



TECHNICAL GUIDE

AN INTRODUCTION TO TEXTILE PRINTING

Second Edition

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Textile printing

Textiles represent an important, and extensive sector of the global Industrial print market. As a historic sector of the printing industry, the marketplace is diverse and complex. Textiles are an essential commodity. Printing onto fabric has evolved in various forms, from batik, through to woodblock techniques, and on to engraved copper rollers, where many of these disciplines are still practiced today for small scale, artisan production.

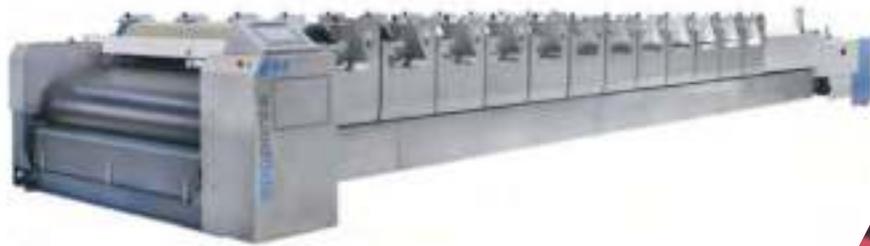


Woodblock preparation

Rotary screen printing

Digital inkjet printing

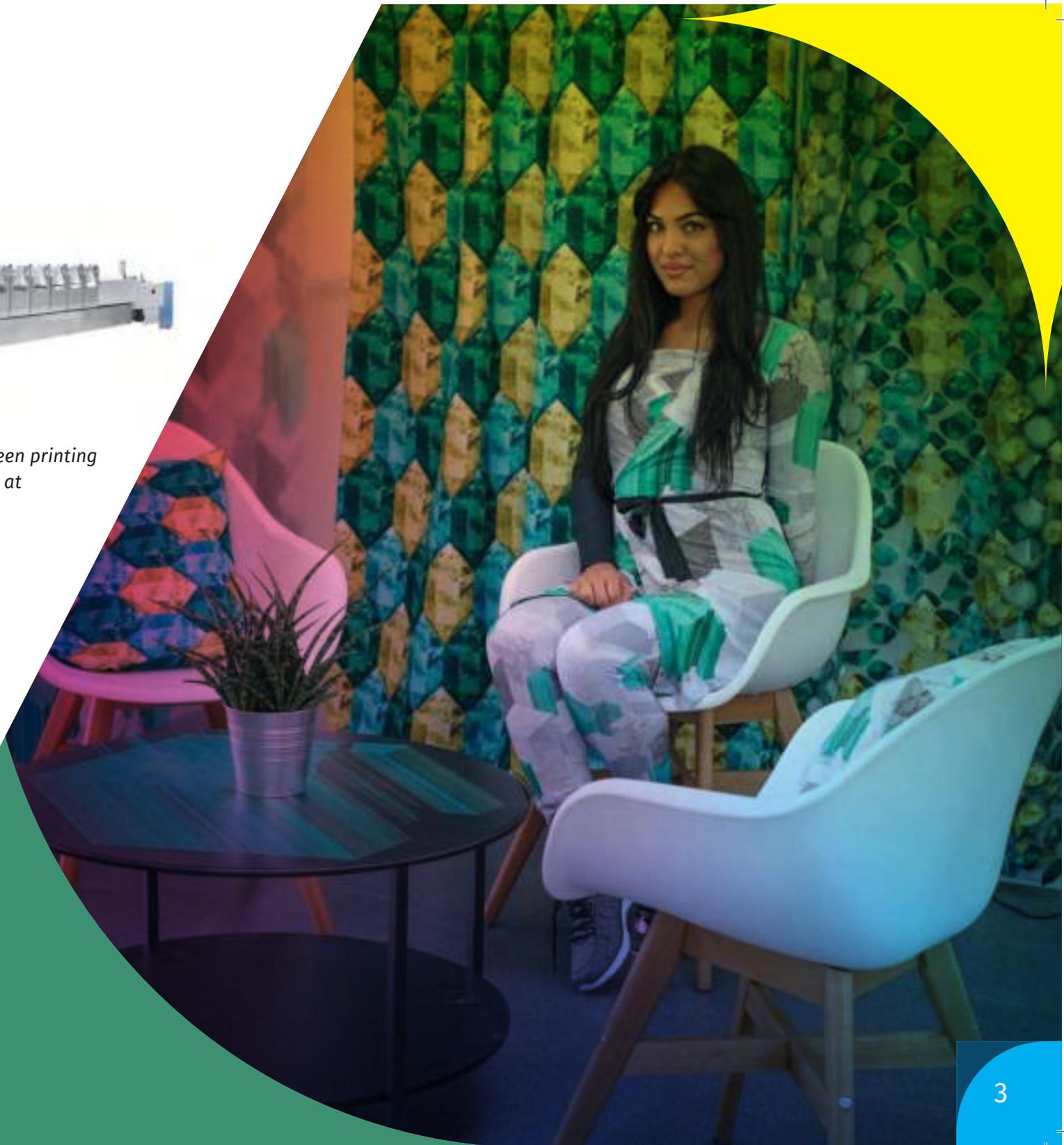
Mass production of textiles in a roll to roll format began in the 1800s with the advent of Box press enabling textile printing for large scale production and advanced to rotary screen manufacturing running at high speed by the 1960s.

