjet paper. Little permanence data is currently available on this paper, and there are no waterfastness tests yet available. Although it is a fiber based paper, the back of the paper is coated with an anti-curl layer. Ilford Galerie Gold Fibre Silk also differs from the Epson paper in that it contains a baryta layer. This paper was chosen according to the advice of Mark McCormick-Goodhart and Martin Jürgens. Both McCormick-Goodhart and Jürgens expect inkjet papers containing a baryta layer to become popular among printmakers in the near future because of the way in which the baryta layer allows the inkjet paper to imitate the look of traditional photographic papers.

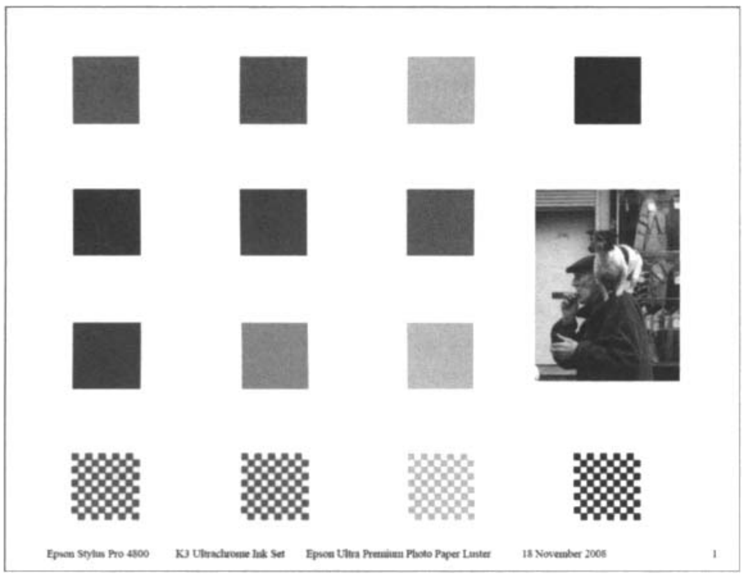

Figure 1 Target Design

Once the materials to be test were identified the next step was to design the target (Fig. 1). A small image was included to give a rough idea of how a real print would respond to cleaning. The hope was that this would provide the opportunity to make conclusions about the effects on real-world images. This information could then be used to guide future research decisions.

One of the first criteria for designing the target was use of a Minolta CR-400 chromameter. The color patches needed to be large enough to accommodate the instrument available, which meant they needed to be approximately one inch square. One inch of space was left between each color patch, so that if any dye migration occurred during wet cleaning, the colors would not interfere with one another or at least this effect would be minimized as much as possible. The amount of color patches was chosen in order to make the best use of space on a letter sized piece of paper.

After consulting with experts in the field including Mark McCormick-Goodhart and Martin Jürgens, it was determined to base the color patches off of the Greytag Macbeth Colorchecker colors. The exact L*a*b* numbers for these colors that appear on the Colorchecker are available on the internet (ColorChecker Colormetric Data 2008). The first row of the target contains the cyan, magenta, and yellow values of the Greytag Magbeth Colorchecker. The values of the black were set to the maximum black, or zero for every channel to reflect the darkest black the printer could create and to exclude the presence of other color inks as much as possible. The second row consists of red, green, and blue color patches. These colors were chosen to represent mixtures of the ink colors other than black. The third row consists of "dark skin," "light skin," and "neutral 6.5 (or grey)" color patches to represent how skin tones and neutrals would react. The fourth row color swatches consist of a checkerboard pattern to make qualitative analysis of potential dye migration easier to perceive. This type of test swatch pattern has been successfully used by Mark McCormick-Goodhart for testing waterfastness of inkjet materials (McCormick-Goodhart and Wilhelm 2003).

Figure 2 Checkerboard Pattern

Each target was labeled along the bottom edge with the printer name, ink set name, paper type, date, and sample number so that the samples could be properly identified during all stages of the project (Fig. 1).

After the target design was complete, the sample prints were created. Photoshop CS3 was used in conjunction with the Epson driver. Image size was set to 8 bits/channel. In the Photoshop driver, color handling was set to "Photoshop manages color," and appropriate ICC profiles were applied to the samples. The Epson Ultra Premium Photo Paper Luster profile was available on the computer used to print, while the Ilford Galerie Gold Fibre Silk profile had to be downloaded from the Ilford website. The rendering intent was relative colorimetric. In the Epson driver, the paper setting used for the Epson paper was Premium Luster Photo Paper, while for the Ilford it was set to Premium Semigloss Photo Paper as recommended by the manufacturer (Ilford Galerie Gold Fibre Silk 2009). The quality was set to 1440 dpi, or dots per inch, to obtain a high quality image. High speed was turned off and color management was turned off, based on common practice. Twelve samples were created and tested.

3. Preliminary Analysis

After the samples had been printed successfully, preliminary colorimetric measurements were made for each sample. This was done using a Minolta CR-400 Chromameter. Three consecutive measurements of each color patch were taken on each sample print. The paper white of each sample print was also measured. This was done in the same place, between the lower left corner of the thumbnail image and the upper right corner of the yellow checkerboard-patterned patch.

It was determined that analysis of change in surface sheen would be qualitative rather than quantitative due to the equipment available and the large amount of figures generated by the colorimetry measurements. In order to accomplish this, the samples were placed on a copy stand,

and the lights were arranged at the most shallow angle allowed by the stand, which was 35°. The camera was then placed opposite the light source at approximately the same angle. This procedure was determined by consulting Harold and Hunter's *The Measurement of Appearance* (1987) and several publications by Jonathan Arney, a leading researcher in the field of surface analysis (2002, 2006, 2007, 2007). Dye migration was also documented qualitatively only in the horizontal direction.

4. Surface Cleaning Materials and Procedures

The three cleaning solutions tested in this research were deionized water, a water and ethanol solution, and a PhotoFlo and water solution. These materials were chosen because they are common cleaning agents which are likely to be found in the laboratories of most photograph conservators.

For this project, first a 70% ethanol 30% water solution was used, but this immediately proved to be extremely detrimental to the prints. Because of this, the 70% ethanol solution was only tested on the cyan patch of each sample, and the rest of the testing was conducted using a 30% ethanol and 70% water solution.

The particular brand of PhotoFlo used was Kodak Professional Photo-Flo 200 Solution. For this surface cleaning test, PhotoFlo was mixed with water according to the manufacturer recommended ratio, which is 1 part PhotoFlo to 200 parts water.

Two cleaning techniques were tested; application with a cotton swab and full immersion. Manufactured swabs are of uniform shape and size in comparison to handmade swabs, and therefore were appropriate for this research project.

Full immersion was tested during this project to provide a basis of comparison for the swab testing, and how the prints would react if exposed to maximum amounts of the cleaning materials. If the prints could withstand this test, exposure to lesser amounts of the cleaning materials would be likely to be successful. *Studies on the Washing of Paper: Part 2: A Comparison of different washing techniques used on an artificially discoloured, sized paper* by V. Daniels and J. Kosek was consulted when developing the treatment criteria for the immersion tests (2004).

The surface cleaning protocol developed was deliberately methodical and detailed in order to be easily reproducible and potentially used in future research. Pip Morrison's *Solvent Effects on Silver Dye Bleach Materials* (2005) and Paul Messier and Timothy Vitale's *Effects of Aqueous Treatment on Albumen Photographs* (1994) were consulted when determining treatment protocol. Table 2 below provides a general overview of the materials and techniques tested on each specific sample. Please note the same tests were conducted on the two different papers on samples with identical numbers. For example, both Ilford 1 and Epson 1 were used as controls.

Table 2 Cleaning Materials and Techniques Corresponding to Samples

Sample Number	Cleaning Material	Technique
1	N/A	N/A
2	Deionized water	Cotton swab application
3	Ethanol solution	Cotton swab application
4	PhotoFlo	Cotton swab application
5	Deionized water	Immersion
6	PhotoFlo and Deionized water	Immersion

During the swab application tests, the samples were placed on a blotter work surface. Commercially available non-sterile 6" cotton tipped swabs were used. Approximately 12 mL of the cleaning solution was placed in a 50 mL beaker. A cotton swab was dipped into the cleaning material perpendicular to and touching the bottom of the beaker. The amount of liquid in the beaker allowed the entire cotton swab to be immersed. The swab was then removed and rolled over a small blotter to remove any excess liquid. The dampened cotton swab was then immediately used to clean the surface of the sample print. On each sample, each color patch was cleaned with one swab, and three swabs were used to clean the small image. Therefore, a total of 18 swabs were used on each sample. The cleaning technique for each patch was kept as uniform as possible. Within each color patch, an area was cleaned using three counterclockwise circular motions of the swab, and this technique was repeated in an adjacent area within the patch until the entire color patch had been cleaned. The same speed was maintained and as little pressure as possible was applied when cleaning each patch. Six samples were treated in this way.

Immersion tests were conducted on four samples. It was determined that due to the dramatic results achieved using the ethanol and deionized water solution during the swab application tests, that the immersion test would not be conducted using an ethanol and deionized water solution. To conduct the immersion tests, the same procedure was used for both deionized water and the PhotoFlo and deionized water solution. Approximately 2 liters of cleaning solution were poured into an enamel tray. The pH was measured using pH test strips, and found to be neutral, or around 7, for both cleaning solutions. A sheet of Holitex, or spun-polyester webbing, was placed in the bottom of the tray as a support for the samples when removing them from the trays. The samples were then placed in the trays by bellying them onto the water surface and lowering opposite corners slowly. Each sample was completely immersed in the solution by rolling a glass stirring rod over the surface of the sample in the horizontal direction. The total immersion time for each sample was 15 minutes, and the solution was agitated approximately every 5 minutes. After 15 minutes had passed, the samples were carefully removed and allowed to air dry on a plastic screen.

5. Results and Conclusions

During the cleaning tests, several observations were made which suggested that two of the surface cleaning materials and methods used were acceptable for future treatment of inkjet prints. Colorimetric, surface sheen, and dye migration assessment were conducted to aid in the evaluation of the materials and methods tested. Overall the results suggest that an ethanol and water solution is not appropriate for cleaning inkjet prints made with K3 Ultrachrome ink, and that deionized water alone or mixed with PhotoFlo may be potentially useful. Further research is suggested in various areas, including surface cleaning tests with other inkjet materials, other cleaning materials, and other cleaning methods.

5.1 Color Change

While conducting cleaning with cotton swabs, it became immediately apparent that the ethanol and water solution is not an appropriate cleaning material for the inkjet materials tested in this study. An unacceptable amount of pigment was removed from the print surface by the ethanol cleaning solution when applied with cotton swabs (Fig 4.1). The action of the swab also served to displace pigment on the surface, giving the color patches an uneven, cloudy appearance. These effects were more pronounced in the Ilford sample (Fig 4.1). The samples which were cleaned with a swab using deionized water and PhotoFlo exhibited a small amount of pigment removal in comparison to the prints cleaned with ethanol and water. During immersion testing, no loss of color could be visually observed, which was promising. The Epson samples, however, exhibited misplaced pigment particles on the surface of the print, which suggested that some pigment had indeed been removed during cleaning, and was dispersed in the bath to some degree.

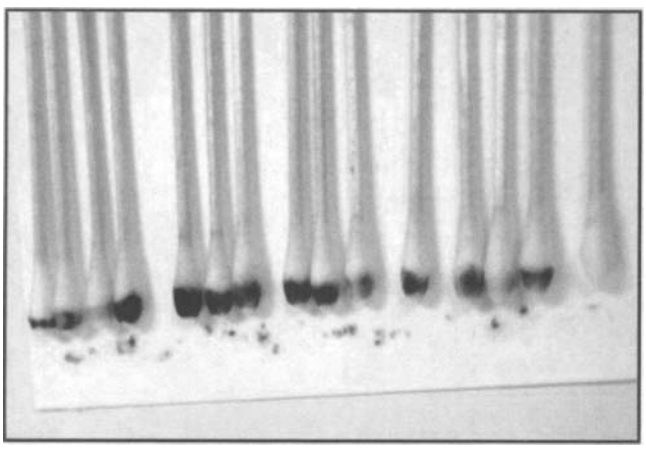

Figure 3 Cotton Swabs Used to Clean Ilford 3 with Ethanol and Water

Once the samples had dried thoroughly, after treatment colorimetric measurements were made. This was done in the same manner as the before treatment measurements; three consecutive measurements of each color patch were made and averaged. The ΔE value for each color patch was then calculated. ΔE is defined as the color change between two samples, using the CIEL*a*b* color space. The formula used to calculate this value is as follows:

$$\Delta E= [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

When comparing ΔE values to observable color change, a ΔE of 1 signifies a visual color change. However, this value does not account for which color channel in particular has been altered, so the separate changes in L*, a*, and b* values must also be considered (Berns 2000).

Table 3 Calculated ΔE Values for Epson Samples

EPSON	Epson 2	Epson 3	Epson 4	Epson 5	Epson 6
Color	Water (SC)	Ethanol (SC)	PhotoFlo (SC)	Water (Im.)	PhotoFlo (Im.)
cyan	0.37	18.76	0.41	0.72	0.50
magenta	0.59	0.77	0.57	0.63	1.16
yellow	1.16	2.23	2.32	0.97	1.12
black	1.21	0.15	0.20	0.18	0.39
blue	0.53	0.67	0.67	0.66	1.08
red	0.36	0.43	0.52	0.20	0.87
green	0.34	0.57	0.24	0.54	1.21
dark skin	0.38	0.44	0.39	0.58	0.47
light skin	0.49	1.39	0.50	0.65	0.32
grey	0.46	0.44	0.43	0.32	0.37
paper white	1.03	1.01	1.04	1.07	1.03

Table 4 Calculated ΔE Values for Ilford Samples

ILFORD	Ilford 2	Ilford 3	Ilford 4	Ilford 5	Ilford 6
Color	Water (SC)	Ethanol (SC)	PhotoFlo (SC)	Water (Im.)	PhotoFlo (Im.)
cyan	0.44	19.36	0.92	0.58	0.72
magenta	0.43	5.98	0.80	0.66	0.58
yellow	2.12	1.58	0.73	1.66	0.98
black	0.63	1.44	0.72	0.56	1.17
blue	0.58	14.33	0.71	0.86	1.04
red	0.73	4.43	0.52	0.90	1.80
green	0.92	7.74	0.58	1.49	1.52
dark skin	0.59	5.26	0.78	1.40	1.11
light skin	0.62	7.19	0.66	0.62	0.59
grey	0.21	2.89	0.25	0.31	0.24
paper white	0.35	0.41	0.41	0.45	0.51

Swab cleaning tests conducted using deionized water and the water and PhotoFlo solution generally resulted in a ΔE of less than one observed for most of the patches (Table 3 and 4). Notable exceptions to this among the Epson samples include the black, paper white, and yellow patches after the deionized water cleaning test and the paper white and yellow patches after the PhotoFlo cleaning test. Among the Ilford samples, the green and yellow patches had a ΔE greater than one after the water cleaning test and the same can be said for the cyan patches after treatment with PhotoFlo. The ΔE for the Ilford sample cleaned with ethanol were much more dramatic and represent unacceptable change for conservation treatment; only the paper white patch had a value of less than one, and eight patches produced ΔE's of greater than one . On the Epson sample, the light skin, paper white, and yellow patches had ΔE's of slightly more than one. Though colorimetry results are less dramatic than those observed on the Ilford sample, visual analysis of the color patches shows that ethanol is still an unacceptable cleaning material for the Epson paper. The removal of color was distributed unevenly within the color patches.

