

# THE CREATION, IMPLEMENTATION, AND SAFETY OF DIGITALLY PRINTED FABRICS IN TEXTILE CONSERVATION: WHERE ARE WE IN 2012?

MIRIAM MURPHY

**ABSTRACT** – When preparing a costume or textile for exhibition, it is a challenge for textile conservators to make it as visually appealing and understandable as possible when significant elements are severely damaged or missing. These cases may require supplementary fabric for use as an inlay, overlay, or even yardage to reconstruct lost areas. In the past, hand painting and screen-printing have been used to replicate printed patterns, and woven patterns have been reproduced by commissioning custom woven cloth. Both techniques can require considerable work hours, long lead-times and significant expense. The use of digitally printed fabric is an increasingly important tool in textile conservation. For this paper I investigated and evaluated recent developments in digital printing with regard to their applications for textile conservation. My goal was to augment the foundation established by a handful of conservators over the past decade and to create a benchmark for conservators upon which to base further investigation.

**RESUMEN** – Al preparar un traje o una tela para su exhibición, los conservadores se enfrentan con el desafío de que se vean lo más visualmente atractivos y entendibles posible cuando algunas de sus piezas o partes están muy dañadas o faltan. En estos casos se deben utilizar telas suplementarias por dentro o por fuera, o incluso para reconstruir partes que faltan. Antiguamente, se utilizaba pintura a mano y serigrafía para replicar los diseños, y los tejidos se reproducían usando paños tejidos personalizados. Ambas técnicas pueden demandar mucho tiempo de trabajo, tiempo de entrega y un gasto importante. El uso de telas estampadas digitalmente es una herramienta cada vez más importante en la conservación textil. Para este documento, he investigado y evaluado los últimos desarrollos en estampado digital con respecto a sus aplicaciones en la conservación textil. Mi objetivo fue ampliar las bases establecidas por un puñado de conservadores durante la década pasada y crear un punto de referencia sobre el cual los conservadores puedan basar sus investigaciones futuras.

## 1. INTRODUCTION

Many times in graduate school I heard experienced conservators lament the closing of the last few domestic mills from which one could order custom-woven reproduction fabrics. I came to textile conservation from a sewing background, and I have been aware of digital printing on textiles since the late 1990s. Digital printing seems to be a relatively quick and inexpensive way to replicate a textile; however I wondered whether it would be appropriate for use in textile conservation.

I looked for conservation literature about digital printing on textiles and I was further inspired about its potential after reading Camille Myers Breeze's *WAAC Newsletter* article, "Digitally Printed Textiles: Their Potential Use in Costume Collections and Living-history Museums," as well as Nancy Britton, Chris Paulocik and Jan Vuori's paper, "Wide Format Digital Inkjet Printing for Textile Conservation," in the 2006 *Textile Specialty Group Postprints*. But given how quickly the digital world is evolving, I decided to augment their excellent foundation by researching the current conservation potential of digital printing.

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### 2. BACKGROUND

Preparing historic objects for exhibition by making them as visually appealing and understandable as possible often requires the use of supplementary fabric, for example to create an underlay or overlay to represent missing regions of the textile, or to recreate yardage in order to construct missing costume elements, reupholster furniture or reproduce hanging household furnishings.

Traditionally, conservators have used hand painting and screen-printing to replicate printed fabric patterns, and woven patterns have been reproduced with custom-woven cloth. But hand painting and screen-printing require an exacting level of artistic ability and hand application of paints and dyes can affect the surface texture of the fabric substrate. The cost and minimum yardage requirements of custom weaving are not only prohibitive, but also the few remaining domestic mills that provided this service have been closing over the past decade. In addition, these techniques require considerable work hours for the conservator and a long lead-time for the mill.

