

Fifth Interim Narrative Report
for IMLS LG 06-07-0067

DP3 Project: Digital Print Preservation Portal
(PART II) – Evaluations of the Effects of Housing,
Handling, and Flood on Modern Digital Prints

For the Period November 1, 2009 to April 30, 2010

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INTRODUCTION TO THE PROJECT

This is the fifth interim report on the Institute for Museum and Library Services Project LG 06-07-0067 titled *The DP3 Project: Digital Print Preservation Portal (PART II)—Evaluations of the Effects of Housing, Handling, and Flood on Modern Digital Prints*. This is a major research and development project dealing with the preservation of digitally printed materials: inkjet, dye diffusion thermal transfer (or “dye sub”), and color electrophotographic (color laser). This project is intended to help all conservators, curators, archivists, librarians, and collection managers better understand and care for these objects in their collections. The project was originally scheduled for completion on September 30, 2009. IPI requested and was granted a 12-month extension. The new completion date is September 30, 2010.

The project involves research into several key elements of preservation for digital prints in libraries, archives, and museums. The research focuses on the potential harmful effects of mixing traditional and digital print collections, the effects of housing and display materials on digital prints, the effects of handling, and minimization of the risk of flood damage. The ultimate goals of the project are to create a set of science-based recommendations to help cultural heritage institutions make collection care decisions and to publish this information on IPI’s *The DP3 Project: Digital Print Preservation Portal* website (www.dp3project.org).

REVIEW OF THE ORIGINAL PROJECT PROPOSAL

The project has three stages: preparatory, experimental, and reporting.

Preparatory

In this stage, which was primarily confined to the first two quarters of the project, experimental equipment necessary to the project were to be purchased, installed, and calibrated at IPI. Any necessary training was also to be concluded during this time. Additionally, a large number of materials (printers, inks, toners, and papers) needed to be collected to create the test sample population. These samples were to be made at IPI or other departments at RIT, or, when unavoidable, obtained from sources outside of IPI and RIT.

Experimental

In this stage, which was to be ongoing from the second quarter of the first year and extend through the second quarter of the second year [now the third year due to the 12 month extension], experimental work would be performed in order to better understand the behavior of these materials over time. A variety of print characteristics and vulnerabilities were to be explored. This experimental phase could be divided into four separate areas: chemical interactions, physical interactions, physical handling, and flood/disaster sensitivity.

Chemical Interactions

First, chemical interactions between traditionally printed photographs and digital prints would be examined. Second, interactions between digital prints (inkjet, dye sub, and electrophotographic)

and common enclosures used in institutions (such as cotton paper, mat board, and polyester films) would be examined. The results would then be used to determine whether digital and traditional prints could be stored together or would need segregation and, further, to determine whether enclosures currently used for traditional materials would be equally suitable for digital prints.

Physical Interactions

Physical interactions between prints in stacks or prints in contact with enclosures and framing materials (for example, ferrotyping, bonding, and colorant transfer) would be explored with the goal of providing suggestions to prevent these forms of damage.

Physical Handling

The sensitivity of digital prints to surface abrasion and emulsion/surface cracking (brittleness) would be examined with the goal of providing guidelines for handling.

Flood/Disaster Sensitivity

Samples of various digital print processes would be exposed to water immersion and evaluated for survivability. This would be done in order to help institutions include specific responses for digital prints in their disaster plans if needed.

Reporting

In this stage, information regarding the properties under investigation would be posted on IPI’s DP3 website, and interim reports transmitted to IMLS at requested intervals. The final results at the end of the project would be reported and made available to IMLS and to the public, and would be specifically marketed to the archives, libraries, and museums that need the information.

REVISED PROJECT SCHEDULE OF COMPLETION (as per IMLS-granted 12-month extension)

The following table shows a simplified version of the project’s schedule of completion as revised in the request for the project extension. The black areas indicate the aspects of work already completed. Gray areas indicate work still to be performed.