Visual analysis suggested a lack of color change during the immersion testing, yet the after treatment colorimetry results revealed that there were visually noticeable color changes. The Epson sample immersed in water showed a ΔE of about one for the paper white and yellow patches, while the sample immersed in the PhotoFlo and water solution showed a ΔE of one or greater for the blue, green, magenta, paper white, and yellow patches. On the Ilford samples, the sample immersed in water exhibited this change in the dark skin, green, and yellow patches, and the sample immersed in PhotoFlo showed a ΔE greater than one for the black, blue, dark skin, green, red, and yellow patches. These changes were perhaps more difficult to detect because the removal was gradual and the pigment was dispersed in the solution. The immersion test results in the area of color change did not fail dramatically, which indicates that these solutions may be used successfully if different cleaning techniques are tested.

After comparing the calculated ΔE values among the various tests, consistent changes in yellow could be noticed in almost every sample. This was unexpected because the yellow patches did not appear to be changing more than the other test colors during the cleaning process. This suggests that minimal removal of yellow pigment results in a greater color change for yellow than in comparison to other colors tested. The one exception to this trend is the immersion test with PhotoFlo conducted with the Ilford paper. The change in yellow is much lower than with any of the other samples. Although this suggests that PhotoFlo immersion would be successful with the Ilford paper in terms of color change, this test proved unsuccessful in terms of change in surface sheen.

Another unexpected result was the lack of removal of ink from the black color patches. The only cleaning test that removed black ink was deionized water applied with a cotton swab on the Epson paper. Since the black colorant used is carbon black, generally considered to be soluble in water, it was expected that more ink removal would occur. The paper white colorimetry measurements of the Epson samples after treatment were also unexpected, especially since the Epson paper exhibited less of a change in surface sheen than the Ilford paper overall.

5.2 Change in Surface Sheen

The surface sheen was altered by swab cleaning in a majority of the samples, especially in the paper white areas. The paper white areas became considerably glossier after treatment. This is particularly noticeable in the paper white area which was spot cleaned on each sample. Overall, the surfaces of the Ilford samples became noticeably glossier regardless of the cleaning material used. This is probably due to the differences in composition between the two papers, most likely the presence of a baryta layer. The Epson paper showed less of an alteration when cleaned with the deionized water and the PhotoFlo and water.

The results of the immersion tests in regard to surface sheen varied greatly between the two papers. The Ilford paper exhibited no change while immersed, but as the paper dried, it curled and fine cracks developed across the entire surface in a horizontal pattern. The surface also appears to have become somewhat glossier, but this is difficult to determine because of the cracks. This occurred after immersion in deionized water and the water and PhotoFlo bath. This dramatic change in surface sheen may also be due in part to the presence of the baryta layer. The Ilford paper was expected to dry differently from the Epson paper, because it is fiber based. Since the fibers absorb water and swell, and then contract during drying, this causes the paper to curl. This behavior is not exhibited by resin-coated papers, because the polyethylene layer prevents water from being absorbed by the fibers.

The Epson paper exhibited tidelines in some paper white areas prior to drying and the paper white areas became glossier after treatment. Visual comparison to the control sample and the calculated ΔE value of the paper white area support this conclusion. The paper white areas for both immersed samples show ΔE values of about one. This is consistent with the ΔE of the paper white areas of the swab cleaned samples, which certainly show a change in surface sheen.

5.3 Dye Migration

In each of the samples, there was no visible evidence of dye migration occurring across the surface of the paper, regardless of cleaning solution and technique. This is not surprising, because the inks used were pigment based, and therefore the colorant particles would not be easily mixed with water and moved across the surface of the paper. While some of the samples which were swab cleaned exhibit movement of pigment on the checkerboard patterned color patches, this was caused by the movement of the cotton swab rather than action of the solvent on the pigment. The dye migration results are promising, as they suggest that wet cleaning may not be entirely destructive, and when applied to these materials will not cause the ink to bleed. This study did not assess whether or not downward migration (versus horizontal migration) occurred into the paper substrate. Such analysis could be conducted by microscopic examination of cross sections of the samples and this type of analysis is suggested for future research.

5.4 Conclusions

Changes in color, surface sheen, and dye migration serve as indications of whether or not an inkjet print has been altered by cleaning tests. Some techniques and materials were initially recognized as inappropriate due to the drastic alterations incurred, while others may require further research to determine whether or not the materials and methods used can be applied to surface clean actual art objects made from inkjet materials.

The use of ethanol solutions in wet cleaning inkjet prints created with K3 Ultrachrome Ink print on Epson Ultra Premium Photo Paper Luster and Ilford Galerie Gold Fibre Silk paper is unadvisable; removal of the ink from the print surface was instantaneous and severe. Despite the change in concentration of ethanol, and despite the less dramatic colorimetry readings for some of the patches, the pigment continued to be removed in a manner that made the color patches uneven in color. For this reason alone, it can be said with certainty that an ethanol and water solution is an unacceptable for cleaning for inkjet prints created with the materials tested in this study.

While cleaning with cotton swabs produced noticeable changes in surface sheen in paper white areas, this technique may be acceptable for image areas. Although some pigment was removed during testing with the deionized water and PhotoFlo and water solutions applied with cotton swabs, the overall affect on the color was barely visible. This is supported by the fairly low ΔE values, with the exception of the yellow color patch. There was also no visual change in surface sheen in the image areas. However, further research is suggested to assess this technique, including investigation of dye migration into the paper substrate.

Inkjet prints created on Ilford Galerie Gold Fibre Silk paper should not be cleaned using immersion techniques. The cracks that formed during this study may have in part been due to the drying method used, however full immersion is unadvisable until further research can be conducted. The results of immersion of the Epson Ultra Premium Photo Paper Luster suggest that this may be a possible cleaning technique for this paper if the print can be dried in a manner that tidelines are unable to form.

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On the Illumination of Light-Sensitive Photographs

Mike Ware

Abstract

The types of light source used to illuminate photographs for copying and study are reviewed, and it is noted that the recent development of UV-free solid state light sources offers a valuable new option for particularly light-sensitive photographs. In order to inform curatorial decision-making, it is shown how the risk of light-damage to a photograph can be assessed from the total dose of light and the sensitivity of the object, expressed in terms of the 'Just Noticeable Difference', to quantify the 'cost' of copying in terms of perceptible change. Controlled photo-flash is shown to be preferable to continuous illumination, and the minimized dose of light is calculated for typical photographic camera parameters to recommend standards of practice for copying such objects.

Introduction

Light, the very agency for creating photographs, can also destroy them. The problem of 'fixing' photographic images was not fully solved by the pioneers of the art-science for some years following its invention in the late 1830s. Consequently, early images were not robust; there exist today in some photograph collections a number of precious and historically significant specimens that are still vulnerable to light (Ware 1994, 1999). The purpose of this paper is to suggest a means of assessing quantitatively the risk to such an object caused by exposing it to light, for various purposes: private study, photographic copying, scanning, photocopying, conservation work, and public exhibition. It is generally acknowledged that the more energetic radiation of shorter wavelengths is intrinsically more damaging (Thomson 1986), so the attenuation, or preferably complete removal, of the ultraviolet (UV) content of any illumination is a primary objective, and a *sine qua non*. The spectral region of concern is the UVA, having wavelengths from 315 nm, where window or picture glass begins to transmit, up to about 400 nm, at the deep blue edge of the visible. However, as a potential cause of damage, there still remains the visible light – and this we cannot do without, if the photograph is ever to be viewed by human eyes. The principal focus of this paper is to assess the effects of visible light on historic photographs.

Light Sources and their UV Content: Preliminary Review

According to the Museums Commission of the UK, Class I Museum Gallery Standard of illumination permits a maximum UV content of 75 microwatts per lumen (μW/lm) (Thompson, 1978). The reason for these rather complex units is that the lumen is a measure of the intensity of *visible* light, and therefore cannot be used to quantify the invisible UV. The UV radiation does however possess energy, so is measured by its energy flux per second, as watts (or, more conveniently, microwatts) and expressed as a proportion of the visible light intensity. In the past, the figure of 75 μW/lm was deemed tolerable because it happens to be the natural UV content of the unfiltered emission from an ordinary incandescent tungsten lightbulb, with a colour temperature of 2860 K. A light intensity of 50 lux (= 4.65 foot-candles in US units) is widely accepted as the most stringent Class 1 Gallery Standard for exhibition and viewing of sensitive works. Since one lux = one lumen per square meter (lm/m^2), at 50 lux this level of UV content corresponds to a UV irradiance of 3.75 milliwatts per square meter (mW/m^2), which is about 5% of the visible light energy flux (1 lumen at 555 nm has an energy flux of 1.47 mW, so 50 lux provides a visible irradiance of *ca.* 74 mW/m^2) but it is still needlessly high and can now be substantially reduced by careful filtration, or even totally eliminated by a more appropriate choice of light source, as seen below.

Five main types of artificial lighting are used for the purposes of copying, study and exhibition:

1) **Incandescent tungsten** filament bulbs. These usually emit 60-80 μW/lm. Tungsten-halogen lamps also fall in this category but have higher UV emission, *ca.* 165 μW/lm. It has been shown that steep-cut interference filters can reduce these UV emissions to less than 1 μW/lm without prejudicing the colour rendition (Saunders 1989). The infrared (IR) emission of tungsten bulbs can also cause undesirable heating of illuminated objects, by radiation and convection.
2) **Photo-flash** units (commonly, but inappropriately, called "strobe units" in the USA) are xenon gas discharge tubes; these are rich in UV, emitting around 300 μW/lm, so must be fitted with efficient UV-absorbing filters, which are usually supplied by the manufacturer. Data on the absorption spectra of these filters are not widely published, however, and the extent of their attenuation of the UV is often taken on trust. Photo-flash has the advantage that it only delivers the minimal light dose to the object needed to record its image in the camera, in contrast to copying methods that employ continuous illumination (Saunders 1995, Michalski 1996).
3) **Fluorescent light** sources are mercury gas discharge tubes, internally-coated with phosphors, and can emit substantial UV, present in the mercury atomic emission spectrum, in the order of 200 μW/lm. When used for copying illumination they must be filtered; sheets of UV-absorbing Plexiglass™ (UK: Perspex™) Type UF-4 provide good attenuation. This is often the type of built-in light source of commercial scanners and photocopiers; before such machines are used on sensitive material it is important to seek information from the manufacturer on their UV emission and filtration – if any.
4) **High Intensity Discharge** (HID) lamps use a plasma discharge in a vaporized metal halide; they include the alchemically-named "Hydrargyrum Medium-arc Iodide" (HMI) lamp, presumably a mercury discharge. They often contain xenon as a starter gas, so are sometimes inaccurately called "xenon lamps". All emit large amounts of UV, in the order of 275-300 μW/lm. Their high colour temperature and efficiency make them very popular for studio photography, but they should not be used to illuminate sensitive objects.
5) **Light Emitting Diode** (LED) sources represent the most recent solid state lighting (SSL) technology, which can claim several advantages: it is safe and fully controllable electronically, economic in energy-efficiency, enjoys a very long lifespan and great robustness. From the published emission spectra, and recent measurements, 'white' LEDs appear to contain no UV wavelengths whatsoever, and no IR radiation either, which can cause undesirable radiant heating (Noll 2008). The emission spectrum does not have the 'blackbody' distribution of sunlight or incandescent tungsten, but the Color Rendition Index (CRI) of the 'daylight balanced' variety of LED has now been improved to a value of 90% or greater, which fulfills the Museum standard. As this technology develops, it seems set on course to offer the best option of a controllable UV-free light source for photographic copying, object conservation tasks, and possibly even gallery exhibition illumination. A commercial LED unit is now available, emitting 100 watts of daylight-balanced white light of Color Temperature (CT) 4400 K with a CRI = 91%, specifically designed for both viewing and photographic copying of sensitive objects. The output is

precisely controllable down to low levels for setting-up, with no color shift, and the unit can be synchronized with a camera shutter to ensure that the object only receives the minimum dose of UV-free light necessary to record its image. Thus, the LED unit has the virtue of photo-flash illumination with none of its disadvantages (Geffert 2008).

A STRATEGY FOR RISK ASSESSMENT OF ILLUMINATION

The safe copying and exposure of photographs, and other objects potentially sensitive to light, is assisted by the knowledge of the following two parameters:
(a) the total light exposure inflicted on the object by the copying process, or period of exposure, and
(b) the object's sensitivity to light, measured by the change it suffers per unit of light exposure (Schaeffer 2001). The purpose of this document is to show that a comparison of these two figures (expressed in the same units) can provide:
(c) an assessment of the 'potential damage' to the object, *i.e.* the notional 'cost' of making one copy, and thus inform curatorial decision-making in a semi-quantitative manner. These factors will now be quantified as far as current knowledge allows.

(a) The total dose of light to the object

This is the exposure sustained by the object during the entire process of acquiring a copy image, or digital image file, by a specified procedure – whether by analogue or digital photography with appropriate external lighting or photo-flash illumination, or by a scanner, or a photocopier, with their built-in light sources. Light exposure is the product of light intensity (illuminance) and duration; to quantify this exposure, the preferred Système Internationale (SI) units are lux seconds (lx s). It is convenient to build in a factor of one thousand, so kilolux seconds (klx s) will be used here as the appropriate units for camera exposures, but lux hours (lx hr) may be more convenient for measuring light exposure through exhibition or study: 1 lx hr = 3.6 klx s.

A number of workers have previously assessed the total exposure for many typical copying set-ups and systems; see Table 1 below for values and references. However, it is essential that individual photographers should evaluate the light dose for their own copying procedures: if the illumination at the copying easel is continuous (and checked to be UV-free) its illuminance should be measured with a lux-meter, and then multiplied by the total estimated time in seconds that the object is irradiated while setting up and making one copy, to give the overall light dose in klx s.

However, as observed above, employing photo-flash illumination can minimize the light dose to the object. The flash exposure for a given distance, as expressed in the Guide Number of the photo-flash unit, determines the camera parameters that must be set by the photographer: an effective arithmetic speed, S, in ISO (ASA), and a lens aperture setting expressed as an f/stop number, A. These two parameters are all that is needed to calculate the light dose to the object, a formula for which is derived in the Appendix. From this it may be seen that, for example, a camera set to a lens aperture of f/11 and an effective speed of 100 ISO, (e.g. for 'fine grain' film or 'low noise' digital imaging), the minimum light exposure of the object is calculated to be 0.36 klx s or 0.1 lx hr, if the camera image is about 1/4 the size of the original object (*e.g.* an object *ca.* 10x8 in. photographed on medium format '120' roll film).

For comparability these calculations all assume a common, nominal camera exposure setting. If the film speed is not 100 ISO (ASA) or the lens aperture number A differs from f/11, the figure should be adjusted accordingly. With flash, the light exposure of the object is just sufficient for the correct exposure of the camera film, so it depends only on the camera parameters, and not the model of flashgun, which is assumed to be set correctly by the photographer.

Typical Equipment	Reference	Light Level (klx)	Exposure Time	Light Dose (klx s)
Scanning CCD camera	(Blackwell 2000)	2	15 minutes	1500
Flat bed scanner	(Vitale 1998)	various		3.6 - 54
Photocopier		various		7.2 - 36
35 mm SLR camera		0.6 *	~3 s **	1.8
" with photo-flash	Appendix	(f/11 @100 ISO magn. 1/8)		0.3
120 Roll film camera		1.5	~3 s	4.5
" with photo-flash	Appendix	(f/11 @100 ISO magn. 1/4)		0.4
5x4 in. studio camera		6	~3 s	18
" with photo-flash	Appendix	(f/11 @100 ISO magn. 1/2)		0.5
Exhibition Class 1		0.05	10 hours/day	1800/day

Table 1. Typical light doses for various copying systems compared with exhibition

* assuming a very basic illumination system of two 100 watt tungsten bulbs at 60 cm distance.

** 3 seconds is about the minimum total time for the lights to be switched on and become thermally stable, and for the camera exposure, which is generally in the order of one second, to be made.