### 3. DIGITAL TEXTILE PRINTING PROCESS

Digital textile printing is the process of printing an image on a fabric substrate using a digitized image file (usually manipulated with software before printing). The image is created by digitally photographing or scanning the subject and printed by an inkjet printer with textile pigments or dyes. Digital textile printing has the added advantage of showing greater design detail than traditional screen-printing, as well as the ability to use an unlimited number of colors.

#### 3.1 IMAGE CAPTURE

Before capturing the repeat (or a smaller part of the pattern if that is all that is needed), it is necessary to calculate the number of megapixels required to make sure that the image can be printed accurately. If more than one repeat is needed, the image becomes the "tile" which the processing software will layout in the same fashion that motifs have traditionally been laid out for printing. There are two options: scanning or digitally photographing the textile.

The advantage of scanning is that the file will capture its actual size, which makes it easier to print it in the correct scale. Now it is more likely for anyone to have access to a quality scanner if the repeat of the print is 11 x 17 in. (27.94 x 43.18 cm) or smaller, and it has become easier to adjust the dots per inch (dpi) setting to get the best print capture. The disadvantage of scanning is that it may require transportation of the object, if a large-format scan is needed, and it may not work as well for textiles that are incorporated into a three-dimensional object. The amount of light exposure sustained by the object is no greater than that used in early studies, which determined that it was acceptable for use in textile conservation.

A digital photograph needs to be taken with a high resolution camera: at least a 3 megapixel camera for an 8 by 8 in. (20.3 x 20.3 cm) tile for repeat, up to a 10 megapixel camera for an 18 x 21 in. (45.7 x 53.3 cm) tile, if the printing will be done at 150 dpi. *The AIC Guide to Digital Photography and Conservation Documentation* is an excellent source of information regarding the current best practices of digital photography for the conservator, and it is not difficult for a professional museum photographer

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if that is an available option. Incorporating a rule within the image makes it easier to scale the digital file to print actual size.

No matter which method you choose, using a color standard in the image will greatly facilitate color matching in the printing process.

### 3.2 SOFTWARE

The most challenging aspect of digital printing for conservators seems to be manipulating the file to stitch together the tile repeat (if required), to color index the image, and then to save it at the appropriate dpi. The image can be manipulated with almost any graphic design software. Adobe Photoshop and Adobe Illustrator are still the preferred software programs, and now there are many online tutorials and how-to books geared specifically for non-professional textile printers. There are also two free software programs which are similar to Photoshop available online: Paint.NET and GIMP.

### 3.3 PRINTERS

Wide-format printers are now capable of printing 600-720 dpi. 300 dpi is considered adequate reproduction, especially on a textile because its surface texture will inherently distort fine detail. The more detailed the design in terms of fine lines versus large color fields, the higher the dpi requirement for successful reproduction. The widest printers can now print up to 138"-wide fabric, and the repeat of the length is only constrained by the size of the image file.

### 3.4 INK, PIGMENT, OR DYE

The use of ink made up from a carrier (water or solvent such as methyl ethyl ketone, ethanol, lactates, and glycol), a colorant (a dye or pigment), additives (surfactants and salts) and possibly a polymer as a binder to adhere pigment to the fabric surface has become very popular in the textile digital printing industry. The cost of printing with ink is similar to the cost of printing with dye, but it does not require pretreatment, and ink cures with heat. Pigment-based inks can be used on all substrates, and there is potential for printing metallic colors and whites using pigments. Pigment-based inks have very good lightfastness, but can fade if the binding agent breaks down due to abrasion, light, or washing (they can be dry cleaned or washed in a mild phosphate-free detergent).

The drawbacks of printing with pigment-based ink are that dark and saturated colors are difficult to achieve; when printed side-by-side they often lack contrast. Also they can affect the hand of the printed textile because the pigment is essentially held against the surface with cross-linkable resins rather than penetrating the fibers. This may only be of concern when drape will factor into the textile's final usage, but improvements in print head technology have greatly improved the fineness of the ink application.

