

TECHNICAL GUIDE

SUBSTRATES

AN INTRODUCTION TO
PRINTING ON TEXTILES

Second Edition

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profit for purpose

Printing on textiles

The Textile Industry is a vibrant and historic sector of the print marketplace where conventional screen printing still dominates mass production. As such the Textile substrates within this ecosystem are clearly defined and aligned to end use, many of which haven't changed for decades. However, how we manufacture those substrates is now increasingly scrutinised in order to meet the accelerating requirements of an industry that must embrace the UN's Sustainable development goals to deliver sustainable manufacturing.

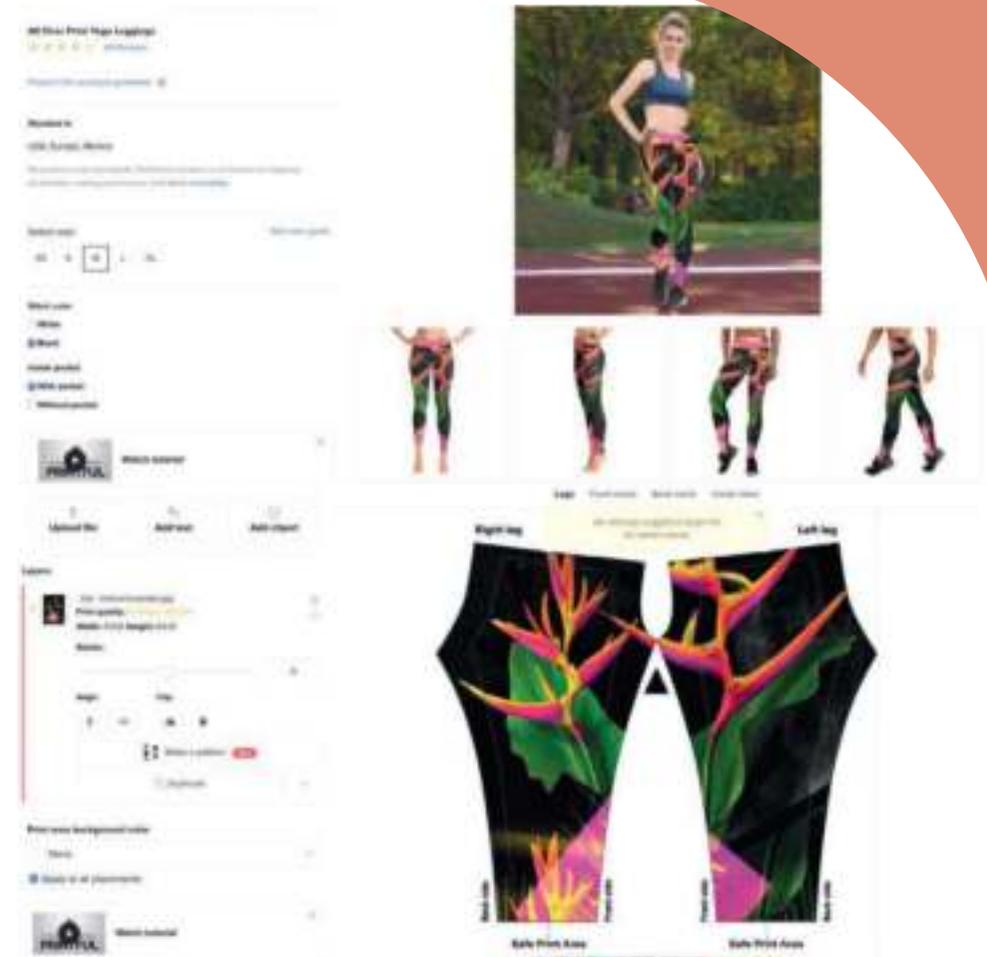
As the speed of manufacture to meet customer demand accelerates, alongside customisation and personalisation, ink-jet technologies offer sustainable production processes. As adoption of Digital technologies increases within the industrial sector so does the demand for textiles prepared for digital textile printing.

Fabrics for ink-jet printing whilst often meeting the same construction criteria of standard fabrics must be prepared for print. Textiles whether Cellulose or Synthetic have inherent properties that must be

controlled within the production environment. Selvedge's must be defined so as not to obstruct print head's, fabrics often need to be pre-coated for specific applications, and the textiles must be stable. Shrinkage can be an issue if not controlled during textile preparation and finishing.

