

Digital Fabric Printing in the 21st Century

BY DAVID KING

I firmly believe that large format digital fabric printing will be hotter than just about anything else today. The product is beautiful, does not curl, and costs less than many other digital printing applications. Traditionally, digital printing onto fabrics has been done using dye sublimation technologies, however there are many direct printing approaches that can also be considered.

My shop has full dye-sub capabilities, but after spending two days at the recent 2002 SGIA show, it soon became clear to me that the question, "Do I dye-sub or direct print my fabric graphics?" has many, many answers. In the end, there doesn't seem to be any single solution that will be right for everyone. The choices are many, and, like so many aspects of this industry, you'll have to analyze your own needs to find the solution that's right for you.

INK OPTIONS

I thought it would be helpful to start off by giving you the basic ink options for producing digital color onto different types of fabric. All types of ink can be used to create a digital print on fabric, but some are better-suited than others. Most of the inks below are direct-print options, with the main exception being disperse dye which needs to be sublimated. Some inks need post-printing treatment, such as steaming, to set the inks, and not all inks work with all machines. As you will see, your options are many and often complex.

Aqueous-based dye inks are supported by most inkjet printers (typically Encad, HP, Epson and Roland machines). The inks are vibrant in color, but in most cases will not support outdoor applications as dye inks tend to fade with exposure to UV light. Dye inks can be used to print onto fabric, and once printed, need no further finishing.



This print was done using the traditional method of printing onto a transfer paper and then sublimating it onto fabric. Sublimation allows inks to bond permanently with the polyester fibers.

However, aqueous inks are water soluble, and, if moistened, colors can run after printing.

Aqueous pigmented inks are typically used in aqueous inkjet printers as an outdoor/UV solution for printing graphics. Most aqueous pigmented inks have a good color gamut but tend to cost more than aqueous-based dye inks. Pigmented inks can be used to print onto fabric, and once printed, the product needs no further finishing (typically Encad, HP, Epson and Roland machines).

Acid dye ink is commonly used for printing onto nylon and silk materials. Many flag manufacturers have added acid dye systems in-house to provide faster turnaround on producing flags. Because of how this ink works, in many cases you can achieve double-sided images with single-



New machines allow you to print directly to fabric, which then can then be sublimated with a heat press.



Choosing between dye sublimation and direct printing is not a simple matter — there are many factors to consider. Here Lycra dye-sub prints were used to create unique trade show graphics.



Dye Sub

VS

Direct Printing



Direct print applications, such as this canvas banner, are easier to produce than dye sub, but every system has its advantages and drawbacks.

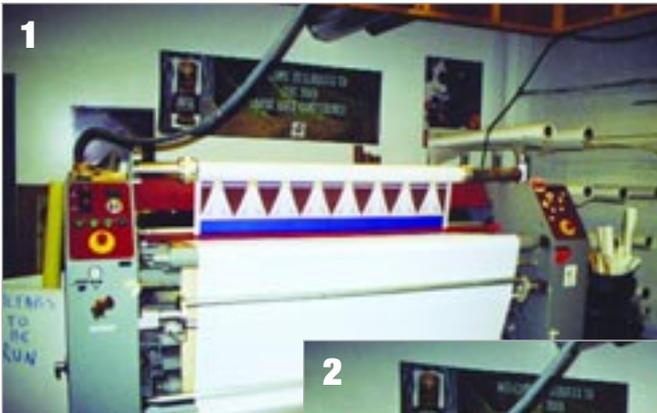
sided printing. After acid dye inks are applied to the fabric, the fabric must be steamed to make the image permanent. As far as I know, only Mimaki and DuPont make printers that accept these inks.

Reactive dye ink is used to print onto cotton fabric. As with acid dyes the cotton must be steamed to make the image permanent. As far as I know, only Mimaki and DuPont make printers that accept these inks.

Disperse dye ink (and toner), also known as dye-sub ink, is currently the most popular way of producing digital images on fabric. For most applications, producing a disperse-dye print onto fabric is a two-step process whereby the image is printed onto transfer paper (mirror image), then the paper is pressed against polyester material and heat is applied with the help of a special heat press. The dye vaporizes and bonds directly to the polyester fibers — a process called dye sublimation. New sublimation methods apply the ink directly to the fabric, and then the material is heated.

