

First 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 October 1, 2007 to April 30, 2008**

Daniel M. Burge,  
Principal Investigator

The Image Permanence Institute  
Rochester Institute of Technology  
70 Lomb Memorial Drive  
Rochester, NY 14623

## INTRODUCTION TO THE PROJECT

This is the first 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 involves research into several key elements of preservation for digital prints in libraries and museums. The research focuses on the potential harmful effects of mixed traditional/digital print collections, the effects of housing and display materials on digital prints, the effects of handling, and minimizing the risk of damage due to flood. The ultimate goal of the project is to create a set of science-based recommendations to help cultural heritage institutions make decisions and to publish this information on IPI’s *The DP3 Project: Digital Print Preservation Portal* website.

There are three stages to the project:

- 1) **Preparatory** – In this stage, which is primarily confined to the first two quarters of the project, experimental equipment necessary to the project and outlined in the original project proposal will be purchased, installed, and calibrated at IPI. Any necessary training will also be concluded during this time. Additionally, a large number of materials need to be collected to create the test sample population. These samples will be made at IPI or other departments at RIT, or, when unavoidable, will be obtained from sources outside of IPI and RIT.
- 2) **Experimental** – In this stage, which is ongoing from the second quarter of the first year through the third quarter of the second year, experimental work will be performed to understand the behavior of these materials over time. As mentioned above, a variety of print characteristics and vulnerabilities are being explored. This experimental phase can be further categorized into three separate areas:
  - a. *Chemical Interactions* – Chemical interactions between traditionally printed materials (chromogenic photographs and offset lithographic prints) and digital prints (inkjet, “dye sub,” and electrophotographic) will be examined. Also, 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 recommend whether digital and traditional prints can be stored together or need segregation and, further, to recommend whether current enclosures for traditional materials are equally suitable for digital prints.
  - b. *Physical Interactions* – Physical interactions such as ferrotyping, bonding, and colorant transfer will be explored with the goal of providing suggestions to prevent these forms of damage.

- c. *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.
  - d. *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.
- 3) **Reporting** – In this stage, which actually occurs from the project’s onset through the end of the fourth quarter of the second year, 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, the public, and specifically marketed to archives, libraries, and museums that need the information.

**Original Project Schedule of Completion**

The following table shows a simplified version of the project’s schedule of completion as outlined in the grant proposal. The black squares indicate the aspects of work completed during this first two quarters of work.

|   | <i>Year 1</i> |           |           |           | <i>Year 2</i> |           |           |           |
|---|---------------|-----------|-----------|-----------|---------------|-----------|-----------|-----------|
|   | <i>Q1</i>     | <i>Q2</i> | <i>Q3</i> | <i>Q4</i> | <i>Q1</i>     | <i>Q2</i> | <i>Q3</i> | <i>Q4</i> |
| Purchase and install experimental equipment | ■             |           |           |           |               |           |           |           |
| Create/collect samples                      | ■             |           |           |           |               |           |           |           |
| Perform chemical interaction tests          |               | ■         | ■         | ■         |               |           |           |           |
| Perform physical interaction tests          |               |           |           |           | ■             | ■         | ■         |           |
| Perform flood experiments                   |               |           |           |           | ■             | ■         | ■         |           |
| Perform abrasion and brittleness tests      |               | ■         | ■         | ■         | ■             | ■         | ■         |           |
| Update DP3 website with project results     | ■             | ■         | ■         | ■         | ■             | ■         | ■         | ■         |
| Reporting/dissemination                     |               | ■         |           | ■         |               | ■         |           | ■         |

**1. PREPATORY STAGE**

***Purchase and Install Experimental Equipment***

Two significant pieces of equipment needed to be purchased to implement the experimental plan. The first was an ultra-low-humidity chamber. This unit is critical for performing both the chemical and physical enclosure interaction studies. The second piece of equipment was an image analysis system. This system will allow for the quantification of the abrasion test. Abrasion has typically been a qualified measurement with great potential for error due to variation in human judgment. In addition, many materials develop significantly different abrasion patterns, which make direct comparisons between the digital technologies almost impossible.

During November and December of 2007, the project PI traveled to the equipment vendors to insure that the proper apparatus and configurations were purchased. The image analysis system was installed in January 2008, and training for IPI staff on the use of the equipment was performed at that time. The ultra-low-humidity chamber has been ordered from the vendor and is expected to arrive in early May 2008. Note that this is significantly longer than the manufacturer's original estimate provided to IPI during the drafting of the project's proposal. This is in part due to the fact that the project required a custom-configured test chamber as opposed to a standard "in stock" configuration. Installation, calibration, and training will need to be performed in order to make that equipment ready for experimental use.

### ***Create/ Collect Samples***

The test targets used in the project either will be printed at IPI or other RIT department or, when internal printing costs are too high, will be obtained from other sources. The advantage of in-house target creation is the ability for IPI to "color manage" the targets and provide rigorous control over sample handling. IPI has purchased a variety of printers and developed sources for all material types it cannot generate internally. Most of the additional samples can be generated at other RIT departments, helping to reduce potential contamination or damage before the experimental work is performed. However, some samples cannot be generated at IPI or RIT.

In addition to printing test materials, IPI has been working to improve the quality of test target designs for permanence testing. Traditional targets designed for evaluating the long-term performance of photographic materials typically only consider aesthetic changes to the materials and not potential compromises to the informational content. While it is true that aesthetic loss will usually precede informational loss, many items in collections will be saved only for information content. Aesthetic loss for these materials may only be a problem if they are indicative of material weakening, such as paper embrittlement. It makes sense to have the performance measures approximate the performance needs of the actual users.