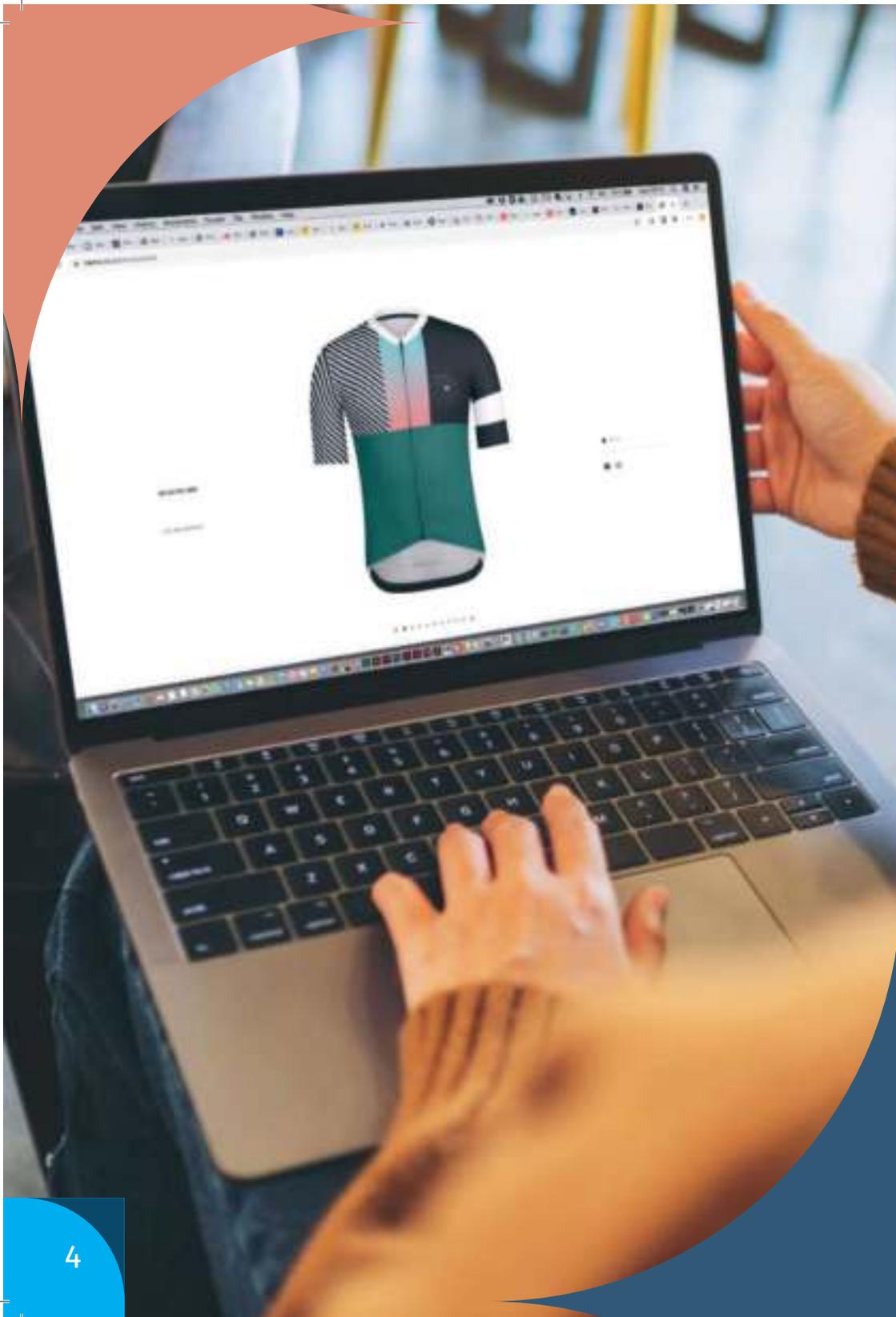
The wonder of digital print is that it delivers a greatly reduced carbon footprint when compared to analogue across the entire supply chain. To do so it simplifies many traditional textile fabric processing steps. Digital smart factories do not typically contain the textile finishing equipment of conventional production, therefore, with consistent, specialised fabric preparation such as sanforizing to control shrinkage, and pre-coating when required many of the traditional finishing processes can be avoided.

