

Fourth 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 May 1, 2009 to October 30, 2009

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INTRODUCTION TO THE PROJECT

This is the fourth 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. 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).

PROJECT SUMMARY

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 and outlined in the original project proposal were purchased, installed, and calibrated at IPI. Any necessary training was also concluded during this time. Additionally, a large number of materials had to be collected to create the test sample population. These samples were made at IPI or other departments at RIT, or, when unavoidable, obtained from sources outside of IPI and RIT.

Experimental

In this stage, which has been ongoing from the second quarter of the first year and will extend through the second quarter of the third year, experimental work will continue to be performed in order to better understand the behavior of these materials over time. A variety of print characteristics and vulnerabilities are being explored. This experimental phase can be divided into four separate categories: chemical interactions, physical interactions, physical handling, and flood/disaster sensitivity.

Chemical Interactions

First, chemical interactions between traditionally printed photographs and digital prints will 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) will be examined. Results will be used to determine whether digital and traditional prints can be stored together or need segregation and, further, to determine whether enclosures currently used for traditional materials are 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) will 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) will be examined with the goal of providing guidelines for handling.

Flood/Disaster Sensitivity

Samples of various digital print processes will be exposed to water immersion and evaluated for survivability. This will be done in order to help institutions include care for digital prints in their disaster plans.

Reporting

In this stage, information regarding the properties under investigation will be posted on IPI’s DP3 website, and interim reports will be transmitted to IMLS at requested intervals. The final results at the end of the project will be reported and made available to IMLS and to the public, and will 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 | Black | | | | | | | | |
| Perform chemical interaction tests | | Black | Black | Black | Black | Black | Black | Black | Gray | Gray | | |
| Perform physical interaction tests | | | | | Black | Black | Black | Black | | | | |
| Perform flood experiments | | | | | | | Black | Black | | | | |
| Perform abrasion and brittleness tests | | Black | Black | Black | Black | Black | Black | Black | | | | |
| Update DP3 website with project results | Black | Black | Black | Black | Black | Black | Black | Black | Gray | Gray | Gray | Gray |
| Reporting/dissemination | | | Black | Black | | | | Black | Gray | Gray | Gray | Gray |

PROJECT STATUS

Preparatory Stage

The preparatory stage of the project is finished. All equipment purchased for the project has been installed.

EXPERIMENTAL STAGE

Completed Project Work

The following are descriptions of the completed portions of the project:

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 many 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 is a risk of storing 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 interaction damage by storing the photographs or the digital documents (whichever are fewer) in plastic sleeves.

The results of this work were presented at the Society of Imaging Science and Technology's Non-Impact Printing Conference in September 2009 in Louisville, KY, and published in the conference proceedings. A copy can be found on the DP3 Project website at:

http://www.dp3project.org/pdfs/2009NIP_DF_BURGE_PG146.pdf

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, and the backs of other prints 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. The following conclusions were reached:

- Digital prints are generally 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.
- Sensitive prints 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.

The results of this work were presented at the Society of Imaging Science and Technology's Non-Impact Printing Conference in September 2009 in Louisville, KY, and published in the conference proceedings. A copy of that paper can be found on the DP3 Project website at:

http://www.dp3project.org/pdfs/2009NIP_DF_RIMA_PG142.pdf

An additional article summarizing the experimental work for librarians and archivists was published in the October 2009 issue of IPI's *DP3 Newsletter*. (For more information on the *DP3 Newsletter* see Reporting Stage, below).

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 prints? The second was: How sensitive are digital prints to abrasion by common enclosure materials (polyester film, envelope paper, interleaving paper, and print verso) or by other digital prints 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 into the light areas of the print.
- In psychophysical tests, smearing of colorant 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 window mats to prevent physical contact between the print surface and other surfaces.

The results of the abrasion testing were presented at the annual meeting of the American Institute for Conservation of Historic and Artistic Works Book and Paper Group, May 19-22, 2009, in Los Angeles. The results were also submitted for publication in the American Institute for Conservation of Historic and Artistic Works *Book and Paper Group Annual*. If they are accepted, a link to the publication will be put on the DP3 Project website.

