

*Second Interim Report  
to The Andrew W. Mellon Foundation*

---

**THE DP3 PROJECT:  
DIGITAL PRINT PRESERVATION PORTAL**

October 31, 2009

Prepared by

*Daniel M. Burge, Senior Research Scientist  
Image Permanence Institute  
Rochester Institute of Technology*

## INTRODUCTION TO THE PROJECT

This is the second-year interim report on the *The DP3 Project: Digital Print Preservation Portal*. This three-year, \$606,000.00 grant is a major research and development project dealing with the preservation of modern digitally printed materials: inkjet, dye diffusion thermal transfer (“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. This report covers the period from November 1, 2008 to October 31, 2009.

The research focuses on the potential harmful effects on digitally printed materials of light, heat, airborne pollutants, and humidity extremes. 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 a new and unique website, *The DP3 Project: Digital Print Preservation Portal*. In addition to the experimental results, the website will also contain tools to aid in print identification, a glossary of terms related to digital print deterioration, an extensive bibliography, a FAQ section, and links to additional helpful information and organizations.

The following is a short review of the work as outlined in the original proposal. There are four stages in the project:

1. **Preparatory** – In this stage, experimental equipment necessary to the project and described 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 printing papers must be collected to create the test sample population. These samples will be printed at IPI or other departments at RIT, or, when unavoidable, obtained from sources outside of RIT.
2. **Experimental** – In this stage, 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 four separate areas:
  - a. Light
  - b. Heat
  - c. Air pollutants
  - d. Humidity extremes
3. **Website Development** – In this stage, which will run concurrent to the first two stages, the website and its content will be created.
4. **Reporting** – IPI will provide scheduled interim and final reports to the Andrew W. Mellon Foundation and will seek additional venues for results dissemination at conferences and through professional publications of interest to archives, museums, and libraries at the national, state, and local levels.

## **PREPARATORY STAGE**

All of the preparatory work on this project has been completed. All materials have been purchased, and all equipment is installed and operational.

## **EXPERIMENTAL STAGE**

All of the digital prints will be compared to traditional prints to provide a context for the relative sensitivities of digital prints to decay forces.

### **Light**

Two types of light are being explored, each having different effects on the deterioration of digital and traditional prints. These are xenon light (which replicates sunlight through window glass) and fluorescent light (which replicates the lighting in many offices and public spaces). Tungsten and halogen light are also often used in cultural heritage institutions; however, there is currently no viable method to test with these light sources. Results with xenon and fluorescent light will have to be extrapolated for tungsten and halogen display environments.

A little more than half of the samples have been exposed to both of the light sources. This includes all of the inkjet materials. The second half, which includes electrophotographic, dye sub, and the traditional printing materials (as benchmarks), should be finished by December. From that point, the data will be analyzed, and rankings of the relative sensitivities of the materials will be made.

### **Heat**

During the first year of the project, approximately 11,000 samples were placed in long-term incubations at various elevated temperatures (85°C, 75°C, 65°C and 55°C) for the heat tests. In the second year, another 4,000 samples were added to improve the accuracy of the data and to speed data collection. This was done because preliminary analysis of the early data indicated that the lower-temperature experiments may take over seven years to complete. Therefore, new samples were included at the additional high temperatures of 80°C and 70°C. With the addition of these new temperatures, IPI should be able to finish the experiment on schedule. To date, all of the 85°C, 80°C, and 75°C tests have been completed.

### **Air Pollutants**

All of the experiments involving the exposure of digital prints to ozone have been completed. The analysis and interpretation of the collected data are currently being performed. The following preliminary observations and conclusions have been made:

- Both documents and photographs printed with pigment inkjet printers are more resistant to fade by ozone than documents and photographs printed with dye inkjet printers.
- Damage by ozone is more likely for inkjet-printed photographs than inkjet-printed documents because of the types of inks and papers used.

- All dye inkjet prints on porous-coated papers should be restricted from extended exposure to the air outside of their enclosures.

An abstract of the results has been submitted to the Institute of Physics 4<sup>th</sup> International Conference on Preservation and Conservation Issues in Digital Printing and Digital Photography for presentation and publication in May 2010.

The exposure of digital prints to nitrogen dioxide will begin soon and should be done by early 2010. The data will then be analyzed, and rankings of the relative sensitivities of the materials will be made.

### **Humidity Extremes**

So far, IPI's test results have shown that digital prints are more likely to yellow at high humidity than at low humidity. Previous research by one of the major photo manufacturers suggesting that low humidity induces yellowing was not replicated by IPI. That work had examined only a small number of digital print materials; IPI's experiments included a very large number of samples representing a greater variety of digital printing technologies. If low-humidity yellowing had been positively demonstrated, the stress on institutions to maintain tight humidity controls throughout the year would have been burdensome and unnecessarily costly. With a wider range of acceptable storage and display humidities, institutions will have greater latitude in their choices of environmental conditions. Institutions will be able to take advantage of natural seasonal variations in humidity to save money by eliminating the need for unnecessarily strict climate controls.