Digital printing technologies offer alternate printing solutions for cellulose and synthetic fabrics, by ink set, where applications and developments continue to evolve at great speed. These disruptive technologies fall into three main groups: High Speed (singlepass), Industrial and Medium, and it is this flexibility within the range of machine technologies that allows both large scale, mass manufacturers and entrepreneurs alike to harness the versatility and production benefits for textile printing. This is especially true for short run bespoke production of custom textiles.



There are many examples of Web to Print online design platforms emerging to enable print on demand production. Courtesy of Printful.com

As the market continues to expand to encompass Apparel, Sportswear, Automotive and Interior Décor, existing marketplaces also converge to reap the advantages of scalable production using a suite of CAD CAM smart technologies which automate the production workflow such as Colour management, 3D Design, PLM - Nesting and Grading, Web-to-print and ERP.



The advantages are clear – Digital Ink Jet Textile printing facilitates on demand production at any volume, large or small. These attributes are now assigned across the Textile printing landscape to deliver alternate, disruptive business models for all existing sectors including the Sign and Graphics Industry.

Digital print technologies facilitate on demand production across multiple market sectors. In an industry now challenged to deliver

Sportswear is probably one of the most demanding types of garments to print, but digital technology makes it possible to print personalised garments with many functionally added features, like for example being water repellent and have good perspiration resistance. Images courtesy of Rapha Sportswear.



diversity alongside speed and sustainability, the process supports creativity and customised production, to reduce waste and to deliver just in time manufacturing.

As the process of digitisation evolves, design revisions are simplified by CAD/CAM production , cloud based software that automates the print process providing a flexible, efficient workflow. These attributes are not present in conventional production where tooling and make ready limit the capability for print on demand.

Efi Reggiani flat table screen printing press courtesy of Standfast & Barracks



MHM Rotary Screen Printing courtesy of Standfast & Barracks

Colour management is greatly simplified within the digital textile print workflow when controlled. Utilising specialist software, it is possible to match digital production to conventional if required, where digital is the sampling process and conventional the mass production model.

The process of Colour management is subject to best practice. Colour between substrates, cellulose and synthetic, must be re-adjusted electronically within the tolerances of the ink set, textile substrate and technology being utilised. Specialised software plays a critical role in these calculations, where profiling and calibration work together to increase print speeds, to save ink and deliver colour consistency between batches, and when matching sample proofs to final print meterage. All of which reduces the expense of print faults, wasted fabric and time, energy and precious resources.

Digital print technologies are energy efficient, offering numerous key attributes for sustainable manufacturing. Water consumption is greatly reduced or even zero for many textile printing applications when compared to screen printing. All in all, digital textile printing offers the solution for sustainable, and importantly, environmentally friendly textile production.



Plan your production

Textile sourcing is a critical component of any successful digital textile printing workflow. Variances in textile supply chain will produce inconsistent print results and must to be addressed and controlled. Alternate suppliers use different chemicals and finishing processes, each can affect the final print quality. OBA's (Optical brightening agents) used in fabric preparation, and chemical pre-coatings can affect the print quality achieved, alongside colour yield and washability post print when sourced from a range of suppliers.

Pre-production textile finishing must also be standardised and agreed, and where possible certified, so as to avoid colour variances, shrinkage and textile waste. Transparency is the key to an efficient supply chain, and increasingly a requirement of the consumer. Certification provides absolute clarity for textiles, inks and machinery and instils confidence to all parties in the print workflow from design through to production and the end-user.



Build your production standards; As customised production grows within our industry pivoting from one print run, or product, to the next, needs to be as automated as possible if it's to be successful. Delivering smart production requires a streamlined, transparent workflow that utilises the most efficient process. Cloud based technologies, ERP, and web to print platforms offer a much-needed control function for digital textile printing supplier.

Utilising such software will deliver a smart factory that is capable of manufacturing large and small volume orders with the same efficiency and ease at speed.

