Exploring Digitally Printed Textiles

Growth potential and opportunities in digital fabric printing

Though digital printing on a wide variety of textiles has been available on a commercially viable level for at least the last decade, there remains huge growth potential in this area of the industry. The technology continues to evolve, and despite some challenges, there is a concerted effort across the industry to fill in the gaps as well as excitement about the role digital textile printing will play.

Current Conditions

Speaking about where the technology is at present, Hitoshi Ujiie, Director of the Center for Excellence in Surface Imaging at the Kanbar College of Design, Engineering and Commerce at Jefferson University, cites WTiN figures that, as of July 2018, only 5.5% of the world's textiles are printed digitally. The rest are printed using more conventional methods. Digging deeper into the WTiN numbers, of this small percentage of digital textile printing, Europe encompasses 38.5%, Asia 37%, North America 9.6%, South America 5%, Middle East 4.4%, Africa 3.5%, and Australia 2%.

Traditional vs. Digital

The vast majority of textile printing, 94.5% to be exact, uses methods such as rotary screen printing for rolls of fabric, or flat screen printing for individual items. For those unfamiliar with fabric printing, in the rotary printing process, screens are cut into the pattern for the fabric. Each color in the print is cut separately, so, for example, a four-color print would require four separate screens. The screens are then wrapped around hollow rollers and ink is fed through the middle of the roller and pushed out of the screen's pattern with a squeegee while the roller passes across the fabric surface. The rollers are aligned down the length of the fabric, which is fed, under tension, down the line under them, emerging at the end with a printed surface.

In contrast, digital printing is very much like a desktop printer where printer heads print color directly onto a roll of fabric

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By Kilara Le, Industry Author

With each new advancement in digital pigment printing, there are new challenges.

— or paper, in the case of sublimation printing. Simply put, with digital printing, all of the colors are printed in one pass of the fabric through the printer — no screens or rollers. In practice, it's a lot more complicated. Printer heads created specifically for textile applications actually print dye, although it's still referred to as "ink," which has to react chemically with the fibers in the fabric to adhere onto it. Some combinations of fabric and ink chemistry require pre-treatment of fabric (to bind the ink to the fabric) or post-treatment of printed fabric (to set the ink), or both.

Disperse Dye Inks

For example, polyester fabric can be printed with disperse dye ink chemistry, which could be printed directly onto fabric or transfer paper. In the case of printing onto paper, it is then heat transferred onto the fabric or product, in what is commonly known as dye sublimation printing. Cotton and other cellulosic fibers require fiber reactive dye and often pre-treatment, with binder to bond the ink to the fabric, and post-treatment steaming to set the dye permanently and ensure washability.

Pigment Inks

Another option gaining popularity is pigment inks, notes Kerry King, Vice President of Research & Development at Spoonflower, a direct-to-consumer digital fabric print house. For digital pigment ink, she says that essentially "pigment is a particle suspended in a water-based carrier, which is technologically advanced to keep it in dispersion." The binder, in the case of pigment printing, is included in the ink, and in addition, King continues, "Pigments offer an advantage in terms of processing, as they can be used on a wide range of substrates with minimal processing and they just need to be dry cured to set the ink." For Spoonflower, this is an important technology, as it enables them to deliver a customized product, on a variety of fabrics, on demand, to their community of customers.

Dye Sublimation Inks

"In markets such as signage, apparel and home furnishings, dye sublimation digital printing has been widely adopted," says Michael L. Sanders, Director of Printable Textiles & Finishing Technology at Top Value Fabrics. However, for other apparel and textile fibers, such as cottons and blends, there have been additional equipment requirements, due to pre- and post-treatment costs with digital pigment. This, combined with the lower printing speed of digital, has kept the technology more costly than the traditional rotary

printing options at a production scale. As binder technology and machine speed improves, Sanders thinks that, "we will see pigment be the most common type of digital printing, as it can go on to any substrate or blend of fabric."

Advantages of Digital

Despite the cost difference, digital does have some distinct advantages over rotary printing, such as (almost) unlimited colors, printing only what you need, using less water and the ability to do very small runs of printed fabric. A middle ground, suggests Sanders, is that "big apparel companies can digitally print their new print patterns for the season without the cost of the screens." Once they know the prints that are going to sell, they can commit to rotary printing. "This will also let them do many more prints for the season without the cost of screens and strike offs," says Sanders, adding, "This is the way this has been done for a large run on a rotary or flatbed printing for prints 1,000 yards and up."

In the last five years, there have been dramatic improvements in the speed and efficacy of the technology, and this exponential development by the print industry continues, with the end goal of getting digital to be comparable in cost and quality to rotary screen printing.

Challenges

If a piece of paper printed from a desktop printer gets wet, it's ruined — or gets spotted and wrinkled — which is what a consumer expects to happen. A digitally printed fabric made into a garment must have a lot more stamina to survive a washing machine or friction from use and wear. Quality testing is extremely important. Color loss of prints on a garment after washing it (low washfastness) or color crocking (rubbing off) of a print from sitting on a digitally printed sofa cushion, is not acceptable, remarks Sanders. These "are the main things to test for with digital prints," says Sanders. "Understanding the end use of the fabric is very important," says King, to help the customer decide what the right type of printing is and what fabrics can be used with it.