Some of the figures in Table 1 remain highly machine-dependent, and are likely to change with advancing technology, so the guidelines for scanners and photocopiers, which were typical of the 1990s, may require updating and re-calculating.

The setting-up exposure: 'modeling lights'

The light exposure inflicted by the actual photography is only part of the total dose sustained by the object being copied: the exposure when setting-up, framing and focusing the image can be even greater. For instance, even if the setting-up is conducted under a low light level of 50 lux, one minute spent doing this will incur an exposure of 3 klx s, which in some cases is greater than that of the actual photographic exposure. It is important that the operating protocols for copying should minimize unnecessary additional exposure of this kind, either by using very low level modeling lights, or preferably by setting-up on a 'dummy' or surrogate object of the same size, and only substituting the precious object at the last moment when ready. It is important to assess, and include in the evaluation, any exposure incurred in this way. On past occasions, more damage has been done to precious sensitive photographs by neglectful and unnecessary exposure to the full illumination at the copying easel, than has been caused by the photographic exposure itself.

(b) The sensitivity of the object to light

This is conveniently expressed as the light exposure (also in klx s) which causes a Just Noticeable Difference (JND) in the object. The condition of the object before and after exposure cannot be directly compared, so either identical reference specimens or 'controls' are required, or precise densitometer readings must be taken, of accurately-located image regions, before and after exposure. A caveat here: densitometers generally have very intense light sources (*ca.* 500 klx) and can cause perceptible damage to very sensitive objects over the sample area within a short time. The readout from a densitometer is in optical density, which is defined as $\log_{10}$(opacity), where the opacity is defined as: incident light intensity/ transmitted or reflected light intensity, depending on the mode. The optical density has no units – it is a pure number.

The JND for human visual perception has been found experimentally, on average, to be a difference in optical density $\Delta D = 0.01$ (Henry 1986). Differences less than one JND are generally imperceptible to the unaided human eye for areas of smooth mid-tone grey, placed side-by-side under good lighting, but they can be measured with sufficiently sensitive instrumentation (densitometers reading to 0.001).

The use of optical density as the measurable unit of change presupposes a monochrome object – which is usually the case with 19thC photographs. However, if a color shift in the object is a significant possibility, the criterion for a JND is more properly expressed according to the measurements of color science, and the change of coordinates in a color space, such as the CIE L*a*b* system, as measured with a color meter (chromameter). In this system, a color change of $\Delta E = 1$ or 2 is approximately one JND. If there is no color shift, $\Delta E = \Delta L^*$, where the lightness scale L* in the CIELAB system runs from 0 (black) to 100 (white). A practical JND of $\Delta E = 1.5$ is widely quoted for colored objects.

The JND is a convenient benchmark for the onset of 'perceptible damage' to an object. It will be useful to call the exposure causing a change of one JND in any significant area of an object, the *Threshold Exposure*. Information on these Threshold Exposures for various types of photographic object is as yet rather sparse (Ware 1994 and 1999). Often we only have an upper limit of exposure, at which no change has yet been observed or measured (McElhone 1993), rather than the true Threshold Exposure, whose determination experimentally would entail notional damage to the object, and may therefore be deemed unethical to attempt. If the Threshold Exposures of precious historical specimens could be determined without arousing serious conservatorial qualms, it would ultimately benefit our knowledge of how best to protect these sensitive objects.

The invention ten years ago of the 'micro-fading tester' (Whitmore, Pan, and Baillie 1999, Whitmore 2002) has brought this hope much closer. These instruments have so far been used mainly for painted artworks, which are much more robust than photographic specimens, so they have powerful light sources (*ca.* 10 Mlx) which can fade a Blue Wool #1 specimen by one JND in about 2 minutes. Based on this instrument, a 'micro-fading spectrometer' has recently been developed (Lerwill, Townsend, Liang, Thomas, and Hackney 2008) which irradiates a disc of the object only 0.25 mm in diameter, and is substantially portable. With an attenuated light source it would be well-suited to the investigation of sensitive photographs.

The exposure of photographs on exhibition is an issue closely-related to that of exposure for copying purposes, and requires similar reasoning but generally involves much longer exposures (Severson 1986). As a qualitative guide to lighting policy, it has been suggested that photographs can be placed in four broad categories of sensitivity (Wagner, McCabe and Lemmen, 2001): (1) Extra- (2) Very- (3) Moderately- and (4) Less- sensitive. The reader is referred to the conservation experience of these authors, with a wide range of photographic objects, to find recommendations for the total exposure per year for exhibiting these various types of photograph. Their proposed categories are adopted in Table 2, below.

What little information on Threshold Exposures that has so far been gleaned for photographs falling in these categories is summarized in Table 2. It is to be hoped that more additions will soon be made to this table. Nearly all treatments of photographic fading published to date tend to assume that the Law of Reciprocity holds; *e.g.* the change (which may be fading or fogging) caused by exposure to a light source of 5000 lux for one hour, will be the same as the change caused by a source of 50 lux in 100 hours. While this may be generally true for silver images (Ware 1994), it certainly is not valid for cyanotypes, which recover from fading by aerial reoxidation (Ware 1999).

Category & Process	**Reference**	**Threshold Exposure (klx s)**	**Comments**
1) Photogenic Drawing	(Ware 1994)*	600	Talbot salt-stabilized
1) Cyanotype @ 4 klx	(Ware 1999)**	720 @ 4000 lx	Herschel's process
2) Cyanotype @ 50 lx	(McElhone 1993)	>36,000 @ 50 lx	NB non-reciprocity
3) Salted Paper Print	(McElhone 1993)	54,000	Thiosulphate fixed
3) Albumen Print	(Pretzel 1991)***	80,000–2,880,000	Highly variable
4) Silver-gelatin print		>1,800,000	Modern processing
Blue Wool Standard Fade	(Colby 1992)	1,440,000	(ISO #1) B.S. 1006
LightCheck® dosimeter	(LightCheck Co.)	18,000	Ultrasensitive version
		216,000	Sensitive version

Table 2. Guide to the categories of sensitive photographs

* Most Talbot prints were stabilized with sodium chloride, but some images were stabilized with potassium iodide – it is thought the sensitivity of the latter may be comparable, but they tend to fade rather than fog.

** Note the failure of the reciprocity law in this case.

*** The conspicuously wide range of values cited here for the threshold exposure of albumen prints is an indication that less stable 'mavericks' can lurk in any population of historic photographs, because of uncertainties concerning the quality of processing.

The British Standard Blue Wool Scale # 1 is too insensitive for the purpose of monitoring the exposure of photographs, but the recent European Commission sponsored project (Light Dosimeter Project) has developed a more sensitive colorimetric photochemical dosimeter on paper strips which offers a useful monitor of light dose, when used as a comparator with a standard color chart calibration (LightCheck® Company UK, 2008).

(c) The 'cost' of making one copy

This is expressed in terms of the 'potential damage' to the object as the quotient of light dose (Table 1) and the Threshold Exposure (Table 2):

$$\mathbf{c = a/b}$$

so **c** is **the number of JNDs inflicted on the object by the copying procedure**.
Curators and conservators are thus assisted in formulating their own criteria as to what may constitute an acceptable value of **c,** as a compromise between the conflicting demands of conservation ethics, commercial factors, and scholarship. An acceptable value of **c** will usually be fractional, i.e. smaller than 1 – probably much smaller – so a more convenient way of expressing the 'cost' is:

$$\mathbf{1/c = b/a}$$

where **1/c** can be usefully regarded as ***the number of times that the object could be copied with the specified method before it begins to sustain a 'perceptible change'*** *i.e.* the accumulated exposure reaches the Threshold Exposure. This assumes, of course, a 'worst case scenario' that the potential damage is arithmetically cumulative, which may not always be the case; for example the assumption of exposure reciprocity is not valid for the fading of cyanotypes, which recover their densities on exposure to air in the dark.

EXAMPLES OF CALCULATING POTENTIAL DAMAGE BY COPYING LIGHTS

(1) A halide-stabilized Photogenic Drawing copied by a commercial scanning CCD camera:
The total light dose **(a)** would be *ca.* 1800 klx s (Table 1).
The sensitivity **(b)** as indicated by the Threshold Exposure in Table 2 is *ca.* 600 klx s.
The 'cost' **(c)** of 1800/600 ≈ 3 JND's is calculated for copying by this means.
This is a measurable and perceptible density change, and in most judgments would be deemed unacceptable damage, and copying therefore not attempted by this means.

(2) A halide-stabilized Photogenic Drawing copied by a large format (e.g. 4x5 in.) studio camera using filtered photo-flash, a speed S = 100 ISO, and an aperture of f/22, (two stops, or 4 times, smaller than our standard, f/11):
The typical exposure light dose (see Table 1) would therefore be 4 x 0.5 = 2 klx s. To this must be added the light dose entailed in the setting-up – perhaps a minute at 50 lux = 3 klx s – to give a total light dose **(a)** = 5 klx s.
The sensitivity is as in (1) **(b)** = 600 klx s. So the 'cost' **(c)** is 5/600 = 0.0083 JNDs only.
In other words, the object could be copied **1/(c)** = 1/0.0083 = 120 times by this means, before the Threshold Exposure for one JND was reached in theory.

(3) A cyanotype photographed by photo-flash illumination, using a 35 mm camera set to a speed of 25 ISO (arithmetic) and an aperture of f/16:
The light dose **(a)** is calculated from the value 0.3 klx s (Table 1) for 100 ISO at f/11 (assuming a magnification of 1/8) modified thus: there are two 'stops' less film speed, and one stop smaller aperture, meaning three stops more light exposure is needed in all, arithmetically: 2x2x2 = 8 times, so the light exposure = 8 x 0.3 = 2.4 klx s.

Again, we must add the setting-up exposure, say 3 klx s, to give a total **(a)** = 5.4 klx s. The sensitivity **(b)** of cyanotype under high intensity illumination is *ca.* 720 klx s. So the cost **(c)** is 5.4/720 = 0.0075 JNDs, which is perfectly 'safe'. The cyanotype could be photographed in this way 1/0.0075 = 133 times before reaching the theoretical Threshold of perceptible damage.

(4) One of the most treasured items in the photograph collection of The Metropolitan Museum of Art, New York, is a unique album containing 36 photogenic drawings sent by W. H. F. Talbot to fellow botanist Antonio Bertoloni in 1839-40. It was decided by the Museum's curatorial and conservation staff to make its contents accessible to the public, so the Bertoloni album was photographed 'in house' with all appropriate precautions. It was illuminated by two CDI LED units (light source 5 above) delivering *ca.* 500 lx at the baseboard with undetectable UV content, a CRI of 91% and a CT of 4400K. Exposures were 2 seconds at f/16 with a medium format digital camera set to 100 ISO. Setting-up was under very low light, so the light dose **(a)** was little more than 1 klx s. The highest sensitivity **(b)** of this material is likely to be 600 klx s. It follows that **(c)** = 1/600, so the object could be copied 600 times by this means before reaching the Threshold Exposure. This large safety margin was deemed acceptable curatorially to justify photographing this precious and very sensitive item, with the excellent outcome which may be now viewed on the Museum's website (Metropolitan Museum 2008).

APPENDIX

LIGHT EXPOSURE OF AN OBJECT PHOTOGRAPHED BY CONTROLLED PHOTO-FLASH

The following theory demonstrates that the light dose to an object exposed by photo-flash is determined only by the setting of the camera lens aperture and the effective speed (of film or digital sensor) used to photograph it. Assuming that the photographer operates correctly, the sensor calculator of the flash unit (or Guide Number) ensures that the correct illumination is delivered for the camera exposure. The benefit of this is that the light dose to the object is minimized and *it is unnecessary to know any technical details of the photoflash output.* The starting point for this calculation is the equation derived by Jones and Condit (James 1977) to connect the illumination of an object with the illuminance at the focal plane of a camera photographing it. When typical parameters are assumed for various features of the camera optics, we are left with the simplified Jones-Condit Equation:

$$L = 5A^2E \quad \text{lx}$$

Where:
L = object luminance in apostilbs
= illuminance in lux for a diffuse white object of Reflectivity = 100%
A = lens aperture expressed as f/stop number
E = illuminance in lux at the camera film plane
We need the Object Exposure = illuminance x duration:

$$Lt = 5A^2Et \quad \text{lx s}$$

Where:
t = exposure duration in seconds
This connects the object exposure, Lt, with the film exposure, Et.
To evaluate the latter, we make use of the definition of ISO Film Speed, S :

$$S = 0.8/H_m$$

Where:
S = film speed on the ISO (arithmetic or ASA) scale
H_m = exposure of film in lux seconds to yield a film density of 0.1 above the filmbase+fog, for specified conditions of development, so:

$$H_m = 0.8/S \quad \text{lx s}$$

Now for a frontally-lit scene, a white highlight is ~50 x brighter than the darkest shadow exposure H_m (Dunn & Wakefield 1981), so the correct film exposure for the diffuse white highlight is:

$$Et = 50 \times H_m = 50 \times 0.8/S = 40/S \quad \text{lx s}$$

and since the object exposure:

$$Lt = 5A^2Et \quad \text{lx s}$$

we can now substitute for Et to get the approximate relationship:

$$Lt = 0.2\ A^2/S \quad \text{klx s}$$

e.g. inserting values of A = 11 and S = 100 for our 'standard' exposure of f/11 at 100 ISO gives:

$$Lt = 0.2 \times 11^2/100$$

$$= 0.242 \quad \text{klx s}$$

The foregoing is a simplified derivation, for the camera lens focused nearly at infinity. To take account of the magnification, due to near-focus used in copying, we need a more accurate version of the Jones-Condit equation:

$$Lt = 0.189(1+m)^2\, A^2/S \quad \text{klx s}$$

where: m = magnification = image size/object size

Magnification	**Factor**	**Light Dose Lt for A=11 and S=100**	
m	**$0.189(1+m)^2$**	**klx s**	**lx hr**
1/∞	0.189	0.229	0.0636
1/10	0.229	0.277	0.0769
1/8	0.239	0.289	0.0803
1/6	0.257	0.311	0.0864
1/5	0.272	0.329	0.0914
1/4	0.295	0.357	0.0992
1/3	0.336	0.407	0.1131
1/2	0.425	0.514	0.1428
1/1	0.756	0.915	0.2542

Table 3. Minimum copying light dose as a function of magnification.

Table 3 shows the effect of magnification on the light dose. These figures all assume an aperture f/stop, A = 11 and a camera speed, S = 100 ISO (ASA). The figure for any other aperture or speed setting can be calculated by scaling appropriately, as illustrated in the numerical examples. There are, admittedly, approximations and assumptions involved in reaching these theoretical values for object exposure, but their essential correctness can be independently checked by accepted practice. For instance, that widely-used photographic light-meter, the Pentax Spotmeter V, is supplied with a manufacturer's conversion (Asahi Optical Co.) for obtaining luminance values from the Exposure Value (EV) readings taken from an illuminated standard greycard. When the units of Luminance B (cd/m^2) are converted to those of Illumination L (lx) by the relation $L = \pi B/R$, where R = 0.18 is the reflectivity of the standard greycard, the working calibration equation for the meter is found to give:

$$Lt = 0.244\, A^2/S \quad \text{klx s}$$

which agrees well with the values derived above.

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[*Note:* A compilation and overview of the current literature for the whole range of museum objects, including photographs. The author's conclusions are based on a 'standard flash exposure' estimated to be only 0.007 klx s (see pp. 17 & 32) - which seems very low, compared with Saunders, 1995, and Neevel, 1994, who cite a range of exposures by typical photo-flash units to be 0.6-1.25 klx s, and 0.35-6 klx s, respectively; this range of values also agrees well with the theoretical results derived in the Appendix.]