Reactive, acid and disperse dyes can be used depending on the fiber makeup and end use of the substrate fabric. Just as in traditional fabric printing with dyes, printing with dyes will successfully print brighter, more saturated colors although a pre-printing padding, and post-printing steaming, as well as washing to remove any excess dye, add time and expense to the procedure. The other drawbacks are also the same as the use of these dye types in other printing methods: it is hard to print an intense black, the colors are not very lightfast, and acid dyes can be reversed under alkaline conditions.

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Dye sublimation can be used for synthetic fabric by printing the pattern file on to transfer paper, then transferring the pattern to the substrate using a heat press. The dye is locked into position as it cools. Some print bureaus can print directly onto a synthetic substrate using the dye sublimation process. Very bright color and fine detail are possible, but the cost of the dye is high.

### 3.5 FABRIC OPTIONS

There are more possible printing fabric choices than ever, including more textured substrates. However, the more challenging a fabric substrate would be to sew (i.e. loose weaves, sheers, and napped fabrics), the more challenging it will be as a print substrate. A fine-grained, plain-weave cloth is still a good choice because it will best allow the weave texture of the reproduced original to read over the substrate's weave. With the higher resolution achievable today in the image capture of the original, it is more possible to visually replicate the weave texture of a textile object on a fabric substrate of a different weave, especially if it is photographed using light sources that highlight the texture, and the contrast is further sharpened during the image processing stage.

Fabric choice is no longer a limiting factor in digital textile printing. The one caveat is that some digital printing processes (such as printing on synthetics or challenging fabric weaves or textures) can be more expensive than printing on a cotton plain-weave fabric because they often require physical stabilization, more expensive pigments, or pre- and/or post- printing treatment.

Many textile conservators have informally told me that they have found printing onto a paper substrate easier, because there are many more variations of ink take-up in fabric compared to paper, due to fabric's greater variety of fibers and textures. For the purpose of creating an underlay for a flat textile display, a paper substrate may still be the quickest and least expensive option. It is also possible to bond printed paper to a textile before printing for use as an underlay.

### 3.6 FABRIC TREATMENTS

PFD (prepared for dye) and PFP (prepared for print) fabrics can be purchased directly from a fabric supplier, prepared by or ordered through a professional print bureau, or prepared by the conservator. Technically PFP is the "cleanest" fabric, but it can be hard to find. However the use of a PFD or PFP substrate is not imperative: pigments can even be printed onto an already printed or dyed fabric (unless it has a protective coating such as a laminate). The main importance of using a PFD fabric is to have a more predictable outcome of dye reaction or pigment adherence.

The same washing process that conservators use to remove sizing and impurities is more than sufficient, and it is still recommended to completely trust the supplier of PFD fabric if not doing it oneself. Many print bureaus, as well as manufacturers of home fabric printing kits then coat the fabric with chemicals to aid in the adherence and wash-fastness of the pigment or dye. There still does not appear to be a way to improve lightfastness of digitally-printed textiles, although fortunately the low light levels already maintained around textile objects will insure the least amount of fading. This is more of an issue for digitally-printed fabric used for non-conservation purposes.

### 3.7 COLOR-MATCHING

It is imperative to use the same color model (also referred to as color space) as the printer, or its software will convert your colors, resulting in a color shift. In other words, because different monitors and printers still have different gamuts (color ranges), if the colors are indexed using one's own desktop computer, the colors displayed on the monitor can be altered because it uses a more limited gamut than the digital printer is capable of printing. Professional print bureaus have more specialized equipment, which is why it is still advantageous to have the bureau prepare the file if feasible.

Different substrate fabrics absorb dye or ink differently, and the subtle variations of each type of fabric's white point also play a role in the colors' appearance in the final textile print. Now a "color blanket," a physical chart of all of the printer's color standards, printed on your base cloth with assigned RGB or CIE L\*a\*b values, is available from the printer for use while preparing your file for print. It makes it easier to bypass monitors and paper printouts and to physically compare the original with the printed cloth, since one can only use colors that are obtainable using that specific digital printing system to reproduce the original.