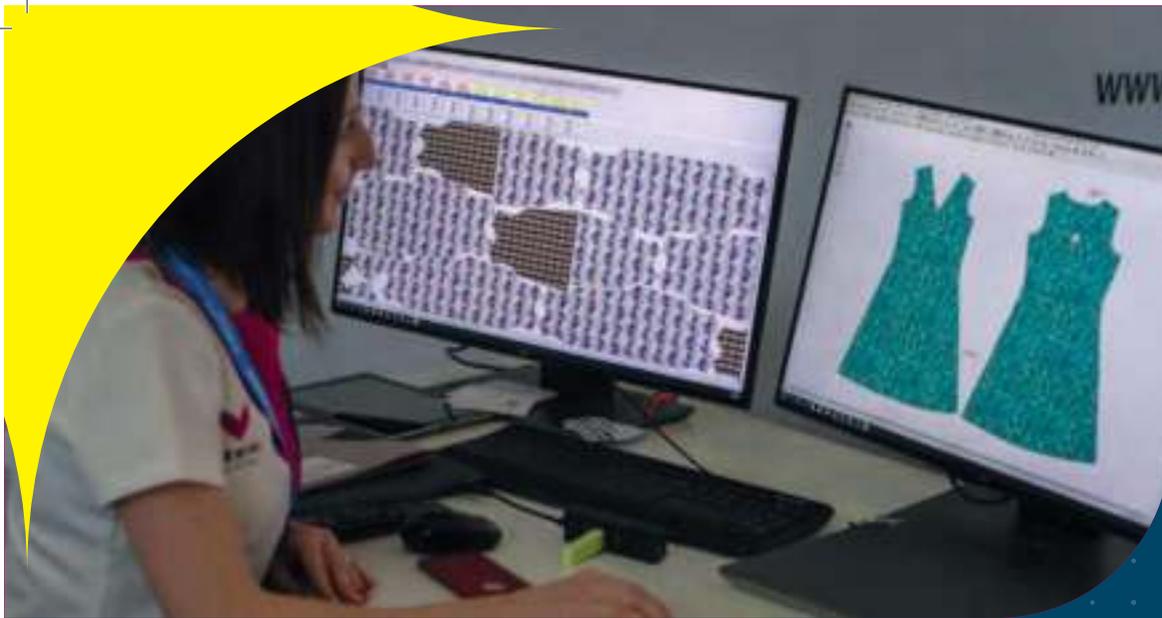


SPGPrints Pegasus EVO 12 colour rotary textile screen printing press capable of printing at 120 metres per minute at 2250mm wide.



MHMS Mechatronic Solutions Era 12 rotary screen textile press runs at 80 metres per minute with up to 24 colours at 3250mm roll width.





Screen printing is still the single most popular method of printing textiles for high volume industrial print production. However, rotary screen production, and its basic principles, hasn't really changed much in the last 60 years, it's now automated and computerised, but the basic methodology the same. As the market has developed and evolved, production volume continues to grow, driving the industries' requirement for new technologies that address speed alongside diversity and efficiencies in production.

Sustainability is a growing requirement for production processes, and ultimately the benefits of efficient eco-production must be adopted by the textile industry as a whole in time. Just as the commercial print industry witnessed a reform over 20 years ago the same can now be expected within the textile industry as we enter a new disruptive chapter for textiles and the digitisation of the print industry alongside the textile manufacturers' workflow.

Digitisation is disruptive

As new digital technologies emerge to reinvent the workflow between printed product and printing methods, they offer new opportunities and business models for all sectors of the Textile Industry. The application of digital technologies has already disrupted the commercial print, and wide format markets, where digital technologies are upending traditional business models to fulfil the needs of a new marketplace with new demands.

All sectors of the textile market are now being similarly disrupted here too; the marketplace has a new set of requirements. Speed, efficiency, customisation, a requirement for print diversity, and importantly sustainability are now required for industrial textile manufacturing.



Hollanders ColorBooster 250 and DS print up to 2520mm wide at 64 square metres per hour using dye-sublimation or disperse dyes. The DS prints to both sides of polyester fabrics simultaneously.



Very high-quality **Epson Surecolour F9400H dye-sublimation printer** with fluorescent inks.



Mimaki TS300P high speed dye-sublimation printer



Durst Alpha Series 5 multi-pass inkjet press runs, acid, reactive and pigment ink formulations. The Alpha 190 can print at a maximum speed of 620 linear metres per hour.



Efi Regianni BOLT high speed single-pass textile inkjet press capable of printing at 90 metres per minute.



Technology is creating new opportunities within all textiles sectors and production environments throughout the print industry. Print service providers already engaged in digital printing, screen printing, or both, for alternate markets, can now converge into new marketplaces and business models for textile growth.

Regardless of scale, there are many opportunities as the sector grows to meet global demand. Business models are changing, and whilst high volume production continues to exist, the quantity and diversity of stock-keeping units have escalated in-line with consumer behaviour, and the global population. Diversity is a strong requirement for entrepreneurial growth. Print on demand and just in time manufacturing utilising digital technologies meets the needs of the marketplace whereby the supply chain is shortened, and the speed of delivery accelerated.



The evolution of Digital

As the marketplace evolves, so does its consumer base and we see many examples of this within the creative communities, where digital textile printing offers a new hybrid breed of print providers. Designers, many of whom can now print in house, using low volume technologies or commission print via specialist bureaus which provide an online, automated, web to print service for small to medium volumes enabling personalised production at incredible speed.

The process of textile printing has been simplified by technology, and as digitisation continues to deepen its value, many of the inherent challenges that textiles often deliver have been overcome to some extent. However, as a diverse range of specialist markets, it's important to maintain a good appreciation of the sector, its consumers, product specifications, textile certifications, print limitations, and best practices to grow your capacity, extend your knowledge and deliver excellence. Pre-treatment and or post-print finishing processes are necessary for most textile fabrics and vary by sector, each must be understood.



It's in the numbers

The simplicity and ease of use of digital textile printing over conventional print unlock the textile industry to new entrants. As a sector, this market is accessible to end-users and entrepreneurs alike (often with no background in textile manufacturing) therefore the sector should also be of interest to printers looking to expand their range of services and those seeking new market opportunities and growth.