Optimise your Print workflow

As the textile marketplace evolves, there are numerous ink sets and technologies to consider. Each process has specific properties, all of which must be considered and utilised to deliver the best possible product efficiently and in alignment with your unique business model. Fabric processing post print must be considered carefully, as technology develops the textile workflow

is shortening, and the speed of manufacture increasing. To remain competitive its essential that your production process can flex to meet the requirement of the consumer. Look at the bigger picture, the ancillary machinery required for post print processing can add a considerable cost to set-up, overheads and the space required for digital production. Not to mention an increased carbon

FABRIC	DYESTUFF	PRE TREAT	PRINT	FIXATION	AFTER TREATMENTS
Cotton	Pigment	Yes	Direct	Thermal Curing	None
Wool	Pigment	Yes	Direct	Thermal Curing	None
Linen	Pigment	Yes	Direct	Thermal Curing	None
Polycotton	Pigment	Yes	Direct	Thermal Curing	None
Polyester	Pigment	Yes	Direct	Thermal Curing	None
Nylon	Pigment	Yes	Direct	Thermal Curing	None
Silk	Acid	Yes	Direct	Ht Steam	Wash
Wool	Acid	Yes	Direct	Ht Steam	Wash
Cotton	Reactive	Yes	Direct	Ht Steam	Wash
Wool	Reactive	Yes	Direct	Ht Steam	Wash
Linen	Reactive	Yes	Direct	Ht Steam	Wash
Silk	Reactive	Yes	Direct	Ht Steam	Wash
Polyester	Disperse	Yes	Direct	Ht Steam	Wash
Polyester	Dye Sublimation	Yes	Direct	Heat Transfer	None
Polyester	Dye Sublimation	No	To Paper	Heat Transfer	None

footprint. New advances in textile ink technology and in-line print processing equipment offer energy efficient, smart solutions for added sustainability.

Digital production offers a flexible, energy efficient workflow. With numerous digital textile printing machines on offer, it's important to plan for the future.

Speed of print is not the only consideration, textiles by nature are not stable, they move, flex and stretch. The technical machine requirements differ by fabric types and print process; light fabrics whether knitted or woven, stretch and slip for example, as opposed to heavy gsm substrates. Some fabrics are more absorbent than others, and for some applications push through may or may not be required. Remember that the textile industry has many eco-systems, and each has a fabric base that is specific to the sector. All of these factors must be evaluated in your proposal. When planning production machinery, you should have the substrate requirements as the starting point, to give the diversity your business model requires. Environmental considerations, such as energy and water requirements, certified sustainable inks and machine intelligence should also influence your choice.



When printing on fabric you need to choose an ink that is fit for purpose. If you print curtains, or other products used for indoor decoration, you have to make sure the final product meets the relevant standards regarding fire retardance, Volatile Organic Compound (VOC) emissions and toxicity.

Understanding testing standards for the Textile Industry

In today's world so much depends on validation, and it's critical that the products you supply as a Print Supplier meet all required regulatory requirements when supplying digitally printed textiles for the Textile Industry.

Standards for Apparel, Sportswear, Interior Décor, and Hospitality fabrics and retail and events (to name just a few eco-systems) have never been higher, and in general, conformity to these standards is a passport to new opportunities.

As the marketplace expands, we see many new entrants into the marketplace; B2B, B2C, DTC, emerging Designer brands selling their fabric collections directly to the Interior Design Industry etc. But how do you choose the correct fabric base to meet your client's requirements?

The standards take two forms: Performance which is not a legal (but a commercial requirement) and Regulatory, which are legal standards which have to be met in order project or product can be certified.

Performance Standards:

These comprise, of various tests that measure the printed fabrics durability under set laboratory conditions. Detailed below and by way of example, are the most common, but not necessarily all the tests that may be required for your project. Required certifications should be agreed with your client for the country of use, before fabrics are specified.

Noted below: Test Standard (or accepted test) and the minimum commercial level pass required. Each is specific to the Country of end use: By example these are the standards that relate to the UK.

- Light fastness BS EN-ISO-105B02 Minimum 6
- Wash fastness BS EN-ISO-105C02 Minimum 5
- Wet & Dry Rub Fastness BS EN ISO – X12: 2002 Minimum 4
- Abrasion Martindale (domestic) Minimum 30,000
- Abrasion Martindale (contract) Minimum 90,000
- Abrasion BS EN ISO 5470-2 (general) Minimum 50,000

There are other tests, which are helpful, such as tensile strength, tear strength and fastness to perspiration, but the above are the minimum performance

requirements that have to be met by your fabric supplier, if you are to be able to consider the accurate specification of textile products.