Dye-sub printing is often done using an electrostatic printer using disperse-dye toners (such as those made by Specialty Toners, Hilord, and others), but many, many inkjet printers (such as Encad, HP, Epson and Roland) can also be used for dye-sub applications using disperse-dye inks, such as those made by Sawgrass, and others.

Oil-based ink can also be used to produce graphics on some fabrics. Some oil-based inks, once printed onto fabric, need no further finishing. Currently, the Xerox ColorgrafX X2 printer accepts this type of ink, and I believe VUTEK's new FabriVu sublimation printer will also use an oil-based ink system when it's released in 2003. However, the VUTEK system will require sublimation.



One of the trickier aspects of working with dye sub is the fact that colors entering the heat press (images 1 and 2) look drastically different than the colors coming out (image 3). Carefully cataloging color profiles for your output, as was done with this design printed onto hercules material, will help you match clients' color needs.

Solvent ink is considered by many to be the ink for all occasions, but I disagree. In most cases, if you can get the material into the printer, the solvent ink will print on it. Most solvent-based printers need a flexible material that comes on a roll, such as canvas. Heat is required on the printer to dry the solvents from the ink. However, I've found that a lot of fabrics do not work well with solvent inks. The product is a finished graphic after being printed. These inks work only in solvent-based printers.

UV curable pigment ink is the hottest new printing ink these days. It can print onto just about everything (from glass to vinyl banner material). The ink is applied to the surface of the material/substrate and within microseconds is cured with an ultraviolet light source that is attached to the printhead of specially designed UV printers. The product is a finished graphic after being printed. Only UV printers equipped with an on-board curing system can handle these inks.

QUESTIONS TO CONSIDER

With all these ink and printer choices, how do you find the right solution? Well, to get there you must first answer the following questions to help determine the best system for your company:

1. *What resolution quality do you need?* Today, applications calling for resolutions less than 200 dpi are not too common unless you're looking at huge mesh building wraps, but fine art printing can sometimes use resolutions over 1000 dpi. My feelings are that large-format fabric graphics never need to be more than about 600 dpi. In general, the higher the resolution, the slower the print speed. Also, can you really charge more for 720 dpi vs someone else's 300 dpi print? Still, I believe that if you print the same



One advantage of direct printing is that "what you see is what you get." In other words, once it's printed, the color doesn't change as happens with dye-sublimation. Here a canvas banner is printed with solvent inks. No post-print processing was needed.

image (on the same machine with the same RIP) at 300 dpi and at 720 dpi, the higher-res image will always look better.

2. *What colors do you need?* All printers support at least four colors (CMYK), but many support six (CMYK, Lc, Lm), or eight (CMYK, Lc, Lm, plus special colors, or combinations). If you are printing a lot of flesh tones, then six or eight colors would be a better choice. I like the printers that offer eight printheads. You can load up two heads per color (CMYK) and double your output speed. Then, with a minimum amount of work, you can switch back to six-color (CMYK, Lc, Lm) printing for those flesh-tone jobs. I like the Mimaki Textile Jet TX2-1600 printer, which supports eight colors. You can use any of their special colors (like red, gold, blue, gray and light blue), along with the standard CMYK colors to produce custom fabrics — very nice for special applications.

3. *How much volume do you need?* Printers range from 30 square feet per hour to over 1000 square feet per hour. This question also plays into the type of ink you will be using because if you must process the prints after they are printed (steaming etc.), then you must take this into consideration when calculating the total volume in one day.

4. *How wide do you need to print?* The first real solution for digitally printing fabric was

the Raster Graphics 5442 electrostatic printer (still used by many *pay for print* dye sublimators). It can produce a 52" x 100' print on paper at 200 or 400 dpi. The printer is fast and the quality is very good.