As digital textile printing innovation extends there is an increasing range of fabric types that can be printed which benefits the wider market and so, continues to generate new business opportunities and new products for customers. Statistics vary in their positive projections for the future value and growth of the global textile market, now estimated to reach \$266.38 billion by 2025 – Grandview Research Inc. Registering 8.9% CAGR during the forecast period.

Predicted growth offers welcome opportunities for the digitisation of the sector. As printing systems advance, new approaches to design, process efficiency contribute to the rapid uptake of digital printing technologies. Innovation in ink recipes and dyeing techniques as well as digitised supply chains, all help to advance new textile printing applications.



The Epson Mona Lisa Evo Tre 32 prints on a very wide range of fabrics using a range of Genesta ink chemistries from For.Ink including the 2 gamut expanding fluorescents. With a roll width of up to 3.2 metres and production printing at a maximum of 704 square metres per hour it supports high quality printing.

Conventional printing methods still account for most textile production, across all sectors. Traditional rotary screen printing still dominates with roughly a 65% market share worldwide and flat screen-printing accounting for some 25%. Digital printing systems, a natural progression from all conventional printing methods, produce much of the balance of work along with hand screen printing and transfer printing.



Efi Reggiani flat screen printer courtesy of Standfast & Barracks.



Rotary textile screen printing press courtesy of Standfast & Barracks.

Digital textile printing is increasingly recognised as an eventual replacement for rotary screen technologies. According to Global Newswire, New York; the global digital textile printing market is predicted to grow with a CAGR of 6% over the forecast period from 2019-2025 as adoption within the wider textile space increases. This is why printers and manufacturers alike are paying attention to digital textile printing. As global supply chains adapt to meet the demands of customised production and speed of delivery, digital technologies offer a viable alternative to conventional production processes.

Digital adoption

The growth of e-commerce, and the widespread adoption of CAD-CAM within manufacturing linked to digital textile printing, has digitised the industry landscape and has profoundly shifted the business model.

Digital adoption is moving most rapidly in developed markets and economies, however, established technologies and processes in these markets mean that adoption is realised with a broadening of customer choices as it's easier to offer a massive range of print on demand economically. Rapid growth shown in markets such as Turkey, Brazil, India, and China have experienced accelerated change with opportunities to bypass conventional printing practices and business models, to leapfrog straight into direct digital production.



Digitally printed sportswear is one of the most common applications of digital printing technologies for textile printing. It is especially popular for team outfits, produced in very short runs. Images courtesy of Rapha.



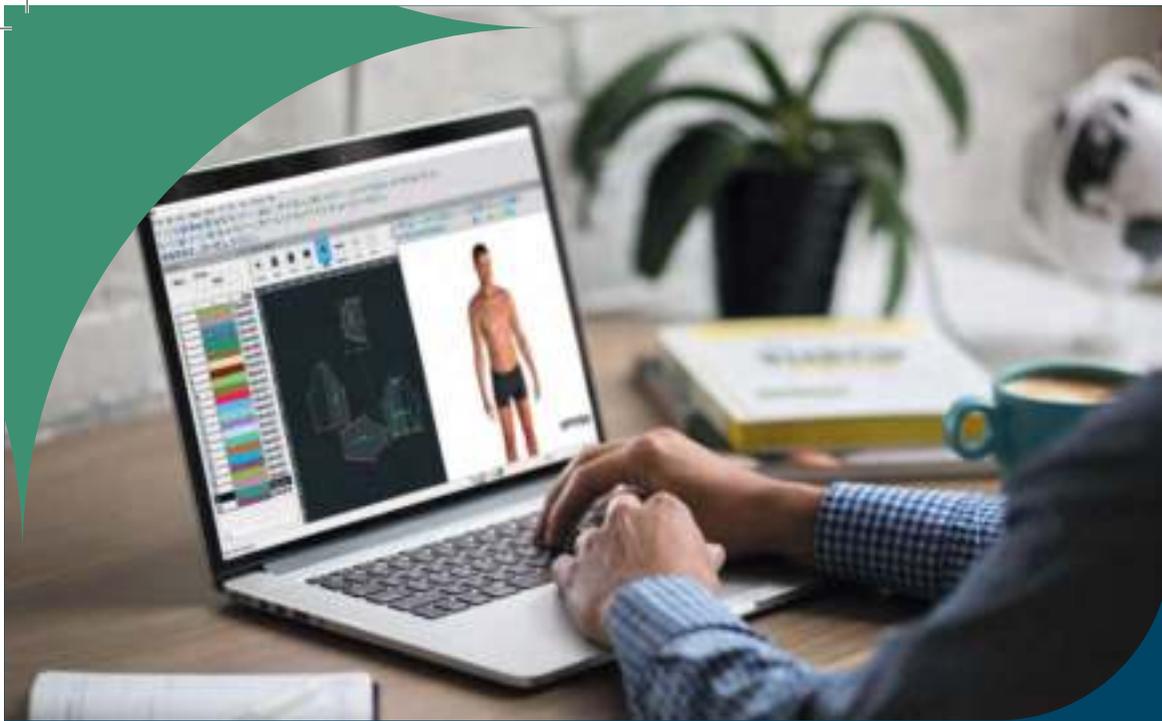
Precedence

The use of digital printing for wide-ranging applications has been underway for many years. Digital printing of fabrics started in the 1990s, with sampling and trials produced at lower costs than were possible using conventional methods. Thus, digital processes have been transforming the textile industry more widely for the last 20 years or so as companies have applied the technology and developed their workflows and meet customer needs. Successful business models depend on a profitable balance between the cost of technology, manufacturing overheads, and consumables. Numerous new business models and applications have evolved within the textile sector as a direct result of its digitisation. Spoonflower, an online, web to print business is a prime example of the successful application of digital printing technology for textile production. Standfast and Barracks based in the UK, continue to increase their digital print capacities to replace conventional technologies.