High humidity tests to determine the risk of colorant bleed in digital prints is about to begin. These are the most complicated tests in terms of measurements. A great deal of effort has gone into development of test targets, experimental method, and measurement techniques. Historically, traditional prints have not been sensitive to bleed; on the other hand, preliminary experiments have validated that some inkjets prints are extremely sensitive to bleed. Final tests will be performed on a wide variety of digital print types to quantify the extent and severity of the problem.

Cycling humidity tests have not shown that digitally printed materials are at risk for cracking or delamination during extreme fluctuations in humidity; however, many materials suffered the planar distortions of curl and cockle. The most sensitive material tested was traditional black-and-white fiber-based photo paper, which was already known to have problems with cycling humidity. The digitally printed materials that were affected experienced only minor planar distortion. Most of the planar damage appeared at the sample clamping points. This shows that rigidly attaching prints to mount boards will result in physical distortion if the prints are exposed to extreme humidity cycling. Mounting methods for prints should therefore allow plenty of room for the materials to expand and contract. Since none of the digitally printed materials showed curl or cockling greater than that of traditionally printed materials, current mounting strategies used for traditional prints should be sufficient for digitally printed materials.

### Development of Care Recommendations

As the data become available from both portions of the DP3 project—one funded by the Andrew W. Mellon Foundation and the other funded by Institute for Museum and Library Services (IMLS)—the relative strengths and weaknesses of each technology can be tabulated. From the weaknesses, a primary care strategy can be established. The table below illustrates the variety of weaknesses and strengths in these materials and the strategies needed to care for them. It is only partially complete, because the experimental work has not yet been completed. Currently only one strength and one weakness are listed for each category. In future versions of the table, multiple strengths and weaknesses may be included. As the project continues over the next year, the table will be completed, and written articles will explain the strengths and weaknesses of the materials as well as the proper responses for care.

Digital Print Material	Strengths	Weakness	Primary Strategy
Inkjet – Dye – Polymer Photo Paper	Ozone resistance	High humidity	Strict humidity control
Inkjet – Dye – Porous Photo Paper	Abrasion	Ozone	Restrict exposure to air
Inkjet – Pigment – Porous Photo Paper	Fade resistance	Cracking	Handle with rigid support
Inkjet – Pigment – Fine Art Paper	Fade resistance	Abrasion	Eliminate contact with adjacent materials
Inkjet – Dye – Plain Paper		Flood	Prevent contact with water
Inkjet – Pigment – Plain Paper			
Electrophotographic – B&W			
Electrophotographic –Dry Toner			
Electrophotographic –Liquid Toner		Flood	Prevent contact with water
Dye Sublimation	Ozone resistance		
Chromogenic			
Offset Lithographic			

One obvious conclusion is that the development of print identification skills will be necessary for success. The term *digital print* does not refer to a homogeneous group of materials. The printing technologies, colorants, and substrates used by these systems to create images and documents are diverse. It is unlikely that a single set of care recommendations for all digital prints will ever be possible. Recommendations will have to be tailored to some subset. The obvious subset would be the three basic digital printing technologies of inkjet, electrophotographic, and dye sublimation. However, the data from

the DP3 Project have already shown that collection care recommendations at the level of printing technology would not be viable, because further sub-categories within each technology (e.g., dye inkjet or liquid-toner electrophotographic) exhibited dramatically different permanence characteristics.

The table above shows that the complexity of caring for these materials will be high. Caring for digital prints will be a new and fundamental skill set for collection care personnel, and the first skill set needed will be print identification. How finely divided the technology sub-categories must be depends on the sub-category level at which unique preservation strategies are required. For example, if all inkjet prints need to be treated the same way, then collection care staff need only identify and separate the inkjet prints from the electrophotographic and dye sub prints. If certain types of inkjet need to be treated one way and other types another, collection care staff must be able to separate the various inkjet prints into their proper categories. Through the study of the various sensitivities and preservation needs of digitally printed materials, IPI has determined the minimum print identification category levels needed by collection care personnel to enable them to effectively care for these objects. That level is listed in the Digital Print Material column in the table above. This in itself is a major and significant result of this project.

### **New Questions**

While the DP3 Project has been very successful so far in generating new data and insights into the preservation of modern digitally printed materials, new questions have arisen in the course of the investigation that will also need to be addressed in order to preserve this unique form of scholarly record.

The IPI-generated data (from both Andrew W. Mellon Foundation and IMLS research projects) have often led to logical conclusions regarding what the recommendations for digital print care should be. Examples include the use of polyester enclosures to reduce abrasion damage and ozone fade; rigid supports to protect porous, photo-coated inkjet prints during handling; and cool or cold storage to reduce yellowing rates of many digital print types. However, in some cases, while the data have led to a greater understanding of the sensitivities of digital prints to decay, they have not always led to a clear preservation strategy. Further work by IPI or other researchers will be needed to do the following:

- **Determine the specific RH threshold (temperature, humidity and time) at which many inkjet prints begin to bleed.** We now know which of the digital print materials are sensitive and the degree to which they are sensitive; however, institutions will need specific limiting values to prevent this significant and quickly developing form of damage.
- **Develop flood response and recovery strategies for digital prints, since current strategies for traditional materials are inappropriate.** Not only are digital prints more sensitive than traditional materials to damage in flood, but also they can damage adjacent materials that may otherwise be recoverable.
- **Perform further work on abrasion to find the minimum level of abrasion for the most sensitive of prints.** While the relative sensitivities have been discovered, the minimum amount of force and repetition to cause damage needs to be determined to

provide proper controls on frequency of use by institutional patrons and further guidance to institutional staff on handling.