It is still good practice to have a strike-off printed if possible so it can be compared to the original, ideally in the lighting condition in which it will be displayed. Despite the advantage of having a color blanket during the color indexing process, because the color standard squares are all the same size and evenly separated on a white ground, in reality optical color changes can occur due to the relative sizes and proximities of color fields in the actual pattern. Additionally, different fabric substrates have varying white points and varying translucencies, both of which will affect how dark or bright a color will appear.

## 4. CONTRACTORS

There are now hundreds of digital print bureaus worldwide, but still only a few do the short runs (i.e. less than hundreds of yards which is what textile conservators need) and most are still based in New York City. The advantage of working with a professional bureau is that it can provide one-on-one guidance for the entire process. It is also possible for the conservator to provide just the manipulated image that is ready for printing. Print bureaus tend to use dye-based print processes, but many offer pigment-based services as well. Some of the companies currently providing short run digital textile printing services are: Digifab, First2Print, LTS Design Service, and SC Fabric Printing.

### 4.1 NON-PROFESSIONAL PRINT BUREAUS

There are also a small number of textile printing companies which service craftspople and cottage industrialists. They are much less expensive, but the tradeoff is that they do not offer as much guidance because they cater to a clientele who is comfortable with digital image processing. After uploading the digital image one specifies one's own pattern repeat and color match using the website's software. The websites are very user-friendly, and customer service is available to answer questions. Most use the water-based pigment printing process, so the finished product is not very wash-fast (and should be checked for potential crocking), but Spoonflower and Fabric on Demand do offer reactive dye printing.

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### 5. IN-LABORATORY OPTIONS

Each year there are more commercially available PFD fabric kits and transfer papers for home craftspeople and cottage industrialists. Professional textile digital printing essentially uses a wide-format version of a desktop inkjet printer, so if only a small dimension of fabric is needed, it can be pigment-printed using a desktop printer. Many quilting supply companies produce these supplies, and as the art quilt community does have archival longevity in mind, it is possible that these products are acceptable for use in textile conservation, especially for short term proximity to museum objects. However they use proprietary chemistry, so further research is necessary to conduct a comparison test to ascertain whether they meet conservation standards.

### 6. CONCLUSIONS

The challenges of design clarity and color matching are similar to those of traditional printing methods, but digital textile printing has the advantage of a quicker turnaround. Resolution of a pigment-printed textile is actually better than that of a screen print. I am currently experimenting with the possibility of reproducing complicated weave textures by taking advantage of the realistic capability of scans and digital photographs as the source image. Although wide-format inkjet printers are still an impractical investment for a textile conservation laboratory, it continues to become easier to contract short-run yardage of digitally printed fabric.

As with all treatment choices in conservation, there is no single solution and decisions must be made for each individual situation. I believe that the use of digitally printed fabric is a promising tool for textile conservation and I hope that this research will serve as both a current best practices guide and as a benchmark towards future investigation.

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### SOURCES OF MATERIALS

#### Freeware

[www.getpaint.net](http://www.getpaint.net)

[www.gimp.org](http://www.gimp.org)

#### Fabric suppliers

Jacquard Inkjet Fabric Systems

PO Box 426

Healdsburg, CA 95448

Tel: (707) 473-9080

Fax: (707) 473-9083

[www.inkjetfabrics.com](http://www.inkjetfabrics.com)

#### Testfabrics

415 Delaware Ave.

PO Box 26

West Pittston, PA 18643

Tel: (570) 603-0432

Fax: (570) 603-0433

[www.testfabrics.com](http://www.testfabrics.com)

#### Professional print bureaus

Digifab

1412 Broadway, Suite 1110C

New York, NY 10018

Tel: (212) 944-9882

Fax: (212) 944-9659

[www.digifab.com](http://www.digifab.com)

#### First2Print

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Non-professional print bureaus  
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[www.spoonflower.com](http://www.spoonflower.com)

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