Although digital output can now match like for like the output quality and productivity of most volume screen printing, other considerations drive investment. The most important of these is the substantial reduction in prepress times due to process

simplification. Digital printing has eliminated screen engraving and manual colour separation leading to workflows that are more efficient reducing multiple production stages to just a few. Depending on the substrate, ink, and imaging technology, digital production can still require pre- and post-treatment for the substrate, but numerous other steps such as engraving, screen washing, and storage, are no longer necessary.

The market also now demands design diversity, and supply delivered at a higher frequency than has previously been the case. Fast fashion has been driving market expectations from seasonal changes, occurring every three months, to monthly and even weekly shifts as shown by the super brands. The consumers' behaviour has also changed in response to retailers providing a reason to visit more often. All of this has put increasing pressure on retailers to reduce inventory as seasonal collections are becoming less viable, with an emphasis on reduced stock holding and a flexible supply chain. Stock turn is increasingly mined from consumer intelligence and data, in real-time, and collections created to reflect micro-trends. Redundant stocks are a huge



Efi Optitex offers a modular structure of software tools that enable, creation, material evaluation, virtual sampling all the way through to print and marking out digital nests for cutting in customised production.

problem for the retailer, according to a report by the Ellen MacArthur Foundation half of high street fashion is disposed of within a year and the amount of clothing purchased in some markets has doubled in 15 years.

This is the model companies such as Inditex with its Zara brand and H&M are exploiting, along with initiatives to recycle clothes. These organisations turn stock every six weeks or so, constantly refreshing their lines. In some cases, it can be as little as every three weeks, so market success depends as much on effective logistics and the supply chain as it does on desirable fashion.

Digital on demand production means the near elimination of warehouse stock and a move to Purchase Activated Manufacturing (PAM) so that logistics is increasingly the differentiator for service providers and fulfilment. Under this model all processes are initiated at the point of order, and when the money for goods is paid. The model is fully automated from ordering, printing, cutting, and sewing through to delivery, and can apply to all forms of textile production.

Garment fit analysis is now possible and ensures the functional qualities of apparel are resolved to improve wear and durability performance.



High quality rendered avatars from Efi Optitex Revu let designers and clients try out different prints, cuts, sizes and patterns with multiple edits before ever making a physical product.



Fashion designers and Retail brands are increasingly successful in manufacturing small and medium-sized batches that are targeted with acute precision as well as remaining price competitive, as a direct result of the digital workflow and its manufacturing efficiencies. Increasingly, although not yet entirely, the production cost for small to medium-sized runs is competitive with costs associated with volume production. Over time the use of digital tools for such business models will be increasingly viable.

Also clear for print service providers and manufacturers is the powerful dynamic that is coming to exist between market demands and production methods. Technological enablers such as e-commerce and automated workflows supporting on-demand production take print applications out of their niches and create new applications and opportunities, for instance for accessories and bespoke objects.





With digital textile print technologies developing rapidly, it's important to find the right production software, Caldera Textile Pro is an example of a workflow suite for textile needs.

The market can expect progressively better quality and output speeds and a growing range of fabric options that can be digitally printed. The speed of production cycles may even encourage a reduction in globalised production, through reshoring jobs in the textile marketplace, so that production takes place closer to target markets. Digital printing advances such as new inkjet printheads, innovative inks, and textile treatments, plus improved fabric transport systems drive market adoption. All of this supports new business models that provide printed textiles on demand, whether it's for fabrics, direct to garment prints, apparel, or Interior decor.

Environmental impacts

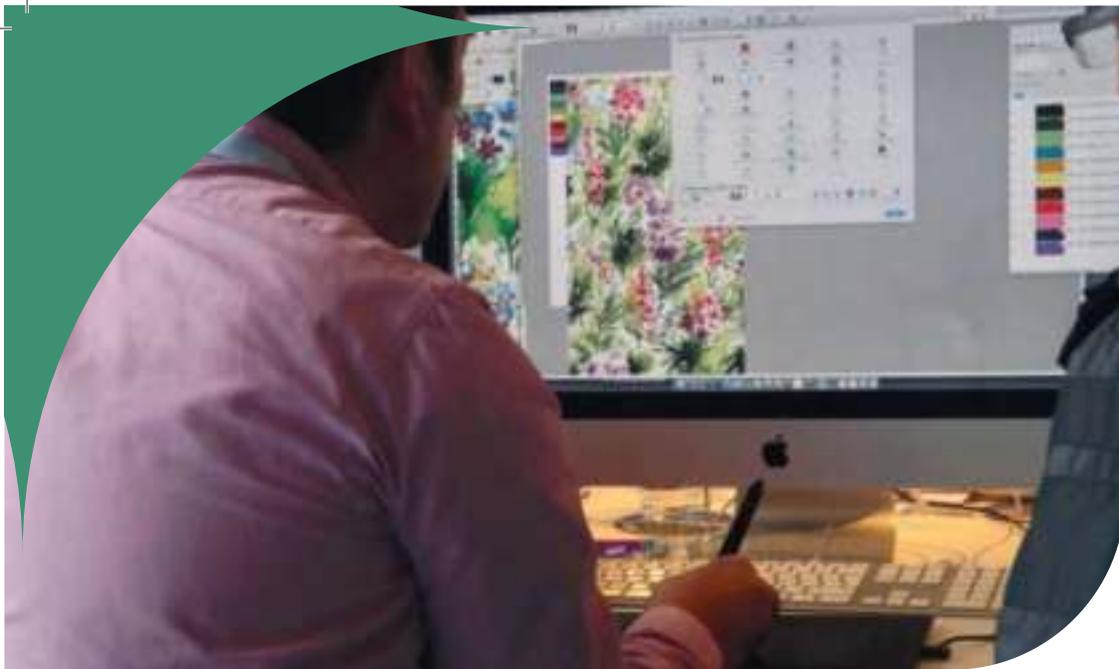
The textile industry is considered to be one of the world's most polluting, second only to energy. The nature of textile production processes means that at every one of the steps needed to make an item of clothing, there is an environmental impact, mostly through aquatic pollution from factories discharging untreated effluent. But fibre spinning and weaving also affect air quality and dyeing and printing by conventional methods use lots of water and chemicals, releasing Volatile Organic Compounds (VOCs) into the air. And then there is the associated transportation of goods to remote markets and the increasing awareness of a product's carbon footprint. All of this has encouraged growth in the use of digital processes, particularly if goods can be produced close to end users, cutting the emissions associated with long-distance transportation. Digital textile printing production requires less water and energy for manufacturing, when compared to conventional techniques, and creates less waste. However, it doesn't solve the issues surrounding the environmental impact of textile fabric manufacturing, from fibre to fabric, which remain challenging to the surrounding environment.