Regulatory Requirements:

All countries have their own legislation regarding the requirements of end use. Your industry Trade association will be able to help make these essential enquiries.



The Diversity of Textile substrates

As we have agreed, the Textile sector is a huge marketplace with 1000's of core fabrics. Many of these overlap between eco-sectors and where they do so, often additional coatings and fabric preparations are required.

When printing on substrates for indoor decoration, for example, and also garments for that matter often Fire-resistant properties are standard. It's essential that the requirements for textile end use be identified at the point of sale for any print provider, for some fabrics this is a legal obligation that must be taken seriously. Post print coating is a common element within the Textile manufacturing community. It's possible to apply so called functional coatings, FR, water-repellent, fire retardant coatings, a UV-block or an electrically conductive coating and laminates to textile post print. Other examples of functional coatings for garment are antimicrobial, anti-fungal and anti-insect coatings (insect repellent).

Another consideration for the final printed product is its durability, both water-fastness, rub resistance and lightfastness, especially resistance to UV light are important contractual considerations. Garments are laundered and durability must be defined at the point of sale. Typically,

questions will be; at what temperature, or should they be dry cleaned? For the Interior marketplace durability must be specified. Sport garments might be among the most demanding applications to tackle, so factors like humidity and perspiration fastness should be added to your list of required information regarding specification. For banners and soft signage, the key question to ask is where they will be placed: Indoor where fire retardancy is key or outdoor, where outdoor usage of course puts greater demands on water, light and ozone fastness.

Printing on polyester, or polyester based fabrics with other types of fibres mixed in (blends), is common practice in DTP. There are many types of polyester based textile substrates, but care must be taken when mixing fibre types i.e synthetic/ cellulose. When you do, you restrict the ink type and print process that can be utilised depending on fibre concentration.

Durability is also an important factor when choosing the ink set and print process. Cellulose fabrics like cotton or linen are popular substrates in garments, often they might need to be printed with reactive dyes to be

durable, and to give a vibrant colour gamut, and so require post printing processes like steaming (in order to fix the ink), washing and drying.

However, advances in Pigment ink printing have increased the use of pigment inks for both fashion and Interiors therefore offering a waterless, sustainable alternative to the wet processing of reactive inks.

Another natural substrate is Protein based fibres, like wool and silk. Printed using reactive or acid-based inks, as with cotton and linen, the printing process typically needs to be coupled with post print processes like steaming and washing, and perhaps also pre-print coating treatment.

Polyamide is a synthetic fabric popular in many types of sportswear, not least in swimwear. This might be the most challenging type of textile in DTP, because of the demands on stretch, durability and colour fastness. But there are solutions where digital printers use acid dyes and have inline pre-coating and infrared drying. Polyamide can also be printed using dye sublimation and pigment technologies with variable results.

Match substrate and ink

There is a wide range of types of inks suitable for textile printing, and they can be split into several categories, depending on what solvent is used, what the colourant is (dye or pigment), and how the ink is transferred onto the substrate.

Dye inks namely reactive dye inks are suitable for cellulose fabrics. Dye based ink is generally considered to offer a large colour gamut, that is, vibrant colours. Reactive dye inks typically offer good washability, however they offer poor lightfastness. Acid dye is mainly used when printing on silk, which can also be printed using reactive inks. Disperse dye is suitable to use when printing on polyester. Dye sublimation printers for textiles typically use a water-based ink printed onto a transfer paper. The image is transferred onto the fabric using heat and pressure, where the dye turns into gas and permeates the fibres in the fabric. This process also fixes the pattern onto the substrate. The print is durable, as it permeates into the structure of the fabric, therefore not prone to peel off or fade, for Signage and Graphics, the image quality can offer a large gamut for maximum impact.