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THE STORY BETWEEN TWO COVERS: THE TREATMENT HISTORY OF P. H. EMERSON'S CUBA ALBUM

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Abstract
The Cuba Album at the George Eastman House contains 48 platinum prints by Peter Henry Emerson. This article will document the preservation of this album at the Eastman House, focusing on the early 1980's treatment by Alice Swan. As the treatment results are presented, an attempt will be made to evaluate the success of the treatment through an examination of the treatment's purpose, plan, proficiency, and product.

Introduction
This article tells a story, the story of a book - an album known at the George Eastman House as the *Cuba Album.* Of course any good story involves interesting people - mine includes a couple of the founders of our profession, Jose Orraca and Alice Swan, as well as a couple of the giants in the history of photography, Peter Henry Emerson and Beaumont Newhall. In addition to characters, a good story needs a few exotic locations – ours include Havana, Cuba, the broads in England, and the George Eastman House in Rochester, NY. This story even has a detective and several useful life applications.

The *Cuba Album* contains photographs taken by Peter Henry Emerson, mostly in the 1880's. It consists of 48 platinum prints, including views of Cuba, the broads of England, and other English settings. The album was initially loaned to the George Eastman House on October 30, 1951, by Dr. William C. Emerson, nephew of P. H. Emerson. Dr. Emerson resided in Rome, NY, about 130 miles east of Rochester, near Utica. Not quite two years later, on May 10, 1953, Dr. Emerson decided to present this album to the Eastman House as a gift.

Emerson and Naturalistic Photography
To appreciate this album, one has to know something about the photographer. P. H. Emerson was born in Cuba in 1856. He was raised in the United States, but at the age of 13 went to school in England. He distinguished himself at Cambridge, studying medicine and natural science. In 1882, after purchasing his first camera, he experimented in photography with the thoroughness typical of everything he undertook. In 1885, Emerson burst onto the photographic scene, winning an incredible number of exhibition prizes. He became a proficient writer and lecturer, and an outspoken critic of the "high art" of H. P. Robinson and O. G. Rejlander. Such work he considered to be artificial and sentimental. Instead he advocated "naturalistic photography" with its emphasis on natural settings, spontaneous poses, and differential focusing. Emerson's influence is hard for us to imagine. He cleared the air for new approaches to photography. As Nancy Newhall states, "Modern photography may be said to date from... the 1889 publication of his book NATURALISTIC PHOTOGRAPHY" (Nancy Newhall, *Image*, March 1953, p. 10).

The characteristics of "naturalistic photography" can be demonstrated with photographs from this album. Emerson was a strong proponent of differential focus. He believed that photography should imitate ocular vision, that the focus should be "as sharp as the eye sees it and no sharper" (Emerson, *Naturalistic Photographer*, 1889). In practice, this meant that the main subject would be in focus but the other parts of the picture would be slightly out of focus. Also, Emerson often used a high horizon line, would make architectonic arrangements of linear objects (such as masts or poles), and would use foreground elements (such as reeds, river reflections, and mooring lines) to calligraphic effect

Emerson did not believe in enlarging his plates, so he produced negatives of appropriate size for his images. In general, his plates were undoctored with the exception of clouds, which he might burn in or print from another negative.

The Album's Early History at the Eastman House

The original loan was for the purpose of exhibition. However, there was a problem – most of the images were not in exhibitable condition. It didn't take Beaumont Newhall long to attempt to remedy this situation. The loan receipt at the Eastman House is dated October 30' 1951. By the next day, October 31st, Beaumont had a letter in the mail. This letter is a classic in the history of photograph conservation.

> October 31, 1951
>
> William C. Emerson, M.D.
> 316 N. Washington Street
> Rome, New York
>
> Dear Doctor Emerson:
>
> I want to thank you for your kindness in lending us the important material about your uncle. I showed the album of platinum prints to Dr. Mees who is the President of the George Eastman House and Vice President in charge of Research at Kodak. He tells me that the pictures can be restored to their original brilliance by a special treatment. It would be splendid if we could bring back some of them to their original condition for exhibition here. In order to do this it would be necessary to remove them from the pages of the album. This could be done without difficulty and the restored prints could be put in cut out mats which would greatly enhance their beauty. I am writing to ask if you would like to have us do this. We of course would want to try out one first. It would make a much more interesting exhibition if we showed originals instead of copies.
>
> I hope to be able to find an extra copy of the magazine with Mrs. Newhall's article. If not, I will have this one copied. Please remember me to Mrs. Emerson.
>
> Yours, sincerely,
> Beaumont Newhall, Curator

We don't know if these treatments were carried out. Neither do we know when these images were first exhibited. However, we do get a hint of what was occurring in a 1968 presentation given by Tom Barrow, assistant director of the George Eastman House. At the SPE meeting in Washington, DC, he gave a talk entitled, "Care and Restoration in a Print Collection." During that lecture he mentions difficulties with mount removals (suggesting the need to find proper solvents). In particular, he mentions the unsuccessful removal of an Emerson platinum print ("We do not know what to do," he says.). While this print does not appear to be from the Cuba Album, it certainly belies Mr. Newhall's original assessment of the ease of their treatment.

Our next written evidence relating to the Cuba Album comes from Alice Swan's 1984 treatment report. Alice was a trained photographer. In 1974 she received her Master of Arts from San Francisco State College. Also that year, she studied paper conservation with Ingle-Lise Eckman in the Museology Laboratory at the University of California. She came to the George Eastman House in the fall of 1975 to study with Jose Orraca. The only problem was that Jose had accepted a teaching position in the Conservation Program at Cooperstown, NY, and had already departed from Rochester. Alice stayed on at the Eastman House anyway and became its Conservator of Photographs until March of 1978. At that time she left the Eastman House and she set up a private conservation studio in Davis, California. She continued to practice conservation until sometime in the late 1980's, at which time she left the field to focus on other pursuits. During her conservation career, she published ground breaking research into the conservation of gelatin prints and daguerreotypes. Several of her publications were required reading for many of us during our graduate school years.

In 1983, Alice was asked to treat the Cuba Album as part of an NEA grant. Alice's initial description of the album was follows.

> The gray toned platinum prints came from an album, the pages and prints of which had sustained remarkable deterioration, brown discoloration and brittleness... Because of the obviously wretched condition, an undocumented and naïve attempt at conservation treatment had been tried. At the time I first came to the Eastman House (September, 1975), the prints were being stored in the conservation lab cabinet of material too fragile to handle. The pages had been removed from the album cover and binding, and most of the smaller and some of the larger prints had been removed from the pages. Unfortunately, the removal, which must have been done with considerable dexterity but no judgment, was accomplished dry, with spatulas and scalpels, and the affected prints had many cuts, thinned spots, breaks, tears and losses... Losses considered large enough to be "worth saving" were taped into position with pieces of "scotch"-type, pressure tape; the adhesive has penetrated the paper noticeably by now.

As you can hear, Alice had a unique way with words. Her style is easily recognizable.

Jose, who was conservator at the George Eastman House from 1974 to 1975, has verified Alice's documentation. He, too, remembers Emerson prints separated from their bindings and mounts. He may even have treated two or three of these prints, but would not have attempted dry removal from mounts as this was a technique he was unaware of at that point in his career. He remembers being introduced to mechanical mount removal while teaching in Cooperstown. Any treatment he performed on Emerson prints would have involved wet removal of the prints from the mounts (if he removed any at all) followed by bleaching with chloromine-T without the use of an anti-chlor. According to Jose, treatments on museum photographs were performed by staff and some volunteers before and during his short tenure at the Eastman House. No written or photographic records exist for such treatments, but evidence of treatment is easy enough to find. Apparently, the Cuba Album was one of those items treated. Beaumont Newhall's proposal to unmount the prints and prepare them for exhibition had obviously been started, but not completed. Treatment had proven to be more difficult then originally anticipated.

Treatment of the Album by Alice Swan

In the early 1980's, the Eastman House decided to complete the treatment of the album. Alice was chosen as the conservator. In late 1983 she received the first 16 prints in her California studio. A couple years later, she treated the remaining 32 images. After her initial assessment, she continued by broadly describing the album's condition and then provided a detailed report for each photograph. Her general comments included the following.

- The pages and prints had sustained remarkable deterioration, brown discoloration and embrittlement.
- Sixteen prints were completely or at least partially on their original mounts. Thirty-two prints had been unmounted using mechanical methods.
- The mounts were "spectacularly discolored, extremely brittle, rigid boards."
- Prints were severely discolored; all highlights of most are yellow-stained to a dramatic degree.
- Prints were badly disfigured by small orange and brown spots which frequently have centers and are not filamentary. (Alice concludes these were caused by residual iron left in the paper after processing.)
- Foxing stains were also present, but were frequently difficult to see over the badly yellowed background.
- Prints showed much rubbing, scratching, puncturing and general abrasion.
- Prints were moderately dirty, with a certain amount of dirt deeply embedded in abrasions and rubbed, scuffed areas.
- pH readings were between 3.2 and 3.8.

From Alice's description you get the sense the photographs were in pretty rough shape. They were, but maybe not quite as bad as she makes them seem. They were dramatically discolored and quite brittle, but tears and losses, while prevalent, were not as disfiguring as might have been expected. Whoever had removed the photographs from the mounts had done amazingly well with the techniques at their disposal. But I will admit, if I had been in Alice's shoes, I too would have been upset at the unnecessary damage.

Treatment of the album consisted of the following steps. I'll quote from Alice's report.

> Treatment began with the gentlest possible surface cleaning of light areas only, using vinyl eraser. Flyspecks were removed with a needle. All of this work was done under a microscope illuminated with raking light in order to minimize further damage to the images.

The tape was removed dry as possible, followed by treatment with petroleum solvents.
Sixteen prints were removed from mounts by immersing and soaking in calcium-replaced deionized water. The first baths were in cool water; later baths were slightly warm water.
The remaining 32 images were washed in the same way. During washing, residual mount materials were removed.
Washing also removed most of the adhesive (a brown gelatin), but a hard yellow residue remained. This was removed in a bath of protease in calcium-replaced deionized water.
After more washing, the prints were air-dried.
All prints were bleached in chlorine dioxide solution, followed by thorough washing and deacidification with a calcium hydroxide bath. Some staining remained, but further bleaching was considered to be too dangerous for the already deteriorated paper.
Tears and thinned areas were mended with Japanese paper and wheat starch paste.
Small losses were filled with rag paper pulp. Inserts of similar paper stock were made for larger losses. In some cases, small edge losses were inserted with another platinum paper.
After mending and filling, the prints were resized with deionized gelatin to provide a more solid, dirt resistant surface.
After drying under weights, losses were sized with wheat starch paste and toned with watercolors and graphite.
The prints were packaged on 4-ply ragboard with Mylar sleeves.

Currently the prints are stored loose on thin archival board inside Kodak triacetate sleeves.

Evaluation of Alice Swan's Treatment

As one can see, Alice's treatment was fairly standard. For the most part she used conventional paper treatment techniques; the same procedures a majority of us would have employed then and would still use today. As part of her treatment she provided a detailed conservation report, supported by invaluable slide documentation. The following is her description for a photograph titled, "Baitsbite" (82.2532.7).

> Removal of this print was particularly disastrous--it is patched with five large pieces of cellophane tape at the verso. Three losses are present on the top edge (described from recto): 0.5 x 1.0, 13 cm from right edge; 0.3 x 0.4, 6.6 cm. from right edge; 0.3 x 0.4, 3.6 cm from right edge. Two edge tears are on left edge, 0.4 cm long, 5.5 cm from bottom; 0.7 cm long, 4.2 cm form bottom.

Alice continues on for another two paragraphs, but you get the idea. These reports tell you everything you could ever want to know about these prints - maybe even more then is necessary. But, without these reports and their details, much of the treatment history of this album would have been lost.

As stated previously, most of her treatment was fairly conventional. Mount removal may have been questionable, but I believe it was necessary in this case. Of course we strive to maintain albums and mounts whenever we can, but these pages were so discolored and brittle that their removal was needed in order to protect the images from breakage, and to lessen the discoloration so the images could be aesthetically appreciated again. The surface cleaning and washing were both implemented with great care. Images were successfully surface cleaned. Washing reduced some of the discoloration in the prints, and also aided in the removal of the mount and adhesives. The use of enzymes proved to be effective as well.

Probably the most controversial aspect of this treatment was the use of chlorine dioxide bleach. Today, most of us would try some form of sun-bleaching first. Chlorine dioxide is one of those bleaches many consider to be too aggressive, one which can make the object too white or may damage the paper fibers. But, I believe Alice made a good choice. One of my guiding treatment principles is the need to look beyond the norm. What we consider to be the less aggressive treatment procedure may, in fact, be the more damaging alternative. The techniques which are accepted as less aggressive are not always the best choice. On occasion these "less aggressive" treatments can be more damaging than a supposedly more aggressive option. For example, most conservators choose to apply solvents locally rather then subject a print to overall immersion. This can lead to trouble. Local solvent application can cause staining, introduce tide lines, or maybe even cause local invisible changes in the paper which will reveal themselves in some way 30 or 40 years from now. Since overall immersion would avoid these problems, in many cases it may be the better option.

The same reasoning applies to bleaching. When bleaching an extremely discolored paper which is already brittle, sun-bleaching or the use of a mild chemical bleach often requires repeated drying and wetting of the print or repeated application of the bleach. This, coupled with the often necessary longer treatment times, can cause serious degradation of the paper fibers, resulting in tears, bubbles, or severe weakening of the paper support. With such cases, bleach such as chorine dioxide is a more aggressive, and much faster alternative. As a result, the print is subjected to less wash time and less physical stress to the support. Therefore, chlorine dioxide bleaching may well result in less damage to the object.

Overall, I must compliment Alice and her skill as a conservator. Her mending, filling, and retouching were the work of a master, beautifully accomplished. But, there were a few questions raised by this treatment which I was not able to properly answer.

- Why wasn't an antichlor used after bleaching? I believe this was standard practice at the time. In fact, I remember being taught to use an antichor by Anne Clapp in 1975. Alice may have had good reasons for this decision, but none were provided.
- Was gelatin sizing appropriate? Reasons for sizing were provided (to yield a more solid dirt resistant surface), but did resizing change the surface appearance? Did it change the image contrast or tone? Was it really needed? The paper was very weak. Possibly the sizing strengthened the paper support. Alice did not address these particular issues, but I suspect you considered them. Everything considered, resizing was a good decision.
- Were other housing options considered? The prints are still very brittle and could use additional support. I wonder if options such as mounting or in-lays were considered. I suspect they were, but were not chosen as the funding for such options was not available.

Conclusions

What can we learn from this treatment? The most important lesson should be the necessity of a good report. This entire discussion accentuates the importance of treatment reports and reveals some of their potential weaknesses. Minute details may not be necessary, but choose carefully when and what you generalize. The more important the object the more important it is to record detail. Also, the more complex the treatment, the more important it is to record the reasoning behind the decisions. This is especially true if the procedures chosen are out of the mainstream. In the case of the Cuba Album, I would have appreciated more information on which petroleum solvents were used to remove the tape, why no antichlor was used, and how the conservator knew the adhesive was gelatin.

The next point is closely related to the last one. Whenever I write a report, I assume I will be the conservator reading it 15 years hence. I ask myself, what information would I want to find? What would I be looking for? I make sure to include this material. Finally, please date your reports. Alice did not, and as a result I had to spend a couple hours tracking down dates. But Alice's isn't the only undated report I've ever seen. Dates are important.

So, how should we evaluate the 1980's treatment of the Cuba Album? When evaluating a treatment, I use four criteria: purpose, plan, proficiency, and product.