	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Purchase and install equipment	Black											
Create/collect samples		Black	Black	Black								
Perform chemical interaction tests					Black	Black	Black	Black		Black	Black	
Perform physical interaction tests					Black	Black	Black	Black				
Perform flood experiments							Black	Black				
Perform abrasion and brittleness tests		Black	Black	Black			Black	Black				
Update DP3 website with project results	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black
Reporting/dissemination												Gray

CURRENT PROJECT STATUS

Preparatory Stage

The preparatory stage of the project is finished. All equipment purchased for the project has been installed and calibrated. All necessary training on the equipment has been conducted. All samples needed for the experimental work have been created.

Experimental Stage

The experimental work for the project has been completed. The following are summaries of the experiments and the results.

Mixed Collections: Chemical Interaction Tests

In these tests, the potential for harmful chemical interactions between digital prints and traditional photographs were examined. The method used focused specifically on whether digital prints may harm traditional photos when the two are stored together. The tests involved separately examining the effects of digital print papers and digital printing colorants for reactivity. The tests also evaluated both digital photographs and digitally printed documents for reactivity.

The results showed that digital printing colorants tended to not be reactive with traditional prints, but that some of the digital printing papers were. These were mostly the digital document papers as opposed to the digital photographic papers. The following conclusions were reached as a result of the experiments:

- It should be safe to store digitally printed photographs with traditional photos as long as the digital prints are physically durable enough to resist abrasion (see *Abrasion Testing* below) and are kept at appropriate storage temperature and humidity levels.
- There does appear to be a risk in storing some digitally printed documents with traditional photographic prints. Unless a digital printing paper in question is known to be safe, digitally printed documents and traditional photographs should be segregated.
- It may be possible to minimize the potential for chemical interaction damage by storing the photographs or the digital documents (whichever are fewer) in plastic sleeves.

Physical Interactions between Digital Prints and Common Enclosure and Framing Materials: Blocking and Ferrotyping

In these tests, both unprinted and printed samples were placed in contact with plastic enclosures, glass, or the backs of other prints (simulating prints in stacks or bound volumes) and exposed to high humidity for one week. The test method clearly replicated the blocking and ferrotyping effects seen with traditional photographic materials in collections. IPI is therefore confident that

these results are accurate for digital print materials as well. Results from the study led to the following conclusions:

- Digital prints are less likely to block or ferrotype than traditional silver-halide photographs.
- Of the digital prints, the polymer-coated inkjet photo paper was the most likely to block or ferrotype.
- Many types of digital prints (including those on plain paper, dye sub, digital press, and inkjet on porous photo-coated papers) did not block at all.
- Traditional photographs and polymer-coated inkjet photo papers are at highest risk for blocking and ferrotyping when they are stored face-to-face, as in a photo album or against glass.
- All prints are least likely to block when stored front-to-back as in stacks.
- Matte-surface prints are less likely to block than glossy prints.

Abrasion Testing

In abrasion testing, two related questions were addressed. The first was: Compared to each other, how sensitive to abrasion are the different digital print types? The second was: How sensitive are digital prints as a whole to abrasion by common enclosure materials (polyester film, envelope paper, interleaving paper, etc.) or by other digital prints (print versos) when stored together in stacks? Results from the study led to the following conclusions:

- Three types of damage resulted from abrasion: change in gloss, loss in density in dark areas of the print, and smear of colorant from the dark areas into the light areas of the print.
- In psychophysical tests, smearing of colorant into light areas of the print was determined to be the most objectionable form of damage.
- Print verso was the most abrasive. However, print versos vary considerably in their roughness; while as a group they were the worst performers, some individual examples proved safe.
- Polyester enclosures were the least abrasive.
- Pigment inkjet prints can be very sensitive to abrasion and should always be stored individually in plastic sleeves or alternatively in window mats to prevent any physical contact between the print surface and adjacent surfaces.