Sanders notes that another challenge is color matching between digital test prints and rotary prints, due to a variety of factors. Adding further depth to this, King comments that, no matter which chemistry is used, the "profile" of each ink color and printhead must be printed and documented to create color accuracy and reproducibility. In addition, not all colors, such as vibrant reds or dark blacks, work well with pigment inks, although they've "definitely improved over the last few years," says King.

Getting the most out of digital printing comes down to understanding the boundaries as well as the possibilities. Sanders says that designers looking to work with digital textile prints should "know what the limitations are and work within these parameters." For example, in the past couple of years, there have been quite a few "layered prints with washed out looks," in the fashion market, says Sanders. So, in this case, a post-cured digital pigment print, "may fit in boundaries, but designers could potentially get deeper colors with pre-treats." When working with digitally printing textiles, Sanders suggests that

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designers, "know what questions to ask." For example, "Sometimes you bring a color down 10% - 15% and that may solve the issue," and make the print feasible to print digitally with pigments. King notes that, though specialized pre-treatments do increase color vibrancy, they can affect the hand, or feel, of the fabric.

King suggests that designers evaluating the print think about "What's the image you need to print, such as solid blocks or a surface design?" In either case, she adds, designers, "often need to look at each color in the design, as they can sometimes see variation from one color to the next depending on the fabric and ink used." As there can be "differences in the color based on the substrate and ink chemistry," King continues, it's also necessary to "perform different tests on the colors to make sure all of them fall within acceptable limits."

Ujiie explains that while pretty much all ink suppliers are referring to American Association of Textile Chemists and Colorists (AATCC) standards in their product information, "there is no standardization of the fabrics," on which they are conducting the tests to know how to repeat their results. He suggests that standards for fabric construction and weight may help the industry to more quickly adapt to the technology.

King also notes that the fabric construction can also affect the way the print performs on the fabric. For example, "roping or 'cracking,' can be a problem for pigment prints on thicker twills as a result of washing," that modifies the dimensions of the fabric.

With each new advancement in digital pigment printing, there are new challenges. For example, "when they started being able to do the recirculating heads," says Sanders, referring to the capability to continually move the ink around using a reservoir feeding the printheads, "the binder would dry out and clog up the machine."

"The drying out of ink on the head used to be an issue," confirms King, adding, "Now, how they dock and conditions they are exposed to while not in use are controlled compared to when they are jetting." Also, adds King, "On pigment-based systems, there is a lot of integration of filters at various levels that prevent solids from moving down into heads, as well as circulation, vacuum features and temperature control."

"In general, most of these systems are run fairly consistently," adds King, both to maximize their production capability and keep the pigment ink moving.

When printing large prints for home goods such as sheets and bedding, consistency and accuracy is important. One bad pass across the fabric could ruin the product — plus, home goods tend to require higher washfastness standards and lower crocking, due to the nature of their use.

One of the big challenges in the past has been what King refers to as "the

bucket brigade," where digital printers have needed to export "one digital output to translate to another, but in the end, the technology still works," but it hasn't been, and still isn't, a seamless process. However, that may be changing.

Future Trends

One trend across the industry is consolidation of the value chain, generally by acquisition, of equipment companies and software companies. "Companies are starting to realize that just to sell the printer is not good enough, so they are starting to acquire the machinery companies as well," says Ujiie. One of the big things to watch for with these consolidations, says King, is "what the real integration is that they achieve," as they begin to align their acquisitions.

The end goal, Ujiie says, is that, "in all one pass, a machine does the pretreatment, printing, steam or dry heat, and then runs the fabric through a washing range."

He adds that then the manufacturers will be beholden to one company for all consumables and service, which would likely be more expensive for them.

The "integration of technologies to create the story of a microfactory," says King, is generating a lot of buzz right now. One element of particular interest to Spoonflower's business model is, "software for managing in an e-commerce environment and having to manage through concept to output on fabric," says King. "In general, workflow is a hot topic within the industry," she adds.

"One of these things will be the breakthrough for digital pigments: new binder technology, printhead design or pretreatment for the fabric," Sanders predicts. And Ujiie says industry players "are looking at more applied technology and trying to create the universal dye, to encapsulate every single functional material."

"We are always looking for the next, even more robust, solution," says King. "We really want to be able sell pigment printed fabrics — without an asterisk." Meaning that there is no limit to what fabric they can print onto for any end use.

Digital fabric printing will play a huge role in the apparel industry, enabling items to be created in a smaller footprint, with increased options for design supported by higher levels of automation, leading to more rapid and more localized production. Many people and companies are working to connect the dots, with the end goal of seamlessly connecting different technologies to automate production and rapidly create printed finished products.

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