Digital technologies can improve the link between environmental sustainability and the economic optimisation of supply and demand for textiles and apparel. This may in turn help to improve the industry's environmental footprint because it eliminates many of the traditional process steps: digital printing can yield water savings of around 60-70% for instance. ICEA, an Italian producer of textiles based on re-generated cotton fibres, has certified a 50% water saving with digital printing compared to rotary screen and 30-40% reductions in energy consumptions and CO2 emissions.

Digital production also requires around half the volumes of colorants and auxiliary chemicals compared to traditional printing methods. These benefits added to the fact that it can be cheaper and more convenient to produce textiles digitally, present strong arguments why the industry has embraced digital production.



The environmental impact of the textile print industry can be greatly reduced using digital textile print and production technologies.



By design

Eliminating manual process stages in supply chains and production are the primary commercial drivers for print service providers who want to go digital, but there are also design and production convenience considerations. It's very easy for instance to generate single or multiple patterns in software for designs with complex pattern repeats. Base pattern designs can be easily rendered in multiple colours using digital design tools without the time or cost penalty, and it is straightforward to create variable data designs using dedicated software tools.

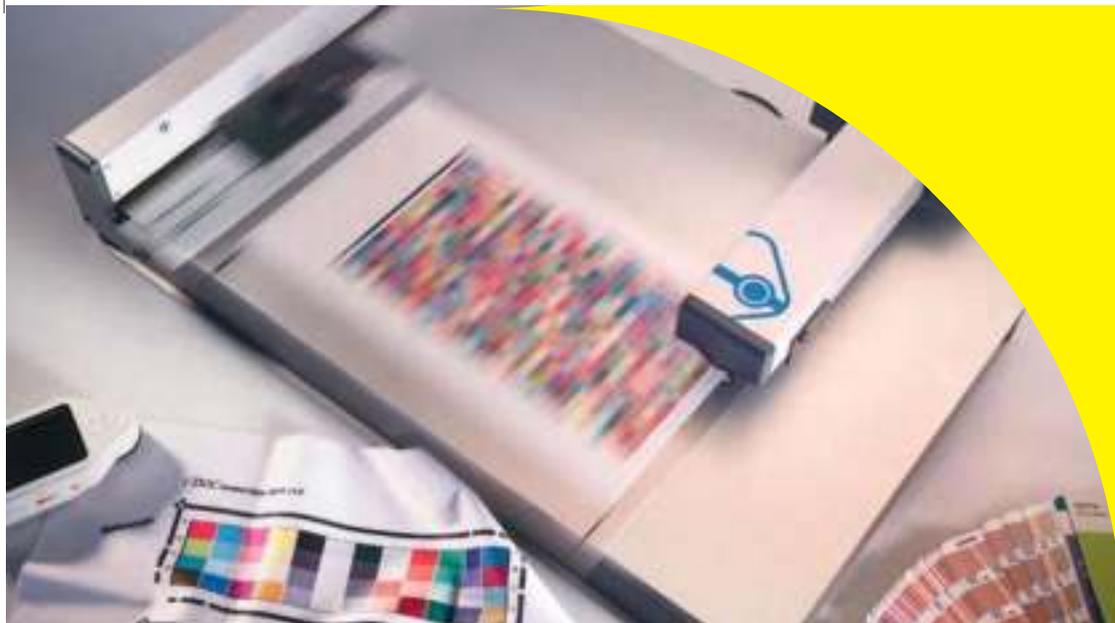
CAD CAM continues to streamline the digital workflow, with software such as AVA where both textile design and colour can be managed and embedded for digital production.

AVA CAD/CAM have more than 35 years of experience in textile production, their software has the capability to create complex step and repeat patterns, colour separations for colourway variations and complex production separations. It also features texture mapping, colour management and digital asset management functionality all learned from decades of application experience in both screen and digital printing.

Product design is an important digital advancement enabling the creation of virtual products and digital twins, whose behaviour replicates the final finished physical product. An important development for e-commerce sales and product prototyping. Production software such as Gemini Cad, removes the need for physical product patterns, and shapes, by shifting the design of products, and their marker making to a digital process.

The printed apparel sector benefits from the advances in software development, Gemini CAD is an example of an ecosystem where designs can be resized easily, planned and nested for digital production with mass customised artwork.





To manage colour across different substrates it's necessary to have a good spectrophotometer with a large aperture to enable calibration and profiling. Here the Barbieri Spectro LFP in action, popular with producers of large format digital print.