Brittleness of Digitally Printed Materials

Brittleness was tested by pulling samples through a decreasing diameter of curvature to replicate the kind of flexing that can occur during handling. The digital print samples were tested at both 50% and 15% RH to determine if low humidity exacerbates brittleness, as it does with traditional photographic images. The results showed that there are various types of possible damage (micro and macro cracking as well as buckling) and various levels of severity (minor cracks to complete tears). The following conclusions were reached:

- The most severe cracking and tearing was found in the traditional black-and-white photographs, fine art inkjet prints, and prints made with porous-type inkjet papers. These types of prints should be well supported during handling.
- The traditional color photograph, dye sub, offset, digital press, and plain uncoated papers were the least prone to cracking.
- Brittleness was more severe for some materials at 15% RH than at 50% RH.

Enclosure Reactivity: Chemical Interaction Tests

In these tests, the potential for harmful chemical interactions between digital prints and common enclosures (such as envelope papers or interleaving tissue) during long-term storage were examined. Such reactions are well documented for traditional photographic materials, but the effects of enclosures on digital prints are unknown. The following conclusions were drawn from the data:

- Digital prints are sensitive to groundwood containing paper but are insensitive to cotton rag papers
- The pH of paper enclosures has little effect on the fading or staining of digital prints (though it may still have an effect on the stability of the paper support).
- Digital prints should be housed in paper and /or plastic enclosures that meet the same requirements for traditional prints outlined in ISO 18902 *Imaging materials – Processed Imaging materials – Albums, Framing, and Storage Materials*.
- The exception is that pigment inkjet prints should be housed in smooth plastic enclosures such as polyester film or in such a way as to prevent all contact between the printed surface and adjacent materials to prevent abrasion damage.

Project Co-PI, Daniel Burge, has volunteered to serve as project leader on a revision of ISO 18902 *Imaging materials – Processed Imaging materials – Albums, Framing, and Storage Materials* for the ISO Committee on Physical Properties and Permanence of Imaging Materials. The goal will be to update that standard to incorporate all of IPI's experimental findings on enclosure issues from this project including abrasion, ferrotyping and blocking, and the enclosure reactivity.

Flood Sensitivity Testing

A large set of digital print types were tested in flood simulations and evaluated for damage using a new set of assessment criteria created by IPI during a preliminary study. This new procedure allowed for a more descriptive evaluation of the various intermediate levels of damage that can occur to materials during flood events than has been previously possible. These include the qualitative metrics of color bleed, planar deformation (cockle and curl), emulsion delamination, and text readability, as well as the quantitative measurements of gloss change and Delta E (a measure of total color change that includes both fade and hue shift) for both the image and the white areas of the prints. The following conclusions were drawn from the data:

- All the prints were damaged by flood to some degree, suffering either catastrophic damage, such as color bleed or delamination, or less severe damage, such as loss of gloss and planar distortion.
- Black-and-white electrophotographic prints were the least sensitive to flood.
- Dye-based inkjet prints were the most sensitive to flood, often being completely destroyed.
- Most digitally printed materials were able to retain textual information after flood.

A technical paper detailing the development of the experimental methodology for the flood testing was published by IS&T in the *Journal of the Society of Imaging Science and Technology* in their March/April 2010 issue. A second paper detailing the final results of the project is currently under preparation. Upon completion, it will be submitted to the *Journal of the American Institute for Conservation*.

REPORTING STAGE

IPI will post all project results on the DP3 website, as stated in the original grant proposal, during the final two quarters of the project (May 2010 to September 2010). The DP3 website (www.dp3project.org) is now up and contains a variety of resources for collection care staff interested in preserving digital prints. There is a section of technical articles from IPI on digital print permanence issues; a recommended reading list including books, journals, conference proceedings, ISO standards, etc.; an in-depth glossary; and a section of downloads that includes IPI consumer guides related to digital printing and IPI's various preservation calculators.

Also, in March of 2009, IPI launched the *DP3 Newsletter* to keep the field up to date on the status of the experimental work, the development of the website, and the dates and locations of IPI presentations on digital print preservation. So far, there are 318 subscribers to the newsletter. Three issues have been published to date. An archive of past issues is available on the DP3 Project website.