1. Purpose: Were the goals of the treatment appropriate? Was the treatment "responsive and appropriate to the condition and needs of the specific cultural property, and to the cultural property in its context" (AIC Code of Ethics, Commentaries to the Guidelines, Commentary 21A)?
2. Plan: Did the treatment adequately address the structural instability of the object? Have immediate and long-term consequences of the treatment been considered? Were potential risks weighed against anticipated benefits? Was the plan within the available resources, including facilities, equipment, and funds? Was the treatment within the conservator's level of competence? Were the proposed procedures within currently accepted practice in the field?
3. Proficiency: Was the treatment skillfully and efficiently carried out?
4. Product: Were the treatment objectives met? Was there personal learning or improvement? Was there proper documentation? Did the treatment result in any innovations for the field?

For this particular album, the answer to most of the above questions has to be, "Yes."

- Did treatment increase the physical stability of the photographs? Yes.
- Did treatment increase the aesthetic enjoyment of the images? Again, yes.
- Where the techniques used appropriate? More of the reasons behind the treatment would have been appreciated, but in general the answer is yes.
- What was the level of skill involved? Extremely high.
- How have the photographs fared since their treatment? They are still brittle; their pH is between 5.1 and 5.6 (compared to before treatment readings of 3.2 to 3.8). There appears to be no stain reversion, and they still look good.

After 20 years, this treatment can still be considered a success. I hope the evaluation of my treatments 20 years from now will be just as positive.

Acknowledgements
At the beginning of this presentation I mentioned this story had a detective. He was the one who tracked down the reports, the before and after treatment slides, and followed up on multiple leads. I owe him my sincere thanks. Thank you, Pau Maynes. I also would like to thank Jose Orraca, my mentor, for his memories of the Cuba Album during his time at the Eastman House.

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RESTORING ANSEL ADAMS

NICCOLO CALDARARO

Abstract

Photographs, like many objects have certain parameters of quality that collectors desire. Restoration and conservation of photographs affect originality, but also collectors have concepts of completeness that affects and limits the original. Conservators often discover elements of the artist's working method during treatment. This paper explores the dimensions of restoration of the original and the nature of the artist's own manipulation of the original.

1.0 Introduction

In the examination and testing of the condition of photographic prints, the conservator is often faced with unique information about how the artist works and also how the artist changed methods and materials. What is also generally unveiled is information on how the artist desired to have his or her work displayed. This is especially true of works on paper, where evidence of previous matting or presentation efforts can be seen in residues or adherent matter like tape, adhesives or fragments of mounting papers or boards still attached to the original. I will assess the condition of a number of works by Ansel Adams discussing each print first and then describe how condition information led to the development of a proposal for a recommended treatment.

It should be kept in mind that the conservation of these prints will not restore them to a pristine state. Collectors often consider photographs to be eminently subject to restoration, and even better for the attention, in fact, some publications have described such activities as part of the duties of the collector. For example, in the Editor's "Introduction" to the Life Library of Photography publication, Caring for Photographs, 1972, states, "Most of the techniques of restoration, storage, and display are no more difficult than common photographic procedures." It is often the expectation of the collector that if he or she takes a problem print to a conservator the result must be to produce a perfect restoration. The goal that conservators hold worth attaining is to return the object to a stable condition and to compensate for loss, yet not falsify the intent of the artist nor erase entirely the evidence of damage. This is an impossible task, and one that has been criticized as being more a part of the character of American conservation tradition than that of Europe (Drysdale, 1988).

While many who work to conserve photographic materials are members of the AIC and conform in their treatments to the AIC Code of Ethics (Revised, 1994), many are not and practice as restorers, producing outcomes that often follow individual and idiosyncratic views of completion and intervention. Partly this follows from the nature of photography where photographers have traditionally been inventors of sort and amateur chemists. This attitude has spilled over into the ranks of collectors who often feel that they can follow the directions of a few existing texts (e.g., Eastman Kodak, 1952, 1979, 1985; Time-Life Books, 1972; Schwarz, 1977; Rempel, 1980; Lavedrine, 1990), though most books in the conservation literature are more oriented to describe conditions for preservation or to give collectors and curators a basis for understanding when problems are present (e.g., Ostroff, 1976; Weinstein & Booth, 1977). Similarly a number of descriptive articles (e.g., Eaton, 1970; Rempel, 1977; Norris, 1992) are available. While much of the photographic conservation literature refers to problems in processing and image stability (e.g., Swan, 1987; Collings & Young, 1967; Wilhelm & Brower, 1993) and blends into the photographic technical literature (see, for example, Chapman, 1999). See, for example, Crabtree, "Stains on negatives and prints: their cause, prevention and removal," 1921. Recent articles on photographic conservation, like the conservation literature in general after 1985 is more concerned with analysis and description of degradation processes (see issues of Topics in Photographic Preservation). In 2005 a collection of essays on photographic conservation, Coatings on Photographs, appeared that seems to reflect the turning of the tide as the volume contains a number of useful and important descriptions of treatments. Like most of the recent conservation literature, however, it still reflects a central concern and focus on description of physical condition and analysis. Evaluation of treatment durability appears to be a long way off.

The idea that collectors can simply follow the directions in publications to complete desired restorations is often demonstrated to be more than a fallacy when they bring prints in the laboratory that have suffered from self-treatment. On the other hand some instructions in respected photographic publications cannot be followed to the desired result due to either problems in the directions or a lack or clarity in methodology and materials as Griggs and I (2001) described concerning published methods for cleaning slides. On the other hand, Bill Cooke made it amply clear in a review article (1989) concerning textile conservation (and I produced a very similar review of most of the rest of the conservation literature the same year Caldararo, 1989), that most of the conservation treatments done are unique experiments, drawn from limited documentation and derived from empirical work by lineages of practitioners. Little progress has been made in the past 20 years. Some books have been published on techniques, and a small number of scientific studies have been carried out on small samples of objects (Caldararo, 2004).

Surface features either of an original quality of the developed print or of the results of mounting have taken on an extreme focus among many collectors and some conservators. This is certainly reflected in the guidelines published by the Photographic Specialty Group in their Chapter 1 of the Photographic Materials Conservation Catalog (2004). The effects on image quality of exhibition exposure to light, heat, etc. or of outgassing from storage conditions, display furniture or matting and framing find special reference. A recent text edited by McCabe (2005) describes this focus in a comprehensive fashion.

This article will report on the conservation of a number of fiber-based gelatin silver prints by Ansel Adams. Some of the treatments discussed will be quite regular and uninspiring, but even these can inform us about the nature of the artist's working method and materials. Other treatments will describe challenging problems, especially of a group that suffered not only physical violence in the vandalism of a collection facility, but in the aftermath, water damage and disaster handling.

2.0 Treatments: Invasive Challenging Undertakings

There are some photographs in this group where considerable damage has taken place with loss of not only the surface features of the emulsion but significant paper loss, tears across the paper support, scratching and adherent debris and dirt onto the emulsion. The paper supports in several cases have suffered physical deformation both due to pressure and trauma as well as in laying in standing water on or among wet materials and piles of debris. It was obvious that after treatment some minor planar distortion might persist as well as irregular transitions in surface sheen, texture and reflectivity. Our goal was to return the images to a degree of authentic viewing integrity. Questions of loss of value resulting from the damage will always be attendant to these injuries in the objects and should always be disclosed. That fact alone will reduce their value in the eyes of some collectors. It was essential that this fact was clearly understood by the owner.

The collection suffered damage to a larger number of objects, our treatment here will be limited to only the Ansel Adams prints. Added to this one collection are several from other private collectors.

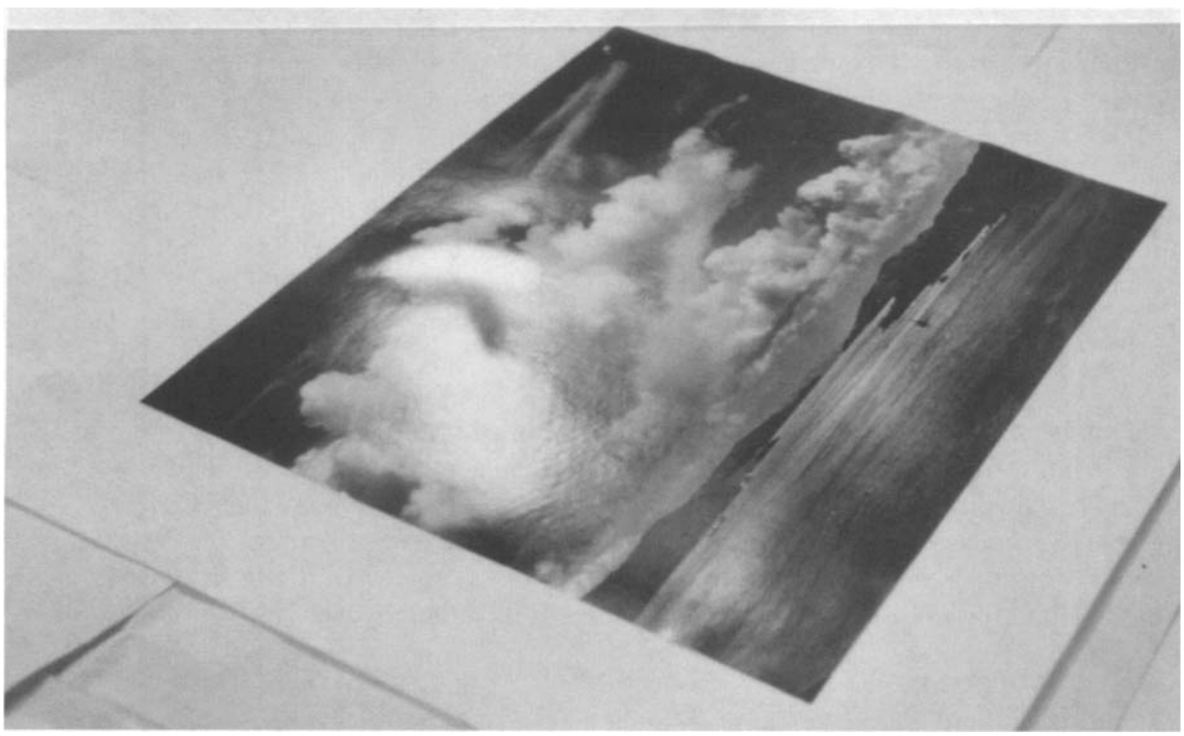


Figure 1

2.1 Ansel Adams <u>Golden Gate Bridge #1,Before the Bridge</u>, this print measures 15 and 1/2 by 19 and 1/4 and is mounted on an acid-free board. In all cases of original artists in this group the existence of a signature on the mat, or across the edge of the photograph and onto the mat, required treatment of the entire sheet, its treatment for mold, cleaning and any problems with flattening.

<u>Condition.</u> This print is a typical fiber-based silver gelatin print (Figure 1) which displays some significant degree of texture probably created in the original mounting process onto the board.

The water damage caused the failure of the adhesive holding the photograph to the board and can be seen as tenting or areas of folded image and indentations in the print. Larger "bubble-like" separations are present. The surface is scratched and there is significant debris and dirt on the surface. The mount board has suffered scratching and a few areas of surface skinning where something might have been adhered. The board and print are distorted and out of plane. Some adhesive residue was noticed on the edges of the print that most likely had resulted from the original mounting process, as these had become slightly yellowed and were visible on the edges of the print, especially the white areas. Some abrasions to the mat were present. It was obvious that when this work was removed from the wall and smashed on the floor, the broken glass shattered away from the print, and the print, supported by a thick 1/2 acid-free foam core backing, simply flexed. The entire set of fragments and the print and mat/backing must have landed outside of the main body of water.

No evidence was noted in any of the prints discussed in this article of degradation of coatings Adams used on some of his prints, especially large "overmantels" meant to be viewed without glass (Adams, 1967). Adams explained that these larger format images needed to be viewed without glass at a distance and the coatings could protect them from dirt, etc. and yet allow them to be cleaned (Adams, 1983). Chen and Albright (2005) published a study of the coatings Adams used on his photographs and had access to the comprehensive archives of framer and restorer, Paul Fredrickson who mounted and treated Adams' work from 1956 to 1984. This is a very useful and well thought out study of an artist's working method and his relationships with other professionals as they affect his or her work's preservation. What would be now helpful is for someone to carry further this study and produce microphotographs of images of coatings from the 1930s to 80s to quantify the ageing characteristics of the different coatings and also a tabulation of the solubility of coatings and their chemical identity. Apparently some varnishes were uses as well as lacquers. Since the technology is available for the visualization of films that individual DNA molecules can now be resolved (Duggal & Pasqualli, 2004) characterization of films on images and their degradation states should be possible.

<u>Treatment.</u> The essence of the treatment process is to restore lost qualities of the original without changing the intent of the artist. Any intervention must be carried out with as little alternation as possible.

1. The board, or mounting support, could be flattened along with the print. It did not sustain any significant damage or soiling, and the moisture it had gained had been controlled by the owner's associates once the disaster was recognized. Though the exact methods applied are in question, it is clear that some increased air movement was used and controlled drying was achieved. Surface treatment was undertaken after the initial period of examination followed by exposure to UV to destroy active mold. The enclosure of the UV bank of lights was a shallow tray into which a thin layer of Boric acid powder had been dusted. A variety of tests using borates have shown that they can retard mold growth (e.g. Kartal, et al., 2003)

A soft Blower Brush was used to lightly remove debris from the surface mechanically. Extensive treatment to kill mold and remove mold stains and any mold remains was not necessary. In this case all that was required was exposure to UV light for 3 hours and dusting with Boric Acid. Sandra Nyberg's updated 1987 Solnet Preservation Leaflet summarizes most of the modalities in dealing with mold and repeats the often heard argument that mold is everywhere so do not panic. Of course, in the case of highly contaminated objects one has to err on the part of prudence, so what is desired is to stop potential production of mold pigments and to assure that the percentage of active mold is returned to an "average" environmental level. Nyberg recommends, as do many other practitioners, UV treatment with care in mind to potential fading.

UV light has been found in medical studies to kill active mold and since the objects had been exposed to blood products and other body fluids this seemed to be a prudent avenue to protect both conservators and the reduce the presence of active mold, bacteria and other pathogens. The use of chemicals such as Thymol to kill mold can often give the conservator a false sense of security as many people are allergic to the dead mold spores as well. Edward's Anti-Stat Cleaner was then applied to the print to remove surface debris and to allow for more comprehensive examination using a microscope (the Prior StereoZoomMaster 65 stand was the most appropriate for this process allowing for complete access to the entire print). Once it was apparent that no significant damage was evident, the surface was cleaned using PEC-12. The adhesive residue on the edges of the print was removed using Toluene. Abrasions to the mat (especially in the lower left) were consolidated with wheat starch paste.

2. The areas of lost adhesion between the print and mount could, in general, be restored by addition of adhesive (usually D-8) and heat or wheat starch paste and pressure. This treatment failed to produce satisfactory results in some cases, while in others during the procedure there appeared to be danger of creasing or tearing, and full removal of the photograph from the mount was then the only alternative.

Full removal was required in this case and the entire photograph had to be lifted from the mount and it was executed to minimize any damage to the mount as well as the photograph. Details of this process, and a summary of different methods used by other practitioners, have been published in an earlier article (Caldararo & Sheldon, 1992). It also involved removal of as much original adhesive and transferred fiber as possible as well as the mounting tissue if any was present. This was accomplished using Toluene applied with a brush and syringe. It was of interest that the adhesive and the mounting paper were hardly yellowed at all. A new Colormount Kodak adhesive was then used. Conversations with an associate of Ansel Adams, Allan Ross, have verified the nature of the adhesive used and the mounting procedures. From these conversations, we learned that Ansel Adams had dismounted a number of his early prints in the 1970s and replaced them with a new mounting tissue as he had seen the results of earlier mounting tissues where exposure to sunlight had caused the tissue to darken and become brittle affecting, in his estimation, the balance of brightness in the prints. Our work has attempted to reproduce the mounting qualities Adams sought in remounting his prints. It was obvious that this print had undergone the remounting process by Adams during the 1970s. In Caldararo & Sheldon (1992) we summarize some of the problems with older mounting tissues and boards from the published literature and our experience. It seems to me, however, that the tissue Adams was using in the cases we examined were not yellowing significantly.