This enhanced creative process also makes it simpler to render designs on different fabric types, so that colours are accurate and consistent across different fabrics using specialist software. Adapting the colour data so that it works on linens, cotton, and silk, for instance, can be managed as the data is processed for output. Using dedicated software, designers have more flexibility for how work can be rendered. In addition to being able to use photographic images in designs, designs can be enlarged or reduced as needed, for example creating panel prints to fit a garment without worrying about the constraints imposed by the size of the printing cylinders.

Digital production software also helps to overcome challenges presented in screen-printing where replicating high



X-Rite have introduced i1Pro3 Plus spectrophotometer with an 8mm aperture for textile measurement and profiling with i1Profiler software.

resolution pattern and colour requires high levels of skill and process control. Inkjet makes halftone process printing easy and creates all sorts of interesting new creative and commercial possibilities for designers as well as brand owners.

The customer base for textiles are seeing advantage where designs for digital printing, with its dramatically shorter production times, can make more immediate emotional connections. Fulfilment cycles for digital production are driving new design demand to support instant gratification, design variety, and demand for customised identity fashion. These include accessories such as hats, scarves, bags, gloves, and shoes, as well as objects, so digital is as much about exploiting new opportunities as it is about superseding established printing methods.

Digital printing can support both on-demand fulfilment and prototyping for high-end fashion, but it has huge potential to serve fast-fashion where brands such as Zara, H&M, and Primark are making fashion disposable and resaleable or available to secondary markets. It is worth noting that an increasing trend demanding more sustainable consumption may counterbalance the excesses of disposable fast fashion. Creativity, artisanal skills, and digital printing also combine to create unique luxury pieces with the sensation of handcrafting, at a lower cost and speed.

Where to begin

Many printing companies have entered this market starting with relatively low-risk investments. They have moved beyond soft signage and into fabrics and garments, starting with wide format roll-to-roll devices printing polyester using dye sublimation. This natural extension of an existing business model is low risk and relatively low cost. Advances in print and finishing technology



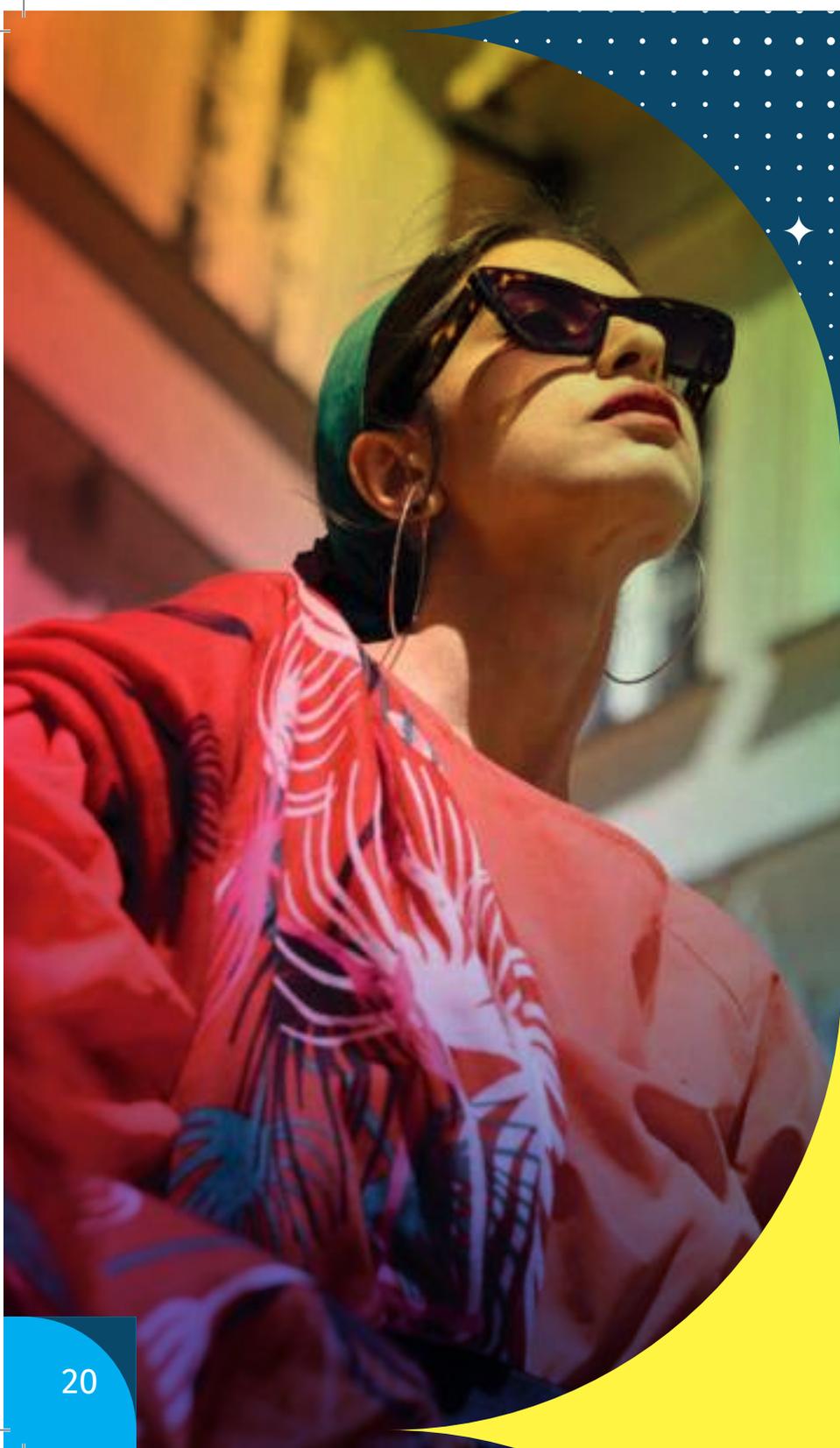
Image courtesy of Kornit.

assure that the digitally printed product meets the consumers' demands and specifications, when compared to traditional output, for most sectors of the textile marketplace.