Water based pigmented inks can be used to print directly onto cotton and other types of fabric, and also be used





when using a transfer material. They have a lot in common with conventional flexo inks, but the ink layer is generally controlled better in a digital printer than in a conventional screen-printing press. Pigment inks are the workhorse of the traditional textile industry, as technology has advanced, water-based pigment ink is increasingly developed to offer a “soft hand” feel to the final printed fabric with the addition of printed fabric softeners.

Among the pigment-based inks, UV curable inks are gaining popularity, including printing with white ink. This is due to the fact that these inks are instantly cured, so no post treatment is required. But this doesn't mean that UV curable ink is suitable for all types of applications.

Limitations in regard to stretch ability and the look and feel might not appeal for all types of fabric. The UV curable inks are perhaps the category where research makes the fastest progress at the moment. Improvements in printability across fabric types, reducing or eliminating the need for post-print treatments, as well as improved durability, continue in development.

Sustainability and Certification standards

As the requirement for sustainable supply becomes an increasing stipulation demanded by the consumer, Regulations and Certifications provide the means for the control of, and the information required for the transparent supply of Textiles. To be clear, Regulations must be adhered to, and certifications provide essential verification to the print provider and final consumer.

Starting with Regulation, the most important set of Legal Environmental Criteria are contained in the REACH Regulations (Registration, Evaluation, Authorisation and Restriction of Chemicals).



Established in 2006 by the EU, but now in general world-wide use, these regulations require any Company importing more than 1 tonne of Chemicals per year into the EU to register the product with the European Chemicals Agency (ECHA). In registering these chemicals, Companies certify that they do not fall into any of the forbidden categories of compounds, such as APE's (Alkylphenyl Ethoxylate), Formaldehyde, CMR's (Carcinogen Mutagen Reproductive Toxins), Phthalates and Heavy Metals.



The Classification, Labelling and Packaging (CLP) Regulation ((EC) No 1272/2008) is based on the United Nations' Globally Harmonised System (GHS) and its purpose is to ensure a high level of protection of health and the environment, as well as the free movement of substances, mixtures and articles.

REACH regulations are strictly enforced by the European Chemicals Agency (ECHA), who are responsible for ensuring compliance in all fields, so that no toxic chemicals enter the Textile Supply Chain. As a legal requirement, these regulations go a long way toward protecting the consumer and the environment against the worst effects of irresponsible chemical usage.

Moving on to Certification, which is a complex field, referring, as it does, to the entire textile supply chain, comprising a vast array of chemicals, processes and trade practices.

Two organisations stand out for valid International certification, giving performance standards to the manufacturer and comfort and peace of mind to the consumer.

The first of these is the Global Organic Textile Standard (GOTS) which is the worldwide leading textile processing standard for organic fibres (Cotton, Silk, Linen), which includes ecological and social criteria, backed up by independent certification of the entire textile supply chain.



GOTS certification of an Organic Textile Fabric ensures that it has been produced responsibly to a given set of criteria, covering areas as diverse as, use of pesticides, fair employment, water pollution and use of dyestuffs.

Downstream from this, and possibly the most important of all the Environmental Certifying Testing Houses is OEKO-TEX®.

Established in Switzerland, this organisation provides the OEKO-TEX® range of services which are tailored to the specific needs and the situation of the textile industry. Using



this approach OEKO-TEX® provides unique benefits and practical help for all businesses that commit themselves to responsible and sustainable management. Certification by OEKO-TEX® enables everyone in the supply chain from the manufacturer all the way through to the retailer to label their products with the OEKO-TEX® 'Made in Green' label.

Using the GRS (Global Recycling Standard) framework, accurate labelling of product can take place, particularly exposing the transparency of the product's supply chain.



The desired effect of the GRS is to provide brands with a tool for more accurate labelling, to encourage innovation in the use of reclaimed materials,

to establish more transparency in the supply chain, and to provide better information to consumers.

MADE IN GREEN is an independent textile label for highlighting consumer products and semi-finished products at all levels of the textile chain that are made from materials tested for harmful substances and that have been



manufactured by using environmentally friendly processes and under safe and socially responsible working conditions. The MADE IN GREEN by OEKO-TEX® label shows the consumer that the textiles concerned are tested for harmful substances and sustainably produced in accordance with OEKO-TEX® guidelines.