3. Residues of adhesive and paper were removed with toluene and heat spatula.

4. Surface scratching was present and could be reduced by the application of slightly warmed photographic gelatin (2% to- 5% in water) via a brush with only a few fine hairs left (nearly a "one-hair brush" produced by reducing hairs with a scalpel), or with the "hairs" modified, sometimes "squared off" as in Figure 2b. Fogging or perhaps "blanching" was apparent, (as in a similar feature in paintings conservation where micro-cracking of the surface coating produces a change in transmittance of light) and often also responded to treatment, usually by delivery of a small amount of heat locally in combination with slightly applied gelatin. (Some coatings and consolidants limit the ability to inpaint effectively, see PMC Catalogue entry on inpainting and the McCabe (2005) text.)

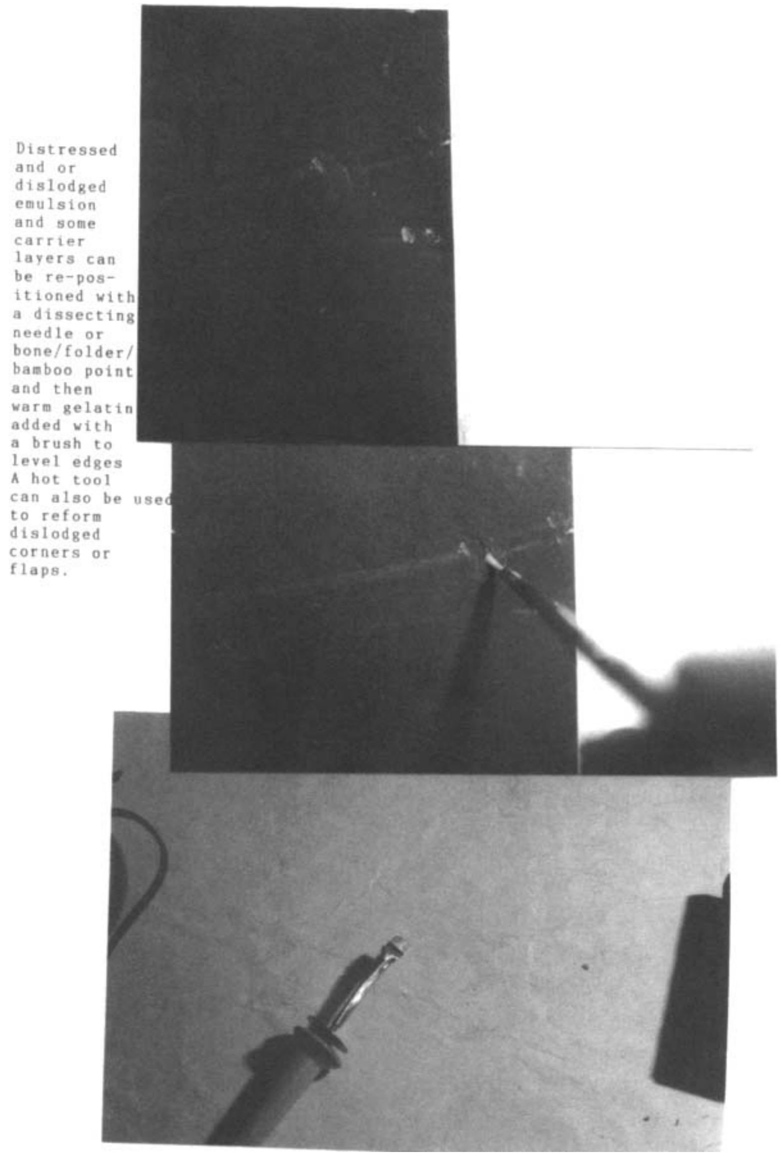


Figure 2a, 2b in center and 2c at bottom

Adherent foreign particles could be seen embedded in the emulsion and could be removed. This involved using a soft brush and a scalpel or plastic probe. As can be noted from the illustration (Figure 2a&b), scratching with broken glass can create deep, and very sharp cuts. The print also showed corner lifting, tidelines on the mat and puckering. The emulsion can separate from the cut, and then when exposed to water, lift on both sides of the cut. The edges of the cuts could be laid down with gelatin or a mixture of gelatin and BEVA D-8 or D-8 alone. The extent of the separation and the layers' ability to adhere were the determining factors. Now and then PVA (AYAA) in alcohol (ETOH) was required though we often use isopropanol (ISOH) as well.

5. Abrasions to the mount were plentiful but could be reduced by burnishing with a bone folder or by the application of wheat starch paste or CMC depending on the difficulty in producing a smooth surface from a roughened or abraded surface with losses. Often these passed into the

area of the print but in most cases they did not penetrate to the photographic base or carrier paper, still they were significant and some "leveling" of the emulsion surface had to be attempted with warm gelatin. Burnishing over a piece of Mylar or other suitable material can prevent polishing. Sometimes small areas of uplifted fiber can be burnished more effectively by using the rounded end of a dental scaler.

The outcome of treatment for this print seemed very good, and its response to treatment rewarded that assessment.

2.2 Ansel Adams, Golden Gate Bridge ,#2 Baker Beach 1953.
This print measures 15 and 1/2 by 19 and 1/2 and is mounted onto 4 ply, acid-free board.

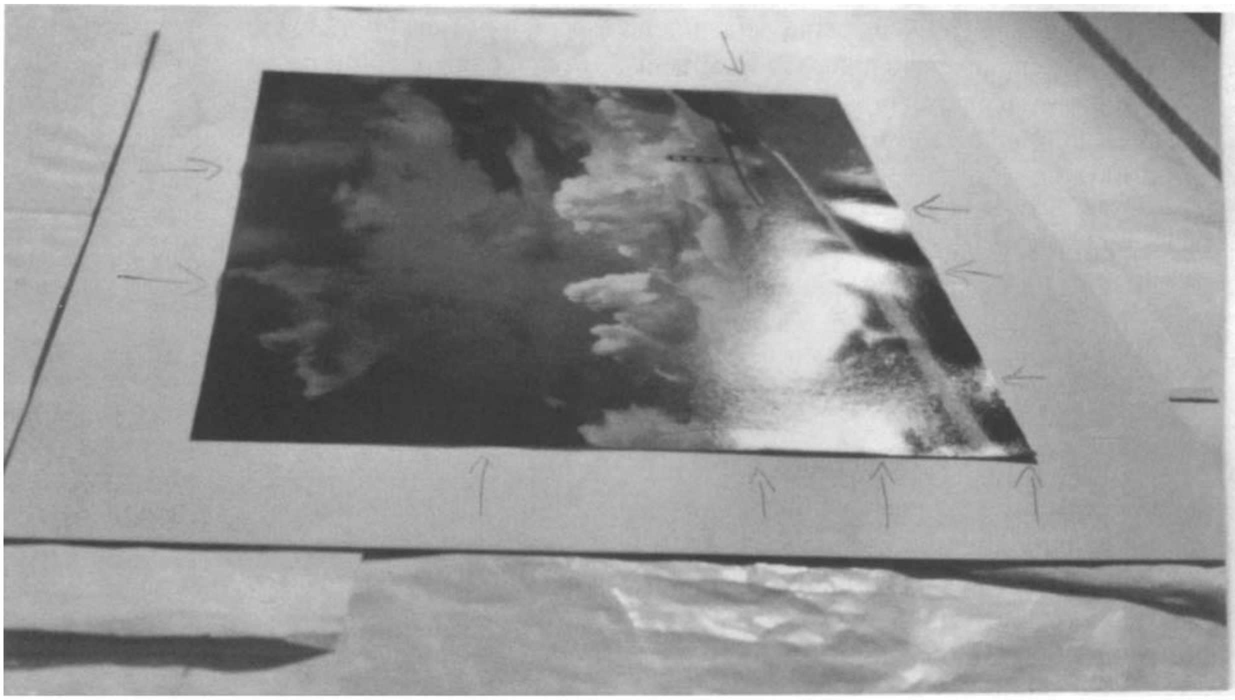
Condition. There were many areas of loss of adhesion; some of these are indicated in Figure 3a with arrows. "Bubble-like" areas were present (Figure 3b). A slight crease appears in a released area in the left central area. We thought this might be able to be relaxed and flattened, but it could resist and require the entire print to be removed to avoid creasing. All possibilities must be evaluated before choosing a treatment design and in this case experience had shown that the width of a crease in millimeters to the thickness of the sheet often dictated the results. If the heat could be applied evenly then some lateral movement of the fold might be expected, however, the degree of flow of adhesive and the rate of movement of heat and moisture through the sheet would determine the outcome. As there are no available means of measuring the potential for such factors to operate, the conservator is dependent on experience and prudence.

There were numerous scratches on the surface and the surface was covered with adherent dirt and there was some minor fogging/blanching.

Treatment.
1. Treatment for mold was undertaken as described in #1.

2. Surface scratching was reduced as described above with gelatin and heat, though some of these were quite significant and did not respond to initial treatment, but required several campaigns. Where cuts are deep and the substructure of the paper/emulsion layers has folded under or become distorted, I use a dissecting probe whose tip has been bent. The end of the needle can be hammered to any shape, or flat and then when inserted directly into the cut or tear rotated slightly to untangle dislodged layers into alignment. Sometimes it is necessary to use more than one needle and bend the end to slightly longer lengths. Reduction of fogging/blanching and removal of foreign particles from the surface was undertaken using fine brushes and swabs.

3. Flattening of print and mount was undertaken in a dry mount press between sheets of silicone treated Pellon (generally I spray my own sheets of Pellon with silicone. There is probably no difference in using Seal Release Paper, but I am sure what I am dealing with). Initial treatment was a success. Planar distortion was reduced, but it was considered necessary to reinforce the old mount by mounting it to an acid-free support of 4-ply mat board. This was thought to be prudent as some "memory" of distortion might remain.



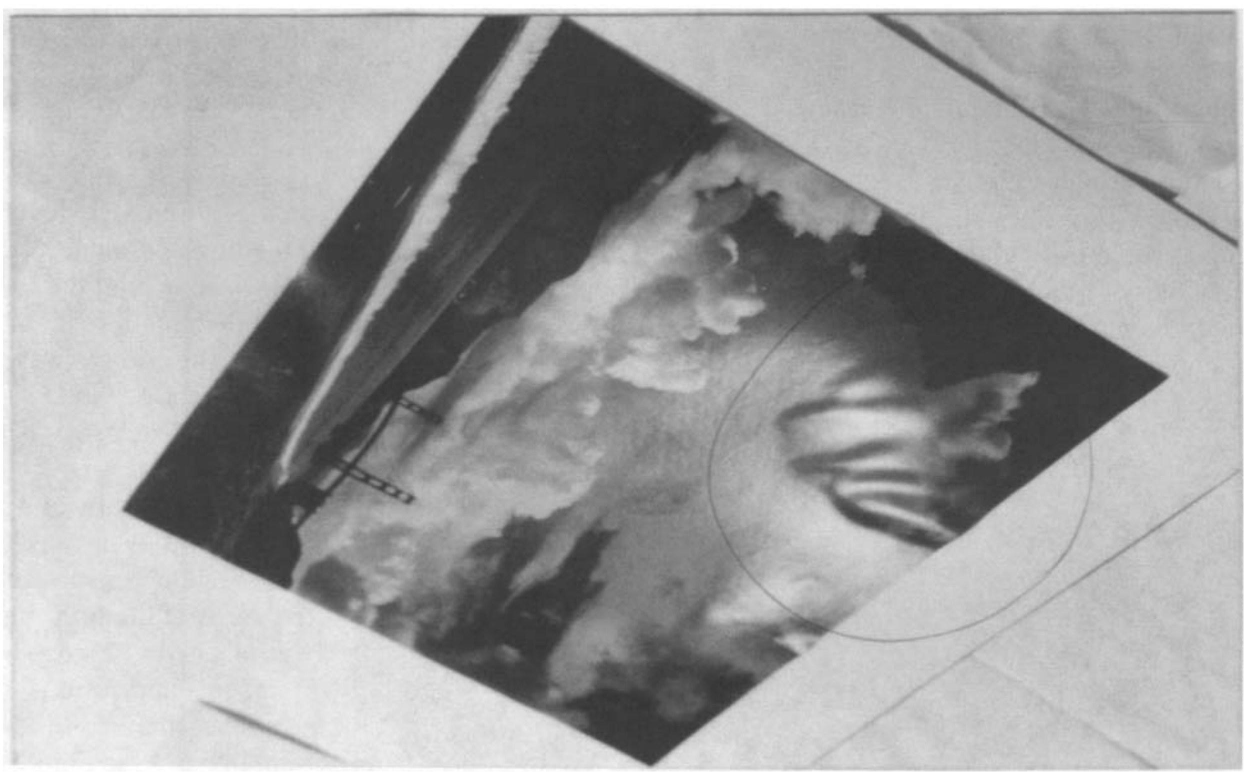


Figure 3a above and 3b below

4. Reattaching the print to the mount and repair of folded or torn areas of the print was carried out using local heat and the addition of adhesive, usually BEVA D-8 with a syringe. Torn edges of the photograph could be readhered using wheat starch paste.

The main problem in cases of partial detachment, especially of the "bubble areas" was the concern to limit the invasive nature of treatments. If reattachment could be achieved using added adhesive without danger of creasing, then this was chosen as the most acceptable approach. The same caveat applied here as to item #1 above where the failure of minimal treatment would then require full removal of the print.

5. The mount was cleaned and an effort was directed to reduce scratches and torn or re-deposited debris. All of these operations could be undertaken with the proviso that existing evidence of the artist's working method would be retained as possible. The most significant element of this was the artist's signature. It was evident that the artist had remounted several of the prints himself in the past.

6. Again, damage to the mount or to the photograph might be possible to repair without unmounting. However, in the case of this print also, if a slight creased area in the center could not be flattened, in situ removal of the entire sheet would be necessary. See Figures 4 for removal of the old mounting tissue from the original mount. Sometimes, where there are small areas of detachment and little risk of folding or creasing, a thermoplastic adhesive, such as D-8, can be introduced by the use of a syringe followed by the application of heat and the print will resume a planar position. However, this is often difficult to predict before hand, and this is due to a number of factors including the flexibility of the sheet, the adhesive potential of both the verso of the print and the face of the mat, the possibility that the print has become distorted in size or shape during degradation or trauma. In this case, the initial tests indicated that some pinching of the print at the corners was possible and the interior areas might crease. As a result the print was detached manually and with the aid of injected toluene. Once removed the verso of the print was cleaned of all paper fragments and residual adhesive, then remounted. See Figure 5 for "after" treatment.