Aqueous-based inkjet machines are also available in similar widths, such as Océ Display Graphics' Carolina Textile Press which offers a 54" width, but in this width-area there are really too many to mention. Wider aqueous-based machines are also available such as the DisplayMaker FabriJet XII from MacDermid ColorSpan, which prints at a 70" width.

Solvent-based printers are available in *really* wide widths that either print to paper or direct to fabric for dye sublimation. NUR has its eight-color FabriGraph printer (in 5- 8- and 10.5-foot widths).

VUTEK's new FabriVu dye-sub printer will be available in 2- and 3-meter widths), and DuPont has just entered the dye-sub arena with the release of its new eight-color Ink Jet 2020 printer, a 1.6 meter (5.3') wide flatbed machine accepting reactive, pigmented, disperse and acid-dye inks. Leggett & Platt offers several superwide UV-curable textile printing machines in widths from 8' to 11'.

5. *What material do you need to print to?*
6. *How much are you willing to pay for quality output?*

Dye Sub

VS

Direct Printing

These last two questions are biggies, so I will answer each in a separate section.

MATERIAL CONSIDERATIONS

By and large most of today's digital fabric prints are used for indoor applications — trade shows, event signage, P.O.P. and retail displays. So does it matter, with these applications, whether the ink runs if it gets wet? No. Each printer that can print to fabric has some type of limitation. In my opinion the more limited inkjet printers are those that can *only* support aqueous-based dye inks and/or pigmented inks that only allow you to print onto certain treated materials.

In most cases these materials have been treated, some come with a paper liner to make sure the ink does not flow through the fabric and onto the printer (the paper liner is also necessary to help feed the material). The treated fabrics that I've seen tend to be fairly expensive, and are not as soft as they could be because of the coatings.

I have reviewed two similar fabrics — one for aqueous-based dye inks at \$1.70 per square foot, and another for disperse-dye inks at \$.25 per square foot. The aqueous-based dye ink material could not get wet (or colors would run), and would fade if placed in a sun-exposed area. The disperse-dye ink material could be washed or dry-cleaned and would last outside for over about two years. Most of us dye-sub printers expect the material to be polyester because polyester is the only fabric that can be sublimated (heated to over 400 degrees) without burning or melting.

On the plus side, polyester comes in so many different styles (silk, satin, denim light, hercules, duck, sheer, felt, etc.) that most people would not know it is polyester. For most of the fabrics I have seen, the cost of polyester was the lowest, but the process for printing polyesters is best done by printing to transfer paper (cheap bond



Once printed and sublimated, dye-sub graphics result in very nice color intensities. In sublimation the dye vaporizes and bonds directly to the polyester fibers.

paper) and then sublimating the image onto the polyester. This requires a dye-sub heat press to sublimate the ink into the fabric (costing between \$10,000 and \$50,000).

The cost of a large format printer that supports disperse dye ink ranges from roughly \$30,000 to \$500,000.

Nylon, silk, wool and cotton look great with digital images printed on them. However, the limitation is that these fabrics require a printer that supports acid dye and/or reactive dye inks (approximately \$36,000) and a steamer to set the dyes (anywhere from \$1,000 to \$20,000), which adds another step to the production process.

WHAT ARE YOU WILLING TO PAY?

We have a Raster Graphics 5442 electrostatic printer that we typically run at 400 dpi (at 200 dpi it can run at 650 square feet per hour) and runs at about 400 square feet per hour (200 square feet per hour when you include the sublimation process). I believe you can purchase a Raster printer and an Astech dye-sub heat press for

around \$100,000 (Astechnologies is now owned by Adams International), and for this investment you can produce finished digital fabric prints for around \$.50 per square foot. In one eight-hour shift you can output around 1,500 square feet. If your average sale is \$5 per square foot for the fabric (excluding stitching) then your return on investment (ROI) would be 22,500 square feet or 110 hours of printing/sublimating.

If your needs are more diversified and you need resolutions higher than 400 dpi, then something like the Mimaki Textile Jet TX2-1600 is the answer. It can print at up to 720 dpi, accepts reactive-, acid- and dispersed-dye inks, has eight printheads and can print at up to 308 square feet an hour. Using two printheads per color (CMYK), you can produce output at 720 dpi at a pretty good clip. But if you use only one printhead per color, your speed will drop considerably.