Each item certified with the MADE IN GREEN label also features a unique product ID or QR code, which provides full traceability and transparency for the consumer. The labelling system gives them access to information regarding the production facilities along the textile chain in which the textile was produced, the stage of production in which the fabrics were employed and the countries in which the product was manufactured. This is not only a robust Certification Process when viewed from the standards employed, but, since it is only granted for one year at a time, continued observance is enforced through strict and regular compliance checks.

The EU Ecolabel for clothing, bed linen and indoor textiles is a voluntary eco-labelling scheme from the European Commission encouraging the use of sustainable practices in textile manufacturing, including quantitative restrictions on waste-water emissions and hazardous substances. The



use of sustainable fibres is also strongly encouraged. It applies to every product and service placed on the market in the European Economic Area – the European Union plus Iceland, Lichtenstein and Norway – that meets the EU Ecolabel criteria for that product or service can be awarded the EU Ecolabel.

Changes to criteria for sustainable cottons, recycled synthetics, and the recovery of wool waste along with the introduction of a new restricted substance list are some of the highlights of the latest version.

The EU Ecolabel Regulatory Committee has voted to accept the new criteria that replaces the previous decision (2009/567/EC) passed in 2009, and comes into force for at least a four-year period. This was approved at a meeting of the EU Ecolabel Regulatory Committee at the end of 2013, where cotton and other natural cellulosic fibres will have to contain a minimum content of organic or 'IPM' (integrated pest management) cottons. In addition, criteria have been put in place for man-made cellulose, recycled synthetic fibres and wool scouring.

Other significant changes are that fluorine chemistry used to make water, oil and stain repellent fabrics are banned under the voluntary standard, and for the first time a brand new restricted substance list has been introduced.

The Eco-Label revision comes as part of the European Union's stated drive to ensure 10 – 20 per cent of textiles sold in Europe are eventually aligned with EU Eco-Label criteria. These criteria are revised and continually tightened – usually every four years.

Also, synthetic textile fibres that would ensure EU Eco-Labelled polyester and nylon fabrics either contain a minimum recycled content (either pre- or post- consumer for nylon) or address VOC or N2O emissions to air from fibre and polymer production sites.

The new criteria also states that if the 70 per cent recycled content threshold is not achieved for nylon, then Eco-Labelled goods should be made of 20 per cent recycled material, or reduced N2O emissions.

In summary, there are a considerable number of checks and balances that the Digital Textile manufacturer can now adopt when sourcing fabrics or inks, in order to provide an increasingly transparent supply chain.

Organic and Sustainable are important considerations, that are now brought down to earth by responsible and scientific

organisations who are not only capable of producing the Industry Standards required, but also enforcing them as well. The Digital Textile Printer can rely on REACH, GOTS and OEKO-TEX and EU Ecolabel to give accreditation to the products that they supply.