- **Understand the effects of temperature as well as air flow rates and diffusion rates on the fading and yellowing of prints by pollution.** Since some digital prints are extremely sensitive to fade by atmospheric ozone, it will be important to determine which enclosure types are best at limiting exposure to ozone over time. Additionally, the effects of reduced temperature on ozone fade rates should be understood to determine if these objects should be kept in cold storage.
- **Develop methods to appropriately monitor and manage the display of digital prints.** As demonstrated by the results of this project, some digital prints may be at great risk if on display. The current data will help institutional staff know which materials are sensitive and which to restrict from display, but it also would be beneficial to the institutions to have methods by which to monitor the quality of the environment as well as the changing state of the object to manage its exhibition over time.
- **Create educational programs to help professionals develop the needed identification and care skills.** Through work on this project, IPI is determining the skill sets needed by institutions to best manage their digital print collections. IPI is developing a web-based identification tool, but the IPI survey of institutional experience with digital prints has shown that most professionals best learn identification through multiple pathways, such as web tools, workshops, sample sets, and interactions with colleagues. Well-designed educational programs that teach the fundamentals of digital printing, identification, and current recommended preservation strategies would increase competencies within the field.

## **WEBSITE DEVELOPMENT STAGE**

Since the last interim report, the initial components of the DP3 Project website have been published. The DP3 Project website now contains a variety of resources for collection care staff interested in preserving digital prints. There is a section of technical articles on digital print permanence issues; a list of recommended reading, 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 relating to digital printing and IPI's various preservation calculators. More sections will be added throughout the next year. The website can be found at:

<http://www.DP3Project.org>

As stated above, print identification skills will be critical for digital print preservation. This was assumed at the outset of the project and has been validated and underscored as the experimental data have come in. In response, IPI is creating an online identification system for digitally printed materials. Images illustrating the many characteristics of digital prints are being collected to provide website users with a variety of ways to examine, understand, and identify the different digital print types.

IPI has also begun publishing the quarterly *DP3 Newsletter* to compliment the DP3 Project website and keep subscribers up to date on the progress of the project. It includes informative articles about digital print preservation, announcements regarding IPI presentations on the topic, links to other useful websites, and explanations of critical terms. IPI has approximately 250 subscribers to this newsletter. Three issues have been published to date. These can be found at:

[http://www.dp3project.org/re\\_newsletterarchive.shtml](http://www.dp3project.org/re_newsletterarchive.shtml)

## **REPORTING STAGE**

In addition to the development of the DP3 Project website, IPI is disseminating information on the preservation of digital prints through a variety of other venues.

- IPI published an article on the definition of the term *digital print* in the Society of American Archivists monthly newsletter *Archival Outlook*. The article, “What Do You Mean When You Say ‘Digital Print’?”, may be found at:

<http://www.dp3project.org/pdfs/ArchivalOutlookMarApr09.pdf>

- IPI presented data from our survey of the experiences that cultural heritage institutions have had with digital prints at the Society for Imaging Science and Technology Archiving 2009 Conference in Washington, DC, in May 2009. The article, “Summary of the DP3 Project Survey of Digital Print Experience within Libraries, Archives, and Museums,” may be found at:

<http://www.dp3project.org/pdfs/ArchivingDP3Survey.pdf>

- A poster presentation on the DP3 Project and its status was given at the Research Forum at the Society of American Archivists 2009 annual meeting in Austin, TX, in August 2009. That poster may be found at:

<http://www.archivists.org/publications/proceedings/researchforum/2009/posters/Burge-SAA-Poster-2009.pdf>

- IPI has submitted an abstract of the results on ozone-induced fade and yellowing of digital prints to the Institute of Physics 4<sup>th</sup> International Conference on Preservation and Conservation Issues in Digital Printing and Digital Photography for presentation and publication in May 2010.
- IPI staffed booths within 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.

- As additional research is completed, more papers will be submitted to journals and conferences to ensure wide dissemination of the project's results

### **INTERIM PROJECT CONCLUSIONS**

The project is progressing as planned. Experimental work is ongoing for many attributes of digital print permanence. The final year of the project will be devoted first to completion of the remaining experimental work, and also to analysis and interpretation of the vast quantities of data that IPI has collected. Those results will then be distilled into recommendations to institutions on how to best care for these materials. Additionally, the DP3 Project website will continue to be developed to incorporate the experimental data and the resulting recommendations. The results of this project will also be submitted to the appropriate committees within the International Organization for Standardization to aid in the revision of their standards, since many institutions look to published standards for guidance on the care of their collections.