I believe you can purchase a Textile Jet printer, RIP software, and an Astech dye-sub heat press (smaller unit than the Raster system I described above) for around

\$61,000; and for this investment you can produce finished digital fabric prints for around \$.80 per square foot (based on disperse-dye ink) and in one eight-hour shift you can output around 400 square feet of printed fabric (six-color at 720 dpi). If your average sale is \$5 per square foot for the fabric (excluding stitching) then your ROI would be 14,500 square feet, or 241 hours of printing/sublimating. If you run the Textile Jet with two heads per color (CMYK) and drop the resolution down to 360 dpi, the printer will produce 290 square feet per hour.

If you're looking for a grand format dye sub printer, the NUR FabriGraph is a 10'-wide printer that accepts both solvent inks and disperse-dye inks, runs at up to 590 square feet per hour and offers a 600 dpi *apparent* resolution. But at its highest resolution this prints at 75 square feet per hour.

For analysis purposes, let's say your FabriGraph is printing in the middle somewhere — say at about 200 square feet per hour (125 square feet per hour when you include the sublimation process time).

I believe you can purchase a NUR FabriGraph printer and a 10'-wide heat press for around \$350,000; and for this investment you can produce finished digital fabric prints for around \$.50 per square foot. In one eight-hour shift you can output around 1,500 square feet of printed fabric. If your average sale is \$8 per square foot for the fabric (excluding stitching) then your ROI would be 47,000 square feet or 375 hours of printing/sublimating.

If you are looking for a very fast grand format dye sub printer, the new VUTEK FabriVu is a 10'-wide printer that runs at 360 dpi and outputs about 700 square feet per hour (350 square feet per hour when you include the sublimation process).

I believe you can purchase a FabriVu

printer and the 10' dye-sub heat press for around \$650,000; and for this investment you can produce finished digital fabric prints for around \$.50 per square foot, and in one eight-hour shift you can output around 2,800 square feet of printed fabric. If your average sale is \$8 per square foot for the fabric (excluding stitching) then your ROI would be 86,000 square feet or 245 hours of printing/sublimating.

What about the other direct printing solutions that do not require any post-processing? My wish is for a full line of fabrics that support solvent inks.

I have this wish because in my shop we have a solvent printing system that would produce great fabric prints — if the fabric would not soak up the ink and cause the image to become very washed out. I have had good luck with a few fabrics (such as canvas), but too few for my liking. I keep asking and hoping for a new solution for printing fabrics with solvents, I guess I will just keep waiting.

Solvents aside, you can see that you really need to do some homework in calculating your ROI on a fabric printing system.

UV CURABLE SYSTEMS

And what about the new UV curable pigment ink systems? These new printers are amazing! I could not believe the speed and quality of these machines, and the list of products they can print to seems unlimited. I purchase most of my materials from a distributor/manufacture that specializes in digital printing, but with these new printers, Home Depot could be my new supplier! So is this the solution for fabric printing? Could be, but, from what I've seen, I do not feel this is the right solution for most fabric applications today because the UV inks tend to be stiff and they may not keep the fabrics soft as you would have with the other fabric

printing solutions. Given time, however, I expect these UV inks to become softer and more accepted for direct printing onto fabric — not just Home Depot doors and ceiling tiles. Leggett & Platt and now 3M offer UV-curable systems designed specifically for fabric applications. We need to keep our eyes on these and other UV developments.

IT'S YOUR CHOICE

The common drawback with all digital fabric printing systems (both dye-sub and direct print) is the stitching needed to finish pieces. Most people don't know how to run a sewing machine, yet a good finishing department is crucial to a finely finished fabric graphic. Plus, it is very difficult to double-side print on fabric. Very few companies do digital fabric the correct way, and even fewer offer all the different fabric printing solutions that we covered in the beginning of this article.

Now you know the questions to ask, and have a bit of information about the printing systems available today. But in the end, it's not so much dye sub vs direct print as it is "What's best for my application needs?" Choose wisely!



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