Brittleness of Digitally Printed Materials

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

- The most severe brittleness behavior was found in the traditional black-and-white photographs, fine art inkjet prints, and prints made with porous-type, glossy 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 had the least severe brittleness behavior.
- Brittleness was more severe for some materials at 15% RH than at 50% RH, so low humidity should be avoided in areas where prints may be handled.

The results of this work were presented at the Society of Imaging Science and Technology's Non-Impact Printing Conference in September 2009 in Louisville, KY, and published in the conference proceedings. A copy of that paper can be found on the DP3 Project website at:

http://www.dp3project.org/pdfs/2009NIP_DF_SALESIN_PG138.pdf

Work Still to Be Done

The following are descriptions of the yet-to-be-completed portions of the work:

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 plastic sleeves) during long-term storage were examined. These tests are in progress. A third of the materials have been tested. After completion of the tests, the results will be reported and also will be integrated with the blocking and abrasion results in order to provide a comprehensive set of enclosure recommendations for digitally printed materials. An abstract for this work has been submitted to the Institute of Physics 4th International Conference on Preservation and Conservation Issues in Digital Printing and Digital Photography, to be held in May 2010.

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. This allowed for a more descriptive evaluation of the various intermediate levels of damage that can occur to the 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 colorimetric 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 and delamination, or less severe damage, such as loss of gloss and planar distortion.

- Black-and-white electrophotographic prints were the most resistant 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.

Two separate papers reporting the flood results are currently being prepared for publication. The first paper details the development of the experimental methodology and has been submitted to the *Journal of the Society of Imaging Science and Technology*. The second paper details the final results of the project and is currently under preparation. It will be submitted to a publication that is easily accessible to the library and archive field.

REPORTING STAGE

IPI will post all project results on the DP3 website, as stated in the original grant proposal, during the final quarter 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.; a *DP3 Newsletter* archive; an in-depth glossary; and a section of downloads that includes IPI consumer guides related to digital printing and IPI's various preservation calculators.

As stated above, IPI has submitted several technical papers to professional societies for inclusion in conferences and/or journals. IPI presented the results of the abrasion experimental work at the American Institute for Conservation of Historic and Artistic Works Book and Paper Group annual meeting in June 2009. IPI gave a poster presentation to the annual Research Forum of the Society of American Archivists in Austin, TX, that provided a general overview of all the research that IPI has performed on the DP3 Project to date. IPI also gave three technical papers at the Society of Imaging Science and Technology's Non-Impact Printing Conference in September 2009. Copies of these last three papers are posted on the DP3 Project website. Additional papers have been submitted to the *Journal of Imaging Science and Technology* and to the Institute of Physics 4th International Conference on Preservation and Conservation Issues in Digital Printing and Digital Photography Conservation to be held in May 2010 in London.

IPI also staffed booths in the trade exhibit areas at the Society of American Archivists annual meeting and the American Association for State and Local History annual meeting to offer one-on-one opportunities to discuss our work with the conference attendees. This is a unique method of dissemination that allows for prolonged dialogues with our constituents to ensure that they fully understand the results of the project and how these results might apply to their particular collections and institutions.

Finally, in March 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. Articles have summarized completed project results as they have become available and have addressed important issues regarding terminology. Additional information on events, presentations, and publications is included in

each issue. So far, there are 250 subscribers to the newsletter. Three issues have been published to date.

CONCLUSIONS

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

- Almost all experimental work is complete with the exception of the work being done to examine the effects of common enclosures on digital prints
- IPI is reporting the project results to our constituent organizations through submission of papers for publication (*AIC Book & Paper Annual* and *Journal of the Society for Imaging Science and Technology*) and presentations at conferences (the American Institute for Conservation of Historic and Artistic Works Book and Paper Group Conference, the Society of American Archivists annual meeting, the American Association for State and Local History annual meeting, the Society for Imaging Science and Technology NIP 25 Conference, and the Institute of Physics 4th International Conference on Preservation and Conservation Issues in Digital Printing and Digital Photography).
- IPI has been posting copies of the published papers on the DP3 Project website along with other useful information to aid collections care staff in the preservation of their digitally printed materials. IPI has also begun publishing the *DP3 Newsletter* to provide updates on the project to our 250 subscribers.