However, the convenience and flexibility of digital printing also raise concerns relating to copyright protection across formats, training in digital production processes, and managing market expectations. Falling short in any one of these areas will be falling short of best practice. Digital printing methods are not a straight swap for conventional methods and there are still plenty of areas where screen printing has the edge, most obviously in the cost and productivity for large volumes which justify complex and time-consuming prepress.

Traditional production models still have a commercial edge over digital textile printing, particularly for designs that use special effects and enrichments, such as *devoré* or metallic prints. Nor are some other enhancements such as adding 3D components, foils, and glitter, but it is just a matter of time before that is no longer the case.



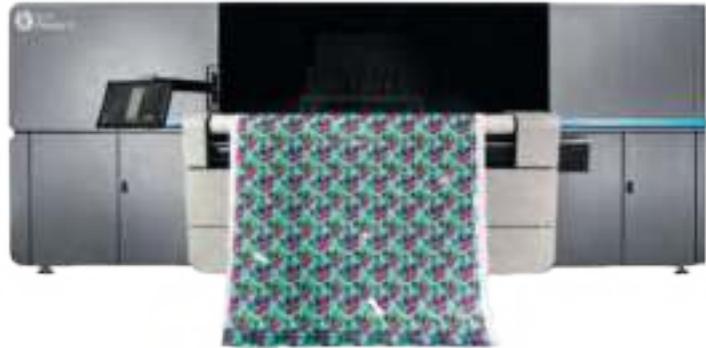


Considering the options

Print service providers who want to expand into this field have first to decide which area of the business is most attractive for their organisation, customers, and investment capacity. To some extent, this depends on the existing client base, printing systems, and digital expertise, especially for prepress workflow management, website design and management, and e-commerce. Can capacity be expanded to produce clothing and printed textiles for interiors? Is Digital Direct to Garment (DtG) printing of t-shirts and hoodies something you can easily move into? Or do you want to get into the fast-fashion business? Which market is the most accessible to you in terms of products and production models?

Understanding substrates and inks

Whichever sector attracts you most, your preferred substrates and the inks that work with those materials will determine your investment options. Textiles are produced with natural fibres such as those based on proteins including silk and wool, and those based on cellulose which include linen, cotton, and hemp. In addition are the man-made fibres including synthetics like polyamide and polyester which are made from petrochemicals. Rayon often referred to as



viscose, is a semi-synthetic commonly used as a substitute for silk. It is made from a spun cellulose mixture, a pulp of plant and wood mixed with chemicals, which is turned into a liquid and then spun into fibres.

Protein and cellulose-based materials make different demands on the ink, and whether there is a need for pre- and post-treatment. Pre- and post-treatment of the fabric may be required for ink adhesion, colour depth, and accuracy, uniformity and output consistency, as well as the feel or hand of the fabric.

The Kornit Presto S utilises NeoPigment Robusto inks in a solution that eliminates the need for off-line pre and post-treatment whilst offering adhesion to a wide range of fashion and décor fabrics at 450 square metres per hour. The ink set has also been certified to ECO Passport and GOTS standards.

Ink types requiring pre- and post-treatment of the fabric include the acid dye inks used for silk, wool, and polyamide. Reactive dye inks or Pigments are required for cotton, linen, hemp, silk, wool,





and viscose. Disperse dye inks for polyester and pigment inks for cotton, linen, hemp, viscose, some silk, wool, polyamide, and polyester generally do not require pre- and post-treatment. Pigment inks are a growing sector of the digital market, mainly because their application is suitable for all fabric bases, synthetic or cellulose with varied performance. Polyester may require post-treatment with special resins and heat, for instance, to make it flame retardant or antimicrobial.

Digital printing devices are optimised for a specific ink and substrate combination, so manufacturers offer technologies to fit specific applications. However, hybrid digital textile printers that support both acid and reactive inks, Dye sublimation, and pigment inks are coming now available.

Post-print finishing for fabrics may be required before the cutting and sewing of garments. Fabric finishes improve the handle (feel) of the printed cloth as well as performance for a given application. Silicones, chemicals, and resins can be added to enhance softness, or make the fabric more water repellent and to make the material more resistant to staining and abrasion. This can also improve wrinkle resistance, the propensity to shrinking and stretch and tear strength.

Technology options

Digital textile printing is acutely primed for millennial manufacturing, meeting the requirement for intelligent, customised production is a vital requirement for successful commerce. Numerous technologies have converged to create a new environment for trade in this digital era, and alongside these a myriad of new opportunities. A digital business's most important consideration is its IT platform, workflow transparency, i-cloud connectivity, supply chain capacity, and product visibility. We live in an age where there is huge scope for vertical platforms to sell online, for instance, interior design print, fashion, and DtG clothing. In such an environment the importance of the IT underlying that platform cannot be understated.

Output system investment decisions will depend on your target application and the nature of the service you want to offer. Technological innovation in this field is a combination of advances in inkjet printing systems and materials science. However new approaches to textile treatment and inks, fabric transport, and drying systems mean that the technology is continuously moving and improving. There is every expectation





that it will continue to get better and better, so consider first your quality, productivity, and margin requirements and then look at what's available on the market. Set targets for quality in terms of output colour accuracy, performance (uptime, running costs, service scheduling), throughput (how many square metres or garments per hour), ease of use, training support and above all, what you can sell to end-users and how much it will cost you to do so.