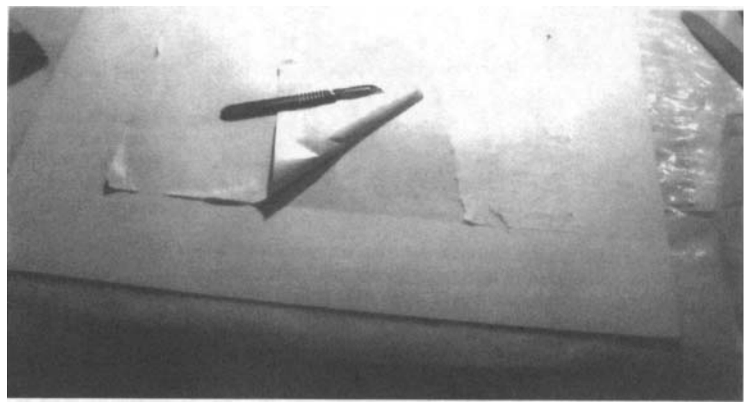


Figure 4

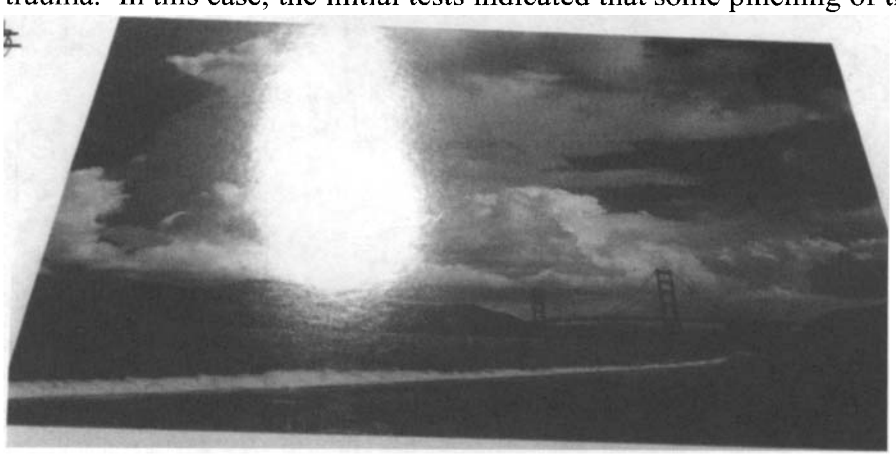


Figure 5

2.3 Ansel Adams, <u>Market Street from Twin Peaks, #3</u>, measures 15 and 1/4 by 19 and 1/2 inches.

<u>Condition.</u> There were stains on the mount and one corner of it broken. It needed flattening and displayed severe planar distortion. Dirt and debris were on the surface and a few areas of minor lifting were present.

<u>Treatment.</u>
1. Treatment for mold was undertaken as in #1.

2. Surface cleaning with solvents was carried out including the use of PEC-12 by Photographic Solutions, Inc. and Anti-Stat Film Cleaner by Edwal. Both solutions are made up of fast-evaporating organic solvents.

3. Flattening of print and mount were mainly accomplished as noted in numbers 1 & 2. The broken corner of the mat was coated with CMC, fragments that had been folded over or pushed inward were reoriented with a dissecting needle or scalpel. Some paste was added with fine brushes to the interior and the corner placed under pressure. Areas of abrasion on the mat were burnished and a stained area was treated with ammonia 2% which lighten the area. Another stained area required treatment with hydrogen peroxide (3%)and alcohol 1:1.

4. Reattaching print to mount and repair corner was also done as described for the other prints. The corner damage also needed repair of the image sheet (photographic paper base) and required the use of wheat starch paste to reconstitute torn and twisted photographic paper. A similar use of tools and method as in #3 for the mat corner repair were involved.

The same course of possibilities for alternative treatment as above for possible need to remove print and remount were evaluated. In this case, however, no complete dismounted seemed necessary, instead the cleaned and repaired original mount and print were mounted to a 4 –ply new backmat of pH neutral 100% rag.

5. The mount was cleaned of dirt, blood and other extraneous and adherent materials. Blood was able to be reduced by swabbing with deionized water followed by saliva.

6. Scratches were reduced using local heat delivered using a specially designed tip (see Figure 3c The thin aluminum creates a heated surface but is not strong enough to be used to force an impression) followed by "Marshal's" solution and P.M. solution or saliva.

2.4. Ansel Adams, <u>Sutro Garden, #4 1933</u> Mount 14 x 18 inches, image 11 x 14 a gelatin silver print mounted onto a 4 ply board (Figure 6).

<u>Condition.</u> Blood residue was present in a number of locations on the print. This has resulted in a slight disruption of the surface of the gelatin where the blood contacted the image. Blood is usually neutral pH and its components mainly protein and a small amount of lipids (some non-polar like triglycerides and cholesterol esters, but also some free fatty acids, vitamins and chylomicrons, see Shen, et al., 1977). Changes in blood as it ages is due to a number of factors

(Schwarzacher, 1930), but we could not determine significant factors for surface damage. Removal, however, in our tests indicated a nearly intact image under the blood. There were creased areas and scratches over the upper left area and traumatic delaminations in the upper right area with several significant losses in the surface of the print and paper. Scratching and abrasions were rife over the print surface. General damage can be seen in Figure 6. The mount board is a poor quality illustration board.

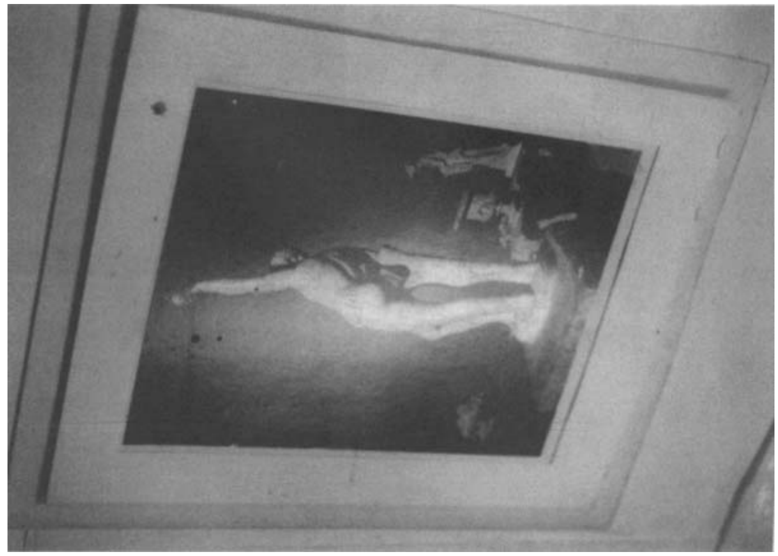


Figure 6

Treatment.

1. Treatment for mold was executed as described in #1.

2. Surface cleaning of debris and removal of debris in the paper support of the print and areas of loss was undertaken mechanically with a soft brush and then with solvents. Salvia removed some of the blood residue on the surface of the print, 2% Ammonia in water removed the rest and Marshall's P.M. Solution (which seems to be composed of some combination of turpentine and vegetable oils which we tested on cotton paper in a test oven for the equivalent of a usual artificial aging regime with little darkening) smoothed the area after. Hydrogen peroxide is often recommended for treatment of blood stains on fabric but should be avoided in regards to those on photographic images where it can produce characteristic oxidation (Reilly, et al., 1988). We were concerned that hydroperoxides in the water might have initiated peroxide associated staining due to the extensive damage to plumbing, walls and ceiling of the facility but none developed.

3. Consolidation of areas of loss was accomplished using warm gelatin. Photographic gelatin was prepared fresh in most cases though we have found that in some cases old gelatin, especially if left out for a few days has different qualities than fresh. Whether this is related to certain aspects of "aged" wheat starch paste in the Japanese practice of mounting is uncertain and needs to be investigated. Gelatin applied with a brush and with alternating the use of a bone folder and needles and pointed or rounded wooden tools to mold and flatten the gelatin surface often resulted in reforming a smooth association of the torn and mangled paper support layers and the gelatin. The delicacy of this operation can be appreciated as over working or too much pressure can enhance and spread delamination of the paper support layers and mangle or dissociate the gelatin film. Application of heated spatulas on raised areas reduced them and injected gelatin (using Tuberculin gauge needles, the 25 not 28 gauge) into raised and distorted layers followed by heat or pressure also had a flattening effect. "No Scratch" solution reduced slight surface abrasions along with small amount of saliva delivered on a fine brush.

4. The problem of restoring print loss areas is essentially an impossible one. Pigment, some of it carbon mixed with gelatin, some from the SpotPen and some applied by brush from Spotone colors (dyes) could be applied. A general leveling of loss areas was achieved by building up areas and blending tone. Some fiber could be added from acid-free scrapped photographic paper, and chalk, and then burnished with a bone folder after heating areas slightly with a hot tool specially made for each area out of aluminum (see figure 2c). Inpainting is similar in nature to that done in other works on paper supports, once the surface has been united by mending tears, filling losses and leveling with coatings of gelatin, etc. Inpainting media varies to the consistency of the surface, absorption and the mottling or design present. A number of popular texts recommend different pigments and methods (e.g., Schaub and Schaub, 1974; Shafran, 1967) and advice from professional photographers and avid amateurs is rife in publications of the trade like PhotoTechniques and Photography. While water color and gouache suffice for many problem losses, in many cases the surface features are unsatisfactory and an oil based pigment provides a stronger pigment layer more durable in later manipulation if necessary. This problem is mentioned in PMC Catalog, inpainting section, especially insufficient gloss and the "wetting" difficulty. Adding wetting agents or ethanol is recommended but practitioners but realize that these can produce irregularities in the pigment solution. Also, often only a small area needs to be compensated and mixing in additional volume can make difficult application given the surface tension required for a uniform layer to form. In these cases a product like the Grumbacher Gamma retouching colors is more effective. Nevertheless, later coatings, either of synthetic varnishes or gelatin are often necessary to achieve a uniform surface for the repair and surrounding areas. Often small areas are difficult to get a brush point into and the application of a small amount of adhesive with a few haired brush followed by crushed dry pigment on the end of a needle can be effective and reduce spreading or seeping of the pigment into cracks or fissures.

5. Compensation of areas of loss to unify image was a primary concern of the owner and translated to a detailed effort to locate any fragments pressed into the paper matrix of the print support. Where a loss existed the creation of a flexible fill to match the layers of the print was assessed. Often photographic paper fibers could be ground up or teased and added to wheat starch paste or BEVA D-8 and burnished or slightly heated with the hot tool. Leveling was monitored under the microscope with raking light and small volumes of D-8 or gelatin could be added with a narrow pipette or a thin brush (00).

The same procedure as above for assessment of the need to remove the print from the support to reattach or flatten, or consolidate was followed. Where a blow to the surface of the print has created a depression without breaking the surface is a terribly difficult one to correct. Local injections from the verso can result in correction but are nearly impossible to control. Removal of the entire print seems overly invasive, however, and a real dilemma results for the practitioner. In cases of tears or loss of the print's surface however, the situation is a bit clearer. One often feels that a depression may still exist after all the fibers have been aligned and logically the impression is that there should be a visual correction, but instead a depression remains even though all the fibers are aligned. Certainly this is not always the case, but when this is the impression it usually results from the compression of the fibers in the area of damage and hydration does not always correct this situation. Therefore compensation can go too far in what may not be entirely reversible since addition of more material or pigment (etc.) can result in a rise in the locality when the impression is perhaps incorrect and the result of a viewing error. Then one is driven to treat a larger area which only compounds the problem. This is why minimal intervention is best and the problem is made worse by coated photographs as Norris and Kennedy (2005) have noted.

6. Clean surface of mount and restore surface as described for above item #3. "after" image in Figure 7.

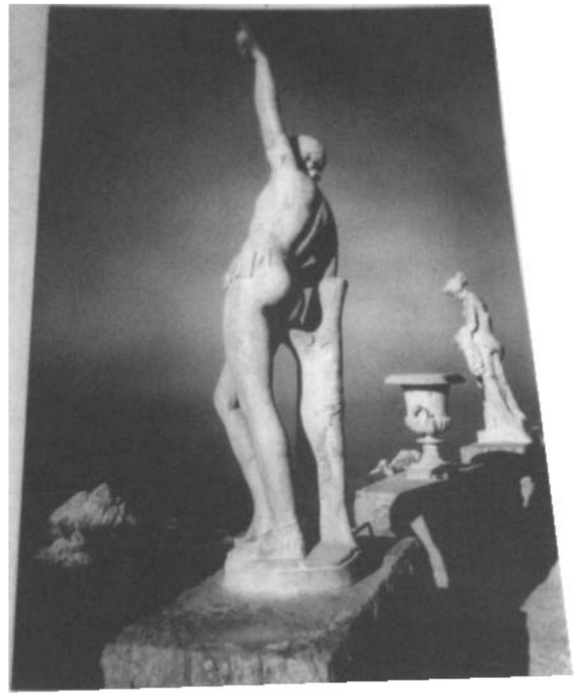


Figure 7

2.5 Ansel Adams <u>Hot Monday Afternoon,</u> 14 x 18, (clothes line) image, a gelatin silver print mounted onto a 4 ply board 11 x 14. (Figure 8.)

<u>Condition.</u> There was significant adherent foreign debris stuck to the surface. The emulsion was degraded and distorted in many areas. There was blood residue dried onto the surface. The mount was torn and stained. There was a general loss of adhesion seen partly in Figure 9 in the sky area as bubbles. Gouging and deep scratches were present. We were told that blue from a bed frame or bedding had covered the photograph when found and is seen staining the print. Mat board stain of the same source is also possible.

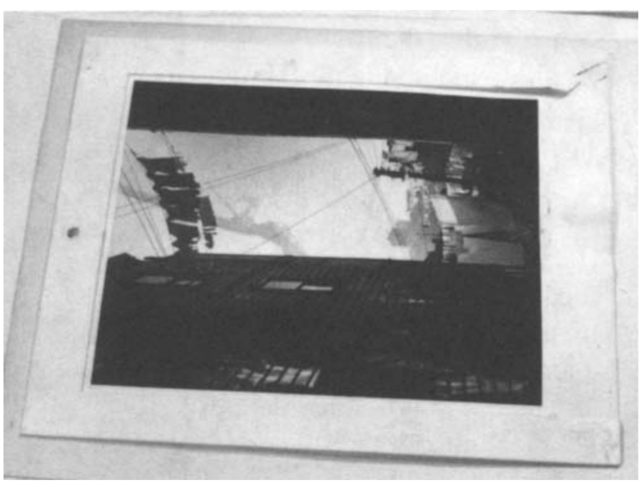


Figure 8

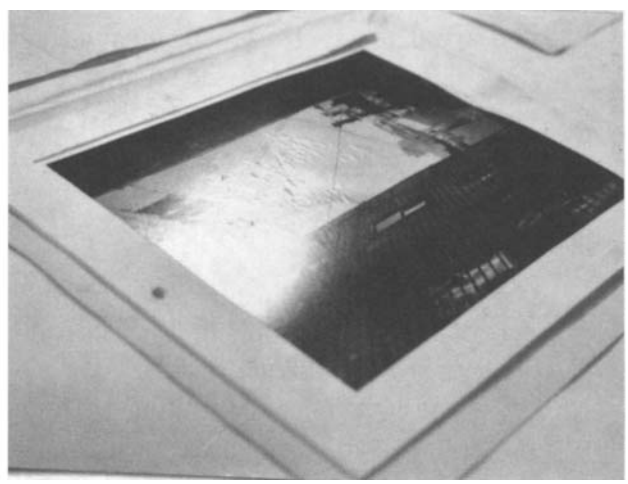


Figure 9

<u>Chemical Tests.</u> The blue staining seemed to respond to reagents at first when some movement or lightening occurred using organic solvents, especially with Dioxane, but no transfer could be achieved onto swabs and therefore more testing was undertaken. A Teas Chart was referred to for extensive chemical tests but results were negative, no window of solubility could be

identified. Characteristics of different pigments were considered along with their potential sources, paper, fabric, paint, plastics. Daniels (1995), Cook & Mansell (1981) and numerous chemical manuals like the CRC Handbook of Chemistry and Physics, 54 ed. 1974-5, offered no solutions, though tests were conducted using a number of steps suggested for microanalysis (e.g., C.H. Sorum, Introduction to Semi-microqualitative Analysis, 2n ed., Prentice-Hall, 1953. However, Grubenmann's (1993) suggestion to consider virtual liquid states versus hypothetical liquid states of molten solids at solution temperature, and related cues concerning dye reactivities, finally produced a methodology.