CIRCULAR ECONOMY



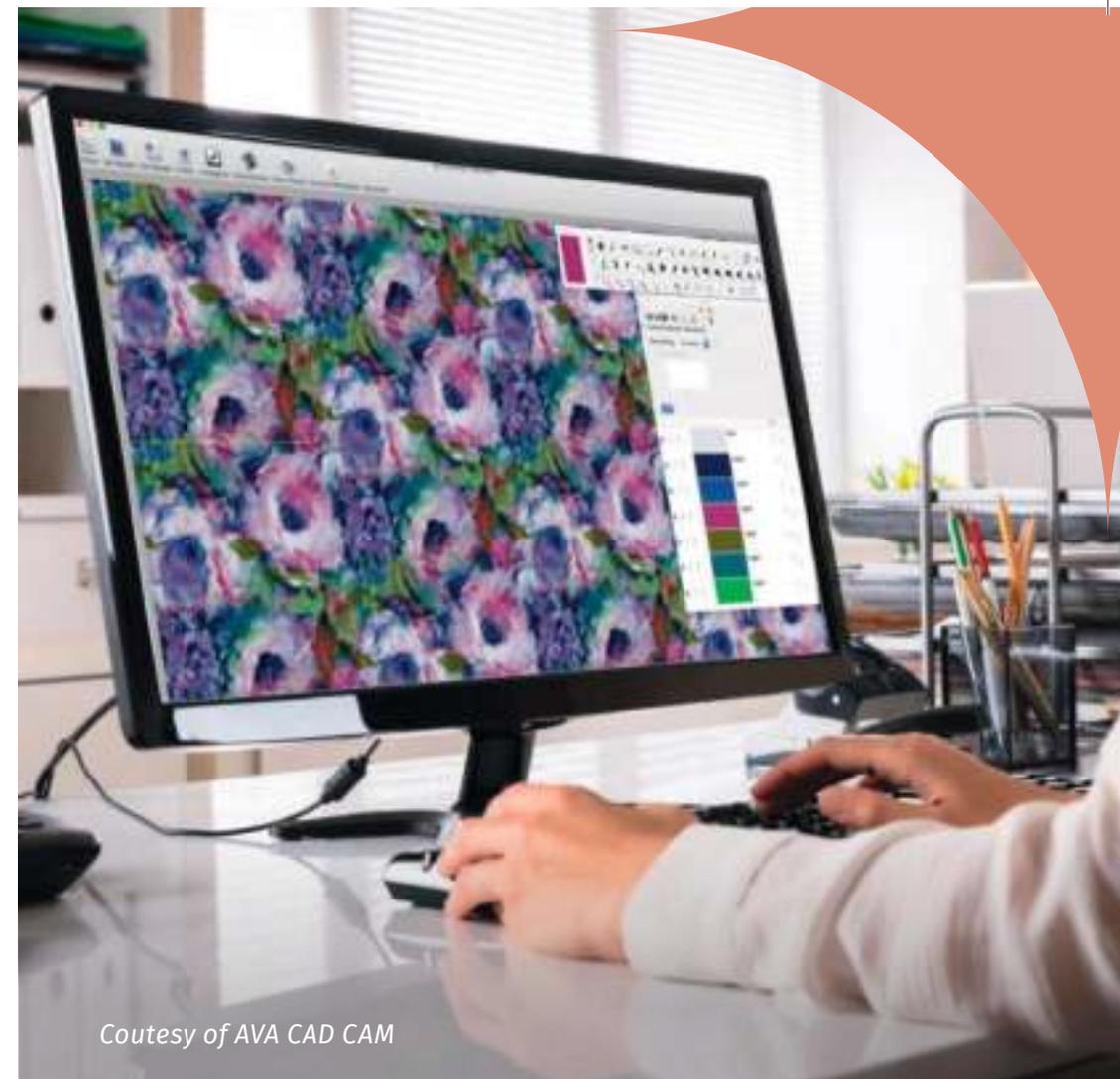
Synthetic Recycled Fibres - The consumer rightly demands authenticity, and absolute transparency to make a considered sustainable purchase. Increasingly Recycled products must now be certified. As the industry moves to a circular, closed loop, or a circular economy, Recycled products are in high demand. But cutting through the greenwashing requires certification. The most prominent certification is provided by GRS. The GRS (Global Recycling Standard) is an international, voluntary, full product standard that sets requirements for third-party certification of recycled content, chain of custody, social and environmental practices and chemical restrictions.

Using the GRS framework, accurate labelling of product can take place, particularly exposing the transparency of the product's supply chain.

Choose your printing system wisely

To ensure that you offer your customers the highest possible image quality cost effectively using digital print production, you need to keep a close eye on the rapid technical development of software solutions for digital printing systems for textiles. The design process is the very start of the digital supply chain, and it is here that often precious time is lost, and waste invisibly created, as the artwork travels along the production workflow. Pre-press is a vital component of the workflow and must be calibrated to the production facility.

Development in both inkjet head technology and ink is rapid, and opens up new markets, and new possibilities. Keeping the design and colour management software suite up to date is essential. What ink can be used in which printer generally determines what substrate can be printed, and the final output quality. The addition of more greyscale levels in a printhead is not merely marketing hype; it really does affect the visual appearance because images look better with a wider gamut of colour. Another side effect is that you might be able to run a digital press faster without loss of quality if you choose to take this route, saving ink, and improving your margins.



Courtesy of AVA CAD CAM

Make sure your workflow system and RIP have the functions and features you need for the production at hand. If you print roll textiles for example, you need to do both step-and-repeat and colour management for spot colours.

Attend digital print exhibitions and read professional trade press magazines and stay in touch with this exciting but fast evolving market.

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