Practical considerations

Your IT foundation is vital to success in digital textile printing, whether you are going for an on-demand fast fashion model or doing prototyping for haute couture. Accurate, reliable, and consistent data management will influence productivity, colour and error rates: don't forget that the cost of errors rises the closer you get to output. But in addition to the IT, the materials you choose to work with will determine your technology choices and be driving factors in your success.

Dye-sub roll-to-roll (transfer printing) is a common starting point and supports a range of applications using polyesters and polyester blends to produce such garments as personalised sports clothing, soft signage, and uniforms. Roll-to-roll technologies print onto a variety of static and stretchy textiles using a variety of ink types including pigment and sublimation dyes. DtG printing relies on inkjet flatbed printing with bidirectional printheads to print water-based specialty inks onto garments. DtG has grown considerably in the last fifteen years, boosted by web-to-print and peoples' desire for personalised and short-run customised clothing. It currently accounts for over 200 million garments annually and this number is rising as manufacturers introduce new machines and the range of fibres and textiles suitable for digital printing grows.



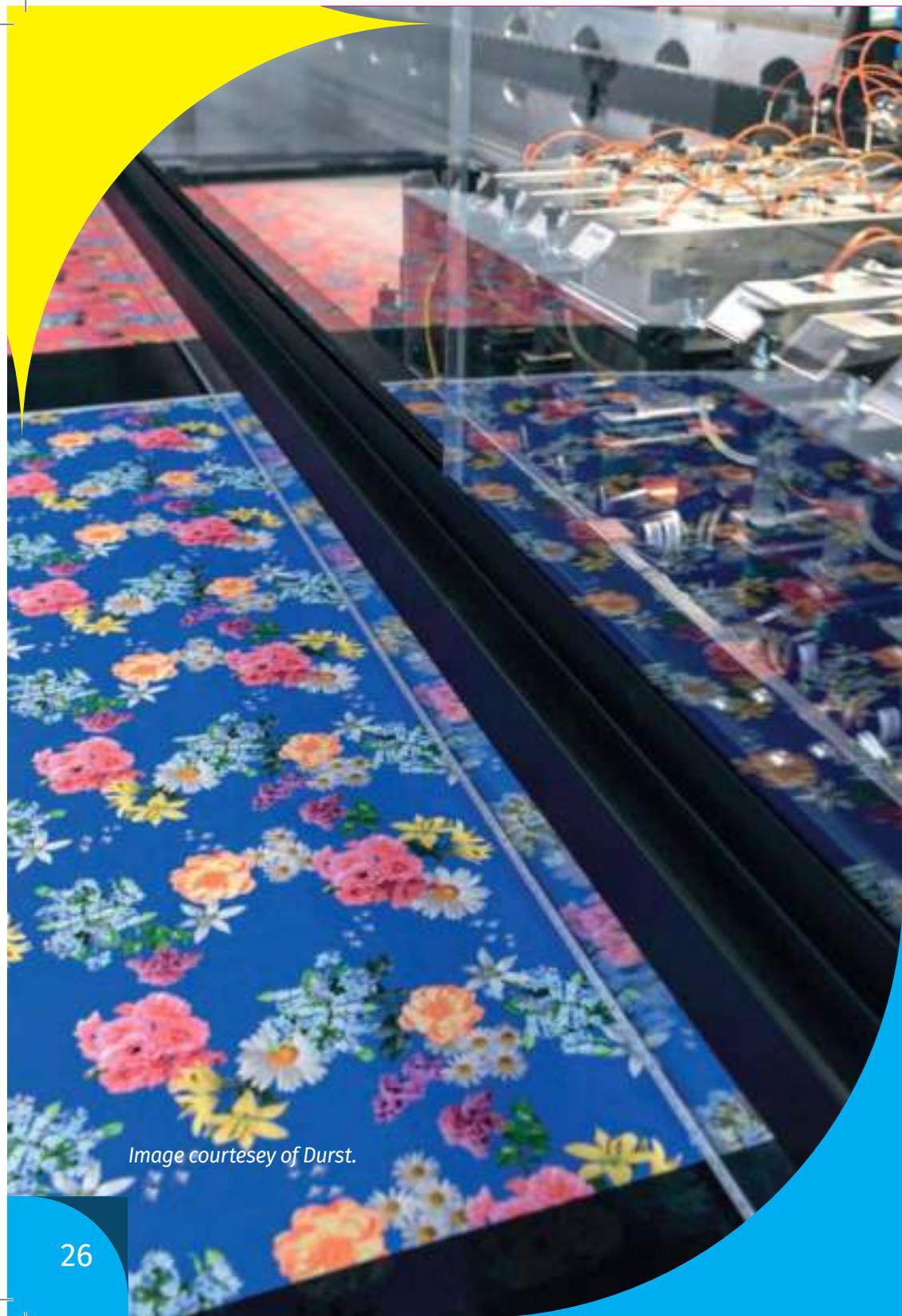


Image courtesy of Durst.

Strategy for success

As with any new venture, you must start with a plan and be prepared to adapt the plan as you research the market, technologies, and the investment impact on your existing business activities. Work with customers and try to research technologies, inks, and materials with them. Don't forget to consider your existing process management and quality assurance procedures and be clear about the market you want to serve, for instance, should you go for the very high end or commodity market? There is a premium on bespoke, customised products, but can you find enough business to keep your capital equipment running at capacity? Don't forget workflow management, associated production software, and variable data tools. Variable data software allows you to both optimise a device's capabilities by ganging lots of smaller jobs for printing on the same fabric and to offer bespoke customisation to your customers.

The technology is changing fast and you should be prepared to put in the time for thorough research. Understand the nature of your production processes and the commercial drivers of your customers. When you come to investing in new equipment, know the answers before you ask the question so that you can be ready for a deeper dive into the offer, and can develop a cohesive and realistic strategy for success.



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