Further tests were necessary to determine the potential extent of removal. These demonstrated a diminishing return in solvent reduction. Even considering Grubenmann's arguments, solubility was limited no matter how the physical nature of the solvent action was applied to the potential windows of solubility. Considering the idea of physical attributes was of value, that is the physical state of the coloring agent and binding in the gelatin, brought the possibility that the nature of the pigment/agent could be approached by the same hypothetical means, that is a physical process, heat, etc.. Analysis of the stain indicated that sun bleaching was unlikely to reduce the stain entirely, but UV exposure did show promise. Exposure times were controlled and carefully monitored (Figure 12). Distance varied with experiments on the mat stain and eventually the lamp was placed within 10 inches of the photograph's surface. This was a "dry" exposure, and ventilation was provided by a small fan at about 3 feet. Eventually the staining was entirely reduced.

Treatment.

1. Treatment for mold was undertaken as in #1.

2. Surface cleaning of debris and removal of debris in paper support was done as in #1.

3. We consolidated surface damage of print as in the above examples.

4. Compensation for loss in silver image and sheen was also undertaken as in those above.

5. Flattening of image and mount was a goal but the same problems as above required some consideration for possible removal of print from the mounting board. "Bubbled" areas of detached adhesion between the print and the mount were restored with the use of a heat press.

6. Cleaning the area of mount at the signature and on the rest of the matting board was done using hydrogen peroxide and isopropanol (ISOH) 1:1 followed by saliva.

7. The abraded and torn areas of mount were restored. In many cases torn edges could be realigned by use of a brush and gelatin, aided with a dissecting needle to tease out fibers turned under or otherwise out of order. Extreme care has to be taken in this action with emulsion that has detached as any untoward movement can result in more damage that is difficult to correct. A small amount of BEVA D-8 can be used to plasticize areas that are bulked by damage and cannot be replaced and then low heat activates the D-8 providing a smooth and secure flat surface.

8. Reduction of staining followed research as noted above. Eventually research (as noted above) led to exposure of the print to UV light. After more than 40 hours of exposure the stain was gone (Figure 10).

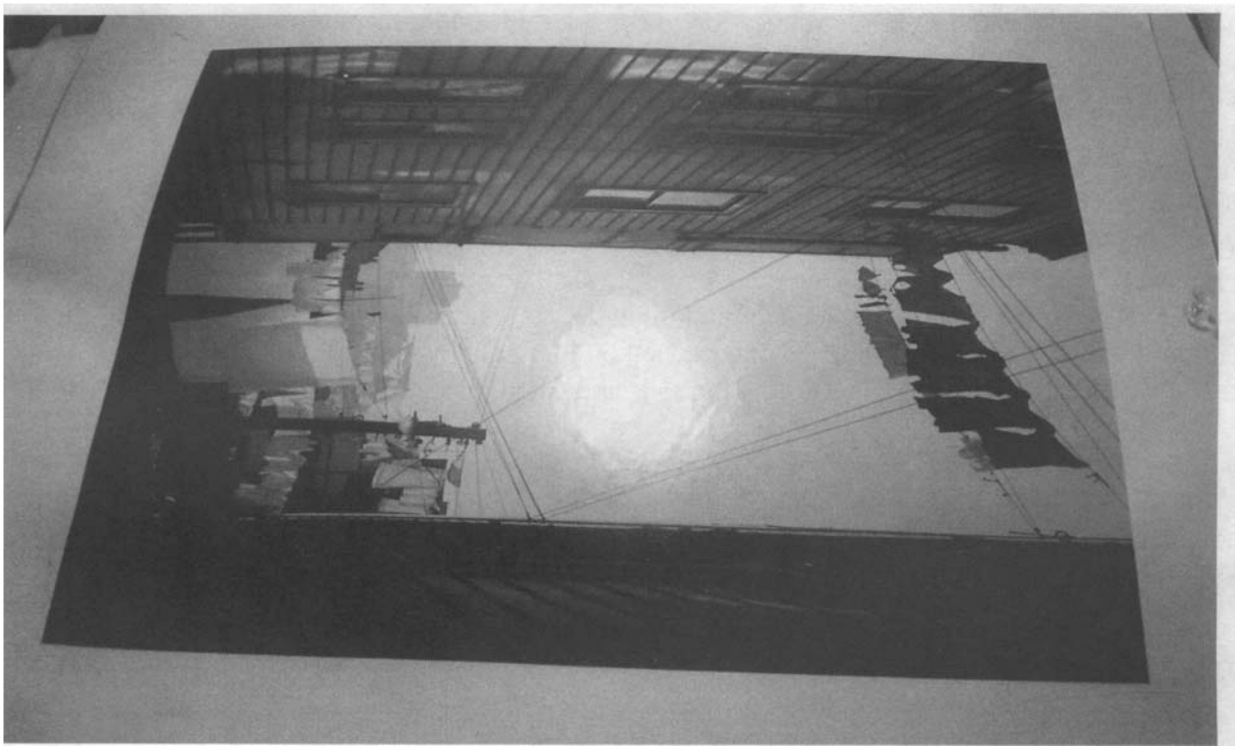


Figure 10

3.0 Treatments: Mundane Problems

This section includes three works by Ansel Adams that are not substantial treatments or did not require invasive operations:

3.1 Ansel Adams, "Mirror Lake" subject landscape of Yosemite with Lake, number 193.

Condition. This photographic silver gelatin print was mounted onto a paperboard that tests near neutral pH that is recommended for photographs. The signature is on the paper mount and the image measures 9 and 1/2 inches by 7 and 1/2. There was a slight ripple in the photographic image.

Treatment. No treatment was recommended for the print. This is the way Adams mounted his prints and there appear to be no problems. Reduction of this ripple may result from treatment, however, it may be that this is how the print was mounted by Adams or one of his staff. The affect is slight and seems insignificant.

3.2 Ansel Adams, "Half Dome" Yosemite Valley.

Condition. This print was mounted onto a back mat using ATG tape. The tape has no carrier once applied and is just a mass of adhesive laid down by a "gun" device that transfers the adhesive from a carrier roll in the "gun." This adhesive is thermoplastic and has been applied across the signature of the artist (Figure 11 & 12)

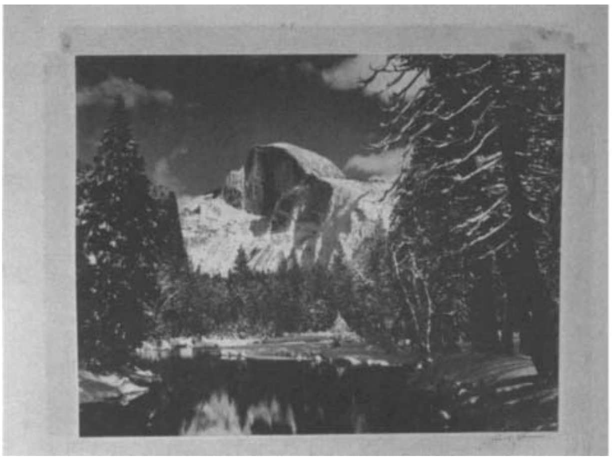


Figure 11

Figure 12

Treatment. Most of the adhesive could be removed manually using an eraser (Architect's Pickup Square). However, that mass near and covering part of the signature had to be removed using toluene and swabs, delivering the toluene with a brush or pipette and removing the gelled adhesive with a pointed cosmetic swab. Very little of the signature was disturbed in the process.

3.3 Ansel Adams, "Mirror Lake" subject landscape of Mt. Lyell, number 91.

Condition. This photographic silver gelatin print was mounted as in the one above. It also had an acidic face mat adhered to it by pressure-sensitive thermoplastic tape. (Figure 13.) The tape adhesive layer has affected the mount, mainly by yellowing but also by a slight change in surface texture. Perhaps the ATG "gun" used to apply the tape pressed down too hard and resulted in this feature, or the degradation of the tape itself is the cause for perceived change. There is an acidic interleaving paper as well that has been attached to the top mat with an "Elmer's" style glue (PVA).

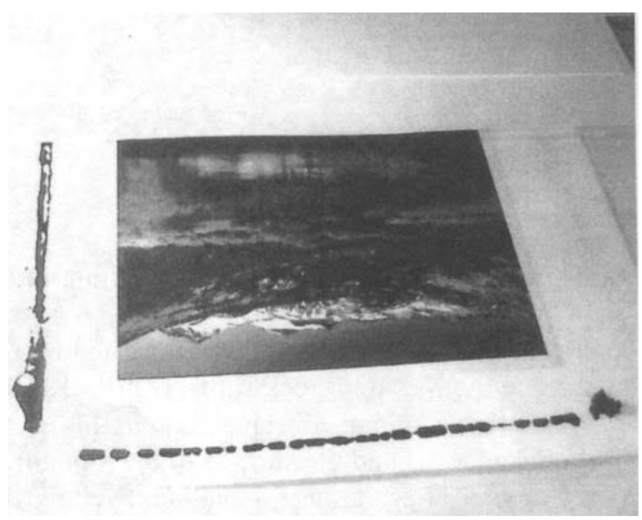


Figure 13

One corner has been lifted in the past resulting in minor skinning of the photo mount. The signature, apparently in an ink, has faded somewhat either by exposure to light or by light and the effects of an acidic mat in contact.

Treatment.

1. The top mat was removed mechanically using the aid of a stream of hot air from a hair dryer, and other acidic materials, tape and tape residue were also removed mechanically using a spatula and hot air or a hard eraser. ATG adhesive residue with fragments of the liner paper attached were a characteristic of this combination over time.

2. Minor repairs were made to correct skinning to the surface of the mount using wheat starch paste and paper fiber and the surface was also cleaned using Groomstick and kneaded eraser.

The treatment followed the initial proposal from the examination with the exception that it was found that the inner lining of the mat was glued to the face of the print with an Elmer's-like PVA adhesive. This was removed using a mixture of solvents and a poultice. Areas of tearing caused by the owner or framer were readhered using wheat starch paste. The lower area of the print sheet was stained with the back inner lining paper due, I think, to the ATG tape or some process used by the original matter. No method could be found to reduce this staining. Slight areas of buffing were noticed on the print near the signature. These were reduced with a surface treatment devised by Kodak (1985). In similar situations Kodak Film Cleaner containing fast evaporating solvents can reduce surface adherent substances, and the formula for removing lacquer (page 137), mixing ethanol and ammonia is also useful. (See figure 14 "after treatment" image).

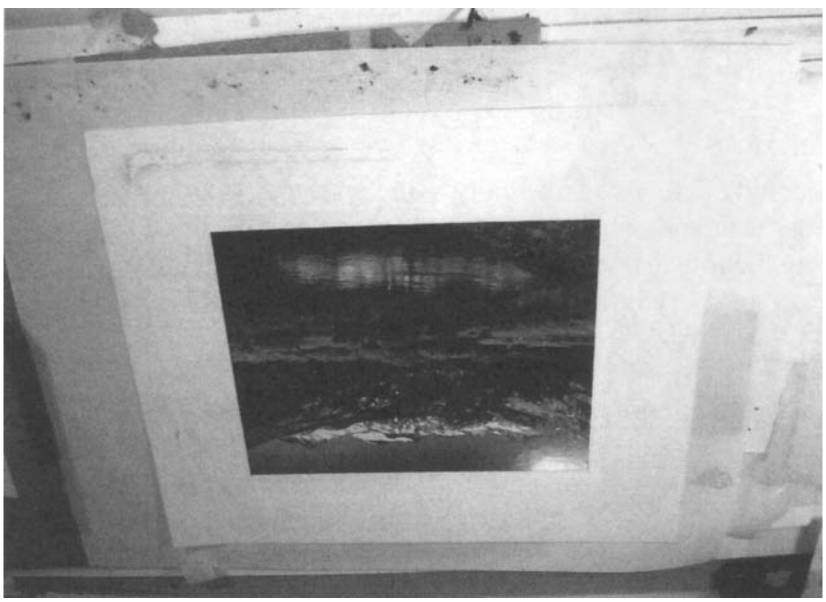


Figure 14

4.0 Comments on Artist's Working Method and Conservation Treatments

One interesting aspect of treatment has brought up a point of art historical note, perhaps. While dismounting the Market Street from Twin Peaks, print it became clear that the print was attached to the mount by a unique adhesive system. In figure 4 you can see that the print has been entirely dismounted and the surface of the mounting sheet is uppermost and a scalpel is laying on a turned up piece of this sheet revealing a yellowed adhesive field below. This is curious since the back of the photograph also has a slight yellow tinge but the mounting sheet it self is free of yellowing.

At any rate, this curiosity did not affect the treatments. I knew that I would have to remove the mounts for some of the prints and remount them to achieve a flat surface. In doing this I have had to save the original matboard that is signed and, in some cases, stamped.

Addressing the Ansel Adams, Market Street from Twin Peaks print, there was some concern in maintaining the association of the mounting materials and the print, especially since Adams signed both the recto of the mat below the photograph and the verso in a stamp. Today many photographers and collectors differ on how to preserve photographs, some continue to mount, others deplore the practice. There are various opinions about the archival nature of mounting adhesives. It is obvious from the oral history of Ansel Adams, "Conversations with Ansel Adams," conducted between 1972 and 1975 by Ruth Teiser and Catherine Harroun (Regional Oral History Office, Bancroft Library, 1978), that Adams felt strongly that archival materials should be used on his prints and was concerned with methods of mounting. Unfortunately few Adams prints' conservation treatments have been published so we do not know precisely what methods and materials he used or were used by technicians and restorers he chose to work with. Perhaps Paul Fredericks will allow publication of his treatment reports which would be a great help. It is clear from the oral history that he used acid-free boards, Strathmore and then Schoeller boards. In speaking with Alan Ross, who was his assistant from 1974 to 1979, Adams used Kodak dry mount adhesives until 1975 and then Seal MT-5 for one year, then ColorMount after that.

This information produces some dilemma. It gives us some general idea about his use of Kodak products, but since the tissue and adhesive are not well characterized in the literature there is some question still about the mounting. Also, many of the prints we are treating are older than this information details. While the mounting tissue noted above in the case of Golden Gate Bridge #2, appears to be made with some rag fiber and has not darkened or yellowed, it does not conform to any known by other photographic conservators I have contacted (at least 15 responded in one way or another nationwide to a query on the Photographic Conservators' DisList). The adhesive could be a Kodak product, though it is not noted as used for this purpose in the literature. As the adhesive has yellowed the verso of the print I have removed it, though it has not affected the image it could continue to age and stain the emulsion or embrittle the paper. The area on the mat where the print was attached has also yellowed, and much more so. I have removed much of this residue and attached a barrier paper over the area to prevent any transfer.

5.0 Final Note on Form and Organization

The form of this article is derived from that of the treatment report for two reasons. One reflects comments and questions many conservators have addressed to me about the nature of the working method in their own practice. How does one use research materials in treatment design and decisions and organize treatments of a number of objects together into a coherent program of treatment, based on experience? The second derives from efforts by Nathan Stolow, Robert Organ, John Asmus and myself to develop materials and an approach for a book on conservation treatments. While these materials lay now as notes, unfinished chapters and ideas, I have utilized some of our discussions in the development of treatment design in this article as a step by step template. Since the demise of the old Preprints format, the AIC has gone to a "scientific" format. What I would like to achieve here is to open a discussion concerning how useful our articles are to practitioners? Who are authors speaking to, what kinds of information are people (practicing conservators) interested in finding in the JAIC and specialty publications? My central interest is to find what is the most useful format for papers? What are the criteria for our publications, their goals and purpose? Hopefully this will be useful to others and spark discussions on treatment design and development.

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