CONCLUSIONS

At this point in the project, the following observations can be made:

- All of the preparatory work on the project is completed.
- All of the experimental work has been completed.
- IPI is reporting the project results to our constituent organizations through submission of papers for publication, posting of articles on the DP3 Project website, and through the DP3 Newsletter (see list of publications below).

The remaining time on the grant period will be used to finish the final paper on the flood test results, organize a single publication that reviews all of the experiments, post results on the DP3 Project website, continue the DP3 Newsletter, and write the final reports to IMLS. Completion of the project will also be announced to libraries and archives through the DP3 Newsletter, and postings to various professional distribution lists.

LIST OF ALL PRESENTATIONS AND PUBLICATIONS TO DATE

The following is a list of presentations of project results given or soon to be given to various professional societies:

- *Abrasion of Digital Reflection Prints* at IS&T's NIP 24, September 6-11, 2008 Pittsburgh, PA
- *Abrasion of Digital Reflection Prints: The Abrasiveness of Common Surfaces and the Vulnerability of Print Processes* at the American Institute for the Conservation of Historical and Artistic Works annual meeting of the Book and Paper Group, May 19-22, 2009 Los Angeles, CA
- *The DP3 Project: Digital Print Preservation Portal* poster presentation at the Society of American Archivists' Research Forum, August 11, 2009 Austin, TX
- *Investigations into Potential Reactivity between Silver-Halide and Digitally Printed Photographic Images in Long-Term Storage* at IS&T's NIP 25, September 20-24, 2009 Louisville, KY
- *Tendency of Digitally Printed Materials to Ferrotyping or Block* at IS&T's NIP 25, September 20-24, 2009 Louisville, KY
- *Brittleness of Digital Reflection Prints* at IS&T's NIP 25, September 20-24, 2009 Louisville, KY
- *Effects of Ozone on the Various Digital Print Technologies: Photographs and Documents* at the Fourth International Conference on Preservation and Conservation Issues Related to Digital Printing and Digital Photography, May 27-28, 2010 London, UK
- *Selecting Suitable Enclosures for Digitally Printed Materials* at the Fourth International Conference on Preservation and Conservation Issues Related to Digital Printing and Digital Photography, May 27-28, 2010 London, UK

The following is a list of articles that have been or soon will be published reporting project results:

- *Abrasion of Digital Reflection Prints* in the proceedings of IS&T's NIP 24, September 6-11, 2008 Pittsburgh, PA.
- *Investigations into Potential Reactivity between Silver-Halide and Digitally Printed Photographic Images in Long-Term Storage* in the proceedings of IS&T's NIP 25, September 20-24, 2009 Louisville, KY

- *Tendency of Digitally Printed Materials to Ferrotypes or Block* in the proceedings of IS&T's NIP 25, September 20-24, 2009 Louisville, KY
- *Brittleness of Digital Reflection Prints* in the proceedings of IS&T's NIP 25, September 20-24, 2009 Louisville, KY
- *Summary of IPI's Research into the Tendency of Digitally Printed Materials to Block or Ferrotypes at High Humidity* in the DP3 Newsletter, Issue 3, October 2009
- *Preventing Cracking of Digital Photographs* in the DP3 Newsletter, Issue 4, February 2010
- *Further Studies Towards Assessing the Risk of Damage to Digital Prints During Flood Events* in the Journal of Imaging Science and Technology March-April 2010, Vol. 54, No. 2
- *Abrasion of Digital Reflection Prints: The Abrasiveness of Common Surfaces and the Vulnerability of Print Processes* in The Book and Paper Group Annual No. 28 (2009)
- *Selecting Suitable Enclosures for Digitally Printed Materials* in the proceedings of the Fourth International Conference on Preservation and Conservation Issues Related to Digital Printing and Digital Photography May 27-28, 2010 London, UK
- *Effects of Ozone on the various Digital Print Technologies: Photographs and Documents* in the proceedings of the Fourth International Conference on Preservation and Conservation Issues Related to Digital Printing and Digital Photography May 27-28, 2010 London, UK

Note that many of the above articles are available for download in PDF form at <http://www.dp3project.org/>