## **2. EXPERIMENTAL STAGE**

### ***Performance of Chemical Interaction Tests***

The first round of testing traditional photographic prints in storage with digital print materials has been completed. In this stage the paper substrates typically used in the creation of digital prints were artificially aged in contact with special detectors used as surrogates for traditional photographic prints. This test showed whether the paper substrates on which digital prints are made would cause fading or staining of traditional prints stored in close proximity.

The test results showed that certain types of digital print substrates were inert with traditional photographs; these included "dye sub" papers, offset press papers, and digital press papers. On the other hand, some examples of electrophotographic and inkjet papers were inert and others were very reactive. This varied behavior can make decisions regarding mixing materials difficult. Taking the approach of not mixing digital prints with traditional prints will require that staff be able to distinguish between the two and extra effort to perform such segregation. Allowing the two types to mix may result in damage to some collection materials. It may be fruitful in a future research project to

determine if these effects can be mitigated by reduced temperature storage. The above conclusions were drawn before any effects of digital print colorants were tested. Future project results may modify the above conclusions.

The next round of testing traditional photographic prints in storage with digital print materials is under way. In this stage the colorants (inks and toners) used in the creation of digital prints will be artificially aged in contact with the same special detectors described above. This test will show whether the colorants used to make digital prints can cause fading or staining of traditional prints stored in close proximity. IPI is currently creating or obtaining the colorant samples for these tests. These results will allow IPI to refine its conclusions regarding the safety of mixing digital and traditional prints in storage.

#### ***Performance of Abrasion Testing***

Work on the abrasion resistance of the digital prints portion of the experimental phase has led to three early conclusions. The first is that the UGRA rub test described in the original project proposal is inefficient for this test regime; the amount of human effort required to operate the apparatus is significant. IPI has recently purchased the Sutherland Abrasion tester, which operates in almost the same manner but is automated. This will allow IPI to reduce physical strain on the staff operators as well as increase the overall number of samples that can be tested. However, IPI has had to modify the original target to match the new abrasion equipment as well as the image analysis system.

Second, IPI observed that abrasion not only caused loss of colorant in higher density areas but could also increase in density in low density areas. This appeared as smearing of the colorant, especially into white areas of the print. Consequently, IPI will be measuring abrasion effects in both low and high density rates of printed materials.

Third, when abraded, some digital print materials did not show the loss of colorant that the preliminary work did, but instead showed dramatic alterations in surface gloss. This change was not uniform and therefore could create significant blemishes across the objects. In order to study this phenomenon further, IPI purchased a BYK Gardner gloss meter to monitor gloss changes in addition to colorant loss. It was found that some samples decreased in gloss with abrasion, as expected, but other samples increased in gloss. In all cases these increases or decreases were not consistent across the surface of the print, but formed in streaks. This created significant blemish to the surface. At this time a large enough population from which to draw conclusions or recommendations has not been tested. Testing is continuing.

Finally, a complication in measurement has arisen because of the transition from gloss changes with no colorant loss (or gain) to colorant change with little change in gloss. This makes interpreting the results extremely difficult.

#### ***Performance of Physical Interaction, Brittleness, and Flood Sensitivity Testing***

These tests are scheduled to begin in the first quarter of the second year. However, collection of paper samples for the brittleness test is almost complete, printing of test samples for the physical interaction test has begun, and development of a new test target design for the flooding experiments is already under way.

### 3. REPORTING STAGE

#### *Update of DP3 Website to Include IMLS Results*

After a two-month search, IPI filled the web designer position described in the grant. It will be the responsibility of the web designer to ensure quality content and functionality to the DP3 website so that users can become educated about the recommendations for the care of digital prints. The DP3 website is currently in the design and testing phase.

#### *Reporting/Dissemination*

IPI intends to post project results on the DP3 website as stated in the original grant proposal. This is dependent on completion of the experimental and the design and publishing of the DP3 website. IPI also intends to submit technical papers to professional societies for inclusion in conferences and/or journals. IPI has already submitted an abstract for a technical paper on digital print abrasion test methodology to the Society for Imaging Science and Technology's Non-Impact Printing (NIP) conference in Pittsburgh in September, 2008. IPI has not received word on whether that paper will be accepted.

In addition to the above, IPI is currently developing a mailing list of contacts at institutions interested in periodic updates for the project. These contacts are not only enthusiastic about the project and eager to begin receiving project results but they can also serve as an ad hoc focus group to provide input regarding the content and functionality of the website. This was not a part of the original proposal, but the response to the announcement of this work has been very high. IPI is considering creating a quarterly or semi-annual newsletter to communicate with the field regarding this project.

Finally, this June in Marly, Switzerland, IPI will be presenting the initial results of this abrasion work to the ISO TC-42 Working Group 5. That group is responsible for the publication of standards related to the physical properties and permanence of imaging materials. They are currently beginning work on developing a standardized method for measuring abrasion resistance of digitally printed materials. The work at IPI will provide significant assistance in the development of this ISO project.

### CONCLUSIONS

At this point in the project, the following observations have been made:

- The IMLS-funded work for IPI's DP3 Project clearly is proceeding according to schedule.
- Developing experience with the test plan is improving IPI's initial selection of test methodologies.
- Response to the project by the field has been exceptionally positive both in terms of the general subject—digital prints—and the particular vulnerabilities of the materials being studied.
- IPI is sharing this information with other relevant organizations through its submission of a paper on abrasion results to NIP and through sharing of those methodologies with the ISO committee charged with photographic print permanence.